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Relevance Judgment: An Integrated Framework for Understanding of Multidimenstional Constructs

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ABSTRACT

Based on an examination of literature related to relevance judgment, this paper proposes a new approach to the integrated framework for relevance judgment. This conceptual framework suggests that information content, individual traits, cognitive feedback, and situations should be jointly considered for viewing the overall relevance judgment. A set of factors is also identified for each dimension that may influence relevance judgment. The relationships between these factors are represented in numerical specifications. It is expected that this framework provides a sound foundation for the underlying relevance judgment research.

INTRODUCTION

New approaches in relevance judgment including search behavior and psychological relevance are necessary to provide rich possibilities for designing information systems [18]. However, much controversy and confusion surrounding relevance still remains in various conceptualizations, compounded by loose and inconsistent terminology [40]. Most studies in relevance judgment are still exploratory or preliminary and call for further work [28, 40].

This paper attempts to develop a consolidated framework to give an understanding of the multidimensional concept of relevance judgment. In doing so, this research explores several factors that can impact relevance judgment in previous works in information science, psychology, and management information systems. It is important to examine relevance criteria in various disciplines, because it is expected that this interdisciplinary approach can give more depth and breadth in relevance judgment study and enhance the value of theoretical approaches [15]. Furthermore, it may be invaluable that reliable variables can be identified through this approach, since if a criterion is frequently identified in diverse areas, then it can possibly be applicable across domains and situations [27].

PREVIOUS RESEARCH

The notion of relevance judgment may be differently understood by system-oriented and human-oriented views. In a system-oriented view [31], relevance is interpreted as the direct match between query terms and document terms. Consequently, most relevance factors are limited to the context of document such as title, author, abstract, keyword, etc. in structured databases such as ERIC, or Dialog [27, 46, 50].

On the other hand, from a socio-cognitive perspective, Barry and Schamber [3] state that relevance is cognitive, subjective, situational, complex, multidimensional, and dynamic. In fact, the view of relevance has shifted from a system-oriented to user- and socially-oriented approach [8, 14, 39], since relevance judgment is heavily dependent on humans' constantly changing perceptions [40]. Therefore, relevance is not solely judged based on a document [41]. However, most factors in relevance judgment limited to focus on information content. Other internal and external relevance factors should be also considered. Tang and Solomon's [50] research found that relevance judgment results are influenced by not only external situational factors, but also internal cognitive factors. Harter [18] suggests that many researchers have claimed that decision-making in relevance is complex and it is beyond topicality [22, 32, 45, 48].

CONCEPTUAL FRAMEWORK

This study proposes relevance judgment can be influenced by four constructs: *Information Content* [2, 4, 7, 31, 33, 40]; *Individual Traits* [2, 3, 7, 23, 27, 30, 32, 50, 51]; *Cognitive Feedback* [6, 11, 42]; *Situations* such as time limit [3, 27, 49, 51], accessibility [3, 32, 51], and information quantity [21, 23, 44]. Relying on only documents or information content for relevance judgment may be limited, since it ignores a focus on the complexity of the individual's background and task situation [31]. The significance of characteristics of judges, especially individual cognitive characteristics, is also important [40]. Users are sometimes inconsistent in the standards that they apply in judgment, and evaluations of judgment often vary as a function of the situation [38]. Consequently a multidimensional approach can be crucial to better understand the concept of relevance judgment.

where,

$$f(R) = w_1 \cdot f(IC) \times \{w_2 \cdot f(IT) + w_3 \cdot f(CF) - w_4 \cdot f(S)\} \qquad (1)$$

R: the degree of Relevance,
W: Weights,
IC: Information Content,
IT: Individual Traits,
CF: Cognitive Feedback, and
S: Situations

Relevance can be represented as the ordinal value *R*, since relevance may not be appropriately judged in a dichotomous way. *R* may have weights for each constructs to analyze the relative importance between them. If *IC* value is 0 (e.g. information does not exist), all other factors need not be considered and then $f(R) = 0$. *IC* cannot be overcome or compensated for by any other factors. This is called non-compensatory [6]. Therefore, *IC* is considered the most important factor in relevance judgment [27, 39, 40]. *CF* may affect to increase the level of *IT* and expect to positively correlate with *IC* and *IT*. However, *S* may be negatively associated with *R* in this study, since *S* can be interpreted as barriers or limitations to make a judgment. The next section explores more detail about the characteristics of individual factors and how they are related.

