

User Evaluation of Diversity and Novelty in the Redesigned Recommender List for an Indonesian E-Commerce Platform

Salsabila Martono¹, Dana Sulistyio Kusumo¹, Arfive Ghandi¹, Su-Cheng Haw², Kok-Why Ng²

¹ School of Computing, Telkom University, Bandung, Indonesia

² Faculty of Computing and Informatics, Multimedia University, Jalan Multimedia, 63100 Cyberjaya, Malaysia

*salsabilama@student.telkomuniversity.ac.id, danakusumo@telkomuniversity.ac.id,
arfivegandhi@telkomuniversity.ac.id, sucheng@mmu.edu.my, kwng@mmu.edu.my*

Abstract. Recommendation systems have been widely used in *e-commerce*, to help users get information on products to be purchased. There have been many studies related to the evaluation of algorithm performance and aspects beyond the accuracy of the recommendation system. In this research, we analyzed the effect of the number of *diversity* and *novelty* aspects on the list of recommendation system items. We redesigned the interface of the recommendation list from one of the top Indonesian e-commerce. The experiment was conducted using within subject design with two different scenarios. We conducted follow-up interviews to dig deeper into what users thought about the two recommendation lists. From the results of the follow-up interview, 80% of the participants liked the second scenario, because the new items recommended gave them ideas to buy them. The results of this study show that the number of *diversity* and *novelty* items has a positive influence on user satisfaction. We also found that the user's perception of the recommendation list is influenced by the user's preferences and the user's goals when using the recommendation system.

Keywords: diversity, novelty, recommender system

1. Introduction

E-commerce is widely used today, and global e-commerce companies have implemented recommendation systems to gain a competitive edge (Kim et al., 2021). The implementation of a recommendation system has a positive impact in helping users process excessive information, making it more manageable for them to consume. Numerous researches have been conducted to measure the accuracy of recommendation algorithm (Pu et al., 2012) and factors beyond accuracy aspect (Kaminskas & Bridge, 2016; Knijnenburg et al., 2012; Mcnee et al., 2006) of recommender system. Current research has begun to focus on aspects beyond accuracy (Kaminskas & Bridge, 2016) that influences and increases user satisfaction on recommender systems. User satisfaction is an important factor for e-commerce, as it indirectly increases activity, revenue, and loyal customers (Castells et al., 2015).

Research by Kim et al. (Kim et al., 2021) and Ekstrand et al. (Ekstrand et al., 2014) compared the algorithm results by considering aspects beyond the accuracy of the film recommendation system. Diversity (Bobadilla et al., 2013) and novelty (Ekstrand et al., 2014) are the main foundations and the most used to evaluate user satisfaction with the recommendation system (Castells et al., 2015). In this study, we conducted a factor analysis for diversity and novelty in one of the biggest e-commerce sites in Indonesia. Diversity and novelty in different recommendation systems need to be adjusted (Ekstrand et al., 2014) because each different recommendation domain needs to be adjusted and depends on the needs of users and domains (Castells et al., 2015; Kaminskas & Bridge, 2016; Mcnee et al., 2006).

In this study, we analyzed the effect of the comparisons of diversity and novelty items on the list of recommendations for the Indonesian e-commerce on user satisfaction. To the best of our knowledge, in the recommendation system research, the composition of diversity and novelty items have not been explored. It is important to explore the design of diversity and novelty items on the list of recommendation because users interact with these two aspects in the same interface in the recommendation list. This research was conducted by simulating the recommendation system of the Indonesian e-commerce by searching for products that were often sought after by our invited participants. From the simulation results, we redesigned the two lists of recommendations adapted to the user experience in searching for products in one of the Indonesian e-commerce. The experiments we carried out on the two lists of recommendations that had been built were carried out using within subject design, to determine user satisfaction with the list of recommendations that we had designed.

2. Related Works

The recommendation system in e-commerce helps users to get information so that the information provided is not excessive (Kim et al., 2021). The recommendation system is also used to make decisions (Champiri et al., 2019). E-commerce users tend to keep looking for as much information as possible before deciding what to buy. This information search process is related to information search behavior where there is some information provided for consideration to increase user satisfaction.

