
Abstract

Knowledge-based systems (KBS), which represent the knowledge and problem-solving expertise of human experts as well as other sources of expertise in narrow knowledge domains, have been used to support group decision-making. This research studied the use of a KBS and its explanation facilities to support group decision-making of experts versus novices in a laboratory setting. Consistent with predictions from social judgment theory, the results indicate that experts exhibit a higher level of criticality and involvement in their area of expertise; this not only decreases their likelihood of being persuaded by the KBS, but also accounts for a lower group consensus among experts as compared to novices. Novices benefit more from KBS use and find KBS to be more useful than experts do. In terms of theoretical contributions, this research integrates social judgment theory from the persuasion literature into research on group use of KBS.

Keywords: Knowledge-based Systems, Group Decision Making, Experts versus Novices, Social Judgment Theory
1. INTRODUCTION

This paper describes an experimental research study that investigated the use of a Knowledge-based System (KBS) and its explanation facilities to support small group decision making by experts and novices. The appeal of KBS is that it can codify knowledge and make it available to decision makers, thus turning individuals’ domain knowledge into transferable assets (Prusak, 1997). Knowledge is one of the most important assets of organizations and the only source of sustainable competitive advantage (Drucker, 1995). Therefore, it is important to understand the effectiveness of KBS as a knowledge management tool (Alavi and Leidner, 1999; Hendriks and Vriens, 1999; Liebowitz and Wilcox, 1997; Nissen, 1999) for the different types of end-users within organizations.

KBS represent the knowledge and problem-solving expertise of human experts in narrow knowledge domains. KBS provide two main types of support to its users: 1) analyses and recommendations, and 2) explanations that provide knowledge and reasoning about what the system knows and does, how it works, and why its actions are appropriate (Swartout, 1987). The KBS used in this research provides both types of support to complement the knowledge of decision makers, but not solutions to the problem. This is in line with Luconi, et al. (1986) who advocated the concept of “Expert Support Systems”, which considers KBS as support rather than replacement tools. In a similar vein, Zopounidis, et al. (1997) have proposed the use of “Knowledge-based Decision Support Systems”.

KBS can codify knowledge in a narrow domain and make it available to less-experienced decision makers and even support experienced ones (Luconi, et al., 1986). KBS have helped firms not only to generate financial returns, but also to become strategically important (Gill, 1995). Examples of such applications include the American Express Authorizer’s Assistant
(Rothi and Yen, 1990) and Carrier's EXPERT (Heatley, et al., 1995). KBS can support both individuals and groups (e.g., Swann, 1988; Sviokla, 1989; Santhanam and Elam, 1998). For instance, at Imperial Chemical Industries, a knowledge-based system (so-called decision assistant system) that supports business planning has been used to assist in group decision-making (Swann, 1988). This system, that proved very effective, was not originally conceived as a group support tool, but became one due to business needs. Similarly, a group of financial planners at The Financial Collaborative has used a KBS called PlanPower to help them perform financial planning for their clients (Sviokla, 1989). Other examples of group use of KBS include support for commercial lending officers in their team-based decision making process (Cross, 1997; Radigan, 1993; Strischek and Cross, 1996), which is the task setting used in the experiment described in this paper. Since most of the important decisions in organizations are generally assigned to committees or task forces and KBS have the potential to provide support for groups, it is important to understand how knowledge-based technology influences group decision making by users with varying degrees of domain expertise.

Although several studies have examined the use of KBS (see Section 2), this is the first study to investigate how user expertise moderates the impact of KBS in the group decision-making context. It also examines expert-novice differences in group decision-making. This research extends earlier works on expert-novice differences to the group context. It explains how expertise differences can lead to different group decision outcomes, and suggests how groups with varying degrees of domain expertise can be supported effectively by KBS.

The rest of the paper covers the following sections. Section 2 reviews the literature. Section 3 explains the theoretical foundations of this research that are used to generate the
hypotheses in Section 4. The research method is described in Section 5. The research findings are presented in section 6 and discussed in section 7.

2. LITERATURE REVIEW

This section reviews the empirical studies and literature on the use of KBS and their impact on experts and novices.

2.1 Empirical Studies of KBS Impact

A number of empirical studies have evaluated implications of KBS use (Dhaliwal, 1993; Eining and Dorr, 1991; Gregor, 1996, Hsu, 1993; Lamberti and Wallace, 1990; Mao and Benbasat, 2000, 2001; Nah, et al., 1999; Nah and Benbasat, 2000; Oz, et al., 1993; Peterson, 1988; Sviokla, 1986, 1989, 1990; Ye and Johnson, 1995). Among them, only Sviokla (1986, 1989, 1990), Nah, et al. (1999) and Nah and Benbasat (2000) have examined the use of KBS in multi-individual settings. Sviokla carried out three case studies of KBS use in organizations -- one of which examined KBS use in a group context. Sviokla focused more on the dynamics of the group processes than group decision variables such as group performance, the variables of interest in this study. The overall findings from Sviokla's studies indicate that KBS use increases the effectiveness and efficiency of organizations but at the expense of increased task rigidity. As KBS are being used, maintained and improved upon, problem solving knowledge improved and problem structure increased. Nah, et al. (1999) compared the use of KBS for individual versus group decision-making; groups outperformed individuals whether KBS support was available or not, which signifies the important role of group decision-making in organizations. Nah and Benbasat (2000) found that it was mainly the explanation facilities, rather than the KBS
analyses, that were responsible for the shift in group judgments after KBS use. In this study, we compared group decision-making among experts versus novices and assessed the impact of KBS in both contexts.

Dhaliwal (1993), Eining and Dorr (1991), Gregor (1996), Mao and Benbasat (2000a), and Ye and Johnson (1995) have looked specifically at the availability of KBS explanation facilities and their impact on individual decision makers. Dhaliwal (1993) found that the availability of KBS explanation facilities led to improved performance, but Eining and Dorr (1991) and Gregor (1996) observed no performance differences. Eining and Dorr (1991) found that the use of KBS (both with and without explanation capabilities) benefit domain novices in terms of both time and accuracy, while Oz, et al. (1993) observed improved decision quality but no time differences. Gregor (1996) showed a positive relationship between frequency of use of explanations and problem solving performance; similarly, Mao and Benbasat (2000a) found that the increased use of deep explanations contributed toward increased knowledge transfer. Ye and Johnson (1995) found justification (Why) explanations to be the most effective type of explanation to bring about changes in user attitudes toward the system. We refer the readers to Gregor and Benbasat (1999) for a detailed literature review on use of KBS explanations in the individual context.