Information Content (IC)

Prior studies in information science and MIS have investigated the quality of information, but they have used somewhat different terms: "relevance" and "information quality", respectively. Eventually the notions of relevance and information quality may not be different. For example, Froehlich [14] insists that relevance is a determinant of content quality of a document. Harter [18, p. 611] also says, "Relevance and information (as-process) can usefully regard as the same, or more accurately, as two very closely related aspects of the same experience". Therefore, investigating information quality criteria in MIS and relevance criteria in Information Science is significant to find valuable information content criteria.

According to two studies [27, 52], five most frequently used factors are remarkably identical, and it is assumed that these factors are closely associated with relevance judgment across applications. As Barry and Schamber [3] indicate, overlapped criteria from diverse studies with various research methods supports and helps validate the existence of a finite set of criteria. As such, information content can be represented as the following equation.

where,

$$f(IC) = w_1 \cdot ACC + w_2 \cdot REL + w_3 \cdot TIM + w_4 \cdot TOP + w_5 \cdot COM \qquad (2)$$

W: Weights,
ACC: Accuracy,
REL: Reliability,
TIM: Timeliness,
TOP: Topicality, and
COM: Completeness

As shown in Equation 2, each factor can be linearly associated, since it is assumed that the effect of one factor does not influence other factors in *IC*. Five criteria have been independently measured in much literature from both MIS and information science. Each factor can have a weighted value in terms of information characteristics.

Individual Traits (IT)

Relevance judgment can be influenced by the degree of *IT* such as users' experience and prior knowledge [23, 27, 32]. The difficulties of making a judgment can be induced by the lack of knowledge and experience, since users don't know how to cope with difficulties. For example, Vakkari and Hakala [51] found that the lack of knowledge at the first stage of a task results in low ability to discriminate among relevant information and eventually leads to information overload.

where,

$$f(IT) = KWE \cdot EXP \qquad (3)$$

KWE: Knowledge, and
EXP: Experience

KWE and *EXP* may not be separated; rather they are strongly collaborated with each other. Therefore, *IT* can be properly described as non-additive. The assumption is thus that users who have more experiences on specific subjects or topics of information may be more knowledgeable. The degree of knowledge or experience is not considered null value (e.g. *KWE* = 0 or *EXP* = 0).

Cognitive Feedback (CF)

CF can positively affect relevance judgment with *IT*, because it helps improve the decision-making quality [11, 42]. Cooksey [6] claims, "cognitive feedback provides a judge with more extensive information about key relationships and statistics associated with his or her performance after they have made an entire series of judgments" (p. 165). Users can build new judgment strategy through iterative *CF* process [19, 24]. Therefore, recurring occurrences of *CF* can help enhance judgment strategy and lead to accurate judgment.

While *CF* could be importantly considered in relevance judgment, few researches have addressed the effects of *CF*. Rather, a major concern is query reformulation in online searching, which is called "relevance feedback" [36, 37]. *CF* is different from relevance feedback. Relevance feedback is "a *system* mechanism that automatically reformulates searchers' queries in response to their relevance judgment" [40, p.34). On the other hand, *CF* is more likely interpreted as interaction with *human* intermediary [28, 39] or instructions at each different search stage [40, 50].

CF consists of three factors [42, p. 97]: the number of iteration, the average time for an iteration, and attention to feedback. It implies that "attention to feedback" can be moderated by IT, because the effects of *CF* may differ based on individual experience and knowledge. As such, *CF* can be jointly determined by number of feedback occurrences, the average time of feedback process, and *IT* to feedback. The equation of *CF* can be described as follows:

where,

$$CF_1 = f(IT_{perceived}) = \frac{1}{n}\sum_{k=1}^{n} TF_k \times f(IT) \qquad (4)$$

CF_1: the value of presence of CF,
CF_0: the value of absence of CF,
$IT_{perceived}$: the value of Individual Traits perceived after CF,
n: Number of feedback occurrence,
TF: Time spent for Feedback process, and

$$CF_0 = f(IT) \qquad (5)$$

There are two different events in CF: the presence (CF_1) and absence (CF_0) of *CF*. In Equation 4, the degree of *CF* value can be obtained by *TF* with *IT*. If a user does not have prior experience or knowledge for specific information, a user may not discriminate relevant information in hand the first time. However, if human intermediary can help differentiate relevant information, a user can perceive new relevant information through the feedback process. As a result, a user newly gains knowledge and experience and obtains perceived knowledge and experience ($IT_{perceived}$). The more *CF* has iterated, the more perceived experience and knowledge are expected to be accumulated. *CF* can be represented by a non-linear and non-additive, because the cognitive reaction may be closely dependent on individual knowledge and experience. Although *CF* is not presented, *CF* value may not be 0, since every user is assumed to have experience and knowledge to a certain degree so that *CF* may not be simply considered as null value. In this case, *CF* value without *CF* can be equal to the current degree of *IT* value, as shown in Equation 5.

