

Received May 17, 2021, accepted May 22, 2021, date of publication June 9, 2021, date of current version June 16, 2021.

Digital Object Identifier 10.1109/ACCESS.2021.3087740

Attention-Based Design and User Decisions on Information Sharing: A Thematic Literature Review

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This work was supported by the Universiti Kebangsaan Malaysia research grant under Grant GPK-4IR-2020-019.

ABSTRACT The spread of misinformation and disinformation online can do serious damage to individuals, organizations, and society in general. To fully comprehend user interaction when sharing information online, we need to examine why users decide to share misinformation without attentive behavior and how the latest attention-based design approach can address this. We investigate and represent knowledge based on Human-Computer Interaction by applying an ontological approach through a thematic literature review to describe a clearly coherent and well-defined pattern about the relationship between attention-based design and user decisions on information sharing. We conducted a review to collect, examine, and synthesize outputs of previous studies, mixing both forward and backward search strategies. Three key themes we identified include attention-based design, attentive behavior for information sharing, and attention-based design on information sharing. The review interpreted that, (1) attention-based design is significantly related to user decisions on information sharing, and a better understanding of the link between these is not yet properly described, (2) attention-based design has a further influence on increasing task effectiveness when users are dealing with a task where they are more focused and aware, (3) attention-based design, including selective attention, can influence user decisions, especially in completing tasks that emphasize a visual-based approach, (4) attention-based design is an indispensable feature to increase user attention when sharing information on the omnipresence of social media, and (5) psychological factors such as social influences, epistemic belief and cognitive dissonance affect user decisions when sharing information.

INDEX TERMS Attention-based design, decision making, information sharing, misinformation, ontology.

I. INTRODUCTION

“Pay attention or pay the price” is a creative tagline for non-commercial adverts, which is defined by Auckland Transport regarding the significance and lack of attentive behavior often encountered in people [1]. The adverts describe customer behavior when they are extra focused on their gadgets rather than on their surrounding environment, such as looking at a phone despite the threat of death caused by accidents which can occur at any time while driving.

Regarding today’s online life, when the sharing of information on social media is not accompanied by attentive behavior, there may be an enormous price we have to pay when dealing with the consequences and potential harm indirectly

The associate editor coordinating the review of this manuscript and approving it for publication was Eunil Park¹.

caused by sharing false information. This can even affect the global economic situation such as what happened on Twitter when Barack Obama was rumored to have been injured in an explosion and this resulted in a loss of \$130 billion in stock value trading [2]. In 2014, a story about Ebola victims went viral, and even though the news was not true it was still shared millions of times and caused psychological burdens such as anxiety, terror, and falsehood in people’s lives. This kind of “hoax” happens every day in social media, especially amid the COVID-19 pandemic [3]. Many of the motives for this are seeking profits for the sake of high network traffic on websites or deliberately causing misleading information to spread in society [4]. As an indication of the extent of this problem, recent studies [5] revealed that around 59% of links on Twitter were shared by users without even reading them.

Important questions arise about why this problem behavior occurs today. Are there human factors that underlie and dominate? What kinds of technological solution approaches have been developed to tackle this issue? Furthermore, how should we underpin the relationship between attention-based design and user decisions on information-sharing behavior. These questions need to be explored, and related research needs to be further investigated. Several research studies [6]–[9] have been carried out and recommend addressing the dimensions of the underlying human psychological factors, particularly on Human-Computer Interaction (HCI), as being essential. However, previous research on information sharing focuses only on identifying types and motivations for sharing information.

This review paper investigates the challenges in effective information sharing associated with attentive behavior influenced by design and on how and why individuals/groups fail to develop attentive information-sharing behaviors effectively. To explore this issue, we conducted an ontological study through a thematic literature review on the key theme of sharing information in the context of attention and its relationship to attention-based design.

This paper is divided into five sections. In Section 1, we describe the phenomenon and the review's objectives. Section 2 contains the methodology and process for the review undertaken. Section 3 presents the results with analysis and ontological representations of the review. Section 4 contains discussion and limitations, and Section 5 presents the review conclusions and future work.

II. MATERIAL AND METHODS

A. DESIGN OF THE REVIEW

According to Maguire and Delahunt [10], “*the goal of a thematic analysis is to identify themes, for example, patterns in the data that are important or interesting, and use these themes to address the research or say something about an issue.*” In this study, a thematic literature review was initiated to carefully determine the current state-of-the-art by identifying key themes within this research topic. Each article was analyzed thematically to identify patterns and relationships among the papers carefully. We used a concept-centric review structure method because a literature synthesis with an author-centric approach will tend to fail as it focuses only on the author, not on relevant concepts or themes developed [11]. This concept-centric review structure method supports the thematic literature review, where the review process focuses on the content, themes, or other matters related to the main objectives.

B. SEARCH STRATEGY

The article search strategy used a forward and backward method. Referring to the study [11] explained that the search technique by going forward is to use the Web of Science (the electronic version of the Social Sciences Citation Index). This approach allows identifying articles citing the key articles

TABLE 1. The inclusion and exclusion criteria.

Included articles were:	Published according to the research key themes between 2000 – 2020 Written in English Contain search key themes Published in selected digital databases Full text available
Excluded articles were:	Published prior to 2000 Had a non-English manuscript Outside the search key themes Were duplicated studies Full text unavailable

identified in the go forward steps and going backwards by reviewing the citations for the articles identified to determine prior articles that are to be considered.

For the first stage of using the go forward technique, we used advanced search in the primary online scientific databases, including ScienceDirect, Taylor & Francis Online, PLOS One, Springer-Link, IEEE Explore, Google Scholar and the ACM Digital Library. The next step was to search backwards through the citations for the articles identified. A consistent process was used for identifying themes in this search related to “*attention-based design*” and its relationship with “*information sharing*” and several other sub-themes.