In previous studies, evaluation of recommendation systems on aspects beyond accuracy has been taken into consideration in designing recommendation systems. High accuracy in the recommendation system does not necessarily give results according to the wishes of the user (Knijnenburg et al., 2012; Mcnee et al., 2006). Kaminskas and Bridge (Kaminskas & Bridge, 2016) gives the opinion that there are aspects beyond accuracy that affect the quality of the recommendation system, and aspects beyond accuracy which are the main basis for this research are diversity and novelty (Castells et al., 2015). Meanwhile, to understand the quality of the recommendation system, it is necessary to consider user experience (Knijnenburg et al., 2012). User experience occurs because there is interaction between users and the recommendation system.

Ekstrand et al. (Ekstrand et al., 2014) conducted an experiment to compare the results of the recommendation system algorithm for movie recommendations based on user perceptions of accuracy,

personalization, diversity, novelty, and user satisfaction. Diversity has a positive influence on user decision making. Meanwhile novelty has a negative impact on user perceptions of recommendation systems to satisfy their information needs satisfactorily. Too many unpopular recommendations can give users a bad impression of the recommendation system. So, it is necessary to pay attention to the novelty of the recommendation system.

Kim J et al. (Kim et al., 2021) did the same experiment with Ekstrand et al. (Ekstrand et al., 2014), but Kim J et al. conducted an experiment by simulating data from e-commerce websites on a recommendation system that had been built to calculate user satisfaction. User satisfaction is very important to maintain a sustainable advantage for e-commerce (Kim et al., 2021). This study strengthens research Ekstrand et al (Ekstrand et al., 2014) , that factors beyond accuracy affect the user satisfaction.

Diversity is an aspect of the recommendation system that provides different items on a list of recommendations (Pu et al., 2011). Castells et al (Castells et al., 2015) defined as the internal diversity within parts of an experience. Diversity generally applies to a set of items and is related to other different items (Castells et al., 2011). The concept of diversity is divided into two (Ge et al., 2012): (1) Inherent diversity, (2) Perceived diversity. Inherent diversity considers dissimilarities between items in a recommendation system objectively. Meanwhile, Perceived diversity considers subjectively and is determined through user evaluation.

Novelty is an aspect of a recommendation system that provides users with unknown or new items (Pu et al., 2011) with the aim of helping users get the new item (Pu et al., 2009). The novelty of information generally refers to how different it is from "what has been seen before" by the user (Castells et al., 2011). The definition of novelty in the recommendation system literature review focuses on two aspects of novelty (Kaminskas & Bridge, 2016): (1) Items unknown to the user, and (2) An item that was different from anything the user had seen before.

Wen Wu et al. (Wu et al., 2013) conducted a comparison between the two recommendation systems built. The first recommendation system provides a list of recommendations that vary according to the personality of the recommender. While the other provides a varied list of recommendations without regard to personality. The experiment was carried out within subject design by inviting users to give a rating on the list of recommendations using a Likert scale. Then there is a post-task questionnaire to express user opinions on the two recommendation systems that have been tried. Their results show that user satisfactions increased when diversity on the recommendation list adapted into users' personality values.

Mouzhi Ge et al. (Ge et al., 2012) conducted a comparison between the two recommendation systems based on the placement of diversity. The first recommendation system scatters the different items in a list in random positions. Whereas in the other recommendation systems, stores diversity items in the same list, by creating a separate section with other items. The experiment was carried out within subject design. The results show that to increase perceived diversity, the placement of diverse items in the bottom of the list, either dispersedly or together. In addition, several factors influence the results such as the influence of domain of recommender systems, movie genres, user preference and user's personal valuation of diversity in the recommendation list.

3. Research Methodology

The research methodology was adapted from various previous studies (Ge et al., 2012; Wu et al., 2013) (Gunawardana & Shani, 2015) (Jugovac & Jannach, 2017) for setting user preference for item recommendation, designing improved recommendation list and within subject design experiment setting. In this study, we built a recommendation list design for one of the e-commerce in Indonesia. Because user preferences were needed for the list of recommendations (Jugovac & Jannach, 2017; Wu et al., 2013), we conducted a user preference survey consisting of 32 participants to find out user preferences regarding products that are frequently searched for or purchased in e-commerce. For the

research purposes, the participants involved in this study were students from one of the top University in Indonesia who frequently use the e-commerce. From the results of the survey, we took the two product categories most searched for or purchased by participants, namely the Electronics (Figure 1 and 2) and Skincare (Figure 3 and 4).

