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AN EXPLICATION OF HOW WEBSITE DESIGN ACTUALLY SHAPES ONLINE CUSTOMER LOYALTY: INCORPORATING SEM AND PERSON-ITEMS MAP ANALYSIS

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Keywords

human-computer interaction; internet of things; person-items map; structural equation modelling; website design

ABSTRACT

This article aims to provide a clear picture of how website/application design equates websites with applications, hereinafter referred to as websites, influences the formation of electronic loyalty (eLoy) through electronic trust (eTrust) and electronic satisfaction (eSat), by providing empirical evidence about the relationship between the demographic aspects of respondents and their choice of response to how the website/app is designed by the company. The research employs a laboratory simulation approach by explicating SEM-based results using the PIM feature within the Rasch model. The verified SEM model demonstrates strong goodness of fit, with six indexes indicating satisfactory results. The findings not only enhance theoretical understanding but also lay the groundwork for future research suggestions, demonstrating the potential for serendipitous discoveries in the evolving landscape of online shopping behavior. Future research should focus on refining the methodology for combining SEM and PIM analysis to further enhance the understanding of online consumer loyalty through website design.

INTRODUCTION

Sociologically, humans interact with other humans to meet their needs. This behavior is studied in behavioral science with the object of measuring human mental attributes. In the era of society 5.0 (Fukuyama, 2018), the majority of social interactions occur on the internet landscape. Social interaction on the internet can be in the form of payment processes, buying and selling transactions, digital ID cards (population issue), digital stamps (laws), social petitions (politic), economic petitions, scientific discussions, hobby communities, formal meetings, even matchmaking, etc. (Bartlett et al., 2014; Vossen et al., 2017). The ease and massiveness of social interaction is a logical consequence of the artefacts of the era of advances in telecommunication and information technology (Bibri & Allam, 2022; Couch & Chen, 2017; DURAR et al., 2023; Kivinen & Piiroinen, 2023; Mengcheng & Tuure, 2022). There have been significant changes in patterns of social interaction and therefore a new approach is needed to model and measure human behavior on the internet.

Methodologically, behavior modeling and measurement is facilitated by a well-known tool called structured equation modeling (SEM) (Fauzi, 2022; Zyphur et al., 2023). SEM analyzes the covariance structure of data with very strict statistical and mathematical requirements. SEM is robust and integrated but very weak in application. SEM is good for verifying complex conjectures/theories by reducing the number of variables, which is the goal of the hypothetical-deductive method. In its

development, the modeling and measurement of human behavior has come to a ratio-based measurement, namely the Rasch model. The Rasch model is an implementation of a new paradigm of measurement in the field of human behavior/marketing (Salzberger & Koller, 2013). The Rasch model applies calibration between the response and the items on the Rasch ruler. The data processed by this modeling becomes ratio-level and therefore all kinds of valid mathematical operations are performed. The drawback of the Rasch model is that the investigation is only carried out on one monodimensional attribute/variable. With the advantages and disadvantages of these two analytical tools, i.e. SEM and the Rasch model, the need to use a new approach can be fulfilled by trying to combine the analysis of these two models.

Specifically, the object of measuring behavior in the digital economy is human behavior which is in the form of mental attributes, with stimuli received by the five senses e.g. websites/ e-marketplace applications installed. Responses given by audience/market also need to be transformed into the language of the internet communication tool. Within the framework of the concept of society 5.0, the digital economy grows together with the increasing use of the internet by involving many types of physical devices, software, as well as websites/applications (Bisht et al., 2022; Gallastegui & Forradellas, 2024; Kamran et al., 2022). In general, this situation can be represented by the concept of the internet of things (IoT) which is one of the research locus. Specifically, the purpose of this research is to provide a clear picture of how website/application design - (Wibowo et al., 2019) (2) equates websites with applications, hereinafter referred to as websites - influences the formation of electronic loyalty (eLoy) through electronic trust (eTrust) and electronic satisfaction (eSat), by providing empirical evidence about the relationship between the demographic aspects of respondents and their choice of response to how the website/application is designed by the company.

This article practices combining SEM analysis with the Rasch model to describe one of the activities of netizens, namely shopping on e-marketplaces. Interests carries the idea of combining these two quantitative models to answer the question "How is the process of forming online consumer loyalty by website design"? This article promises to provide entirely new insights for behavioral researchers and researchers in the ICT field. This article aims to provide empirical evidence showing that combined analysis provides abundant benefits. Serendipity results regarding the proposed distribution of market-based online research which is the basis for research suggestions. In this article, the verified SEM model is explicated with the Rasch model.