In the second search stage, the backward method used the concept described [11] by reviewing the citations from identified articles. We searched for relevant literature on the dominating citation, and among them were searched in Google Scholar.

C. SEARCH OUTCOMES

After conducting initial paper searches with the forward and backward technique based on predetermined key themes, we found 232 papers. We organized and sorted all significant studies using the Mendeley application and then applied the inclusion and exclusion criteria, including those listed in Table 1. We determined which papers were relevant in the inclusion and exclusion criteria process, based on their publication between 2000 and 2020, written in English, containing search key themes and full text being available. This stage of the process resulted in 66 articles.

The 66 papers were then subjected to a quality-based assessment (QA), using a set of criterion questions by answering major studies' findings that resulted in audit decisions [12]. At this stage, 58 articles were left. After that, in the fourth stage, we conducted a thematic analysis by analyzing the content, and in the final (fifth) stage, we entered into ontology development, which represents significant relationships from the analysis results and clarifies each key theme's role.

D. QUALITY ASSESSMENT (QA)

Quality assessment (QA) helps researchers assess a paper's quality using a set of criteria to provide decisions about the

TABLE 2. The five quality assessment criteria.

Number of Quality Assessments	Questions
Quality Assessment 1	Are the topics discussed in the paper related to key / main themes?
Quality Assessment 2	Is it clear in what context the research was conducted?
Quality Assessment 3	Is the research methodology sufficiently explained?
Quality Assessment 4	Is the process and methodology for data collection described in sufficient detail in the paper?
Quality Assessment 5	Is the data analysis approach evaluated accurately?

analysis and findings in studies [12]. We use quality-based assessments in this review to analyze the objective quality and appropriateness of the selected relevant studies. A total of five quality assessment criteria, along with the topics of the review, are shown in Table 2:

Based on the five quality assessment criteria for the 66 articles reviewed, to strengthen our assessment of the credibility of the findings in this review, three quality ratings have been determined [13], namely “high”, “medium”, and “low”. Therefore, the quality of each article can be considered through a resulting load score. Results were divided into three ranks:

1. If a study really meets the quality criteria, then it is given a score of 2.
2. If a study partially fulfills the quality criteria, it is given 1 for that criterion.
3. If a study does not meet the quality criteria, 0 is given for that criterion.

Therefore, concerning the five quality criteria, the highest score assigned to an article is 10 (or 5×2), while the lowest score is 0 (or 5×0). In this review, each paper’s quality is considered high if the value is more than or equal to 6. Papers with a score of 5 are considered medium quality, and papers with less than 5 are considered low quality. The details of the stages of the selection process from stage 1 to stage 5 in this thematic literature review can be seen in Figure 1.

E. ONTOLOGY CONSTRUCTION

The definition of an ontology is broad, according to the context of its designation. According to [14], “An ontology is a conceptualization specification.” An ontology is a description of knowledge in a particular domain that can help share and explain, store, and reuse/transfer it to that domain. To understand it further, the ontology building procedure is carried out through the construction of its components. The components that make up an ontology are:

1. Individual: is a member of the ontology. Individuals are examples of classes that have suitable characteristics.
2. Class: is a set that includes instances with similar characteristics. Classes are partitioned into subclasses, and all their instances share the superclass property.

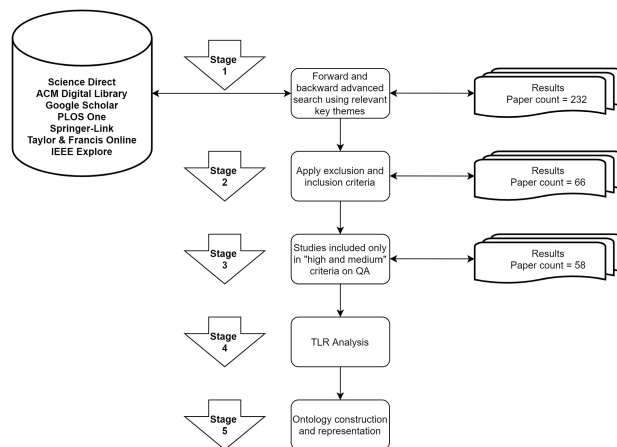


FIGURE 1. Review selection process.

3. Connection: is a relationship that connects classes. The connection defined indicates how two or more classes may be related. The connection name is the semantic definition of the interaction between connected classes.
4. Attributes: are individual characteristics; they refer to the quantitative characteristics of an individual, and their values are not always the same between individuals in the same class.
5. Property: is a relationship between individuals and attributes. An individual’s properties reveal attributes that can distinguish him/her from similar individuals. Like connections, property names define the semantics of individual-attribute relationships.
6. Annotation: is a string that includes the object definition. The definition can be thought of as attributes that become strings describing an individual’s functionality or class.

After defining the ontology through these components, a hierarchy of classes and subclasses can be developed. This can also be referred to as a taxonomy and result in an ontology that connects different classes via connections that define subclass and superclass relationships. Following this step, an early stage hierarchical structure is achieved. This is the initial fundamental structure of the ontology that has been developed. According to this review, the relationships linking classes with different relationships were determined, as we shall see in the next section.

III. RESULTS

In the analysis of findings that we carried out, we also review and examine different contexts from the primary research topics/themes discussed regarding the use of attention-based designs for information sharing purposes. The results indicate that the review covered a wide spectrum of different research contexts and research themes.