To design the list of recommendations, we built an improved design of list of recommendation from one of the top e-commerce sites in Indonesia combining aspects of diversity and novelty in one list of recommendations, where there were two product categories consisting of 12 total items in the list of recommendations. For the electronics category, they were 3 types of items: keyboards, mouse, and monitor. Meanwhile, for the skincare category, we included 3 types of items: facewash, toner and moisturize. The labeling of types of items for the recommendation list was based on the results of interviews with participants regarding the types of items in the electronics and skincare categories that were frequently searched for and purchased by the participants. The results of the list of recommendation for the improved design is static recommendations (Ge et al., 2012).

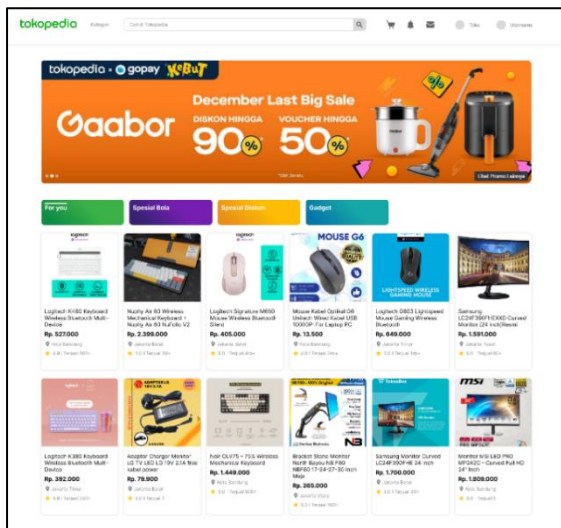


Fig.1: electronics category recommendation list for scenario 1

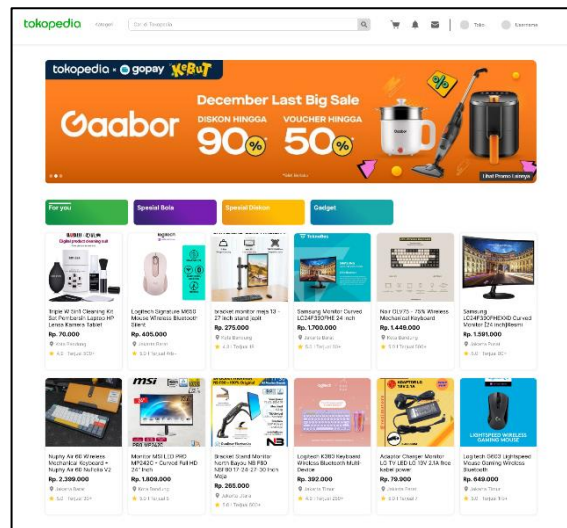


Fig.2: electronics category recommendation list for scenario 2

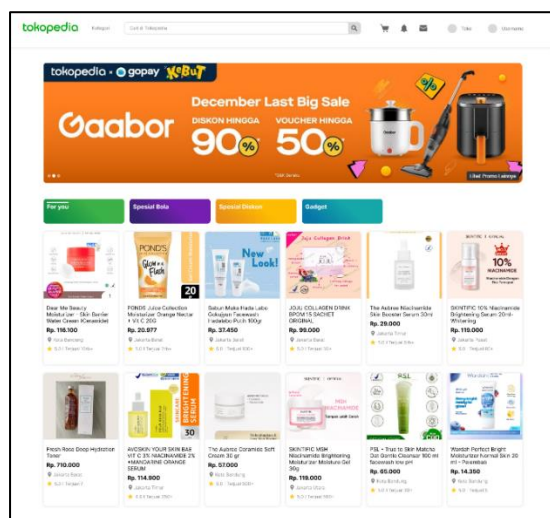


Fig.3: list of skincare category recommendations for scenario 1

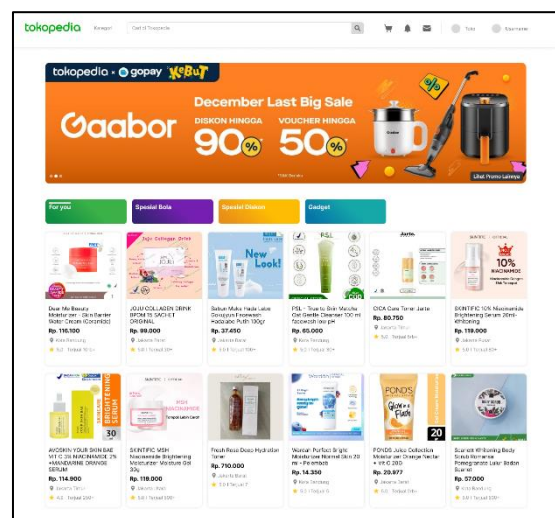


Fig.4: list of skincare category recommendations for scenario 2

Based on the objectives of this study, we designed two scenarios to find out user satisfaction with

