Information Search and Consideration Set Formation in a Web-Based Environment

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ABSTRACT
The research reported here attempts to understand information search and consideration set formation in a web-based choice environment. A conceptual model is used to propose hypotheses that link information search and consideration set formation with antecedent factors that are typical of online settings. A study that simulates information search and consideration set formation in a web-based choice environment is conducted to test the hypotheses. The empirical findings offer qualified support for the conceptual model. The implications of the model for understanding how consumers make choice decisions in an electronic environment are discussed.

INTRODUCTION
A recent U. S. Census Bureau report shows that e-commerce sales are growing at 28 percent as compared to 9 percent for sales through off-line retail channels http://www.census.gov/mrts/www/ecommm.html. The rapid growth of web-based stores has created a need to understand how people search for and evaluate products while shopping online. Online settings offer consumers immense choice and great convenience, but finding products that match needs can sometimes be a difficult task. Consequently, most web-based decision environments now make a “smart agent” or “recommendation agent” available to facilitate the decision-making process.

Electronic decision aids can assist in a variety of decision making tasks that may be automated. For instance, an electronic decision can help people search and evaluate products by screening and/or organizing information about available alternatives. Specifically, two important functions that can be performed by such an aid are information filtration (i.e., sorting) and integration. Examples of these types of aids may be found at http://www.amazon.com and http://www.expedia.com. They enable consumers to use a preferred alternative screening strategy (e.g., select flights based on “lowest price,” or books based on “publication date” and “title words”).

Individuals may be able to screen alternatives and rapidly identify the most attractive options in an online setting. But, they may also “over-screen” alternatives (i.e., use too many selection criteria), leading to the premature elimination of attractive choices or (at the extreme) the recommendation of a null choice set (e.g., the “no matches found” message). The number of alternatives in the relational database linked to the electronic decision aid may influence the extent to which consumers are able to find alternatives that match needs. Likewise, the amount of time available may determine whether consumers are able to re-set selection criteria and re-screen alternatives to match needs. When confronted with too few alternatives and/or too much time, consumers may adopt less efficient calibration strategies by setting wider or lower attribute cut-off levels, thereby diminishing the usefulness of an online environment. Consequently, it is important to understand how two important task environment factors (i.e., number of alternatives and time available) influence information search and consideration set formation in a web-based choice environment.

CONCEPTUAL MODEL DEVELOPMENT
The proposed model of information search and consideration set formation in a web-based environment, like its traditional counterpart, assumes a two-stage decision process. During the first stage, alternatives are searched (i.e., screened and examined) with the use of an electronic decision aid to form a consideration set. In the second stage (which is not considered here), alternatives in the consideration set are evaluated in more depth through available online information and/or through retail visits. There are several (at least seven) important influences on information search and consideration set formation in a web-based environment. These are first presented and discussed individually and then linked together in the proposed model.

First, search costs are assumed to be lower in a web-based environment. Yet, the evidence on whether consumers exploit the lower search cost to make better quality decisions is mixed. While some studies provide (limited) evidence that search is increased in web-based environments (Lynch and Ariely 2000), the dominant finding is that consumers do not search more in these settings (Haubl and Trifts 2000; Johnson et. al. 2004). The divergence in findings suggests that consumers possibly encounter new (i.e., unexpected) search costs that influence the overall cost of search. One such cost in a web-based environment is the cognitive cost of using the available electronic decision aid. This cost can be viewed as being akin to the cost of controlling the information flow (Ariely 2000) or the cost of planning (Benbasat and Todd 1996).

Second, more use of digital attributes can be expected in a web-based environment, because search costs for these attributes are lower (Lal and Sarvary 1999). The distinction between digital versus non-digital information is useful for understanding search and evaluation in an online store, because it is conceptually similar to the distinction between price and quality information. Previous research has found that electronic shopping can lower the cost of acquiring quality information and thus decrease price sensitivity (Lynch and Ariely 2000). But, when a “smart agent” is made available price sensitivity may increase even though the cost of acquiring quality information may still be lowered (Diehl, Kornish and Lynch 2003). The effect can be attributed to the information filtering (i.e., sorting) capability of the electronic decision aid. Extrapolating these findings suggests that the digital sensitivity (which may be defined in a manner analogous to price sensitivity) of consumers is likely to be heightened in a web-based environment where an electronic decision aid is available. Consequently, the use of digital attribute information is likely to be enhanced.