2.2 Literature on KBS Impact: Expertise Differences

The literature has indicated that KBS improves judgments in individual and group decision-making, particularly in the group setting (Nah, et al., 1999). We next discuss the literature that indicates individual differences influence knowledge transfer, and that KBS support benefits novices more than experts in the individual decision-making setting.
Hsu (1993) found that a user’s cognitive style and interface design features were two important factors influencing the transfer of knowledge from the KBS to the users. He observed that field-independent type individuals were affected more by different interface designs than were field-dependents. Hsu did not directly examine expert-novice differences.

Lamberti and Wallace (1995) found that KBS has a greater impact on improving the performance of low-skilled users than high-skilled ones. Peterson (1988) found that KBS improved the performance of users; however, this improvement in decision accuracy was greater for inexperienced users than those who were experienced in the task domain.

Mao and Benbasat (2001) observed that novices, by virtue of requesting more deep explanations, were influenced more by the knowledge in the KBS than experts, and made decisions that were more congruent with those of the source experts whose knowledge were used to develop the KBS.

Anderson's (1982, 1999a, 1999b) Adaptive Control of Thought (ACT) and Three-Stage Learning Model can be used to account for the observed expert-novice differences in KBS impact as noted above. In ACT, two main types of knowledge associated with long-term memory were introduced -- declarative and procedural/production. Declarative knowledge refers to knowing that something is the case (i.e., factual knowledge), and production knowledge refers to how to do something (i.e., knowledge that lead to performance). According to ACT, experts generally possess both production (or procedural) and declarative knowledge whereas novices generally have declarative knowledge to solve a problem but lack abstracted procedural knowledge. As such, novices rely more on declarative knowledge than procedural knowledge in problem solving, which explains why novices are more influenced by deep (i.e., factual) explanations when compared to experts (Mao and Benbasat, 2001). KBS analyses and the
associated explanations are also helpful to novices in overcoming their lack of procedural knowledge. This explains why KBS impact is greater for low-skill/inexperienced users when compared to high-skill/experienced users (Lamberti and Wallace, 1995; Peterson, 1988).

The concept of expertise associated with ACT is further elaborated in Anderson's Three-Stage Learning Model. As one advances from a novice to an expert, one would be advancing from the "cognitive stage", to an intermediate stage called the "associative stage", and finally, to the "automatic stage". These three stages describe the degree of automation of one's production knowledge. The cognitive stage is characterized by the discovery of relevant aspects of the task and the storage of declarative knowledge about the skills. It takes effort to understand the task and to learn which information one must attend to. The associative stage involves making the cognitive processes efficient, allowing rapid retrieval and perception of required information. Thus, during the associative stage, skills are chunked, or compiled, into procedural knowledge. At the autonomous or automatic stage, performance is automatic, and conscious cognition is minimal. The procedures of the basic skills undergo a process of continual refinement (i.e., tuning) and strengthening, which increases performance, speed, and accuracy. Novices perform at the cognitive or associative level, and require conscious cognitive effort and deliberate thinking in carrying out the task. Hence, KBS explanations that assist them in understanding the task domain could be very useful to novices (Mao and Benbasat 2000). On the other hand, experts are less likely to find KBS support useful when compared to novices since most of their problem solving processes have been automated.
3. THEORETICAL FOUNDATIONS FOR KBS USE IN GROUP CONTEXTS

In this research, we use a construct called *congruence* to assess the persuasive influence of KBS. Congruence is defined here as the *degree of similarity* between the judgments made by the KBS users and those made by the knowledge-source experts (i.e., experts whose knowledge were used to develop the KBS). We expect that the utilization of KBS analysis and explanation support, which reflect the knowledge of the source-experts, will influence the groups' judgments toward those of the knowledge-source experts, resulting in increased congruence between them. Figure 1 illustrates the congruence construct. It is discussed in more detail in Section 5.

![Figure 1: Congruence](image)

One general theory that discusses the conditions that lead to behavior change as an outcome of persuasive communication is Petty and Cacioppo’s (1981, 1986) *Elaboration Likelihood Model* (ELM). ELM was used in an earlier study to predict the differential impact of different levels (or types) of KBS support on decision congruence (Nah and Benbasat, 2000). In this study, however, the focus of the investigation is on how KBS advice and explanations affect congruence differentially for novice versus expert decision makers in group settings. Since
Anderson's ACT Model and Three-Stage Learning Model do not take into account the social setting among decision makers, they cannot explain the phenomena in the group setting completely. Therefore, both ELM and Social Judgment Theory (SJT) are used to generate the hypotheses for this research and to explain differences in group decision making behavior between experts and novices provided with a KBS.

According to ELM, persuasion can take place via two routes – central and peripheral – based on the moderating effects of either motivation or ability for elaboration. With a higher ability to process information, experts are more likely to take the central route (rather than the peripheral route) to persuasion because their likelihood of elaboration is higher. Central route occurs when careful and thoughtful consideration of the true merits of the persuasive message takes place, while peripheral route refers to change or response induced by cues that do not necessitate scrutiny of the central merits of the message (Petty and Cacioppo, 1986). Although experts typically possess higher motivation for elaboration, their level of motivation may decrease due to their ego-involvement (Sherif and Cantril, 1947).

The SJT emphasizes how one's prior attitudes and ego-involvement affect one's perception of the position advocated in a new persuasive message, which in turn influence one's agreement with the message. SJT has been called the “assimilation-contrast” theory (e.g., Insko, 1967; Sherif and Hovland, 1961) and the “social judgment-involvement approach” (e.g., Sherif, et al., 1965). These names highlight the theory’s key constructs: 1) assimilation and contrast effects in perception, and 2) ego-involvement, the extent to which an attitude is part of one’s self-concept and is thus “intimately felt and cherished”.