The number of relevant studies selected for this review, as retrieved from different online databases using the forward and backward searching processes and applying the inclusion and exclusion criteria, are shown in Figure 2. Most relevant

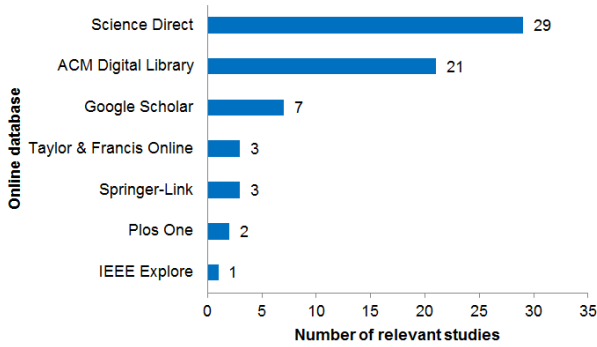


FIGURE 2. Number of primary studies selected.

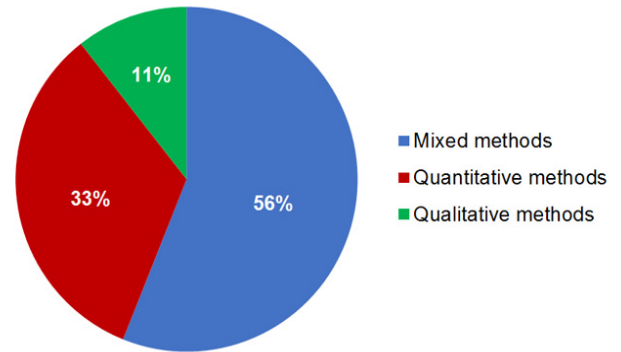


FIGURE 4. Research methodologies distribution.

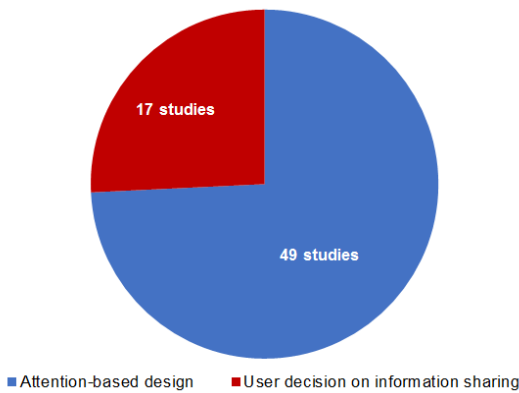


FIGURE 3. Distribution of relevant studies, according to key themes.

studies were returned from ScienceDirect (29), followed by the ACM Digital Library (21), Google Scholar (7), PLOS One (2), SpringerLink (3), Taylor & Francis Online (3) and finally IEEE Explore (1).

Figure 3 provides an overview of the distribution of selected relevant studies concerning the different themes in which research into attention-based design for information sharing, has been conducted. The analysis shows that many studies within the research themes have come from attention-based design, where 49 studies have been reported, and 17 studies were conducted in the area of user’s decisions to share information.

We organized and examined existing literature based on multiple methodologies that have been utilized. The distribution of included studies concerning research methodologies is shown in Figure 4, which shows that the majority of attention-based design and information sharing studies used a mixed methodology, and most of these studies are experimentally based. In some studies, both qualitative and quantitative methodologies have been used together as a means of complementing each other, as shown in Figure 4. Out of 66 studies, 33% used a quantitative, 11% used a qualitative, and 56% used mixed methodologies.

A. COVERAGE BY RESEARCH REGIONS

The research for relevant studies covered 18 different countries. As can be seen from Figure 5, the Asia-Pacific region (China, Taiwan, Republic of Korea, Singapore, Pakistan,

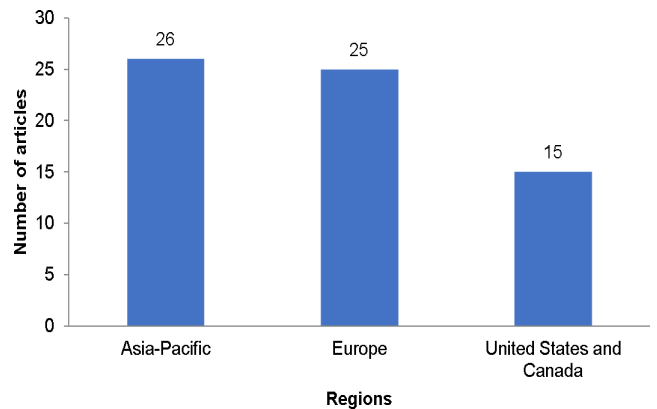


FIGURE 5. Articles published by region.

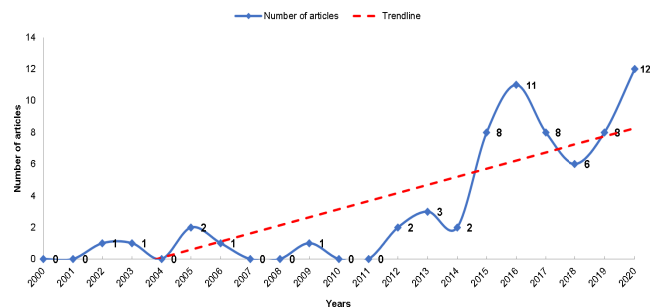


FIGURE 6. Coverage of research timeline.

Indonesia, Australia, and India) contributed the largest number of articles at 26, followed by the United States, which contributed 14, Europe (United Kingdom, Italy, Germany, Switzerland, Poland, Portugal, Finland, and the Netherlands) which contributed 25 and Canada which contributed 1. This result roughly indicates that most research publications focusing on attention-based design and user decisions on information sharing were mainly published within the Asia-Pacific, the United States and European regions, as shown in Figure 5.