the number of diversity and novelty on the list of recommendations for the Indonesian e-commerce sites. Adjusting the number of diversity and novelty items using parameters m (diversity) and n (novelty) (Table 1). The method of adjusting the number of diversity and novelty items was adapted from previous research (Wu et al., 2013). Because novelty has a negative influence on user perceptions of recommendation systems to satisfy their information needs satisfactorily (Ekstrand et al., 2014), in this experiment, the number of novelty items was less than the number of diversity items. The purpose of developing these scenarios was to analyze the effect of the number of diversity and novelty items by providing fewer novelty items in the scenario 1 recommendation list than in the scenario 2 recommendation list. A remote experiment (Effendy et al., 2023) was carried out using within subject design (Ge et al., 2012; Jugovac & Jannach, 2017; Wu et al., 2013) by giving questionnaires to participants to give an assessment of the two scenarios and followed by follow-up interviews to get deeper feedback regarding the two lists of recommendations. We used a within subject design because we want the participants to compare the prototype of the design of the two scenarios. From the 32 participants in the user preferences survey, we invited 20 participants to test the prototypes (Figure 1, 2, 3 and 4) because they had the same product preferences in the user preference survey. Thus, the participants at the testing phase felt familiar with the list of recommendations provided. Only 15 participants agreed to involve in the prototype testing. This number of participants could well evaluate the usability problem (Nielsen & Landauer, 1993) that influence the user satisfaction using the recommender system.

Table 1: Adjusting the number of items for diversity and novelty in the list of recommendations with

N=12 items

	Number of diversity items (m)	Number of novelty items (n)
Scenario 1	10	2
Scenario 2	8	4

The questionnaire used in the prototype testing was based on previous research (Knijnenburg et al., 2012; Pu et al., 2011) which had tested the reliability and validity.

- **Diversity:** Does the list of recommendations provided have varied items?
- **Novelty:** Does the new recommended item give you an idea to buy the item?
- **User satisfaction:** Are you satisfied with the list of recommendations provided?
- **User preference:** Which list of recommendations do you prefer?

The questionnaire (Q1-Q4) had a 5-point Likert scale answer from 'strongly agree' to 'strongly disagree'. The participants answered the questionnaires after reading the list of recommendations provided. The questionnaires were tested on several participants for readability, because there was a change in the words used in this study, because this study was in Indonesian. And the results of the final questionnaire obtained from the readability test are in Table 2. We conducted follow-up interview (Effendy et al., 2023) to dig deeper into user preferences regarding the selected list of recommendations.

Table 2: Questionnaire for experiment and follow-up interview

ID	Question	Aspect	Type
Q1	Does the list of recommendations provided have varied items?	Diversity	Questionnaire
Q2	Does the new recommended item give you an idea to buy the item?	Novelty	Questionnaire
Q3	Do you like all the new recommended items?	Novelty	Questionnaire
Q4	Do you like all the recommended items?	User satisfaction	Questionnaire
Q5	From the two recommendation list scenarios, which recommendation list is the most prefer?	User preference	Follow-up interview

4. Results

Prototyping testing was conducted on 15 participants using the within subject design. Participants were given two scenarios to be assessed based on user satisfaction using the questionnaire in Table 2. From the results that we have obtained in Table 3, the results have less significant differences in each questionnaire (Q1-Q4). However, when we conducted follow-up interviews, we found significant differences (Table 3): 80% of participants liked the list of recommendations for scenario 2 (with diversity items (m) = 8, and novelty items (n) = 4) and 20% participants liked the list of recommendations in scenario 1 (with diversity items (m) = 10, and novelty items (n) = 2).

