User acceptance of knowledge-based system recommendations: Explanations, arguments, and fit

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ABSTRACT

Knowledge-based systems (KBS) can potentially enhance individual decision-making. Yet, recommendations from KBS continue to be met with resistance. This is particularly troubling in the context of deception detection (e.g., border control), in which humans are accurate only about half the time. In this study, we examine how the fit between KBS explanations and users' internal explanations influences acceptance of KBS recommendations. We leverage cognitive fit theory (CFT) to explain why fit is important for user acceptance of KBS evaluations. We also compare the predictions of CFT to those of the person–environment fit (PEF) paradigm. The two theories make conflicting predictions about the outcomes of fit when it comes to KBS explanations. CFT predicts that explanations with a higher cognitive fit will have more influence and be evaluated faster whereas PEF predicts that individuals will take more time in evaluating explanations with greater fit. In our deception detection scenario, we find support for CFT in the sense that people are influenced more by cognitively fitting explanations, however PEF is supported in the sense that people take more time to evaluate the explanation.

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1. Introduction

Knowledge-based systems (KBS) have the potential to enhance the way people make decisions. In cases in which a KBS's accuracy is much higher than the decision maker's—such as IBM's Jeopardy-playing Watson [1]—the decision makers are missing out on the potential value created by the KBS if they do not use them [2]. Nonetheless, in many domains, such as credibility assessment [3] and medical informatics [4], acceptance of KBS decisions often still falls below 60%. The potential value of accepting a correct decision from a KBS can be particularly meaningful in cases where individuals are attempting to discern whether or not someone is being deceptive, such as in border crossings [3] and auditing [5]. Therefore, if researchers can better understand why users do or do not accept the decisions of a KBS, the potential value of KBS for decision making in practice can be improved.

One unique aspect of KBS is the use of lines-of-reasoning explanations [6]. These explanations attempt to assist the user in evaluating the KBS's decision by helping the user understand how the KBS came to a certain conclusion (e.g., showing the logic by which the system arrived at the conclusion). Explanations have been studied since the introduction of MYCIN (a medical KBS) in the 1970s [7] to today [e.g., 8–10]. Notably, researchers continue to explore ways to present lines-of-reasoning explanations to users to increase acceptance of KBS recommendations [6]. Ye & Johnson [5] proposed that "one future direction may be to assess the impact of different kinds of justification and to identify the appropriate conditions under which each should be employed" (p. 169).

In addition to differential impacts of justifications, research also indicates that differing representations of information can alter the amount of KBS influence. For example, Papamichail and French [11] found that users preferred certain information formats over others. Users performed better with their preferred formats, and the preferred formats were not consistent among users (i.e., some users preferred formats rejected by other users). This finding suggests that a matching, or fit, between users and information format is needed for the KBS to be perceived favorably and thus adopted. When we combine this with the suggestion that certain justifications (i.e., lines of reasoning) are stronger than others [12], it logically leads us to propose that providing justifications that fit with user preferences should be valuable for increasing KBS recommendation acceptance. Accordingly, the following research question guides our study:

RQ: How does fitting KBS justifications to a user's cognitive preferences influence the user's acceptance of KBS recommendations?

To address our research question, we first review the explanation literature to build a foundation for our research. Then, we leverage CFT to explain why fit is important for understanding the influence of

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KBS recommendations on users. We also employ the PEF paradigm to provide an alternative explanation of how KBS recommendations will influence user behavior. Our theoretical model is then tested by an experiment in which we examine the processing of explanations provided by a KBS—focusing on explanations in a credibility-assessment task that will allow us to compare the two theories. Finally, we address the results and contributions of this experiment with respect to improving KBS acceptance.

2. Theory and hypotheses for KBS recommendations

We examine KBS explanations through two bodies of literature. First, we examine the KBS explanation literature. The KBS explanation literature provides constructs such as explanation quality and explanation influence (see Fig. 1). Second, we combine the KBS literature with theories of fit literature. In particular, we look out how fitting the explanation to the user will impact explanation quality and explanation influence. Fig. 1 depicts the overall theoretical model that we propose and further justify in this section. Before explaining our specific hypotheses, we define our null hypothesis:

H0. Fitting KBS justifications to a user's cognitive preferences does not influence the user's acceptance of KBS recommendations

2.1. Knowledge-based system explanations

KBS have been an important theme in information systems (IS) research for quite some time. Topics include adoption of early medical information systems [e.g., 7], loan evaluation systems [e.g., 13], and more recently, deception detection systems [e.g., 3]. One continuing theme in KBS research is the use of explanations. An explanation is a description of the reasoning processes the KBS uses to solve problems and make recommendations [5,14].