B. COVERAGE BY RESEARCH TIMELINE

To examine research by timeline, we also conducted a trend analysis to explore the development of the key themes being reviewed. Figure 6 illustrates the chronological evolution of the number of articles published in several online

selected databases. In general, the publications’ linear trend chart, which includes 66 selected relevant articles, shows an increasing trend from 2000 to 2020. This trend shows that coverage of topics related to attention-based design and user decisions on information sharing continue to increase in publications. Many articles discuss why this phenomenon occurs, starting from research on what psychological factors incentivize users to share information and what approach is recommended.

C. QUALITY ASSESSMENT SCORE RESULTS

In the quality assessment stage, the method shows 66 papers given a score/rating that considers each question’s criteria from QA1 - QA5 (see Figure 8). This presents each selected study’s quality assessment scores. The score/rating is tabulated to identify which articles are suitable for thematic analysis.

Through the quality assessment process, it was determined that 2 studies had low ratings of key themes. Based on the quality assessment criteria, most articles achieved a relatively high score representing 63 articles, 2 had low rating, and 1 was medium, as shown in Figure 7.

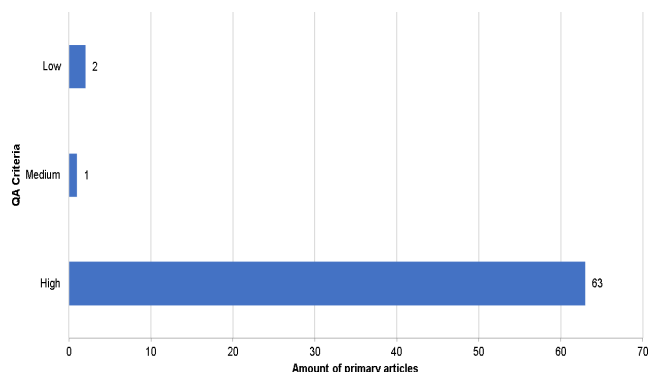


FIGURE 7. Distribution of articles based on quality assessment.

In Table 3, we group articles according to the suitability of their key themes, concerning questions QA1 and QA2 whether the topic was addressed in the paper and whether it was clear in which context the reported research was carried out.

From the QA assessment results, we also determined which articles are most related to each key theme, wherein the article there is a section on attention-based design and its application to information-sharing behavior. The results of the distribution of the most related articles are shown in Figure 9.

D. THEMATIC ANALYSIS

An analysis of key themes in this review determined five (5) main clusters which we now present in turn.

1) THE ROLE OF DESIGN TO INCREASE ATTENTION, FOCUS AND AWARENESS

Several of the conclusions we reached from the process of analyzing key themes, especially regarding the role of design

TABLE 3. Quality assessment count related to key themes.

Category	Article number	Count of papers related to key theme
Medium relationship to key themes (based on QA1 and QA2)	S1, S2, S3, S4, S6, S7, S8, S9, S10, S11, S15, S16, S17, S18, S19, S20, S21, S23, S24, S25, S26, S27, S28, S29, S30, S31, S32, S33, S36, S37, S38, S39, S40, S42, S43, S44, S45, S46, S48, S49, S50, S51, S52, S53, S55, S56, S58, S59, S60, S61, 64, S65, S66	52
High relationship to key themes (based on QA1 and QA2)	S12, S13, S14, S22, S34, S41	6
Least relationship to key themes (based on QA1 and QA2)	S5, S35, S47, S53, S54, S57, S62, S63	8
Total		66

on attentiveness, were stated in terms of improving coordination in sharing the use of daily resources, for example, the use of electricity [15], which states that an interface that can improve coordination is essential for paying more attention to sharing systems. Furthermore, it builds an intelligent interaction in the interface that can increase attention with the attention history approach, which logs the user’s gaze, becoming a cache for interface intelligence development [16].

The research conducted by Pang *et al.* [17] shows that visual flow in designing web-based applications can effectively guide user attention in developing web designs.

Another approach, such as that taken by Chen and Chen [18], results in a pattern and display of locations that have succeeded in improving selective attention performance and the concepts behind the application of quick display, were employed in the experimental design to examine the performance of selective attention for different interface designs. This result was also confirmed by Bi *et al.* [19], who increased user attention to their targeted object by designing a focus of attention through a virtual-spatial environment, comparing start with end as a temporal-spatial congruity and left with the right of the location of a target object. A focus on web-based application development in [20] and [21] showed that attention-based high order could become a benchmark standard that can increase user attention, especially in web-based learning.

In the medical and health fields, the development of designs that integrate health literacy, running on online information, can increase user attention in seeking health information [22]. In line with what has been reported in [23], health literacy affects attention in accessing online information through flicker design for far away objects but does not affect close objects. The research conducted in [24] also stated that a key strategy for increasing attention is to make important information “visible” by designing a communication

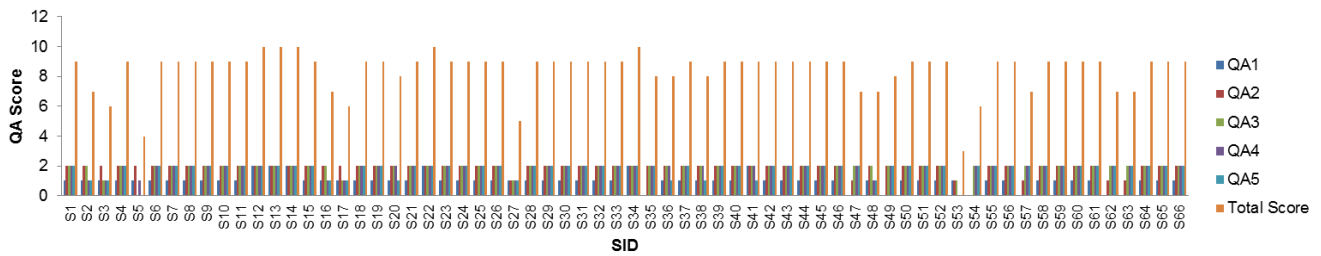


FIGURE 8. Quality assessment scores of each selected study.