Third, more preference construction is known to occur in a web-based environment. Consumers are more likely to discover new alternatives and/or attributes (Bettman, Luce and Payne 1998) as they navigate through the product assortment in an online setting. The available electronic decision aid makes it easier for consumers to control the display of information (West et al 1999) and also restructure information on available alternatives (Coupey 1994). Consequently, stimulus-based influences on preference construction (e.g., number of available alternatives, time available, etc.) are likely to be enhanced (Lynch and Srull 1982). Previous research has found that the mere inclusion of an attribute in a web environment makes it more prominent during product evaluation (Haubl and Murray 2003).

Fourth, the search process in the web environment can be expected to be iterative (Payne, Howes and Reader 2001). Research using the human-computer interaction (HCI) paradigm suggests that the search process in an electronic environment interactively combines search planning with action. Another phenomenon that suggests that search in electronic environments is more iterative is...
that of “information foraging” (Pirolli and Card 1999) in which individuals move from one information resource (or “patch”) to the next depending on a cost-benefit rule. A related idea of how individuals examine information in a web environment is that of “wayfinding” (Hodkison, Kiel and McColl-Kennedy 2000) where the search process alternates between examining inter-site and intra-site information.

Fifth, more use of elimination-type screening strategies (e.g., where selection criteria are exclusionary) for evaluating alternatives can be expected in a web-based environment, because they are easier to use in an online setting. Additive-type screening strategies (e.g., where selection criteria are inclusionary and exclusionary) require making trade-offs between attributes, which is more difficult in a web-based environment. While elimination-type strategies can help rapidly narrow the set of available alternatives, they are relatively rigid (i.e., inflexible) in their application which could lead to the premature elimination of otherwise attractive alternatives (Widing and Talarzyk 1993). A greater use of elimination-type strategies may also be observed because they are more congruent with the information format in a web-based environment (Payne, Bettman and Johnson 1993).

Sixth, more browsing behavior can be expected in a web-based environment, because of the increased significance of browsing behaviors (in comparison to directed-search behaviors) in electronic environments (Marchionini 1995; Rowley 2000). Likewise, more exploratory behavior may also be observed as consumers are distracted by the visual salience of attribute information (Jarvenpaa 1990). Some researchers have proposed that the psychological state of “flow” may be important in an online setting (Hoffman and Novak 1996). The time-distortion effects commonly associated with the phenomenon can be expected to lead to more browsing behavior. Further, a greater tendency toward exploration and novelty seeking has been found to result from the “atmospherics” of an online store (Menon and Kahn 2002).

Seventh, the electronic screening of information has been identified as the most important development in online shopping (Alba et al 1997). The typical web-based environment includes some type of electronic decision aid (Haubl and Murray 2003; Iacobucci, Arabie, and Bodapati 2000). An electronic decision aid can strongly influence search and evaluation in a web-based store. For example, an electronic decision aid can be used to reduce search costs or improve the quality of the consideration set or do both. Also, consumers seem to be willing to trust the product recommendations offered by an electronic decision aid (Haubl and Murray 2003), particularly when it only acts as a “clerk” (West et al 1999).

As mentioned earlier, whether or not consumers are able to screen alternatives in an electronic environment to match needs may depend on two important task environment factors (e.g., number of alternatives and time available). These factors have been studied in off-line decision environments as potential causes of information overload. The available electronic decision aid makes information overload less of a concern in online settings. In fact, to the contrary, information underload may be a greater concern, because of the need to re-set selection criteria and re-screen alternatives if few alternatives are available and/or the opportunity to do the same if there is too much time. Thus, two task environment factors that are known to influence search and evaluation in off-line settings may also do so in a web-based environment, but with very different consequences. In order to predict these effects we incorporate the two task environment factors and the seven influences on search and evaluation discussed above into a conceptual model of information search and consideration set formation for a web-based environment (see Figure 1).