Situations (S)

IC and *CF* can be considered internal factors; however, situational factors are considered external factors including time limit [3, 27, 49], information quantity [23, 44], and accessibility [3]. The effects of each factor can be varied, since users' perceived situations are different. Wilson [53, p. 460] states, "Situational relevance is relevance to a particular individual's situation". Therefore, all situational factors may not be concurrently presented. For example, when users can seek information without any access limit (e.g. paying fees for database), accessibility is no longer considered as a situational factor.

Time limit

Decisions have to be made under certain time pressure [1, 13]. Increased time constraints can give users fading judgment analysis [17, 54] such as increasing stress [25], and decreasing confidence [43] and accuracy [12]. On the contrary, the quality of judgment performance can be increased if there is no time pressure [16]. As a result, time limit can be negatively associated with making a judgment [1].

Information Quantity

It is evident that both information overload and underload can affect decision-making performance [13, 26]. Consequently, the

amount of information can be an important situational criterion. The study from multiple criteria decision-making perspective shows that information overload is considered one of the criteria for decision-making [5]. When users have more information than expected, they have to spend more time to deselect irrelevant information for their judgments. Likewise, when they have less information than anticipated, they have to spend time to seek more information for their judgments. If they have lack of knowledge and experience, it is assumed that they have less control over these issues than experienced and knowledgeable users do. For example, Buchanan and Kock [5] insist that experts are good at filtering out irrelevant information and focusing on the critical factors.

Accessibility

Accessibility is defined as the extent to which information is available. While Web provides the flexibility to access information, some information may not be accessible because of cost [34, 35] or failure to find [9, 47]. Consequently, the scope of information is limited to accessible information. The accessibility of information can be also associated with the time limit and information quantity. Strong et al. [47] found that the amount of data and the timeliness problem are linked to accessibility problems.

Therefore, *Situations* can be represented by the following equation:

where,

$$f(S) = \frac{TL + \left(\frac{IQ}{AI} - 1\right)}{IT} \quad (IQ > AI, TL \neq 0) \qquad (6)$$

$$f(S) = \frac{TL + \left(1 - \frac{IQ}{AI}\right)}{IT} \quad (IQ < AI, TL \neq 0) \qquad (7)$$

$$f(S) = \frac{TL + IQ}{IT} \quad (IQ = AI, TL \neq 0) \qquad (8)$$

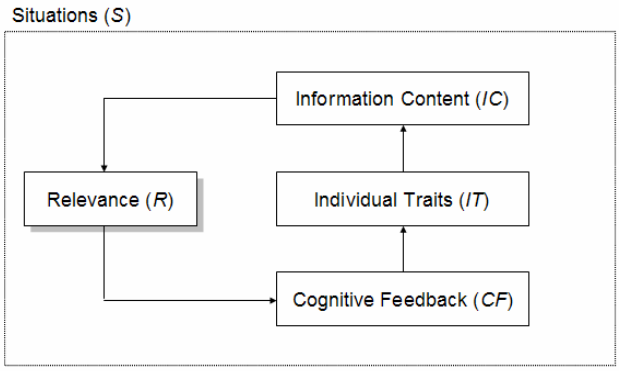
TL: Time Limit,
IQ: Information Quantity,
AI: Available Information,
IQ/AI – 1: Accessibility, and

As shown in Equation 6, 7, and 8, *S* can consist of *TL*, *IQ*, *AI*, and *IT*. The effect of *TL* and *IQ* value (numerator) can be moderated by *IT* value (denominator). If *IT* value is bigger than numerator value, the influence of *S* may be reduced. On the contrary, *S* can significantly hinder users' judgment, when *IT* value is smaller than numerator values. Unlimited time is not considered (*TL* = 0), because it may rarely occur in reality. In Equation 6, the accessibility can be decreased if *AI* value is far smaller than *IQ* value, but users may face information underload problem. In contrast, if *IQ* value is far greater than *AI* value, then the accessibility can be increased, but it can lead to information overload problem (see Equation 7). In Equation 8, if *IQ* is equal to *AI*, the accessibility can be ignored. In other words, it is assumed that accessibility is no longer an issue in terms of relevance judgment, because all information is available.