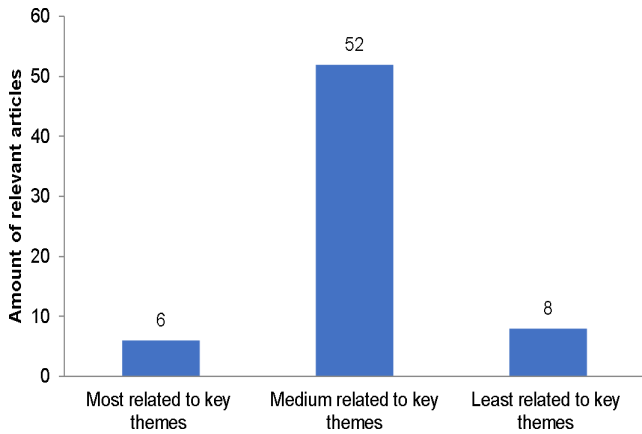


FIGURE 9. Distribution of relevant studies according to related key themes.

and collaboration system. According to [25], product selection in food nutrition information can be improved by designing health logos using colors, and in the context of “Midas touch” for mobile-based applications, a visual attention-based design approach can solve gesture-based interaction [26].

Resnick and Albert in [27] demonstrates that semantic attributes in advertising design can strongly influence user attention. In line with the research results [28] regarding the importance of design in increasing attention when learning, mobile gaze tracking using teacher’s scaffolding can significantly influence target gaze and provide insight into teacher’s teaching and learning interactions. Likewise, in terms of improving attention to learning, using video learning with lecture capture and picture-in-picture design techniques is significant [29]. The interface design role is also significant in operating a teleoperated-crane-based interface through a markerless augmented reality (AR) approach, which can reduce by 57%, the chance of accidents or collisions and affect a high level of user satisfaction.

In increasing confidence and focusing on using tools, Bonanni *et al.* [30] found that exogenous cues based on spatial-attention-sensitive projections were beneficial. A design based on the typology eco-feedback dimension has an essential meaning for the correspondence of behavioural mechanisms, especially in attention, motivation, and learning [31]. Other studies, such as the results of research by

Taylor *et al.* [32], identified that context-appropriate peripherals or cues could significantly increase attention to a message’s content. The basic idea in attention-based design through selective attention is that not all “objects” in a visual scene provide us with information and only focus on the relevant part of the scene while ignoring other irrelevant stimuli [26]. Prior studies [33] also reviewed how attention works using appropriate metaphors. According to the metaphor of the spotlight technique, attention can be characterized as an internal radiance illuminating the location where an object is placed [34]. To quote Rensink [35], “if displays are designed so that the user can interact with them optimally, this finding is important to understand as attention operates on one’s cognitive abilities.” What all these results show is that the first theme that we identified, namely that appropriate design increases attention and focus from users when performing a task, is very prevalent in the literature.

2) THE EFFECT OF ATTENTION-BASED DESIGN ON TIME ALLOCATION EFFECTIVENESS TO INCREASE ATTENTION, FOCUS AND AWARENESS

According to several research results that we have reviewed, these show the direct impact that attention-based design significantly affects users to focus more quickly (increased time allocation) on an object in a task. Some of the supporting research results include research produced in [18], which states that an object’s design display position on the left of screen is the best location to be selected effectively and efficiently. In [36], it is suggested that design in attention data can speed up navigation access to a document, highlighted parts, direct reading, and facilitate the user’s need to read specifically and efficiently. In line with a conclusion from the research results in [37], this emphasizes that the attentive display system can increase the speed of the user’s time in responding to a task.

Research conducted by [27] stated that almost all participants need more time attending to task-relevant ads, but not if given a visual design approach. In [38], when a user is faced with a change in the appearance of an object, the user quickly sees the change, and the information is then extracted to complete the current tasks. Likewise, as D’mello *et al.* [39] stated when detecting Mind Wandering (MW), a design interface in reading comprehension is used to intervene by

asking just-in-time questions that can influence the user to re-read information. The effectiveness of time allocation can also be seen from the results of studies using the “*Three levels of user interface*” designed in a game, and the results prove that it can effectively improve attention performance and awareness [40]. From these results, it can be confirmed that the effect of attention-based design on time allocation effectiveness to increase attention, focus, and awareness, is valid.

3) THE INFLUENCE OF ATTENTION-BASED DESIGN AND SELECTIVE ATTENTION ON USER DECISIONS

According to Zizlsperger *et al.* [41], behavioural attention to using a feature-based or design-based approach can increase choice certainty. For the first time, this finding shows the separation between accuracy and choice certainty with a significantly stronger effect of top-down attention on subjective performance measures than on objective performance when the user faces a task. Together, their findings show that user certainty in the choice is significantly increased with the selective attention approach and that this increase is significantly more than that observed as a measure for accuracy.

A study produced by Kim *et al.* [42] stated that the rhetorical function in the form of hashtags had influenced user decisions in attention-seeking information. If a person’s history of success, ability, and prestige is highlighted in the design of information sharing on social media, it is a strong way to encourage users’ decisions to learn and increase attention [43]. Studies conducted by [44] and [45] argued that consumers could reduce cognitive dissonance or increase their confidence in making decisions when buying a product by adding additional information to a product’s design or when used in recommender systems.