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3.1 Assimilation and Contrast

According to SJT, a recipient’s own attitudinal position serves as a judgmental standard or anchor that influences where a communicator’s advocated position is perceived to lie along an evaluative continuum. Attitudes that are relatively close to one’s own are assimilated (perceived to be closer than they actually are), but attitudes that are very discrepant from one’s own are contrasted (perceived to be further than they actually are). As will be explained later, experts are more likely than novices to contrast (rather than assimilate) their judgments with a new advocated position such as one put forth by the KBS or another group member.

3.2 Role of Ego-Involvement

People’s judgment is assumed to vary as a function of ego-involvement. Sherif and Cantril (1947) define ego-involved attitudes as those that are part of the person’s self-concept or “ego”, attitudes that “have the characteristic of belonging to me, as being part of me” (p. 93). Sherif and Cantril view ego-involvement as having important motivational and affective consequences.

The concept of “ego-involvement” is important in this research as most experts exhibit such a characteristic. Experts are known to possess special skills, knowledge, and experience in a particular domain and would feel frustrated, annoyed, or even “threatened” if their status or ideas were challenged. SJT assumes that exposure to discrepant attitude positions creates little “tension” or “incongruity” for the less involved person (e.g., a novice), but a great deal of psychological discomfort for the ego-involved person (Sherif and Sherif, 1967, p. 130). The ego-involved person is presumed by the theory to become highly engaged in attitude-relevant tasks and to encode attitudinal information in a highly personalized, self-protective manner. By
contrast, the uninvolved person is presumed to be less personally engaged in such tasks and to encode attitudinal information in a relatively detached, objective, and factual manner (Sherif and Hovland, 1961). Similarly, Fiske and Taylor (1991, p.480) noted that involved recipients respond with more negative thoughts to a high credibility source.

According to SJT, experts are less likely than novices to accept conclusions and explanations provided by KBS. Since experts tend to be more ego-involved than novices, their latitude of rejection is larger, indicating that they are more likely to strongly reject arguments different from their own. The SJT also suggests that experts tend to be critical not only with KBS but also among themselves, thus making it more difficult for experts to achieve true consensus compared to novices.

4. HYPOTHESES

As mentioned earlier, to measure the persuasive influence of KBS, we employ a construct called **congruence**, which refers to the **degree of similarity** between the judgments of KBS users and the knowledge-source experts (refer to Figure 1). (Section 5.4 describes the “congruence” construct in greater detail.) Knowledge-source experts are the experts whose knowledge was utilized in developing the KBS used in this research. We expect that, in general, KBS analysis and explanation support will influence group judgments of decision makers toward those of the knowledge source experts, resulting in congruence of judgments with those of the knowledge source experts.

According to SJT, domain experts tend to be highly ego-involved and critical in their area of specialization and, thus, are less likely than novices to accept the analysis and advice given by the KBS. We, therefore, hypothesize that, compared to group judgments made by
novices, group judgments made by domain experts will be less congruent with those of the knowledge-source experts.

H1: With KBS support, group judgments made by novices will be more congruent with those of the knowledge-source experts than group judgments made by experts.

In line with the heightened criticality hypothesis (Biek and Wood, 1996) and the social judgment theory (Sherif and Hovland, 1961), domain experts not only have a greater ability to critically evaluate even strongly argued messages (such as those from the KBS or other experts), but also have a stronger tendency to reject or oppose them. Thus, domain experts are, in general, more critical and more likely to disagree with one another's judgments. We, therefore, expect groups comprising domain experts to reach a lower level of consensus after KBS-supported discussions than groups comprising novices.

H2: After KBS-supported discussions, groups comprising novice decision makers will achieve a higher level of group consensus than groups comprising experts.

According to SJT, experts are less likely than novices to yield to the analysis and advice given by KBS. KBS, therefore, exert greater influence on novices and provide greater help to novices than experts. Hence, it is hypothesized that:

H3: Groups comprising novices will perceive KBS to be more useful than groups comprising experts.
5. RESEARCH METHOD

A laboratory experiment was conducted to test the research hypotheses in a KBS-supported group decision-making context. The task was a financial analysis case involving the evaluation of a commercial loan application by a hypothetical firm called Canacom. All subjects were provided with five years’ financial statements of the firm, financial ratios derived from the statements, and information on the purpose and size of the loan requested. The subjects were asked to assume the role of corporate loan officers to assess various aspects of the firm’s financial health.

The subjects were required to answer six questions about the strengths and weaknesses of the company’s financial condition. These questions asked the subjects to rate, on a scale of 1-10, the liquidity, long-term solvency, asset utilization, the value of stock as collateral, and the quality of financial and operating management of the company, respectively. For example, the question concerning liquidity is as follows:

*Based on your analysis and under current economic and interest-rate conditions, rate Canacom's current liquidity position. Please circle the correct answer.*

*Very Weak Position: 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 : Very Strong Position*

5.1 Experimental KBS

For experimental control, a simulated KBS, named FINALYZER, was developed and used for the study. Six senior financial analysts, whose experiences ranged from 12 to 23 years, were recruited for knowledge acquisition. They were given the same commercial loan evaluation case to analyze as the one used by the subjects in this study. The panel's concurrent verbal protocols were collected to determine the type of analysis that they performed and their detailed reasoning
processes and explanations. The problem-solving process of the panel members was also captured and used as the basis for developing FINALYZER. The conclusions derived by the panel members were extracted, grouped into sub-analyses, and incorporated into FINALYZER as recommendations under the respective sub-analyses. The results became the basis for FINALYZER (Dhaliwal, 1993).

To validate the system, two accounting professors, three doctoral students in accounting/finance, and two junior financial analysts used the KBS. None of them was able to detect that it was not a fully functional KBS. The system was used in prior research, and was considered highly realistic and useful by the subjects (Dhaliwal, 1993). Subjects also rated very highly the level of expertise displayed by the system, as it was compared to the best human experts in industry.

The experts whose knowledge was used to develop the KBS (labeled as knowledge-source experts) were also asked to provide a “solution” to the six judgmental questions involved in the experimental task. The final set of scores agreed upon by the panel, after a two-round Delphi process, was taken as a benchmark of the “correct” judgments for the case. These consensus scores (i.e., judgment scores that were agreed upon by the knowledge-source experts) were retained as the benchmark solution for assessing decision congruence.