**HYPOTHESES**

Embedded within the conceptual model are several hypotheses that link information search and consideration set formation to antecedent factors that are typical in online settings and the two task environment factors mentioned above. These hypotheses are presented next.

**Information Search**

Information search in an online setting is more iterative because it combines planning with action (Payne, Howes and Reader 2001). The use of an electronic decision aid results in a greater emphasis on the initial (i.e., screening) phase and a lesser emphasis on the subsequent (i.e., examination) phase of search. The initial phase involves screening (and re-screening) choice alternatives by performing search iterations to identify alternatives that match preferences. Once identified, alternatives may subsequently be examined (i.e., scrutinized) for more detailed information.

**Number of Search Iterations.** In the web environment, consumers can be expected to conduct more iterative search (Payne, Howes and Reader 2001). Hence, they are likely to perform multiple search iterations as they seek to identify alternatives for inclusion in the consideration set. Lynch and Ariely (2000) found evidence of more (insert term) search, which is similar to iterative search. Chu and Spires (2000) found evidence of broader (i.e., less selective) information search when a DSS was used. As the number of alternatives increases, the number of search iterations is likely to decrease in the web environment due to the reduced likelihood of criteria over-specification (Widing and Talarzyk 1993) and less “information foraging” (Pirolli and Card 1999). However, the time available increases more search iterations can be expected due to browsing (Marchionini 1995), greater likelihood of “flow” (Hoffman and Novak 1996), and the increase possibility of being distracted by the visual salience of information (Jarvenpaa 1990).

**H1:** There will be fewer search iterations in a web-based environment as the number of alternatives increases.

**H2:** There will be more search iterations in a web-based environment as time available increases.

**Number of Alternatives Examined.** A consequence of more search iterations in the web environment is that fewer alternatives may actually be examined (i.e., scrutinized) for information. The web environment offers a lower search cost, but this feature offers little benefit in terms of the cost of inspecting every screened alternative. Haubl and Trifts (2000) found evidence of fewer alternatives being examined for information. Also, consumers are likely to trust the electronic decision aid when it is only acting as a “clerk” (Haubl and Murray 2003), and may feel little need for examining every screened alternative for further information. As the number of alternatives increases, fewer alternatives are likely to be examined for information because of the greater likelihood of screened alternatives matching needs (Widing and Talarzyk 1993) and the reduced need to de-construct preferences or restructure information (Bettman, Luce and Payne 1998; Couhey 1994). But, as time available increases, more alternatives are likely to be examined for information due to exploratory and novelty seeking behavior (Menon and Kahn 2002) and browsing of screened alternatives (Rowley 2000).

**H3:** There will be fewer alternatives examined for information in a web-based environment as the number of alternatives increases.
FIGURE 1
PROPOSED MODEL OF INFORMATION SEARCH AND CONSIDERATION SET FORMATION IN A WEB-BASED ENVIRONMENT

- TASK ENVIRONMENT
  - Time Available
  - Number of Alternatives

- PRODUCT ATTRIBUTES
  - Mix of Digital vs. Non-Digital

- TASK ENVIRONMENT
  - Size

- CONSIDERATION SET

- ALTERNATIVE SCREENING STRATEGY
  - Additive-type
  - Elimination-type

- INFORMATION SEARCH
  - Number of Search Iterations
  - Number of Alternatives Examined

- PREFERENCE CONSTRUCTION
  - Prior Preferences
  - Exposure to New Alternatives

- CONSIDERATION SET
  - Size
  - Heterogeneity

- ELECTRONIC DECISION AID
  - Type (clerk vs. advisor)

- SEARCH COSTS
  - Lower Search Costs
  - New Cognitive Costs

- TASK ENVIRONMENT
  - Number of Alternatives
  - Prior Preferences
  - Exposure to New Alternatives
  - Elimination-type
  - Additive-type
  - Size

- PRODUCT ATTRIBUTES
  - Mix of Digital vs. Non-Digital

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H4: There will be more alternatives examined for information in a web-based environment as time available increases.