As stated by studies in [24], the role of design interaction to influence user decisions is valid when building a framework that can stimulate reflection in shared systems. In making a judgment when understanding the relevance of a reading document, users tend to allocate the highest level of attention at the beginning of reading (about 20% to 40%). This decision indicates that the user is more attentive to reading at the initial time, and “*efficient goal-directed behavior is crucially mediated by visual selective attention*” [46]. The important things about the ideal technique for influencing users’ decisions on specific tasks are also described in the study by Wood *et al.* [47]. Previous researchers have widely used several metaphors as a basis for theorizing the nature of attention with a visual approach such as a spotlight technique with a moving fixed-size diameter focus. This study suggests that designers should view attention as a dynamic process when designing views for attention management. Yang *et al.* [48] found that selective attention approaches have been known to play an important role in decision making. This study combined the cueing paradigm with the overload detection task to examine how attention influences the decision process when detecting over-targeting.

These research contributions collectively show that there are many examples of how attention-based design influences users decisions. However, there does not seem to be much exploration into what types of domain this is prevalent, so we do not know whether there is a more significant influence in consumer purchasing, health, or social interaction with others.

4) THE NEED FOR ATTENTION-BASED DESIGN ON INFORMATION SHARING ON SOCIAL MEDIA

We found a relationship between attention-based design and how it is applied in social media applications, including an article [49] which states that users employed control strategies to share their information in a way they like or believe (preferred), influenced by the risk factors and the benefits they get from the control behavior. The control meaning here is how the social media application designs the features that can control and suggest that concerted efforts with inputs from a wide range of disciplines are needed to design social media applications [29].

The need for attention-based design that emphasizes the use of social media applications was also emphasized by Wang *et al.* [50], where they indicate that informational (i.e., information uniqueness), ambient (i.e., information crowding), and social (i.e., social interactivity) cues arouse individuals’ positive emotion, which subsequently promotes their urge to share information. The influence of success, ability, and prestige displayed in social media cues also attracts users’ attention to sharing information on social media [43]. The development of a set of recommendations designed in social media applications also increases people’s attention and social media literacy for improving the design of social-computational systems [51]. Likewise, research in [52] argued that the design sets implications could be influential for devising future sharing services. Collectively these articles indicate there is a definite need for attention-based design in information sharing apps.

5) SOCIAL INFLUENCES, EPISTEMIC BELIEF AND COGNITIVE DISSONANCE ARE FACTORS AFFECTING USER DECISIONS IN SHARING INFORMATION

In this thematic review, we also determined the role of sub-key themes for psychological factors such as social influences, epistemic belief, and cognitive dissonance in user attention when users decide to share information on social media. The roles of several of these sub-key themes can be described as follows. In a study produced in [45], it is stated that a user’s attention to an item is very easily influenced by social closeness. A related point was also put forward in [53], who suggested that the effect of self-interest incentives was found only in users who focused on close friends (focus on bonding) but not in those who focused on distant friends (focus on bridging).

According to research [54], when there are more comments, comments with a less positive tone, and comments with more thought-provoking statements, these are correlated

with an iteration of information sharing and dissemination social media. The study in [55] showed that shared values, community identification, and privacy in information are directly affected by a website and its membership's credibility. In connection with a user's decision to share information on social media, Guazzini *et al.* [56] found that users are more likely to be influenced by when they identify with the same group than with different groups (Group In/Out).

The effect of collective opinion in a group on social media can also reduce users' attention when biased towards the quality of information [8]. More research on this issue could help develop a series of recommendations for increasing social media literacy in society and improving social computing system design to increase productivity and social welfare.

The influence on social development and more intense information sharing with peers than others was also stated by [49] and [57], which finds that someone who has many friends is less likely to be influenced by any one of them. Studies [42] found that three Facebook application features can characterize people who engage in communication on Facebook, namely, like, comment and share. The findings suggest that different message features produce different behaviors. Sensory and visual features cause liking, rational and interactive to comment, and sensory, visual, and rational to share. These visual features suggest that liking is affective driven, comments are cognitively triggered behavior, and sharing is affective or cognitive or a combination of both. Furthermore, in the study [58], people tend to participate in the same activities as their peers, and social influence is believed to play an important role in recognizing, adapting, and sharing content such as news on social media. Likewise, information producers use different cues to show the credibility of their information on various social media sites [59]. These cues can take the form of cues (designs), whereby organizations can leverage this study's findings to increase targeted engagement with their customers. The information disclosed features are to demonstrate the credibility of the information shared to provide a mechanism for identifying quality cues in social media communication.

System designers can improve on existing algorithms built to analyze the quality of content on social media. Liu and Keng [44] explore from the results of their research that consumer's intentions to provide untrue or negative electronic word-of-mouth (eWOM) messages while undergoing conflicting cognitive dissonance and after experiencing social comparisons. These findings suggest that after making comparisons with other users on the Internet, consumers with high cognitive dissonance were more likely to spread true and negative eWOM messages (information) than consumers with low cognitive dissonance.

Guazzini *et al.* [56], who investigated social influences on human decision-making processes, argued that social pressure and individual cognitive dynamics are complex variables in decision making that can provide relevant insights in predicting human behavior. It is also valuable for exploiting the important factors embedded in ICTs to equip them

with human cognitive-inspired features. Vosoughi *et al.* [60] conducted a study on the current spread of misinformation limited to a small, ad hoc sample analysis that ignores two of the most important scientific questions: How do truth and falsehood differ differently and what factors of human judgment explain these differences? In this research, human behavior contributes more to the spread of falsehoods and different truths than automated robots. This finding implies that misinformation retention policies should also emphasize behavioral interventions, such as labelling and incentives to prevent the spread of misinformation, rather than focusing exclusively on the bot or machine-based restrictions.

According to Chen *et al.* [61] it was found that respondents often shared incorrect information for non-informational reasons. The findings suggest that concerted efforts are needed in social media application design and information literacy training to help reduce misinformation sharing and encourage users to flag (correct) constructively and to refute misinformation through the design of an app's features. Likewise, Chua and Banerjee [62] examined Internet users' epistemic beliefs that can influence their online information processing behavior, and the epistemic beliefs of Internet users influence their decisions to share health rumours online. Our review discovered a lot of literature that investigated how social influences and beliefs influence information sharing making this a strong theme to emerge from our analysis.