Table 3: Comparison results of scenario 1 and scenario 2

Comparison	Scenario 1	Scenario 2	Scale
Q1	4.9	4.6	Likert Scale (0-5)
Q2	4.1	4.3	Likert Scale (0-5)
Q3	4.0	4.3	Likert Scale (0-5)
Q4	4.1	4.3	Likert Scale (0-5)
Q5	20%	80%	Scale (0%-100%)

5. Discussion

In Table 3, a comparison of the results of Q1 – Q4 on the list of recommendations for scenario 1 (with diversity items (m) = 10, and novelty items (n) = 2) with the recommendation list for scenario 2 (with diversity items (m) = 8, and novelty items (n) = 4), shows results that are not much different. In Q1 (“Does the list of recommendations provided have varied items?”, Table 2), we asked the diversity of items on the list of recommendations from each scenario, **the participants preferred scenario 1**. The results showed that it was directly proportional to the number of items varied on the list of recommendations and (scenario 1 with m = 10 and mean = 4.9, while scenario 2 with m = 8 and mean = 4.6). Whereas in Q4 (“Do you like all the recommended items?”, Table 2), which all items on the recommendation list have various and new items, the results show that **users give high ratings to the recommendation list scenario 2** (with diversity items (m) = 8, and novelty items (n) = 4) compared to the recommendation list scenario 1 (with diversity items (m) = 10, and novelty items (n) = 2). In contrast to the results of the questionnaire in Q1 (scenario 1 has a mean = 4.9 compared to scenario 2 with a mean = 4.6), this can be due to the goals and needs of users when using a recommendation system (Castells et al., 2015; Kaminskas & Bridge, 2016). Thus, the user's perception of the number of diversity aspect items on the recommendation list is affected based on the goals and needs of the user (Castells et al., 2015). It can be concluded that the number of diversity aspect items is affected by the number of novelty aspect items, when there is a reduction in the number of diversity aspect items when adding the number of new items (novelty). It shows that the users in the e-commerce are more interested in new items compared to various items that have been searched for or purchased on the list of recommendations provided.

In Q2 (“Does the new recommended item give you an idea to buy the item?”, Table 2), we asked for a new item given giving them an idea to buy that item. Scenario 1 has a mean of 4.1 compared to scenario 2 has a mean 4.3. This result indicates that the user agrees that the new item attracts the user to buy the new item. This has a positive impact on e-commerce as well, due to an increase in user activity to make purchases. Because there is an increase in user activity, it can be concluded that users are satisfied with the recommendations given (Castells et al., 2015). In Q3 (“Do you like all the new recommended items?”, Table 2) we asked user preference regarding all novelty items given. The results of this questionnaire indicate that users agree to like all the novelty items recommended in scenario 2

compared to scenario 1. By increasing the number of new items in scenario 2 compared to scenario 1, the results of the questionnaire show that the user's perception of the new items in the e-commerce recommendation system has a positive response. This result is in contrast with (Ekstrand et al., 2014), whose novelty has a negative impact on user perception. In the previous research (Ekstrand et al., 2014), novelty had a negative impact on user perceptions of the film recommendation system used, because too many unfamiliar recommendations gave a bad impression to users. Whereas in this study, the recommendation system provided novelty items that were still related to items that had been searched before, so that users felt novelty items provided new ideas for buying other items. It can be concluded, there are different goals and needs (Castells et al., 2015; Kaminskas & Bridge, 2016) of users when using a recommendation system, novelty does not always give a negative impact on user perceptions.

Based on the results of the follow-up interviews (Q5 "From the two recommendation list scenarios, which recommendation list is the most prefer", Table 2), there were many opinions given by the participants on the two lists of recommendations when we asked them to explain the reasons why they preferred the lists of recommendations in the selected scenarios. Opinions given by participants when selecting recommendation lists from both scenarios, we found that 20% of participants who selected scenario 1's recommendation list (with diversity items (m) = 10, and novelty items (n) = 2) tend to be less interested in new items recommended. Whereas 80% of participants who chose the scenario 2 recommendation list (with diversity items (m) = 8, and novelty items (n) = 4) tend to be very interested in the new items. According to them, the new recommended items gave them an idea to buy them. The results of the follow-up interviews are consistent with the results of the previous questionnaire, where Q2, Q3, and Q4 in scenario 2 (list of recommendations with novelty items (n) = 4) have an average mean = 4.3 higher than in scenario 1 (list of recommendations with novelty items (n) = 2) with an average mean of 4.07.

