

## FURNITURE ORDERING MARKETPLACE WITH TENDER SYSTEM USING TOPSIS FOR PICKING WINNER RECOMMENDATION

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### ABSTRACT

*The use of technology in custom furniture sales is still not utilized to its full potential. A problem is going on inside society, namely that no application helps the custom furniture ordering process. There is a problem where the buyer has difficulty finding a craftsman to accept custom furniture according to their wishes in large quantities at competitive prices and quality, and vice versa. Craftsmen had difficulty finding willing buyers to make purchases of custom furniture. This marketplace can help with these problems by helping buyers and craftsmen carry out custom furniture transactions safely.*

*Consumers can offer custom orders to craftsmen through the application by stating the specifications, and interested craftsmen can submit offers in terms of price, processing time, quantity, and other agreements, which will be stated in the contract when the transaction occurs. This contract will protect the rights and obligations of customers and craftsmen. On the other hand, consumers are given recommendations for craftsmen using the TOPSIS method, considering the quality of work obtained from the rating, the price offered, working time, and the credibility of the craftsmen's experience.*

*With this marketplace, 60% agree that it makes it easier to bring together customers and craftsmen to make custom furniture. 70% satisfied that the working progress feature helps buyers to know custom furniture progress status and reduce ordering errors. The TOPSIS method helps customers make decisions/selection of craftsmen with a precision of 67.58%.*

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### INTRODUCTION

After the outbreak of COVID-19, business people who initially carried out business activities conventionally are slowly making changes by making their business activities online. Online trading activities have experienced a high increase in times of limited community activities and changes in habits. People who previously made purchases in person have now changed to purchasing online. The furniture business is a form of business that needs to be developed to increase

convenience for customers and increase online sales.

This marketplace also provides features so that craftsmen can provide offers for custom orders carried out by the buyer. Besides sales and custom orders, live chat features are available on this marketplace to facilitate communication between buyers and craftsmen. The application also provides a notification feature, making it easier for craftsmen to obtain information regarding custom order submissions by buyers. Supported by the reasons above, this marketplace can be a

solution for furniture craftsmen trying to survive during this period of restrictions on community activities due to COVID-19, as well as being a way to develop furniture business in line with advances in information technology whose development is accelerating.

## LITERATURE REVIEW

In this section, we will explain the theory used as a reference in creating a furniture ordering marketplace application with a tender system, namely marketplace, tenders, tender process and TOPSIS method.

### Marketplace

According to Putra (2017), a marketplace is an internet-based online media platform for business activities and transactions between buyers and sellers. This can bring together sellers and buyers from various regions because both buyers and sellers come from all over the world and are connected via the internet. Another advantage of the marketplace is the unlimited types of products that can be sold, flexible payment methods, various delivery methods, and the fact that it is equipped with customer service with many alternative media used. (Deni Apriyadi: 2017)

### Tenders

According to Presidential Decree No.16 of 2018, tenders are a selection method for getting providers of goods, construction work, or other services. Meanwhile, outside of government projects, a tender can be interpreted as an official offer and structured to submit prices, contract work, or provide goods and services provided by large private companies to other companies.

According to Malik (2010), a tender is a series of activities that aim to select, obtain, determine and appoint which company is most appropriate and appropriate to carry out a work package. Dewi Masitah (2016),

based on the method of opening (offer documents), the tender can be divided into open Tender and Closed tender. Open tender, namely opening and reading of documents bids from tender participants, are made in front of all participants so that each person knows the bid price of their competitors. Closed tender, where the bid documents submitted are not read in front of all tender participants. Sometimes, even the participants do not know each other who their competitors are.

The following are the steps in the tender process in general;

1. Preparation of tender documents.
2. Tender announcement.
3. Registration and taking of tenders.
4. Preparation and submission of offers.
5. Opening and evaluating bids.
6. Negotiation and clarification.
7. Determination and announcement of winners.
8. Signing the contract.
9. Work implementation.
10. Completion of work.

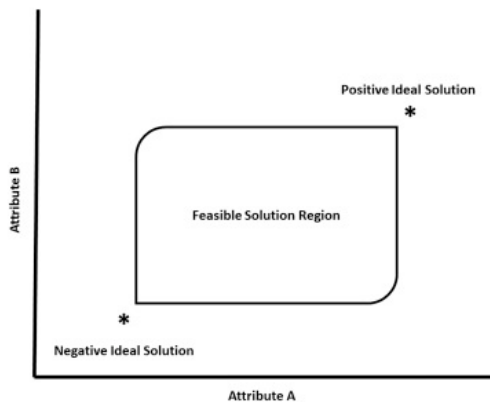
### Normalization

According to Purwanto (2022), each value in the dataset has a different value and has a different upper and lower limit. So, normalization needs to be done so that the data is in the same range. The data must be in the same range because weighting will be given to each data. A significant value will be contributed significantly if the data is not in the same range when weighted, so that the weighting will be inappropriate.