E. ONTOLOGY REPRESENTATIONS

After we had confirmed the existence of a strong relationship between attention-based design and user decisions on information sharing, we then built an ontology to describe the resulting relationship to explain the significance of the effect of attention-based design and user decisions on information sharing.

We determined the class, sub-class, properties, and relationships between each class in the resulting ontology based on justification and confirmed these relationships through articles that have gone through our thematic literature review analysis. We visualize this conceptual pattern relationship starting by determining the "Design-based system" class, which has sub-classes "Display pattern" and "Color stimuli" which can influence (hasAffectTo) the "User attention" class (according to the findings of articles S1, S3-5, S7-9, S15, S17-28, S31-32, S36, S42, S44, S46, S48, S50-52, S55-56, S58-60, and S64-66). Then the process continues when the "User attention" class has been influenced, then the "User attention" class which affects (hasAffectTo) two classes, namely the "User decision" and "Response time" classes, the relationship between the "User attention" and "Response time" is justified by the findings of articles S1-4, S26, S32, and S66, which justify that attention-based design affects the time allocation (user effectiveness) to increase attention, focus and awareness on a task. Then the direct relationship between the "User attention" class, which states can influence (hasAffectTo) the "User decision" class



FIGURE 10. Ontological representations of attention-based design and user decision on information sharing.

is justified by the findings of articles S7, S9, S10, S27, S22, S29, S31, S34, S48, S50, and S64.

The indirect relationship between the “Response time” class and the “User decision” class is mediated by the “Psychological dimension” class, where the response time is influenced by the user’s undesirable feeling (cognitive dissonance) to reduce the pressure generated, both by the “Social influence” and “Epistemic belief” sub-class, “so users tend to be influenced (hasAffectTo) by ”User decision”. The class “User decision” has a relationship in context or occurs (OccursIn) in the Information sharing phenomenon. Then the “Information sharing” class has a direct relationship with the “Context of information” sub-class, where the types of information commonly shared by users on social media include the “Political, casual, sensational and sensitive” sub-class, according to the justification generated by the findings in articles S11 and S38.

A rich representation of attention-based design and user decisions on information sharing will allow us to identify a technological approach to a proprietary solution in the future

(see Figure 10). We believe that the ontology can benefit current attention-based design research on information sharing. The formal and detailed conceptualization of attention-based design and user decisions on information may ultimately reveal the gap (body of knowledge) in the technological approach to information sharing. The ontological specifications facilitate integrating and interoperating entities from diverse sources by ensuring consistency and interoperability regarding the Human-Computer Interactions field.

IV. DISCUSSION AND LIMITATIONS

This section will discuss some related topics around the concept of attention-based design, including its relationship to information-sharing behavior issues and how significant attention-based design influences user decisions and available resources for further research.

A. ATTENTION-BASED DESIGN

The significance of attention design to decision making has been identified in this review. We focus on decision-making

rendered by attention-based design, specifically concerning sharing information behavior, and those affected by them. Our literature review found that users felt encouraged and empowered to deal with social influences, epistemic belief, and cognitive dissonance factors, which extended to research in information sharing behavior. Information sharing around the attention-based design phenomenon was severely lacking, which coincided with the absence of research on the topic.

We identified 66 papers that we understand have not discussed any direct links among attention-based design for handling user decisions on information-sharing behavior. Attention-based design approaches are still generally used to influence several assignments, particularly regarding improving cognitive skill aspects, including augmented reality kitchen interfaces that affect the user's attentional focus [30] and considering attention in display design to reduce the viewer's cognitive load [37]. We also found results that both display patterns and display locations in the user interface affect selective attention performance, which is influenced by cognitive styles [18]. In line with studies such as [63] which found that attention-based user interfaces resulted in high user satisfaction levels for a tele-operated crane, Reale and Flint [25] also indicate that nutritional information should be provided in color or as health logos as this has the most significant impact on food choices.

The findings of this thematic literature review indicate that attention-based design still lacks application to the information sharing behavior phenomenon. It was also implied that a particular design would enhance human cognition in decision making.

On another aspect, when misinformation has been shared, there are several recent perspectives on the process of modelling dissemination of misinformation and predicting related situations in the future. In this research domain, we also suggest that to consistently understand propagation and diffusion of misinformation that occurs in social media. Xiao et al. [64] discuss the latest aspects based on real-world social data simulating a rumoured model on dynamic propagation based on evolutionary game and anti-rumour. This research uses evolutionary game theory to construct the driving force mechanism of information and to explore the causes of user behaviour in the spreading process of rumours. This research also provides a theoretical basis for extended user decisions on public decision-making and has significant social and application value, ultimately creating an ideal condition called herd psychology.

Other recent research [65] on the aspect of how to understand social media application management explains that the complexity of user behaviour, the multidimensional communication space, the imbalance of the data sample, and the symbiosis and competition between rumours and anti-rumours are challenges associated with in-depth studies of the topic of misinformation and rumour context.

Furthermore, there are also limitations to the ontological representations we construct in this study, particularly concerning the "Information context" class. This research also

explained that the information context class is also affected by complex constructs, high dimensions, and the timeliness of rumours. The problem that should be exposed is how to disclose social relations and interests among users under rumours adequately. The nature of the messages varied under rumours, and some models of rumour propagation do not give incidental messages impact on rumours in social networks. Furthermore, some research suggests that the study of rumour propagation is significant to regulate social behaviour, which can clearly describe the current model of spreading rumours.

Despite a lack of knowledge around attention-based design for information sharing behavior, users are significantly affected by factors such as social influences, epistemic beliefs, and cognitive dissonance. However, the themes revealed by this review highlighted the role of attention-based design in enhancing users' decisions on the sharing of information.