As a decision support tool for a semi-structured (financial analysis) task, the KBS does not provide solutions to its users. Instead, it provides analyses and explanations that reflect the consensus judgments of the knowledge-source experts. In FINALYZER, each conclusion or recommendation has three types of reasoning-trace explanations that describe the problem-solving process of the system. These reasoning-trace explanations reveal: 1) why the recommendation is relevant and important (Why explanation), 2) how the recommendation has been reached (How
In addition to reasoning-trace explanations, deep explanations underlying generic domain knowledge for each of the concepts used in financial analysis are also provided. Deep explanations (Swartout and Smoliar, 1987) include: a) Terminological Knowledge: knowledge of concepts and relationships of a domain that domain experts use to communicate with each other, b) Domain Descriptive Knowledge: “textbook rudiments” which are required before one can solve problems, providing abstract factual knowledge about a domain and is typically represented declaratively, and c) Problem-Solving Knowledge: knowledge about how tasks can be accomplished. Three types of deep explanations for each concept are available in terms of: 1) its definition (How explanation), 2) why it is useful and important (Why explanation), and 3) relationships with other concepts involved in the same task (Strategic explanation). Appendix A shows examples of the KBS analysis (or recommendation) screens and the reasoning-trace and deep explanations.

FINALYZER performs financial analysis in terms of several sub-analyses such as liquidity, capital structure, and profitability. It provides three types of screens (Figure 2) for each of the sub-analyses: 1) an information screen containing an index of domain concepts (financial ratios and procedures), for which deep explanations can be requested, 2) a data screen of relevant financial ratios calculated from the financial statements of the firm to be evaluated, and 3) recommendation screens presenting results of the “evaluation” of the financial statements and ratios, in the form of recommendations. Reasoning-trace explanations can be requested for each of the recommendations. The sequence of the screens is shown in Figure 2, which is consistent with the normal procedure of financial analysis, i.e., calculating financial ratios first and then
yielding judgments for making decisions and predictions.

Furthermore, FINALYZER allows contextualized access to deep explanations via hypertext-style links. Contextualized access makes deep explanations available not only through the information screen prior to the analysis, but also from system recommendations and reasoning-trace explanations. When examining deep explanations, users can access explanations on related domain concepts by following the hypertext-style links. Therefore, deep explanations are not only linked to other related deep explanations but also integrated into other parts of system output (i.e., reasoning-trace explanations and recommendations).

5.2 Subjects

Two groups of subjects were involved in this research: experts versus novices. Since specialized skills, i.e., skills related to advanced accounting and financial statements analysis, were needed to carry out the financial analysis task, only subjects knowledgeable in accounting were recruited to increase the generalizability and validity of the study. The expert subjects were experienced professionals whose work involved financial analysis and whose job responsibilities include making commercial loan decisions on a regular (daily or very frequent) basis in major
financial institutions. Hence, they satisfy Camerer and Johnson's (1991) definition of experts, which refer to those who are experienced and have some professional or social credentials in the domain. The novice subjects included business seniors and MBA students who either specialized in accounting or had taken accounting courses extensively. They had conceptual domain knowledge on financial analysis but had no practical experience in its performance. These novices were different from laypersons, which refer to people with little or no specialized skill in the domain area. They were “educated novices,” similar to entry-level employees for financial analysis positions. A total of 27 novice subjects (9 groups of 3) and 18 expert subjects (6 groups of 3) participated in the study.

As a manipulation check, we captured the subjects’ self-rating of their competence as a financial analyst in the background information questionnaire by asking: “How do you rate yourself as a financial analyst (of a corporate loan decision)? (1– Excellent, 2 – Good, 3 – Somewhat good, 4 – Fair, 5 – Somewhat poor, 6 – Poor, 7 – Bad)” The average rating of the novice subjects was 3.8 and that of the expert subjects was 1.9. The difference is statistically significant at $p<0.01$. This supports our operationalization of the expertise construct. For the experts, the average number of years of financial analysis related working experience was 13.3 years.

### 5.3 Experimental Procedures

Figure 3 illustrates the experimental procedures. We randomly assigned the novice subjects from the same session of accounting classes to groups of three. We also randomly assigned the expert subjects working for the same financial institution to groups of three.
#1. Individual Judgments

*Training: Familiarize with Features of KBS*

*KBS-supported Group Decision Making*

#2. Group Judgments

#3. Individual Judgments

**Figure 3: Research Procedure**

The subjects first completed the consent forms and background information questionnaires. They were next given the relevant financial information of the company to be evaluated. They then worked on the case *individually and without* any form of KBS support, and produced a set of individual judgments concerning the financial strength of the company by evaluating it along the following dimensions: liquidity, long-term solvency, asset utilization, the value of stock as collateral, and the quality of financial and operating management of the company.

Subjects were then provided with the appropriate training to familiarize them with the features of the KBS. Another system for evaluating consumer credit applications that has similar features as the experimental KBS was used for the training session. Next, the subjects worked in their assigned groups of three until a group consensus was reached on the same set of judgments they had made earlier. Finally, they were asked to make the same set of judgments again *individually* taking into account what they had learned from their group discussions and the KBS. The final individual judgments allowed us to evaluate consensus within the groups. The
perceived usefulness of the KBS was captured using a survey questionnaire administered at the end of the experiment.

The group members used the KBS together. A “chauffeur” carried out the group member’s verbal requests to access KBS advice system and explanations (see experimental setup in Figure 4) so that no one member would “dominate” the process by controlling the mouse.

![Figure 4: Experimental Setup](image)

### 5.4 Measures for Dependent Variables

Recall that the answers to six questions (i.e., liquidity, long-term solvency, asset utilization, value of stock as loan collateral, quality of financial management, and quality of operating management) were used to evaluate the congruence of the group judgments with those of the knowledge-source experts.