Furthermore, the articles are arranged in the following order: 1) explanation of the main reasons for incorporating quantitative methods on the research background; 2) literature review on human interaction and the internet of things (IoT), adoption of the Wibowo interaction model (2023) and visualization of research locations, as well as arguments for selecting quantitative tools; 3) research sample arguments, explicated variable arguments, combining techniques in the method section; 4) Discussion on the person-items map (next PIM) and how to interpret it, Differential Item Functioning, Visualization of interaction patterns of respondent characteristics with website design items, combining SEM results and PIM, as well as research serendipity; research shortcomings 5) summarizing what this article has to offer and suggestions for future behavioral research.

The research contributes to the fields of behavioral studies and information and communication technology (ICT) by innovatively combining Structural Equation Modeling (SEM) analysis with the Rasch model to investigate online consumer loyalty in e-marketplaces. This integration of two quantitative models offers a novel approach to understanding how website design influences consumer behavior, thereby filling a gap in existing literature. By providing empirical evidence that highlights the advantages of this combined analysis, the article promises to deliver fresh insights for researchers, particularly in the context of market-based online research. The findings not only

enhance theoretical understanding but also lay the groundwork for future research suggestions, demonstrating the potential for serendipitous discoveries in the evolving landscape of online shopping behavior.

METHODS

This section operationalizes the inquiry into how online consumer loyalty is formed through website design. The research employs a laboratory simulation approach by explicating SEM-based results using the PIM feature within the Rasch model. This empirical strategy emphasizes direct observation or experience of phenomena, without being guided by a priori hypotheses. Instead, the research design is structured to answer specific research questions, focusing on a carefully controlled selection of research material to describe the interaction between companies and consumers. The strict control of PIM usage is crucial to achieving the intended sample outcomes.

The sampling process involves selecting a smaller population to represent the broader group under study, with the importance of selection methods varying between social and natural research. In cases where research subjects are homogeneous, smaller sample sizes may suffice. For this study, the Wibowo model is chosen as the sample, representing an internet-based behavioral research model where website design serves as the independent variable. This choice acknowledges that even pre-planned online purchases can be influenced by dynamic content. The verified model demonstrates strong goodness of fit, with six indexes indicating satisfactory results: RMSEA of 0.069, NFI of 0.98, CFI of 0.99, IFI of 0.99, RFI of 0.98, and GOF of 0.91.

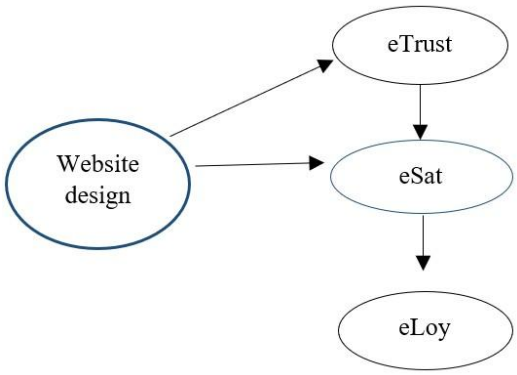

Figure 1. Verified SEM model (our research sample)
Source: Research results of Wibowo et al. (2019)

Explicated variable arguments

According to the Online Cambridge Dictionary (2021), explication is the act of explaining something in detail, especially a piece of writing or an idea while the Online Merriam Dictionary (2006a) writes it as explicate (verb) which means to develop the implications of: analyze logically. Merriam-Webster also wrote explication (noun) as a definition in the category of children. The explication in this study is intended to explain in detail the selected variables and explain the impact of this detailed explanation. The variable that is being explicated is the website design. Previous researchs Wibowo & Indarti (2020) and Wibowo et al. (2022), religiosity was chosen as an independent variable which was explicated for reasons of contextuality.

In this research, website design is explained because online interactions that occur between industry and market, companies and consumers, occur in website design variables. This is the premise raised in this research, namely the existence of mutual interaction between industry and markets. In

the Wibowo (2019) model, website design is the first location where the audience/market responds to the company's offers. After interacting with the website through its design, the audience/market proceeds to another mental behavior based on their perception of the website design, this mental behavior is eTrust then to eSat and finally to eLoy. As such place for initial interactions to continue to business transaction decision making, this study chose website design as the variable to be explicated. Methodically, website design is a variable that meets the requirements for using the Rasch Model, namely a monodimensional variable.