### TOPSIS method

According to Behzadian (2012), Multiple-criteria decision analysis (MCDA) or Multiple-criteria decision making (MCDM) is a sub-discipline that is concerned with designing mathematical and computational tools to support the subjective evaluation of decision alternatives under a finite number of performance criteria by a single decision

maker or by a group. TOPSIS is an acronym for 'Technique of Order Preference Similarity to the Ideal Solution' and is a straightforward MCDA method (Papathanasiou:2018). TOPSIS was introduced by Yoon and Hwang in 1981, and it is a method used for multi-criteria decision-making (Musrini, 2020). TOPSIS has a principle that the selected alternative must have a relatively short distance from the negative ideal solution and must be derived from a geometric point of view using Euclidean distance to help determine the relative closeness of each alternative to the optimal solution. The positive ideal solution is the sum of all the best values achieved for each attribute, while the negative-ideal solution consists of all the worst values achieved for each attribute. The illustration can be seen in Figure 1.



**Figure 1. Graphical representation of alternative assessment (Abraham:2017)**

According to Roszkowska (2011), TOPSIS can be used to assist in considering both the distance to the positive ideal solution and the distance to the negative ideal solution, which is done by taking the relative proximity to the positive ideal solution (Deni Trisnadi, 2018). TOPSIS method steps are (Setiawansyah, 2022):

1. Determine suitability criteria and ratings. The first stage determines the criteria used as a reference in decision-making, namely  $C_i$  and the nature of each criterion. Next, a rating of the suitability criteria of the alternatives for each criterion will be made.

2. Create a normalized decision matrix.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \dots\dots\dots(1)$$

3. Calculate weighted normalized decision matrix

$$v = \begin{bmatrix} w_{11}r_{11} & \dots & w_{1n}r_{1n} \\ \dots & \dots & \dots \\ w_{m1}r_{m1} & \dots & w_{mn}r_{mn} \end{bmatrix} \dots\dots\dots(2)$$

4. Determine the alternative distance for the positive ideal solution and the negative ideal solution.

$$A^* = [v_1^* v_2^* \dots v_n^*]$$

$$A^- = [v_1^- v_2^- \dots v_n^-] \dots\dots\dots(3)$$

Where  $v_j^* = \begin{cases} \max v_{ij}, & \text{if } j \text{ is benefit attribute} \\ \min v_{ij}, & \text{if } j \text{ is cost attribute} \end{cases}$

$$v_j^- = \begin{cases} \min v_{ij}, & \text{if } j \text{ is benefit attribute} \\ \max v_{ij}, & \text{if } j \text{ is cost attribute} \end{cases}$$

5. Calculate preferences for each alternative.

$$V_i = \frac{\sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2}}{\sqrt{\sum_{j=1}^n (v_{ij} - v_j^*)^2} + \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2}} \dots\dots\dots(4)$$

6. Rank alternatives based on proximity to the ideal solution and furthest from the negative ideal

$$R = \text{rank}(v_1, v_2, \dots, v_n) \dots\dots\dots(5)$$

Mean Average Precision (MAP)

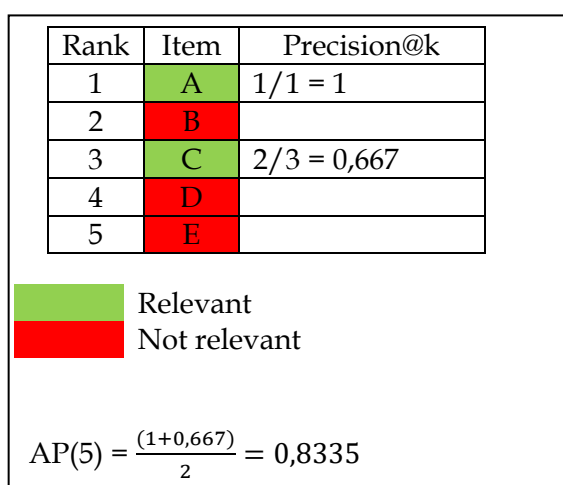
Recommender or ranking quality metrics are divided into three categories:

1. Predictive metrics. They reflect the "correctness" of recommendations and show how well the system finds relevant items.
2. Ranking metrics. This reflects the ranking quality: how well the system can sort items from more relevant to less relevant.
3. Behavioral metrics. These metrics reflect specific properties of the system, such as how diverse or new the recommendations are.