The level of congruence for each of the six judgments is assessed by its absolute deviation from the judgment of the knowledge-source experts:

\[
D_i = |G_i - S_i| \quad i = 1, 2, \ldots, 6
\]
where $D_i$ is the absolute deviation of the group judgment from the judgment of the knowledge-source experts on the $i$th question, $G_i$ is the group judgment on the $i$th question, and $S_i$ is the judgment of the knowledge-source experts on the $i$th question. The total deviation score, $D$, is the sum of the absolute deviations of these six group judgments from the judgments of the knowledge-source experts:

$$D = \sum_{i=1}^{6} D_i$$

Therefore, the lower the total deviation score, the closer are the group judgments from the judgments of the knowledge-source experts, and hence, the higher the level of congruence.

For each of the six judgments, group consensus was measured by the sum of the absolute value of the deviations (or differences) between the final (post-discussion) individual judgments of every pair of group members. Hence, the total score, $C$, is:

$$C = \sum_{q=1}^{6} \sum_{i\neq k}^{3} |J_{iq} - J_{ik}|$$

where $J_{iq}$ is the final (post-discussion) individual judgments on the $q$th question by the $i$th member of the group. Therefore, the lower the total score ($C$), the higher the level of consensus in the group.

Perceived usefulness of KBS refers to the degree to which users perceive the KBS to enhance their task performance. The scale for Perceived Usefulness of KBS was adapted and modified from the instrument developed by Dhaliwal (1993), which was an adaptation of the instruments from Moore and Benbasat (1991) and Davis (1986). Since Dhaliwal’s (1993) study was carried out in the individual context, the scale was slightly modified in this research to suit
the group context. The instrument was included as part of the post-study questionnaire administered to the individual subjects. The items in the scale are presented in Appendix B. Based on the data collected in this study, the perceived usefulness scale had a Cronbach’s alpha coefficient of 0.92.

6. FINDINGS

Quantitative analyses were carried out to compare the congruence of group judgments, group consensus, and perceived usefulness of KBS between experts and novices. Since this study looks at group decision-making, the default unit of analysis is at the group level. For measures captured at the individual level, the nested hierarchical ANOVA design is used. The Mann-Whitney U test, a non-parametric test (Siegel and Castellan, 1988), was used when the assumptions of the parametric tests were not met (Neter, et al., 1996).

6.1 Congruence in Group Judgments

The first hypothesis compares the group judgments (#2 in Figure 3) of experts versus novices in terms of their level of congruence. Since the distribution of the total deviation scores does not meet the normality assumption, the Mann-Whitney U test was used for the analysis. Table 1 shows the descriptive statistics while table 2 presents the results of the Mann-Whitney U test.
Table 1: Descriptive Statistics – Congruence of Group Judgments

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts</td>
<td>6</td>
<td>6.83</td>
<td>1.60</td>
<td>.65</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Novices</td>
<td>9</td>
<td>4.89</td>
<td>2.09</td>
<td>.70</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>5.67</td>
<td>2.09</td>
<td>.54</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 2: Results of Mann-Whitney U Test – Congruence of Group Judgments

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
<th>Mann-Whitney U</th>
<th>p-value (1-tailed)</th>
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<tr>
<td>Experts</td>
<td>6</td>
<td>10.42</td>
<td>62.50</td>
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<td>.04</td>
</tr>
<tr>
<td>Novices</td>
<td>9</td>
<td>6.39</td>
<td>57.50</td>
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</table>

The results of the Mann-Whitney $U$ test indicate that experts were less likely than novices to buy-in to KBS advice and recommendations ($p<.05$). Hypothesis 1 was supported. This phenomenon can be explained based on the SJT, which posits that experts, by being more ego-involved than novices, are more critical and less likely to accept KBS analysis and advice.

A test was carried out to assess if the observed difference could be attributed to differences in extremity of initial judgments. To do so, the congruence levels of the initial (pre-discussion) individual judgments (#1 in Figure 3) of experts versus novices were compared at both the individual and group levels. Since the normality, homogeneity of variances, and independence assumptions were satisfied, the $t$ test was used for the analysis.

The congruence level of the initial judgments of the expert subjects is not statistically different than those of the novice subjects when analyzed at the individual level ($t$ test: $p=0.53$ (2-tailed)) or at the group level ($t$ test: $p=0.67$ (2-tailed)). The descriptive statistics of the congruence level (absolute deviation) of the individual pre-discussion judgments from the
judgments of the knowledge-source experts are shown in Table 3. Table 4 shows the equivalent
descriptive statistics aggregated at the group level. Table 5 shows the results of the analysis.

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev</th>
<th>Std. Error</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts</td>
<td>17</td>
<td>8.47</td>
<td>3.48</td>
<td>.85</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Novices</td>
<td>27</td>
<td>9.15</td>
<td>3.48</td>
<td>.67</td>
<td>3</td>
<td>15</td>
</tr>
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<td>Total</td>
<td>44</td>
<td>8.89</td>
<td>3.46</td>
<td>.52</td>
<td>3</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 3: Descriptive Statistics – Congruence of Individual Pre-discussion Judgments

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev</th>
<th>Std. Error</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts</td>
<td>5</td>
<td>8.73</td>
<td>1.84</td>
<td>.83</td>
<td>7.00</td>
<td>11.33</td>
</tr>
<tr>
<td>Novices</td>
<td>9</td>
<td>9.15</td>
<td>1.59</td>
<td>.53</td>
<td>6.00</td>
<td>10.67</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>9.00</td>
<td>1.63</td>
<td>.43</td>
<td>6.00</td>
<td>11.33</td>
</tr>
</tbody>
</table>

Table 4: Descriptive Statistics – Congruence of Individual Pre-discussion Judgments

Aggregated at the Group Level

<table>
<thead>
<tr>
<th>Source</th>
<th>Level of Analysis</th>
<th>t</th>
<th>df</th>
<th>p-value (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expertise</td>
<td>Individual</td>
<td>.63</td>
<td>42</td>
<td>.53</td>
</tr>
<tr>
<td>Expertise</td>
<td>Group</td>
<td>.42</td>
<td>12</td>
<td>.67</td>
</tr>
</tbody>
</table>

Table 5: Results of t Test – Congruence of Individual Pre-discussion Judgments

There is no significant difference in the congruence of initial individual judgments
between the experts and novices. This is presumably because the novices, like the experts, are
knowledgeable in the task domain. Recall that the novice subjects had been trained in the domain
and had the prerequisite domain knowledge on financial analysis. This validation check rules out
position extremity (anchoring effect) as a possible cause, thus supporting the SJT. According to

---

1 Only 17 instead of 18 (6x3) cases were considered because one of the subjects did not specify one of his/her
individual pre-discussion judgments.
SJT, the larger latitudes of rejection exhibited by experts are the result of heightened ego-involvement, not the result of extreme positions per se (Sherif, et al., 1965, p.233).