Incorporation technique arguments

This research replicates what was done by Wibowo & Indarti (2020) but without the need to choose an independent variable because it has a single independent variable. The combination of SEM analysis with the PIM is carried out by explicating the results of the verified SEM research on it's independent variable. If the SEM model is robust, then further action is needed to clarify how actually happened between the independent variable and the dependent variables? What part of the respondent might be involved in varying responses to the company's offerings through website design? Hence an explication on website design will answer the two questions above.

Explication is executed by analyzing the results of the calibration of the respondent's level of ability to agree on. with the level of difficulty to agree of the website design items. Respondents' ability to agree on is directly proportional to their knowledge of the intent of the website design items. The higher the knowledge that comes from experience and the fast learning process, the higher the probability of respondents agreeing with difficult website design items. Technically, from the PIM ruler, the means and standard deviation of both the person and the items will be compared. The most difficult and easiest items to agree on are also identified at this stage.

I also conducted a Differential Item Functioning (DIF) test on website design items to determine whether there is an item bias based on the demographic characteristics of the respondents. The DIF test intends to answer the question "are the website design scores more in favor of respondents with certain demographic characteristics"? The characteristics referred to are gender, transactions on websites/applications/both, when was the last transaction, income level, and education level. If the probability value is significant, which is less than 0.05, then the item is affected by bias. DIF calculation results for each demographic character in each class are tabulated. To clarify, this study visualizes the interaction patterns of the class of respondents in one characteristic with website design items.

After the PIM analysis stage was carried out, the results were elaborated with the results of Wibowo et al. (2019). Visually, the phenomena captured and described in the fifth paragraph of the literature review section, and what this research will do are shown in Figure 2 below.