B. USER DECISIONS ON INFORMATION SHARING

By understanding the findings obtained from several studies, it can be concluded that the influence of interface design on users with specific tasks can increase their levels of attention and encourage them to make decisions on a particular task in terms of their information-sharing behavior. As the results of Baudisch et al. [37] conducted, "when people make decisions about display sizes and resolutions, not only do cost and space requirements for rendering hardware and display play an important role, user productivity itself is at stake."

This justification is reaffirmed by [18], suggesting that both the display pattern and display location in the interface design that the user interacts with affect selective attention performance. Studies such as [63] show that interfaces prevent a 57% chance of accidents in operating teleoperated cranes and find that interfaces can produce high user satisfaction levels. This interface design suggests that humans prefer decision-making strategies that emerge from focusing on one task, one decision, especially when they are the most prominent [66]. By further understanding the effect of attention-based design on user decisions, after analyzing several articles based on pre-determined themes, it is clear that attention-based design, especially on selective attention theory, is substantial. Attention-based design significantly affects user behavior in making decisions and subsequently taking actions. This result is relevant to several studies concluding that humans tend to favor decision-making strategies that arise from focusing on a single, yet the most salient, cue when assessing cue-outcome relationships in multi-cue environments. Results from experiments such as in [18] showed that both display patterns and display locations in the user interface design did affect the performance of selective attention, and [41] also found that selective attention increases certain choices in human decision making.

The absence of studies around attention-based design for affecting user decisions on information sharing is indicative of the need for more research in the area. Further research is fundamental to facilitating best practice in how

attention-based design links to user behavior factors when users decide to share information. Studying the effect of attention-based design phenomena on decision-making would be beneficial, as it would explore how such design can influence users to share or not to share information. Furthermore, the effects of the factors affecting user behavior in sharing information would be altered in future.

Research into design-based attention and how those designs would affect users' decisions in sharing information is required. It is also suggested that research be carried out to develop design-based approaches to understand information sharing behavior and include how to model these phenomena. Research is also needed into the requirement for attention-based design to prevent sharing misinformation and improve users' decisions in sharing useful information with attentive behavior based on the design stimuli approach.

The study in [42] shows that users share their emotions on social media. People love to share their feelings to increase social interactions, such as receiving 'likes' and comments. However, due to excessive sharing, some people fail to attract and are seen as attention-seekers. People do not empathize with attention-seeking posts and consequently, reduce the number of social interactions with the attention-seeker. Emotions shared with a hashtag (#) are a classic example of being considered attention-seekers. In this context, hashtags (#) can function as influential design features (cues) in social media applications.

V. CONCLUSION AND FUTURE WORK

This paper has reviewed many published research studies which try to understand the extent of using attention-based designs for information sharing. From the review, it is shown that the concept of using attention-based design for decision making in sharing information is still not discussed enough. In some of the current thinking about the use of attention for decision-making purposes, some topics have received limited attention and require more significant investigation, especially for information sharing activities.

We find that there is a lack of attention by researchers regarding the impact of attention-based design and relating it to the factors that influence users' attention when sharing information. This has been highlighted by researchers other than ourselves, such as the proposal that the most fundamental problem lies in underlying psychological factors rather than algorithmic ones.

Understanding the findings obtained from several studies shows that interface design for users with specific tasks can increase attention and encourage users to make decisions on a particular task in terms that influence their information-sharing behavior. This justification reaffirms that both display patterns and display locations in user interface design affected selective attention performance. This suggests that humans tend to favor decision-making strategies that arise from focusing on a single, yet the most salient, cue when assessing the cue-outcome relationship in multi-cue environments.

The highlights that can be concluded from the results of this review include that (1) attention-based design is significantly related indirectly to users' decisions on information sharing, and a better understanding of the link between and direction is not yet properly described, (2) attention-based design has a further influence on increasing the effectiveness of time when users are dealing with a task where they are more focused and aware, (3) attention-based design, including selective attention, can influence user decisions, especially in completing tasks that emphasize a visual-based approach, (4) attention-based design is an indispensable feature to increase user attention when sharing information on social media, and (5) psychological factors such as social influences, epistemic belief and cognitive dissonance affect user decisions when sharing information on social media.

Understanding there are many strategies and approaches to research, we want to explain clearly that specifically in this study, we only address the phenomenon of sharing misinformation on social media from the scope of preventive behaviour. When this initial phase occurs, the user receives the information before deciding whether that information will be shared or not. We clearly state that activities to intervene into users' decisions when sharing information are needed in the initial phase through a comprehensive understanding of some of the literature on the attention-based design approach as discussed. These results, relate to how the information screening process occurs to users. In our opinion, this critical part is one of the fundamental stages because when this behavioural process can be understood, the potential negative impact arising from the spread of misinformation will be reduced. We also realize that we do not focus on discussing more deeply, any research that explores the role of the user's capacity to verify information based on their own cognitive abilities, especially on the knowledge literacy scale and the anti-rumour confirmation that he/she knows.

In future research, it is expected that an appropriate interface design can influence users' decision to share or not share information. Such a design would not direct a system to make information easy to instantly share, but fundamentally it would drive a wider impact for consuming information constructively at the individual or organizational level. As opposed to this, information that is not necessarily useful should not be disseminated irresponsibly without attentive behavior. Furthermore, there is a need to design a system that is integrated with added security features, primarily designs that can influence user decisions when sharing information on social media platforms. We suggest that future research needs to be evaluated, refined, and improved for the resulting ontology representation that we generated, especially regarding key themes and some related concepts and classes. This enhancement is necessary because technology changes rapidly, and our needs require updating knowledge iteratively and with speed.

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