As presented in Table 6, the congruence in group judgments (from the group average of individual pre-discussion judgments) of both experts and novices improved by magnitudes of 4.26 and 1.73 respectively with KBS use in a group setting, indicating that the KBS exerted a greater influence on the novices than on the experts.

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts</td>
<td>5</td>
<td>1.73</td>
<td>1.51</td>
<td>.50</td>
<td>-1.00</td>
<td>3.67</td>
</tr>
<tr>
<td>Novices</td>
<td>9</td>
<td>4.26</td>
<td>1.93</td>
<td>.87</td>
<td>2.33</td>
<td>6.33</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>3.36</td>
<td>2.03</td>
<td>.54</td>
<td>-1.00</td>
<td>6.33</td>
</tr>
</tbody>
</table>

Table 6: Descriptive Statistics – Change in Congruence Level from Group Average of Individual Pre-discussion Judgments to Group Judgments

The results indicate that the novices were more receptive to the KBS advice and explanations than the experts were, since according to SJT, the experts are bound to be more critical of the KBS advice and explanations, and therefore, were less likely to accept them.

6.2 Group Consensus

The second hypothesis compares the level of group consensus between experts and novices. The descriptive statistics are presented in Table 7. Since the distribution violates the normality assumption, the Mann-Whitney U test was used for the analysis. The results of the Mann-Whitney U test are shown in Table 8. The results indicate that the level of group consensus

---

2 Only 5 cases were considered because one of the subjects did not specify one of his/her individual pre-discussion judgments.
consensus between the experts and novices differ significantly \((p<.05)\). Compared to the novices, the experts reached a lower level of consensus in their final judgments (#3 in Figure 3). This indicates that experts are not only less likely to agree with the KBS as discussed in the previous section, but also less likely to agree with one another.

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Min</th>
<th>Max</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts</td>
<td>6</td>
<td>17.00</td>
<td>3.03</td>
<td>1.24</td>
<td>14</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>Novices</td>
<td>9</td>
<td>9.56</td>
<td>7.60</td>
<td>2.53</td>
<td>2</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>12.53</td>
<td>7.11</td>
<td>1.84</td>
<td>2</td>
<td>28</td>
<td>26</td>
</tr>
</tbody>
</table>

*Table 7: Descriptive Statistics – Level of Group Consensus*

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
<th>Mann-Whitney U</th>
<th>(p)-value (1-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts</td>
<td>6</td>
<td>11.50</td>
<td>69.00</td>
<td>6.00</td>
<td>.01</td>
</tr>
<tr>
<td>Novices</td>
<td>9</td>
<td>5.67</td>
<td>51.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 8: Results of Mann-Whitney U Test – Level of Group Consensus*

To verify that the observed difference arose during or after KBS-supported group discussions, a pre-test was carried out to compare the level of consensus in the initial (pre-discussion) individual judgments (#1 in Figure 3) of the experts and novices (with group as the unit of analysis). Since the distribution violates the normality assumption, the Mann-Whitney \(U\) test was used for the analysis. The descriptive statistics are presented in Table 9. The results of the analysis are shown in Table 10. There is no difference in the initial (before KBS use) level of consensus between the expert and novice groups \((p=.52)\), indicating that the observed difference in level of consensus (after KBS use) occurred after the KBS-supported group discussions.

\(^3\) Only 5 cases were considered because one of the subjects did not specify one of his/her individual pre-discussion judgments.
Based on the SJT, the outcomes observed can be explained as follows: The novices, by being more receptive to the KBS advice and explanations, were able to reach a higher level of group consensus compared to the experts. On the other hand, the experts were more ego-involved in the decision making process and were less likely to accept the advice and explanations offered by the KBS or other members of the group. As such, KBS influence novices more than experts in reaching group consensus. However, it is still the case that both experts and novices show a significant improvement in consensus due to KBS use, as a comparison of the data in Tables 7 and 9 show. This finding is consistent with that reported in a meta-analysis (Benbasat and Lim, 1993) that consensus is enhanced when a level 2 group decision support system (one that provides modeling and analysis similar to the KBS employed in this study) is used.

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4 Only 5 cases were considered because one of the subjects did not specify one of his individual pre-discussion judgments

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### Table 9: Descriptive Statistics – Level of Consensus of Initial Judgments

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
<th>Mann-Whitney U</th>
<th>p-value (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts</td>
<td>5</td>
<td>8.50</td>
<td>42.50</td>
<td>17.50</td>
<td>.52</td>
</tr>
<tr>
<td>Novices</td>
<td>9</td>
<td>6.94</td>
<td>62.50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 10: Results of Mann-Whitney U Test – Level of Consensus of Initial Judgments
6.3 Perceived Usefulness of KBS

The third hypothesis compares the perceived usefulness of KBS between experts and novices. Since perceived usefulness of KBS was measured at the individual level, the nested hierarchical ANOVA design is most appropriate for the analysis (Anderson and Ager, 1978). The primary aspect of the nested hierarchical ANOVA design is the assumption that an individual's score is in part influenced by the social unit to which he or she belongs. In this study, subjects were assigned to (and therefore nested within) groups of three, which were nested within expertise. Therefore, the total variability among subjects has three potential sources: treatment effects, group effects, and residual individual differences (subjects within the same group may vary due to such factors as attitude or ability).

As the distributions for perceived usefulness of KBS satisfy the normality, homogeneity of variances, and independence assumptions, the nested hierarchical ANOVA design will be used for the analysis. The descriptive statistics are presented in Table 11 and the results are presented in Table 12.