Based on the three categories above, the evaluation for this paper belongs to the ranking metric. One of the evaluation calculations for ranking metrics uses Mean

Average Precision (MAP) based on Liu (2015). MAP in K evaluates the average precision across all relevant ranks in the list of top K recommendations. This helps to obtain a comprehensive measure of recommendation system performance, considering the rankings' quality.

To calculate MAP, the Average Precision (AP) for each list of average Precision values across all positions in K must be calculated with relevant recommendations. An illustration of the AP calculation can be seen in Figure 2.



**Figure 2. Illustration of AP Calculation**

In Figure 2, the step to calculate precision is a recommendation from relevant rankings only, and irrelevant ones are not counted. AP will be calculated after getting the precision of the relevant raking recommendations, where AP is the average precision. After counting AP, the next step is counting MAP.

$$MAP = \frac{\sum_{k=1}^n AP(k)}{N} \dots\dots\dots(6)$$

Where N is the number of queries in the set.

**RESEARCH METHOD**

This application uses the waterfall method, where the steps for creating this application are:

1. Planning stage. The purpose of creating the program and searching for literature supporting this paper will be determined at this stage.
2. Analysis stage: at this stage, an analysis of custom furniture sales activities, the tender system, and the decision-making system will be carried out so that deficiencies can be met if an application is created.
3. Design stage. At this stage, a design will be carried out to have an idea of the application that will be created. The design stage will include database design and application interface.
4. Implementation stage. At this stage, program code will be written so that the application can run as expected
5. Trial stage. At this stage, the application that has been created will be tested on users, both from the tender system and evaluation of the decision-making system using TOPSIS
6. System improvements. At this stage, after testing is carried out and errors are found, improvements will be made so that this application can run according to expectations and objectives

**RESULT AND DISCUSSION**

In this marketplace, there are three actors, and each actor has different roles or rules in each role. The actor's role will be adjusted to the system requirements required in the application. The detailed explanation of each actor is that the admin is the party that manages the application monitors members, and manages master types of wood, foam, accessories, fabric, and materials needed to make custom furniture. This architectural design is explained starting from the users, the servers needed, and the relationship flow. Depicting a miniature application can give system developers a good idea of understanding the flow of how the system works. An overview of the system flow can be seen in Figure 3.