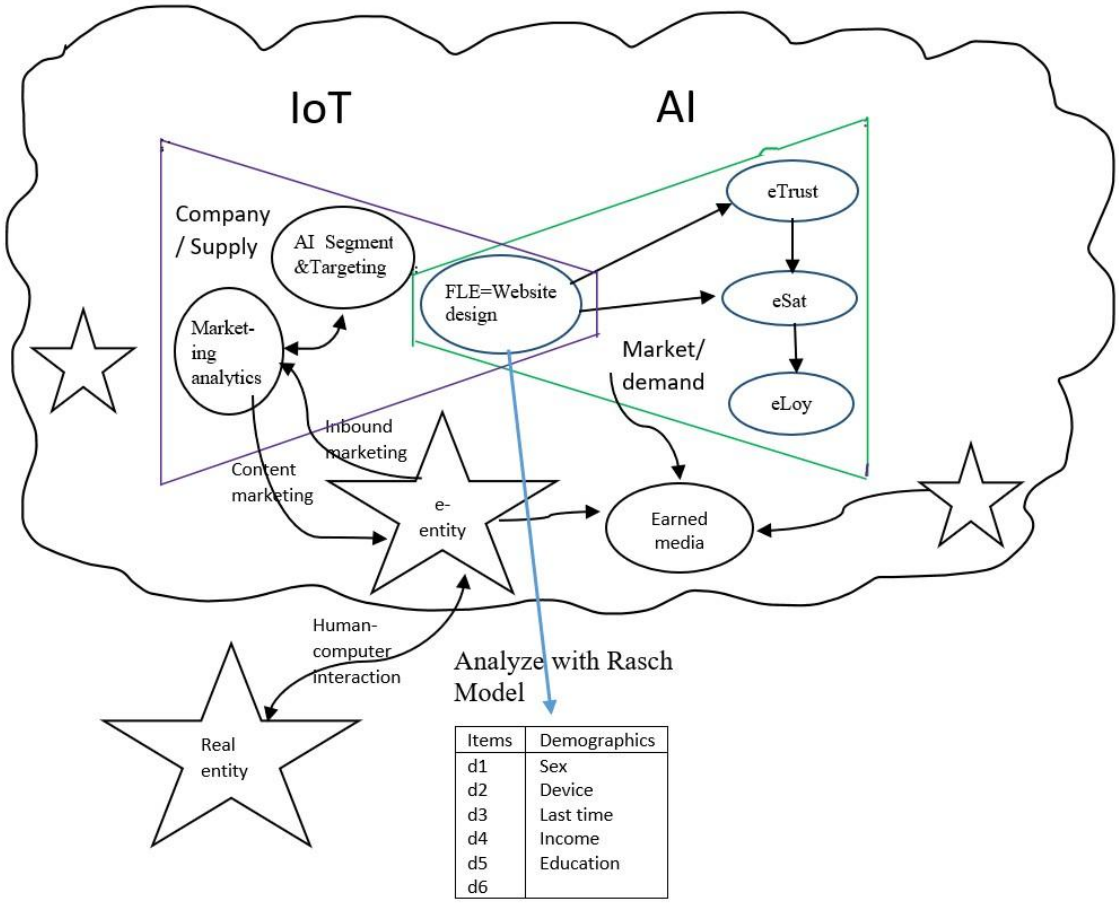

Figure 2. Company-consumer interaction on the internet
Source: Combine and adaptation of Wibowo (2023) *and* Wibowo et al. (2019)

RESULTS

Morphology of PIM

Figure 3 below, shows the respondent's ability level is on the left side which is occupied by 495 people, while the item difficulty level is on the right side which is occupied by website design tems (d1, d2, d3, d4, d5, d6). The letter M means average, S means standard deviation, while T is twice S.

Mean and Standard Deviation

Because the responses and items have been calibrated by placing them on the PIM ruler, from Figure 4.1 the author confidently states the average respondent's ability is far above the average item difficulty level. The interesting thing is that respondents with abilities below the average, as long as they are not lower than S, have all the knowledge needed to agree on all the website design items. The standard deviation of the respondent's ability level is much larger than the standard deviation of the item difficulty level. This means that the quality of the website design measuring items is not able to provide positions that respondents can choose according to their ability to agree. In other words, many aspects of the website are not successfully exposed by website design variables. The item that was the most difficult to agree on was d3 (the appearance of Bukalapak implies competence) while the item that was easiest to agree on was d1 (using the Bukalapak site/app did not waste my time).

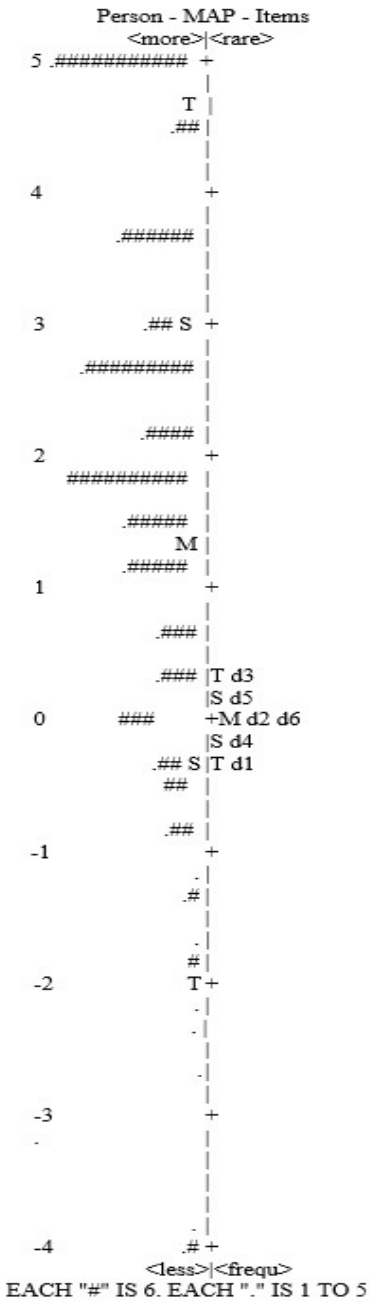

Figure 3. Person-Item Map
Source: Data processed

Differential Item Functioning Test

Table 1. List of bias items per DIF measure

No.	Characteristics of respondents	Number of groups	Class name	items	Probability	Decision
1.	Gender	2 classes	Male Female	d3	0.0129	bias
2.	Internet access by	3 classes	Apps Website Websites&Apps		All items > 0.05	Valid
3.	Last transaction	3 classes	in a week in a month In 6 months		All items > 0.05	Valid

4.	Income	6 classes (in IDR)	Less than 1 billion 1.1 – 1.5 billion 1.51 to 2 billion 2.01 to 2.5 billion 2.51 to 3 billion More than 3 billion	All items > 0.05	Valid
5.	Education	6 classes	elementary Junior high school senior high school Bachelors Masters Doctorate degree	All items > 0.05	Valid