SUMMARY

Relevance judgment is dynamic and in that decisions have changed during the evaluation process [18, 41, 45]. Judgment dynamics reflect changes in both the cognitive states and judgment situation of those judging relevance [2, 4, 50]. Therefore, relevance judgment is a process of cognitive adaptation and change (see Figure 1). Relevance judgment can be moderated by external environments and internal cognitive capabilities. Wilson [53] insists that relevance is not a single notion but multiple concepts, and information is defined as situationally relevant

Figure 1: Relevance judgment framework



so that it has significantly changed in one's view of a situation. *R* is subjectively assessed by Individual Traits (*IT*), Information Content (*IC*), and Cognitive Feedback (*CF*) that influences *IT* under certain Situations (*S*).

DISCUSSION

This paper suggests the multidimensional approach can provide the comprehensible view of relevance judgment. This framework is expected to provide a streamlined relevance judgment that uses across applications and has potential to be more efficient and accurate. This research is significant, because it first attempts to identify multidimensional factors of relevance judgment and inter-relationship between these factors. However, the validity of constructs and intra-relationships between constructs needs to be more carefully examined in further research. Furthermore, there may be a controversy whether "relevance" and "information quality" is identical. The future research would focus on the validation of the framework and consider possible enhancements of notions in relevance judgment.

REFERENCES

[1] Ahituv, N., Igbaria, M., and Sella A. "The Effects of Time Pressure and Completeness of Information and Decision Making," *Journal of Management Information Systems* (15:2), Fall 1998, pp.153-172

[2] Barry, C. L. "User-defined relevance criteria: An exploratory study." *Journal of the American Society for Information Science*, 45, 1994, pp.149-159

[3] Barry, C. L., and Schamber, L. "Users' Criteria for Relevance Evaluation: A Cross-situational Comparison," *Information Processing & Management* (34:2/3), 1998, pp.219-236

[4] Bruce, H. W. "A cognitive view of the situational dynamism of user-centered relevance estimation." *Journal of the American Society for Information Science*, 45, 1994, pp.142-148

[5] Buchanan, J., and Kock, N. "Information Overload: A Decision Making Perspective," in *Proceedings of the 15th International Conference on Multiple Criteria Decision Making*, 2000, pp.49-58, Springer Verlag, Berlin, Germany

[6] Cooksey, R. W. "The Methodology of Social Judgment Theory," *Thinking and Reasoning* (2:2/3), 1996, pp.141-173

[9] Culnan, M. J. "The Dimensions of Perceived Accessibility to Information: Implications for the Delivery of Information Systems and Services," *Journal of the American Society for Information Science* (36), 1985, pp.302-308

[11] Doherty, M. E., and Balzer, W. K. "Cognitive Feedback," in Brehmer B. and Joyce C. R. B. (Eds.), *Human Judgment: The SJT View*, pp.163-197, North Holland: Elsevier Science Publishers, 1988

[12] Edland, A., and Svenson, O. "Judgment and Decision Making under Time Pressure," in Svenson, O., and Maule, A. J. (Eds), *Time Pressure and Stress in Human Judgment and Decision Making*, pp.27-40, New York: Plenum Press, 1993

[13] Evaristo, J. R., Adams, C., and Curley, S. "Information Load Revisited: A Theoretical Model," in Proceedings of the 16th International Conference in Information Systems, Dec. 1995, pp.197-206, Amsterdam

[14] Froehlich, T. J. "Relevance Reconsidered – Towards an Agenda for the 21st Century: Introduction to Special Topic Issue on Relevance Research," *Journal of the American Society for Information Science*, April 1994, pp.124-134

[15] Greisdorf, H. "Relevance: An Interdisciplinary and Information Science Perspective," *Information Science Research* (3:2), 2000, pp.67-71

[16] Hahn, M., Lawson, R., and Young, G. "The Effects of Time Pressure and Information Load on Decision Quality. *Psychology and Marketing* (9), 1992, pp.365-379

[17] Hart, S. G. "Theory and Measurement of Human Workload," in Zeidner, J. (Ed.), *Human Productivity Enhancement: Training and Human Factors in Systems Design* (1), pp.396-456, New York: Praeger, 1986

[18] Harter, S. P. "Psychological Relevance and Information Science," *Journal of the American Society for Information Science*, (43:9), 1992, pp.602-615

[19] Hogarth, R. *Judgment and Choice*, 2nd Edition, John Wiley and Sons, Chichester, England, 1987

[23] Iselin, E. "The Impact of Information Diversity on Information Overload Effects in Unstructured Managerial Decision Making. *Journal of Information Science* (15), 1989, pp.163-173

[24] Jacoby, J., Mazursky, D., Troutman, T., and Kuss A. "When Feedback is Ignored: Disutility of Outcome Feedback," *Journal of Applied Psychology* (69:3), August 1984, pp.531-545