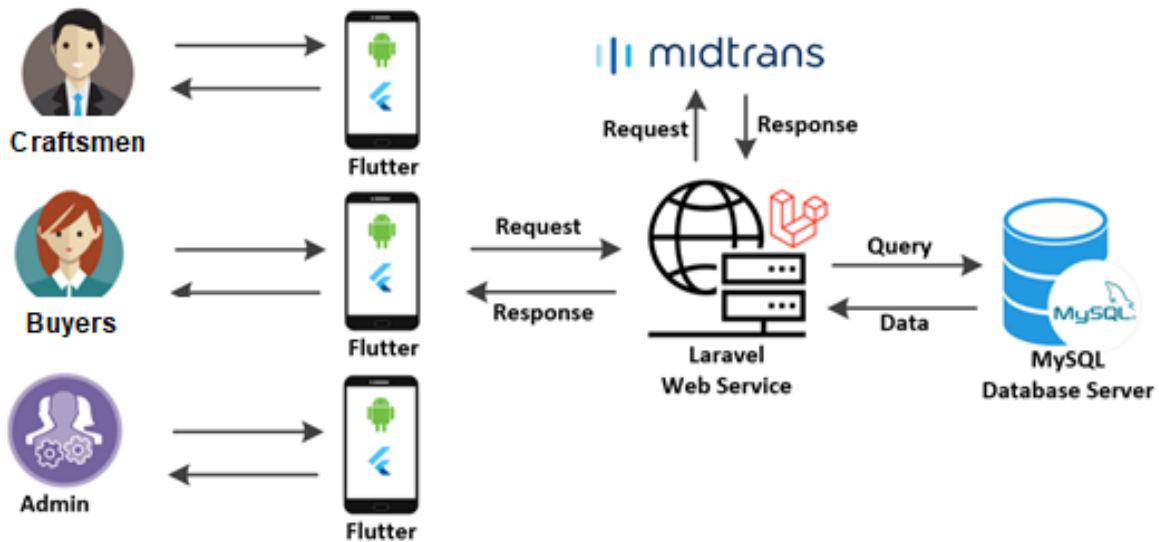


Figure 3. Architecture Desain

Craftsmen in the application are large shops that accept custom orders or craftsmen who act as providers of custom furniture-making services. Apart from that, craftsmen can also participate in/cancel tenders they are participating in and update the status of making custom goods. Craftsmen can participate in the tender based on items or overall. The item referred to here is the type (for example, if the buyer wants to make a custom dining table set and ten sets of nightstands, the craftsman will take only ten sets of nightstands. What is not permitted is that the craftsman will take five sets of nightstands. This is because they consider the same item if different craftsmen do it. The results will differ, even if the requested specifications are the same).

The buyer is the party who acts as the custom furniture orderer. The buyer can create a tender offer list by completing the required documents and filling in the criteria to determine the recommendation for the tender winner. The tender offer will only be displayed if the admin has verified the documents uploaded by the buyer. The flow diagram for offering customer orders can be seen in Figure 4.

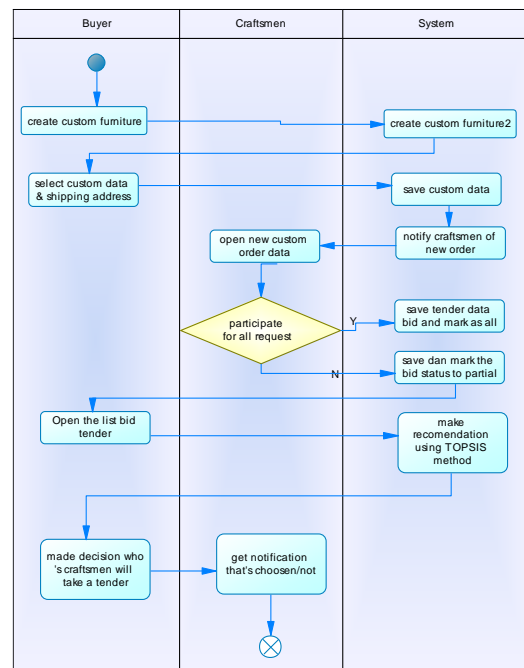


Figure 4. Custom Tender Offering Flow Diagram

The list for Custom Transaction Offers is given. The system will notify craftsmen of a tender for making new furniture. Craftsmen can see the list of tenders stored in the system. Craftsmen can submit two offers: a tender work offer for one set and a tender work offer per item (not by the number of items). The tender design interface that craftsmen can see can be seen in Figure 5. On the left is the list of custom Tenders that craftsmen can bid on. If



craftsmen want to see the detailed tender, they can double-click, and the detailed tender interface will be shown on the right of Figure 5. There are detailed specifications, sizes, wood, quantities, and designs so that craftsmen do not misinterpret the custom furniture that will be made.

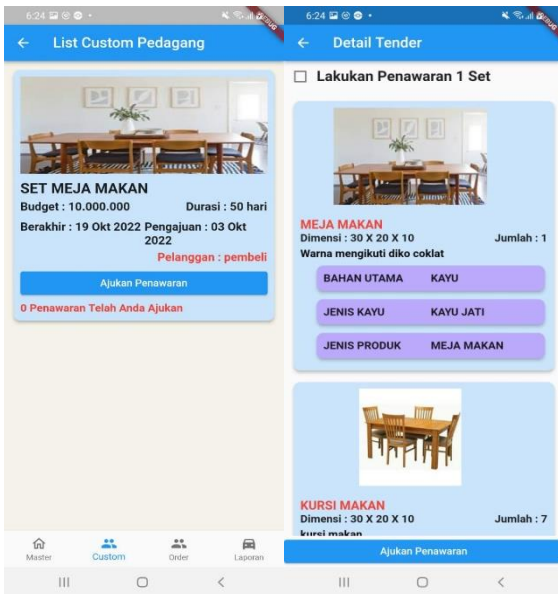


Figure 5. List Tender and Tender Detail

The system will save the bid, which can be seen by the buyer who made the tender. Buyers who make tenders can see the offers made by craftsmen so that when there is a suitable offer, the buyer can choose the offer. Offers made by craftsmen can be sorted based on date, price, or recommendations obtained from the TOPSIS method. The system will automatically win the craftsman whose offer has been selected by the buyer (this is because the selection of the winner is still done manually by the buyer, not based on recommendations). Figure 6 shows the interface from the craftsman's side if he wins the tender. If the craftsmen win the tender, there will be buttons to download the contract, upload the contract, update progress, and view payments. Apart from that, information will be given on the duration of the work, where the duration will be counted down after the contract is

signed by both parties (craftsman and buyer) and the buyer has paid a down payment of 25%.