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Min</th>
<th>Max</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experts</td>
<td>18</td>
<td>42.50</td>
<td>10.19</td>
<td>2.40</td>
<td>18</td>
<td>55</td>
<td>37</td>
</tr>
<tr>
<td>Novices</td>
<td>27</td>
<td>49.30</td>
<td>6.52</td>
<td>1.25</td>
<td>39</td>
<td>62</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>46.58</td>
<td>8.75</td>
<td>1.30</td>
<td>18</td>
<td>62</td>
<td>44</td>
</tr>
</tbody>
</table>

*Table 11: Descriptive Statistics – Perceived Usefulness of KBS*
The results indicate that the novices perceived the KBS support to be more useful than the experts did ($p<.05$), which is consistent with what was expected. Since experts are more ego-involved, they are less influenced by KBS advice and explanations compared to novices. Novices, on the other hand, are more willing to accept KBS advice and explanations. Therefore, novices find KBS support to be more useful than experts do in helping them improve their task performance.

### 7. DISCUSSION AND CONCLUSIONS

This research extends earlier studies on KBS by investigating the effectiveness of KBS in a group setting for decision makers of different levels of expertise. The results suggest that KBS have a high potential in influencing group decision making by both novices and experts, but that the impact is more pronounced for novices.

Expertise is a key factor moderating the effectiveness of KBS. As the skills of the professional financial analysts who participated in our study are highly valued in the financial industry, they tend to be highly ego-involved in their area of specialization (Sherif and Cantril, 1947). Social judgment theory suggests that experts, by being ego-involved, have larger latitudes of rejection, i.e., they are more likely to oppose arguments different from their own. Experts are more likely to critically evaluate KBS conclusions and to generate opposing opinions, which in
turn reduce their likelihood of accepting KBS conclusions. For instance, one expert, after reading a KBS conclusion indicating that “the company was following a policy of accepting lower asset turnover for higher profit margin”, disagreed:

“I think that's a dangerous conclusion to say that one (higher profit margin) follows from the other (lower asset turnover). They are accepting a lower asset turnover, that's no question. But that doesn't mean that's why they're generating a higher profit margin. They could be generating a higher profit margin because they have a better computer. And the fact that they have lower turnover is just bad management. So, I appreciate that may be the case, but it's certainly not an easy conclusion to draw.”

Such behavior is in line with the heightened criticality hypothesis (Biek and Wood, 1996) and the social judgment theory (Sherif and Hovland, 1961). They are supported strongly by the results of our data analysis: experts’ judgments were less congruent with those of the knowledge-source experts than the novices’ judgments were, implying a lower level of acceptance of KBS conclusions by the experts. Although both the experts and novices in our study did not differ in their amount of usage of KBS explanations, expert decision makers were less likely to be persuaded by the KBS than the novice decision makers.

The heightened criticality hypothesis also applies to interactions among experts, as they tend to be critical not only with the recommendations of the KBS but also among themselves. In other words, they also critically evaluate recommendations given by their peers. Thus, in the presence of KBS support, expert decision makers achieve lower group consensus than novice decision makers.
Perceived usefulness is an important variable in IS research as it strongly influences users’ intention to use a system (Davis, Bagozzi, and Warshaw, 1989), which in turn influences actual usage of the system (Moore and Benbasat, 1996; Taylor and Todd, 1995). KBS is perceived to be more useful by novices than experts in improving task performance that was carried out in groups, indicating that novices are more likely than experts to use KBS. Since novices have less experience in carrying out the task, the KBS would be more helpful to them than it would be to experts.

In this study of group decision-making, novices were found to be more willing to accept KBS recommendations than experts. Lamberti and Wallace (1995) and Peterson (1988) also made the same observation for individual decision makers. Additionally, novices found KBS to be more useful in improving their group decision-making effectiveness and they achieved higher consensus than experts with KBS use.

These findings are consistent with the theories, which predict that novices are more likely to accept advice from external sources. But to accept such advice, novices should also believe in the veracity of the advice they are receiving. From earlier research (Nah and Benbasat 2000) we know that for novices, the provision of both KBS explanations and advice (as was the case in this study) are necessary for accepting KBS recommendations and increasing decision congruence. Explanation facilities are likely to enhance users' trust in the KBS because they increase users' comprehension of KBS advice and reasoning, and the perceived technical capability demonstrated by the KBS. Explanations also increase the force and diversity of arguments that support the KBS analyses and recommendations, thus making the specific messages (advice) provided by the KBS more believable.
There are several limitations in this research. First, we faced many difficulties recruiting *experts* for this study, though we were able to have 18 experienced financial analysts from two major financial institutions (nine from each institution) to participate in the study. This is adequate for statistical analysis, since according to Siegel and Castellan (1988), we need a minimum of 5 data points per cell for non-parametric statistics. Our original design was a factorial design that not only compared expert versus novice use of KBS for group decision making, but also compared the effectiveness of *different levels* of KBS support for both expert and novice groups; however due to the small number of experts available for this study (six groups of three) we were not able to do a more extensive study. Another limitation of this study concerns its generalizability. Since this study was a laboratory experiment, it may lack realism. Subjects may behave differently when asked to make decisions in such a setting. Further, since this experiment was conducted in a face-to-face group context, the results may not be generalizable to a *non* face-to-face setting. Future research is needed to evaluate if experts and novices would approach the use of KBS differently in a non face-to-face group decision making setting, and how such differences (if any) would impact on group decision making effectiveness.

Third, since this is a one-time cross-sectional study, the possibility of novelty effect cannot be ignored. Since each experimental session lasted about three hours (due to the nature of group decision making), we were not able to ask the subjects to analyze another case without sacrificing reliability and validity (e.g., fatigue). Although it would have been possible to arrange another session for the same group of subjects in order to study the longitudinal effect of KBS use, attrition was an issue - particularly since all three subjects of a group must be present to carry out the session. However, a number of measures were taken to minimize novelty effect. Before the subjects began to use the experimental KBS, we provided them with a training
session to familiarize them with the features of a similar KBS. We also provided them ample time to familiarize with the case (during the initial individual decision making phase) and the KBS (during the training session) to minimize the cognitive load and complexity involved in using the KBS for group decision-making.

The contributions of this research can be viewed from both the empirical and theoretical perspectives. From an empirical perspective, this research extends the use of the KBS technology to the group context. To the best of our knowledge, this is the first study to offer empirical evidence of KBS support for group decision-making among experts versus novices. From a theoretical perspective, this research links KBS research with group decision-making and persuasion theories. We believe the integration of persuasion theories with empirical evaluation of group decision-making by experts versus novices is an important and unique contribution to the existing literature.