Source: Processed data

Table 1 shows us that in aggregate, only item d3 (the display of Bukalapak implies competence) is affected by item bias. The value of the item probability d3 is less than 0.05, namely 0.0129. That is, item d3 is more in favor of one class of respondents, namely between male and female respondents. It should be noted that the facilities of the Winstep software provide the option to assess items individually per class. Here the aggregate value is used. To find out which class benefits more from item d3, and to gain a better understanding of what kind of interaction patterns occur between the respondent class and the website design items, a visualization is required which is presented and explained below.

Visualization of the interaction patterns of the respondents' characteristics with website design items

Before entering into the discussion session, please note that the website design uses items that are all unidirectional in terms of favorability. The keywords for website design measurement statement items, namely: d1 for "time efficiency", d2 for "personalization is appropriate", d3 for "implies competence", d4 for "attracts", d5 for "pleases", d6 for "looks creative."

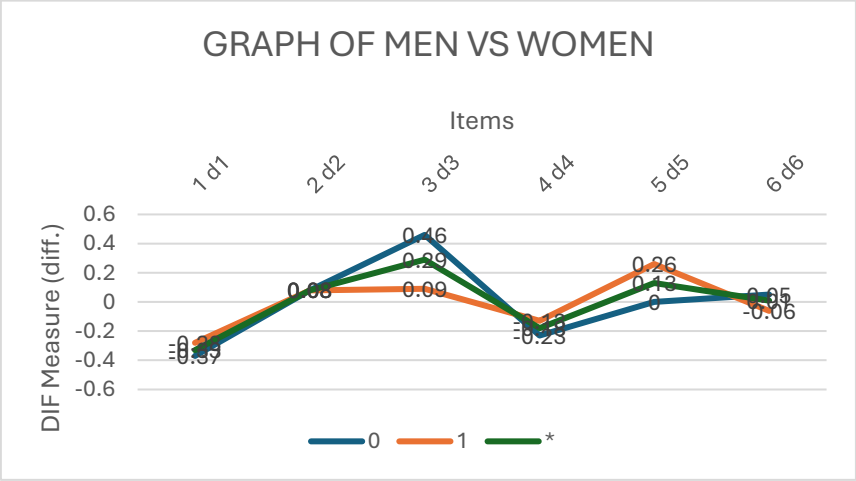

Figure 4. DIF items for gender

In Figure 4, the orange graph is for the male respondent class (code 1), while the blue graph is for the female respondent class (code 0). The average is shown by a gray graph. Gender is the only demographic characteristic that is biased in measuring interactions of respons with items. In general, Figure 4 shows that an anomaly occurs in item d3 which indicates bias. It was more difficult for male respondents to agree on item d3 (competence) than female respondents with a large difference in ratings. In other words, item d3 which contains an assessment of the display of Bukalapak which implies competence, the female respondent class has an advantage so that it has a higher score than the male. Meanwhile, affective items (d4 and d5) show that male respondents are more easily satisfied by Bukalapak than women.