In addition, when conducting follow-up interviews, we found that how users receive the list of recommendations is influenced by several other factors, such as the user's preferences and conditions when using system recommendations. If the given list of recommendations was used for searching items, the user tended to prefer the recommendation list scenario 1 (with diversity items (m) = 10, and novelty items (n) = 2), where the recommendation list has fewer new items than the recommendation list scenario 2 (with diversity items (m) = 8, and novelty items (n) = 4). However, when a user was looking for new item references, the user tended to like the recommended list scenario 2 (with diversity items (m) = 8, and novelty items (n) = 4), where the recommendation list has more new items than the scenario recommendation list scenario 1 (with diversity items (m) = 10, and novelty items (n) = 2). The next factor is to consider the relevance of new recommended items with searched or purchased items. Because recommending new items that have less relevance to items the user has searched for or purchased, will have a negative impact on the user's perception of the recommendation system (Ekstrand et al., 2014). The last factor depends on the domain of recommender system. In the follow-up interviews, the results of this study are in contrast previous studies (Ekstrand et al., 2014), due to different recommendation system scenarios. In the previous study (Ekstrand et al., 2014), using a film recommendation system, while in this study using an e-commerce recommendation system

6. Conclusions and Future Works

We found that the novelty aspect of e-commerce recommendation systems has a positive impact on user satisfaction, in contrast to previous studies (Ekstrand et al., 2014), where novelty has a negative impact on user perceptions of recommendation systems to satisfy their information needs satisfactorily. In this research, the recommendation system offered new items that were still relevant to previously searched items, which gave users fresh ideas for purchasing other items. While in the previous research (Ekstrand et al., 2014), the recommendation system gave too many unfamiliar recommendations. It shows that the users have different goals and needs (Castells et al., 2015; Kaminskas & Bridge, 2016) This is shown by the results of the questionnaires Q2 ("Does the new recommended item give you an idea to buy the

item?") and Q3 ("Do you like all the new recommended items?"), where the list of recommendations for scenario 2 has an average mean of 4.3, higher than the list of recommendations for scenario 1 (with mean = 4.1 (Q2) and mean = 4.0 (Q3)). In addition, the number of items in the aspect of diversity has an influence on user satisfaction, as indicated by the results of the questionnaires Q4 ("Do you like all the recommended items?") with mean scenario 1 = 4.1 compared to mean scenario 2 = 4.3. The results of the Q4 questionnaire show that the mean scenario 2 recommendation list is higher than the scenario 1 recommendation list. This can be due to the number of diversity aspect items affected by the number of novelty aspect items on the list of recommendations and due to the goals and needs of users when using the recommendation system. (Castells et al., 2015). In addition, compared to previous studies (Ekstrand et al., 2014; Gunawardana & Shani, 2015; Pu et al., 2009), our study highlighted that different domain of the recommendation system may be further researched because each has domain-specific problems (Mcnee et al., 2006; Pu et al., 2009) and different user goals and needs (Castells et al., 2015; Kaminskas & Bridge, 2016; Mcnee et al., 2006) by considering user preferences (Jugovac & Jannach, 2017; Knijnenburg et al., 2012; Pu et al., 2011; Wu et al., 2013).

The limitation of this study is on the variety of the composition of the number of comparisons between novelty and diversity. From the limitations of this study, it can be taken into consideration for future research, to explore the limits of the number of diversity and novelty on the list of recommendations based on user satisfaction and user preference. In addition, the future research should consider other factors influencing diversity and novelty when conducting experiments.