In terms of knowledge management, the accumulated knowledge from several studies (e.g., Nah, et al., 1999; Mao and Benbasat, 2000, 2001) on KBS and explanation use leads to the following observations about the “transfer” of knowledge from a KBS to its users:

1. **Benefits of KBS Use**: KBS use benefits both individuals and groups, that is, individuals (or groups) provided with KBS support exhibit higher decision congruence than individuals (or groups) without KBS support.

2. **Benefits of KBS Use for Individuals versus Groups**: Groups with KBS support achieve higher decision congruence than individuals with KBS support, indicating the high potential and benefits of KBS use for group decision-making.

3. **Individual Differences**: Novices are more strongly influenced by the deep explanations they receive from a KBS than experts (Mao and Benbasat, 2001). This study
also observed that for decision-making groups, KBS support is more influential for novices than experienced professionals.

In summary, the effect of KBS appears to be less influential for experts, either in groups or as individual problem solvers. In this paper, we provided an explanation as to why this is the case based on the heightened criticality hypothesis and the social judgment theory. The open research question is whether support features that might benefit expert decision makers can be identified, or such attempts are bound to be dysfunctional by creating an adverse reaction on the part of the experts. The results and anecdotal evidence from this study indicate that expert subjects exhibited a strong critical stance towards the KBS, even when this use was for an academic study; one would expect a more adverse reaction if such use was suggested in one’s work setting. We also know that (Mao and Benbasat, 2000) even when they request KBS explanations, experts do so more to compare their problem solving strategies to that of the KBS and to challenge the way the KBS analyzes the problem. The elaboration likelihood model (Petty and Cacioppo, 1981, 1986) predicts that explanations support is necessary to convince and persuade experts to accept conclusions provided by KBS, whereas novices may be persuaded based partly on the perceived credibility (expert power) of the KBS. The benefits of providing KBS explanations to novices have been empirically verified in an earlier study (Nah and Benbasat, 2000). Therefore, a potentially promising avenue to identify how to promote KBS use by expert decision makers is to focus on the type of explanations that they should be provided to convince them to accept the analyses and recommendations advocated by KBS.

Lastly, this research contributes to the testing and development of SJT. In past research, ego-involvement and position extremity have been confounded due to their empirical association, making it impossible to rule out position extremity as a possible cause (O'Keefe,
1990; Petty and Cacioppo, 1981). This confounding effect created a classic controversy in the literature. In this research, we rule out position extremity as a possible confound to the relationship (refer to validation check in Section 6.1) between ego-involvement of decision makers and persuasiveness of messages. This is a major contribution to the SJT literature.

References


Prusak, L. (1997), Knowledge in Organizations, Butterworth-Heinemann, Boston, MA.


Appendix A

An Example of a Recommendations Screen
An Example of Reasoning-Trace "Strategic" Explanation

The conclusion was reached based on the following evaluations:

1. the 'current ratio' and 'acid-test ratio' are both above 1,
2. both these values are superior to the competitor and industry indices,
3. there is a healthy increasing trend over the last five years in these ratios and in the amount of 'working capital', and
4. the 'cash to current liabilities' ratio being at 97.78 percent suggests that the enterprise has the potential to settle virtually all its current liabilities immediately in cash.

An Example of Reasoning-Trace "How" Explanation
An Example of Reasoning-Trace "Why" Explanation

As a rule of thumb, the more liquid a company's assets in relation to its current liabilities, the better it is able to settle its debts in the near future and the lesser the short-term risk of bankruptcy. Conacon is in good standing in this regard.

An Example of Deep "Strategic" Explanation
An Example of Deep "How" Explanations

**Working Capital = Current Assets - Current Liabilities**

Working capital is often referred to as net working capital, as it represents the excess of current assets over current liabilities.

Working capital is closely related to the "current ratio", but it is an absolute number. When comparing companies of different sizes, absolute amounts can be misleading. Therefore, working capital is generally used in conjunction with the current ratio.

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An Example of Deep "Why" Explanations

The amount of working capital indicates the ability of a company to meet short term obligations with assets that would normally be consumed during a single operating cycle. It measures the net investment in short term operating assets.

Higher numbers indicate greater liquidity, but accounts receivable and inventory, which are part of current assets, should be at reasonable levels.

The absolute amount of working capital has significance only when related to other variables such as sales, total assets, and so forth. Therefore, ratios such as "sales to working capital" and/or working capital as a percentage of total assets could also be calculated.
Appendix B

1. The use of FINALYZER greatly enhanced the quality of my group's judgments.
   Strongly disagree: 1 - 2 - 3 - 4 - 5 - 6 - 7 : Strongly agree

2. Using FINALYZER gave my group more control over the financial analysis task.
   Strongly disagree: 1 - 2 - 3 - 4 - 5 - 6 - 7 : Strongly agree

3. Using FINALYZER made the financial analysis task carried out by my group easier to perform.
   Strongly disagree: 1 - 2 - 3 - 4 - 5 - 6 - 7 : Strongly agree

4. Using FINALYZER enabled my group to accomplish the financial analysis task more quickly.
   Strongly disagree: 1 - 2 - 3 - 4 - 5 - 6 - 7 : Strongly agree

5. Using FINALYZER improved the quality of the analysis my group performed.
   Strongly disagree: 1 - 2 - 3 - 4 - 5 - 6 - 7 : Strongly agree

6. Using FINALYZER increased my group's productivity.
   Strongly disagree: 1 - 2 - 3 - 4 - 5 - 6 - 7 : Strongly agree

7. Overall, I found FINALYZER useful in helping my group analyze the financial statements.
   Strongly disagree: 1 - 2 - 3 - 4 - 5 - 6 - 7 : Strongly agree

8. Using FINALYZER enhanced my group's effectiveness in completing the financial analysis task.
   Strongly disagree: 1 - 2 - 3 - 4 - 5 - 6 - 7 : Strongly agree

9. FINALYZER helped my group make good decisions.
   Strongly disagree: 1 - 2 - 3 - 4 - 5 - 6 - 7 : Strongly agree

Items to Measure Perceived Usefulness of KBS