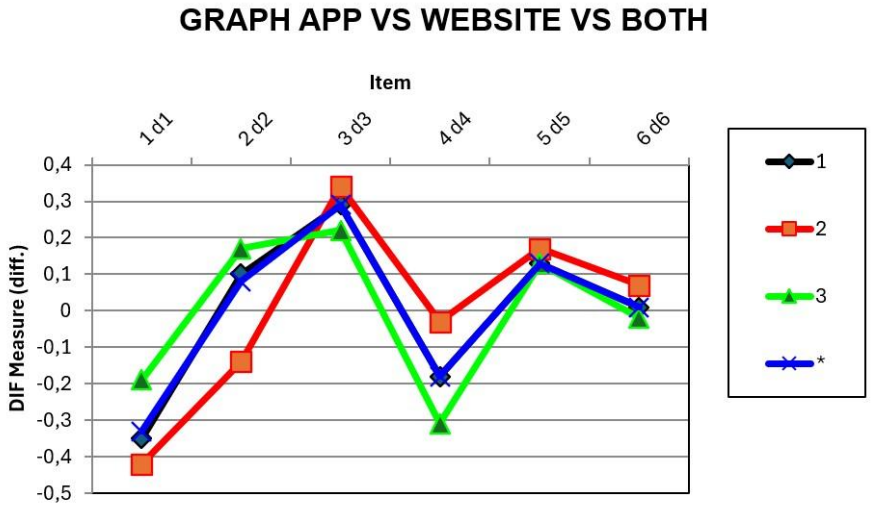

Figure 5. DIF items for acces devices

In Figure 5, the black graph is access via the Bukalapak application (code 1), while the orange graph is access via the website (code 2). The green graph is access via both (code 3). The average is shown by a blue graph that coincides with the application graph. We compare access via application (black) vs website. From the combination of black and orange graphs, it can be concluded that access via applications is more time efficient than websites. The level of application personalization is also better than the website. However, for the display of Bukalapak implying competence, access via the website is considered better. For heart appeal, fun, more creative appearance, all of these are won by the website.

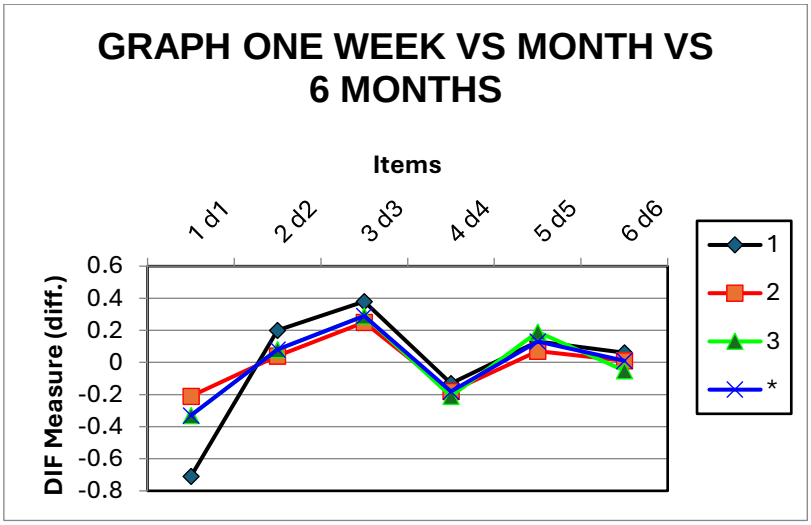

Figure 6. DIF items for access frequency

In Figure 6, the black chart is access in a week (code 1), while the orange chart is access in the last month (code 2). The green graph is access for the last 6 months (code 3). The average is shown by a blue chart that coincides with the access chart for the last 6 months. We compare the graphs of respondents who accessed the last week vs. the last month. In terms of time efficiency, respondents in the past week rated Bukalapak very low compared to respondents' ratings in the past month. However, for personalization, respondents in the last week considered Bukalapak to be more suitable than respondents in the past month. Bukalapak looked more competent in the eyes of respondents in the last week than respondents in the past month. This assessment also applies to the attractiveness of the display, the pleasing appearance, and the creative appearance of Bukalapak.