Explanation use is an important determinant of the influence and user acceptance of the KBS's decision [15–17]. Explanations help the user understand the situation or how the KBS came up with its results. Understanding a KBS can influence the user to believe the KBS, thus causing the user to agree more with the KBS [18].
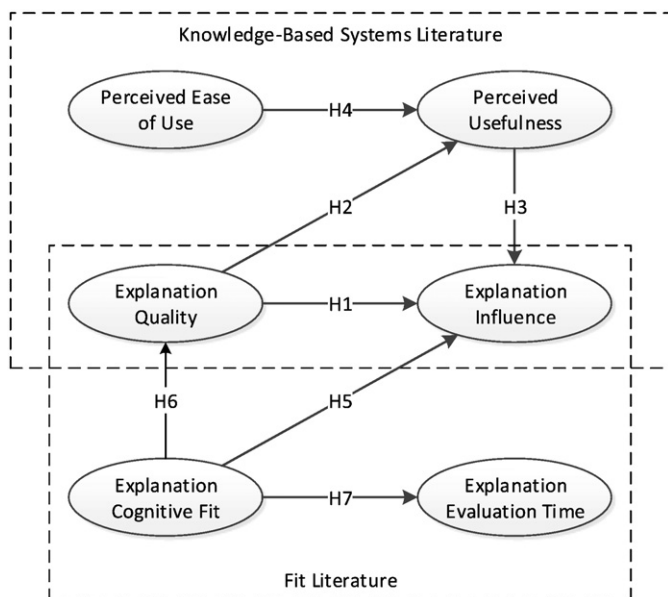

Fig. 1. Hypothetical model.

Because convincing the user to agree with the KBS is the goal of a KBS (assuming that the KBS recommendation is correct), we use two metrics to evaluate the KBS regarding this goal: explanation influence and explanation evaluation time. *Explanation influence* is the amount of change from what a user would have decided before the explanation to what the user decides after the explanation. This is often measured as the accuracy of the user [19]. *Explanation evaluation time* is the amount of time the user spends reading the explanation and coming to a decision [19].

Many types of explanations are possible, from emotion-based explanations to probability-based explanations [20–24], and people process explanations in different ways [25–28]. When people process explanations they aggregate their thoughts, feelings, and the argument made by the explanation into a perceived explanation quality. *Explanation quality* is a user's perception of the explanation's strength and adequacy. Measuring this allows researchers to collect and remove individual differences in scientific studies. An explanation with high quality is perceived as well written and understandable, whether or not the user agrees with it. Evidence of strong, persuasive arguments leading to attitude and belief change has been well supported in the literature [29–31] (see Fig. 1). When a user perceives an explanation to be strong and of high quality, he or she is more likely to have favorable message-oriented thoughts that cause the user to believe the message [32]. These message-oriented thoughts occur because high-quality explanations motivate a reader to understand and process the explanation [30].

H1. Explanation quality will increase explanation influence.

The perceptions and influence of a KBS explanation are tightly integrated with the KBS that provides the explanation to the user. Specifically, explanation quality will increase the user's perception of the system's competence. Explanations can cause users to perceive a KBS as more competent [10] than a KBS without an explanation. KBS are seen as competent when users believe that KBS have the ability, skills, and expertise to act [33]. Explanations make the reasoning process of the KBS transparent, allowing the user to judge the ability, expertise, and usefulness of the system [10]. The *perceived usefulness* of the KBS is a user's belief regarding its ability to enhance job performance [34].

H2. Explanation quality will increase perceived usefulness of the KBS.

When users perceive KBS as more useful, they will have more confidence in the output and decisions made by the KBS [35]. This confidence is due to users perceiving KBS as accurate and reliable, which in turn leads them to trust KBS to make more correct decisions then the user would have made without the KBS [10,35]. When users believe that KBS will provide more correct decisions, they will follow the recommendation of KBS, thereby increasing the influence of outputted explanations on the user.

H3. Perceived usefulness of the KBS will increase explanation influence.

The perceived usefulness of a KBS is not complete without considering the influence of how easy the KBS is to use. *Perceived ease of use* is the degree to which a user believes using the KBS is free from effort [34]. When a KBS is easier to use, all other things being equal, it has greater potential to be useful [34]. This positive relationship has been replicated in a large number of studies [e.g., 34,36]. We add this relationship to our model simply for nomological completeness.

H4. Perceived ease of use will increase perceived usefulness.

2.2. Applying theories of fit to KBS

The combination of the task and the style and wording of the explanation can influence the effectiveness of the explanation [37]. Therefore, the fit between the explanation given and the person