Figure 6. Custom Tender Page from Craftsmen's side

After the buyer chooses the tender winner, the following process can be seen in Figure 7, where the process begins with signing a contract between the buyer and the craftsman and paying the down payment. Payment is divided into terms: term 1 of 25%, term 2 of 50%, and term 3 of 100% (paid in total). In each of these terms, the craftsman must update his work progress so that the buyer knows and can immediately make improvements if what the craftsman is doing is not following the contract. In term 3, payment must be paid in full before the craftsman sends it to the buyer. After the goods arrive at the buyer's address, the buyer is obliged to check the condition of the goods. If damage occurs, repairs will be carried out. If the buyer does not check the goods when they are received,

the buyer will bear the consequences, and the buyer is obliged to provide a rating and review. The buyer must give the rating because it is for the benefit of the craftsman's criteria data when making recommendations for decision-making in the following tender.

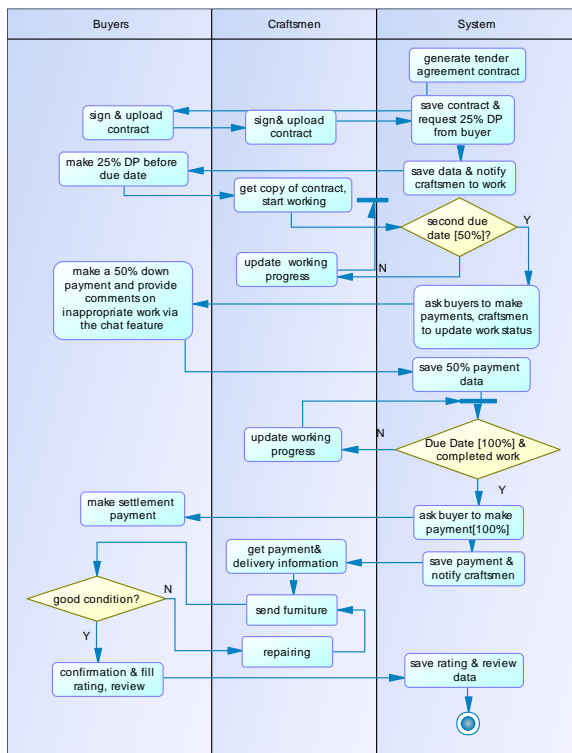


Figure 7. Custom Tender Process Flow Diagram

When the final due date follows the contract, the system will ask the buyer to pay 100% of the total. The system will check for craftsmen to upload furniture that has been made and completed. Next, the system will inform the buyer that the furniture has been completed. The system will also inform the craftsman that the buyer has completed the payment. After payment and furniture have been completed, the system will provide delivery address information to the craftsman. Craftsmen will deliver the furniture to the address entered by the buyer. Delivery can be via courier service or delivered by the craftsman himself. After delivery, the buyer can return once if the furniture received is damaged. Next, after

repairing the furniture, the craftsman will send the furniture back to the buyer, and the system will ask the buyer to give a rating and review.

To determine recommendations for decision-making, it is necessary to determine the criteria used for weighting, as shown in Table 1 as an example of weight. These criteria include the quality of work (obtained from the rating), bid price, work time, and craftsman experience.

Table 1. TOPSIS Criteria and its weight

Criteria	Weight(%)
Quality of work	40
Bid Price	30
Work time	10
Experience	20

The buyer fills in the weight of these criteria when they want to conduct a tender to determine the buyer's preferences for selecting the tender winner. The work quality criteria are obtained from the craftsman's rating, the offer price (in rupiah), work time (in days), and the craftsman's experience obtained from entering the craftsman's data when registering their business in this application (in years). An example of a decision matrix is shown in Table 2.

Table 2. Example Decision Matrix for a tender

Craftsmen	Rating	Price	Work time	Exp
A1	4	50M	20	4
A2	3	35M	14	2
A3	2	20M	8	1
A4	4	35M	8	2
A5	5	60M	12	5

From the criteria data, normalization will be carried out using formula 1, so the decision matrix will be:

$$\begin{bmatrix} 0,478 & 0,529 & 0,659 & 0,566 \\ \vdots & \ddots & \vdots & \vdots \\ 0,598 & \dots & & 0,707 \end{bmatrix}$$

Where decision matrix(1,1) is obtained from:

$$= \sqrt{\frac{4}{4^2+3^2+2^2+4^2+5^2}}$$

$$= 0,478$$

After counting the decision matrix, the next step is multiplied by giving weights

according to the criteria in Table 1. The results can be seen in Table 3. At the bottom of the table, count the alternative distance for positive and negative ideal solutions using formula 3.