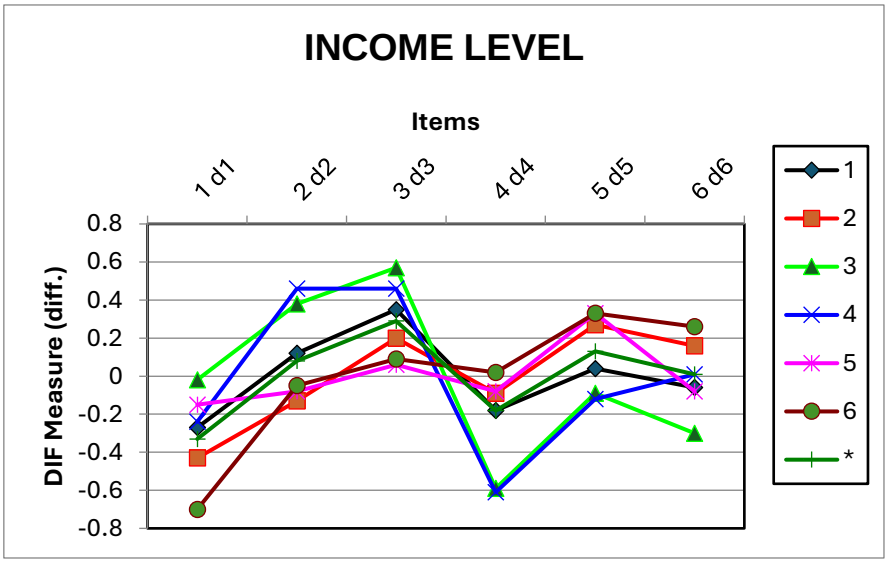

Figure 7. DIF items for the income level of the respondents

Specifically for figure 7, the higher the code number the higher the income range. This study will compare the green and blue charts where the movements are quite extreme or separate from the crowd. Respondents on the green chart (Rp. 1.51 -2 billion) thought that using Bukalapak was less time-consuming than respondents on the blue graph (Rp. 2.01 – 2.5 billion). However, for the personalization level, compared to green respondents, blue respondents rated Bukalapak as better. Furthermore, the display of Bukalapak implies competence, looks attractive, and is pleasing to the

eye, both classes of respondents rate it almost the same with a higher score given by the green graph respondents. Uniquely, when the item statement relates to the appearance of creative Bukalapak, there is a difference in assessment that is quite far and is the opposite of the three previous assessments.

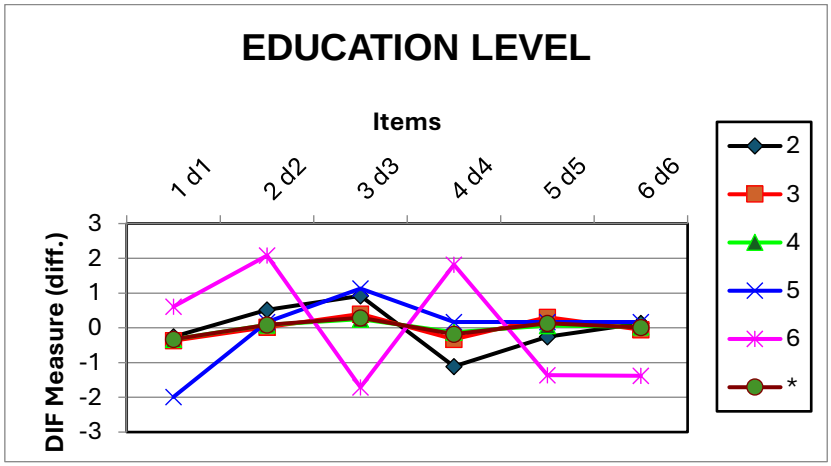

Figure 8. DIF items for respondent's education

Figure 8 above shows the relationship between the education level of the respondents and their response to the website design items. Black is junior high school, red is senior high school, green is bachelor, blue is master's degree, and purple is doctorate. Although interesting, the purple graph only consists of 2 respondents, the blue graph only has 3 people. Then the class of respondents analyzed is the red and green graphs whose ratings are very similar and have the same pattern. In item d1, the red and green respondents considered it unfavorable, while d2 was assessed in a neutral position. For item d3, the competency of Bukalapak is positively assessed by both classes of respondents. Both of them were not interested in the appearance of Bukalapak, but what is unique is that they consider the appearance of Bukalapak to be pleasing. The class responses of red respondents tend to be more than those of green respondents. If green agrees more red agrees more, and vice versa.

Incorporating SEM results and PIM

As already written in the background, the idea of combining SEM and PIM analysis is to answer the question "How is the process of forming online customer loyalty by website design"? This question consists of two sub-questions, namely "If the SEM model is robust, then how do you clarify the process of influencing the independent variable to the dependent variable?" What characteristicts of the respondent are involved in varying responses to the company's offerings through website design? In this regard, this section will present a summary of the answers to the two sub-questions above: the interactions that occur on the website design and the interactions between the quality of the items and the demographics of the respondents using the DIF test.

Person response interaction with website design items

The discussion of the PIM came to the conclusion that the respondent's ability to agree came from their knowledge which was re-evaluated when they accessing the website. This ability is hampered by the quality of website design measuring items that do not expose all parts of the website that are known to the audience/market. Respondents with the ability to agree below the average but above the standard deviation were still able to respond in agreement to the website design measuring items, from the easiest to agree with d1 (using the Bukalapak site/application doesn't waste my time) to the most difficult to agree with d3 (display of Bukalapak imply competence).