[25] Keinan, G., Friedland, N., and Ben-Porath, Y. "Decision Making Under Stress: Scanning of Alternatives Under Physical Threat," *Acta Psychologica* (64), 1987, pp.219-228

[26] Mackie, R. R. *Vigilance: Theory, Operational Performance, and Psychological Correlates*. New York: Plenum Press, 1977

[27] Maglaughlin, K. L., and Sonnenwald, D. H. "User Perspectives on Relevance Criteria: A Comparison among Relevance, Partially Relevant, and Not-Relevant Judgments," *Journal of the American Society for Information Science and Technology* (53:5), 2002, pp.327-342

[28] Mizzaro, S. "Relevance: The Whole History," *Journal of the American Society for Information Science* (48:9), 1997, pp.810-832

[31] Park, T. K. "Towards a Theory of User-based Relevance: A Call for a New Paradigm of Inquiry," *Journal of the American Society for Information Science* (45), 1994, pp.135-141

[32] Park, T. K. "The Nature of Relevance in Information Retrieval: An Empirical Study", *Library Quarterly*, 63(3), 1993, 318-351

[34] Redman, T. C. "Data Quality for the Information Age." Artech House, Boston, London, 1996

[35] Salaun, Y., and Flores, K. "Information Quality: Meeting the Needs of the Consumer," *International Journal of Information Management* (21), 2001, pp.21-37

[36] Robertson, S. E., and Hancock-Beaulieu, M. "On the Evaluation of IR Systems." *Information Processing and Management*, July/August, 28(4), 1992, pp.457-466

[38] Sanbonmatsu, D. M., Kardes, F. R., Posavac, S. S., and Houghton, D. C. "Contextual Influences on Judgment Based on Limited Information," *Organizational Behavior and Human Decision Processes* (69:3), March 1997, pp.251-264

[39] Saracevic, T. "Relevance Reconsidered '96," in Ingwersen, P. and Pors, N. O., *Information science: integration in perspective*, pp.201-218, Copenhagen, Denmark: Royal School of Library and Information Science, 1996

[40] Schamber, L. "Relevance and Information Behavior," *Annual Review of Information Science and Technology* (29), 1994, pp.3-48

[41] Schamber, L., Eisenberg, M. B., and Nilan, M. S. "A Re-examination of Relevance: Toward a Dynamic, Situational Definition," *Information Processing and Management* (26), 1990, pp.755-776

[42] Sengupta, K., and Te'eni D. "Cognitive Feedback in GDSS: Improving Control and Convergence," *MIS Quarterly*, March 1993, pp.87-113

[43] Smith, J. F., Mitchell, T. R., and Beach, L. R. "A Cost-Benefit Mechanism for Selecting Problem-solving Strategies: Some Extensions and Empirical Tests," *Organizational Behavior and Human Performance* (29), 1982, pp.370-396

[44] Speier, C., Valacich, J. S., and Vessey, I. "The Influence of Task Interruption on Individual Decision Making: An Information Overload Perspective," *Decision Sciences* (30:2), Spring 1999, pp.337-360

[45] Spink, A., and Greisdorf, H. "Regions and Levels: Measuring and Mapping Users' Relevance Judgments," *Journal of the American Society for Information Science and Technology* (52:2), 2001, pp.161-173

[47] Strong, D. M., Lee, Y. W., and Wang R. "Data Quality in Context," *Communications of the ACM* (40:5), May 1997, pp.103-110

[49] Svenson, O., and Edland, A. "Changes of Preferences under Time Pressure: Choices and Judgments," *Scandinavian Journal of Psychology* (28), 1987, pp.322-330

[50] Tang, R., and Solomon, P. "Toward an Understanding of the Dynamics of Relevance Judgment: An Analysis of One Person's Search Behavior," *Information Processing and Management* (34:2/3), 1998, pp.237-256

[51] Vakkari, P., and Hakala, N. "Changes in relevance criteria and problem stages in task performance." *Journal of Documentation*, September, 56(5), 2000, pp.540-562

[52] Wand, Y., and Wang, R. Y. "Anchoring Data Quality Dimensions in Ontological Foundations," *Communications of the ACM* (39:11), November 1996, pp.86-95

[53] Wilson, P. "Situational Relevance," *Information Storage and Retrieval*, Aug. 1973, pp.457-471

[54] Wright, P. L. "The Harassed Decision Maker: Time Pressures, Distractions, and the Use of Evidence," *Journal of Applied Psychology* (59), 1974, pp.555-561