**Table 3. Weighted Normalized Decision Matrix**

Craftsmen	Rating	Price	Work time	Exp
A1	0,191	0,159	0,068	0,113
A2	0,143	0,111	0,048	0,057
A3	0,096	0,063	0,027	0,028
A4	0,191	0,111	0,027	0,057
A5	0,239	0,190	0,041	0,141
A+	0,096	0,063	0,068	0,141
A-	0,239	0,19	0,027	0,028

After getting the weighted normalization decision matrix values, the next step is calculating preferences and determining

rank. The ranking results for this data example can be seen in Table 4.

**Table 4. Preference and Get Rank**

Craftsmen	Vj*	Vj-
A1	0,138	0,11
A2	0,11	0,129
A3	0,12	0,191
A4	0,142	0,097
A5	0,193	0,114
GET RANK		
Craftsmen	Vi	Rank
A1	0,444	3
A2	0,539	2
A3	0,614	1
A4	0,405	4
A5	<b>0,371</b>	<b>5</b>

In Table 4, it can be seen from the data that the first recommendation will be A3 craftsmen. This is because the Vi value is the highest, so it is thought to have the criteria most similar to the criteria desired by the buyer.

The trial will be divided into 2: a trial to determine user assessments of the

furniture ordering marketplace application built using a questionnaire. Questionnaires were distributed to 30 respondents, of which 20 respondents had used the application as buyers and ten respondents had used the application as craftsmen. The results of the questionnaire can be seen in Table 5.



**Table 5. Questionnaire**

Question	1	2	3	4
This marketplace helps craftsmen find buyers who want to custom-order furniture	1	3	18	8
The application makes it easier for craftsmen to submit tender offers	0	8	12	10
The application helps craftsmen and buyers to get information regarding the progress of custom order	0	2	7	21
the recommendation feature helps buyers to choose the winning bidder	0	0	5	9

The second trial was a trial of the accuracy of recommendations produced using the TOPSIS method, which uses MAP evaluation. This trial was carried out with 20 respondents as buyers, each making four tenders (a total of 80 tenders). From the data on the 80 tenders, AP will be

calculated for each tender, where the recommendations calculated are the top 5 recommendations produced using TOPSIS compared to the ranking chosen by the respondent. The results of the MAP evaluation calculation can be seen in Table 6.

**Table 6. AP(k) based on tender and result of MAP**

tender	RECOMMENDED					ORIGINAL					AP(i)
	1	2	3	4	5	1	2	3	4	5	
1	A	D	C	B	E	A	B	C	E	D	0,833
2	B	A	D	E	C	A	C	D	E	B	0,417
3	E	D	B	C	A	A	D	B	C	E	0,639
4	B	D	C	A	E	B	D	C	A	E	1,000
5	C	E	A	B	D	C	B	E	A	D	0,700
6	B	A	D	C	E	A	D	B	C	E	0,325
7	E	C	D	A	B	A	C	D	E	B	0,589
8	D	E	B	A	C	B	E	D	A	C	0,533
...	...	...	...	...	...	...	...	...	...	...	...
79	D	B	A	E	C	D	C	A	E	B	0,806
80	C	E	D	A	B	C	E	B	A	D	0,917
<b>MAP</b>											<b>0,6758</b>

In Table 6, data is given on the buyer's preference ranking compared to the recommendation ranking, where those coloured green are the relevant rankings, and on the far right, the AP(k) is calculated using the formula as in Figure 1. After obtaining each AP(k) for each tender trial (amounting to 80 data), the next step is to calculate the MAP using formula 6, and the MAP is 67.58%.

**CONCLUSIONS**

Based on 30 respondents who are using this marketplace (10 respondents as craftsmen and 20 respondents as buyers), and every buyer makes four tenders, there are the conclusions about the functionality and the Precision:

1. 60% agree that the marketplace brings together customers and craftsmen to make custom furniture easier.

2. 70% satisfied that the working progress feature helps buyers to know custom furniture progress status and reduce ordering errors.
3. The TOPSIS method helps customers make decisions/selection of craftsmen with a precision of 67.58% using MAP.

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