Summary of DIF test results

From the results of the DIF test, compared to female respondents, male respondents agreed more with the statements in items d1 (Bukalapak does not waste time), d4 (Bukalapak's appearance is attractive) and d5 (Bukalapak's appearance is pleasant). However, for d6 (see Bukalapak advertising materials) it is the opposite. For item d2 (personalization is appropriate), both men and women are at the same level. Access via the application is better in terms of time and personalization. As for competence, attractiveness, fun, and creativity, access via the website is superior. In terms of when the last access was, respondents in the past week agreed to give higher positive responses than respondents in the past month on items d2, d3, d4, d5, d6. The exception occurred in item d1 where respondents in the past month had higher agreement. From the income side, the respondents on the green graph (Rp. 1.51 -2 billion) and the blue graph (Rp. 2.01 – 2.5 billion) have the same pattern but are more extreme than the other items. In terms of education, the majority of respondents are a combination of respondents with senior high school and bachelor education. Item d1 is considered unfavorable, while d2 is in a neutral position. For item d3, the competency of Bukalapak is positively assessed by both classes of respondents. Both of them were not interested in the appearance of Bukalapak, but what is unique is that they consider the appearance of Bukalapak to be pleasing. The class responses of red respondents tend to be more than those of green respondents. If green agrees more red agrees more, and vice versa.

This research sample has verified the influence of website design on eLoy with the mediation of eTrust and eSat. As a single independent variable, variations that occur in website design originate from itself. In offline behavior, the determination of a single variable is difficult to achieve due to contextual uniqueness and the researcher's ability to abstract. While behavior in the online domain, according to Figure 2, website design is proposed as a single independent variable because it is the first medium of interaction that occurs between industry-market or company-consumer. Another reason is that dynamic content makes heuristic methods difficult for consumers to carry out. Therefore, re-evaluation of knowledge will always be carried out by consumers and this will make the website design variable the only independent variable - subject to difficult heuristics - in the online behavior research model.

This article has answered the research question "How is the process of forming online consumer loyalty by website design"? after obtaining conclusions from the results of the analysis of PIM and the DIF test. Technically, to manipulate eLoy ups and downs, what is needed is to manipulate the website design items (company FLE) that interact with the market. From interaction with the website design, the consumer evaluates whether his privacy will be maintained, the transaction will be secure, the goods will be delivered as promised, if he finds a "yes" answer then he is currently eTrust. Expectations for good performance come from the results of evaluating website design and a sense of eTrust. After the expectation has been partially confirmed, for example by looking at the status of the packaged goods, getting a delivery receipt number, feeling that shopping at Bukalapak is a wise choice, then at that time consumers already feel eSat. After being mediated by eSat, the influence will then run to online consumer eLoy.

By combining SEM and PIM analysis, we get a detailed picture of the ability of respondents to interact with the quality of the independent variable items. In addition, the demographic characteristics of the respondents which are closely related to the independent variable items are also described in detail. In this way, a thorough understanding of the results of SEM research will increase.

Serendipity of research

Serendipity is the faculty or phenomenon of finding valuable or agreeable things not sought for (Online Merriam Dictionary, 2006b). Just like Wibowo & Indarti (2020), who found serendipity that changing the model to a simpler one with the latent variable score (LVS) technique had no impact on decreasing the quality of the variation of the dependent variable. The reason is because the grouping of the results of the factor analysis is similar to the results of grouping the results of the PIM. Meanwhile the current article finds that it is important for researchers in the online domain to indicate the location of their research. The location of the research will influence the type of mental variable chosen, be it the type of perception, attitude or belief, feeling or opinion.

The results of internet observations show that there are very few articles that specifically show the position of their research in a particular online interaction model. Meanwhile, a characteristic of research in the online domain that is difficult to achieve in behavioral research in the offline domain is high measurability. Every social entity active on the internet, must change its behavior according to its interaction requirements inherent in IoT. Like it or not, they have to use internet devices and interact with each other through website design or one similar variables that represent their second party.

CONCLUSION

The research successfully addresses the question of how online consumer loyalty is formed through website design by combining SEM and PIM analyses, providing a richer understanding than using a single quantitative tool. SEM effectively verifies complex theories by streamlining the number of variables, while PIM offers detailed insights into demographic characteristics related to a monodimensional latent variable. The article emphasizes the importance of sampling in social research and suggests that the methodology requires further refinement. Future research should focus on clarifying the stages of online behavior, ensuring the website design remains the sole independent variable when content is frequently updated, and defining psychological variables like perceptions and attitudes. This comprehensive approach will enhance the understanding of the interplay between website design and consumer loyalty.

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