References

- Bobadilla, J., Ortega, F., Hernando, A., & Gutiérrez, A. (2013). Recommender systems survey. *Knowledge-Based Systems*, 46, 109–132. <https://doi.org/10.1016/j.knosys.2013.03.012>
- Castells, P., Hurley, N. J., & Vargas, S. (2015). Novelty and diversity in recommender systems. In *Recommender Systems Handbook, Second Edition* (pp. 881–918). Springer US. https://doi.org/10.1007/978-1-4899-7637-6_26
- Castells, P., Vargas, S., & Wang, J. (2011). Novelty and Diversity Metrics for Recommender Systems: Choice, Discovery and Relevance. *DDR-2011: International Workshop on Diversity in Document Retrieval at the ECIR 2011: The 33rd European Conference on Information Retrieval*.
- Champiri, Z. D., Salim, S. S., Mutjaba, G., & Chog, C. Y. (2019). User Experienced and Recommender System. *2019 2nd International Conference on Computing, Mathematics and Engineering Technologies (ICoMET)*, 1–5. <https://doi.org/10.1109/ICOMET.2019.8673410>
- Effendy, V., Kusumo, D. S., Selviandro, N., & Laksitowening, K. A. (2023). Usability Evaluation Using Unmoderated Remote Usability Testing on Angkasa LMS Website Case Study. *Lecture Notes in Networks and Systems*, 447, 761–769. https://doi.org/10.1007/978-981-19-1607-6_68
- Ekstrand, M. D., Harper, F. M., Willemsen, M. C., & Konstan, J. A. (2014). User perception of differences in recommender algorithms. *RecSys 2014 - Proceedings of the 8th ACM Conference on Recommender Systems*, 161–168. <https://doi.org/10.1145/2645710.2645737>
- Ge, M., Jannach, D., Gedikli, F., & Hepp, M. (2012). Effects of the placement of diverse items in recommendation lists. *ICEIS 2012 - Proceedings of the 14th International Conference on Enterprise Information Systems*, 2 ISAS(SAIC/-), 201–208. <https://doi.org/10.5220/0003974802010208>
- Gunawardana, A., & Shani, G. (2015). Evaluating recommender systems. In *Recommender Systems Handbook, Second Edition* (pp. 265–308). Springer US. https://doi.org/10.1007/978-1-4899-7637-6_8

- Jugovac, M., & Jannach, D. (2017). Interacting with recommenders-overview and research directions. In *ACM Transactions on Interactive Intelligent Systems* (Vol. 7, Issue 3). Association for Computing Machinery. <https://doi.org/10.1145/3001837>
- Kaminskas, M., & Bridge, D. (2016). Diversity, serendipity, novelty, and coverage: A survey and empirical analysis of beyond-Accuracy objectives in recommender systems. In *ACM Transactions on Interactive Intelligent Systems* (Vol. 7, Issue 1). Association for Computing Machinery. <https://doi.org/10.1145/2926720>
- Kim, J. K., Choi, I. Y., & Li, Q. (2021). Customer satisfaction of recommender system: Examining accuracy and diversity in several types of recommendation approaches. *Sustainability (Switzerland)*, 13(11). <https://doi.org/10.3390/su13116165>
- Knijnenburg, B. P., Willemsen, M. C., Gantner, Z., Soncu, H., & Newell, C. (2012). Explaining the user experience of recommender systems. *User Modeling and User-Adapted Interaction*, 22(4–5), 441–504. <https://doi.org/10.1007/s11257-011-9118-4>
- Mcnee, S. M., Riedl, J., & Konstan, J. A. (2006). Making Recommendations Better: An Analytic Model for Human-Recommender Interaction. *CHI EA '06: CHI '06 Extended Abstracts on Human Factors in Computing Systems*, 1103–1108. <https://doi.org/10.1145/1125451.1125660>
- Nielsen, J., & Landauer, T. K. (1993). A Mathematical Model of the Finding of Usability Problems. *Proceedings of the INTERACT '93 and CHI '93 Conference on Human Factors in Computing Systems*, 206–213. <https://doi.org/10.1145/169059.169166>
- Pu, P., Chen, L., & Hu, R. (2012). Evaluating recommender systems from the user's perspective: Survey of the state of the art. *User Modeling and User-Adapted Interaction*, 22(4–5), 317–355. <https://doi.org/10.1007/s11257-011-9115-7>
- Pu, P., Chen, L., & Rong, H. (2011). A user-centric evaluation framework for recommender systems. *RecSys '11: Proceedings of the Fifth ACM Conference on Recommender Systems*, 157–164. <https://doi.org/10.1145/2043932.2043962>
- Pu, P., Zhou, M., & Castagnos, S. (2009). Critiquing Recommenders for Public Taste Products. *RecSys '09: Proceedings of the Third ACM Conference on Recommender Systems*, 249–252. <https://doi.org/10.1145/1639714.1639760>
- Wu, W., Chen, L., & He, L. (2013). Using Personality to Adjust Diversity in Recommender Systems. *24th ACM Conference on Hypertext and Social Media*.