Consideration Sets

Consideration Set Size. In the web environment, consumers are likely to use more attributes to screen available alternatives while forming a consideration set. The electronic decision aid makes it easy to include even unimportant attributes during the screening process (Todd and Benbasat 1994). Also, consumers are likely to use elimination-type screening strategies due to information format and processing style congruence (Bettman and Kakkar 1977). These two influences are likely to lead to smaller consideration sets compared to off-line decision environments. Haubl and Trifts (2000) found evidence that consumers develop smaller consideration sets in online settings. However, as the number of alternatives increases, consideration set size will increase because of the increased likelihood of more alternatives matching needs and the diminished need to re-calibrate the electronic decision aid and re-screen alternatives (Payne, Howes and Reader 2001). But, as time available increases, consideration set size will decrease due to more information foraging (Pironi and Card 1999) and the greater use of elimination-type screening strategies (Payne, Bettman and Johnson 1988).

H5: The size of the consideration set in a web-based environment will increase as the number of alternatives increases.

H6: The size of the consideration set in a web-based environment will decrease as time available increases.

Consideration Set Heterogeneity. In the web environment, the tendency toward more browsing (Marchionini 1995) and iterative search will result in heterogeneous consideration sets. Also, changing selection criteria as consumers re-calibrate the electronic decision aid will also result in consideration set heterogeneity. As the number of alternatives increases, consideration set heterogeneity will increase because of more dissimilar alternatives being included in the consideration set (Roberts and Lattin 1991). But, as the time available increases, consideration set heterogeneity size will decrease due to the use of additional selection criteria resulting in more similar alternatives being included in the consideration set.

H7: The heterogeneity of the consideration set in a web-based environment will increase as the number of alternatives increases.

H8: The heterogeneity of the consideration set in a web-based environment will decrease as time available increases.

METHOD

Study Design

A study that simulated consumer decision-making in a web-based environment was conducted to test the hypotheses. The scenario consisted of undergraduate students choosing an apartment to rent near a hypothetical university. The web environment was characterized by the availability of an electronic decision aid that could be used to search a relational database of available apartments. Apartments were profiled using photographs and written descriptions.

The study employed a 2 number of alternatives (many, few) x 2 time available (more, less) x 2 web environment (web, web-auto) design. The first two factors are the two task environment influences of interest in the study. The two web environment conditions were collapsed because the distinction between them related to particular features of the electronic decision aid used, which were not pertinent to the study purpose. Prior to pooling the data on the third factor, homogeneity tests revealed no significant difference between the two web environment conditions.

Stimulus Development

Selection of Product Category. The selection of (hypothetical) rental apartments as the product category was based on a number of considerations. First, the product category is familiar to student subjects. Second, alternatives in the product category can be objectively evaluated. Third, attribute importance normally differs across individuals leading to preference heterogeneity. Several experimental studies of decision behavior have used rental apartments as a product category (Payne 1982; Todd and Benbasat 1992).

Task. Subjects were instructed to role-play a student transferring to another university who needed to find an apartment. They were asked to develop a list of apartments that they would like to visit for further consideration on arrival at the new campus. The purpose of the task was to search for apartments and form a consideration set. Profiles for apartments were constructed using a fractional factorial design based on attributes such as rent, location, number of bedrooms, and the number and type of amenities. Each profile described the apartment on twenty attributes. Unrealistic and dominated alternatives were eliminated.

Task Environment. The web environment was simulated by converting the apartment profiles into web displays. An electronic decision aid and relational database of apartment profiles similar to those at apartment search sites (e.g., http://www.apartments.com) was developed. A “search page” provided the interface between the electronic decision aid and the relational database. Subjects used this page to query the database about apartments that met their selection criteria. A screen indicated whether matching apartments had been found (or not). If matches were found, a screen displayed a list of matching apartments, with each listing being hyper-linked to the corresponding apartment profile. Hyper-links gave the subject the ability to: 1) return to the list of matching apartments, 2) return to the search page, or 3) add the apartment to their list of selected apartments.

Experimental Conditions. The number of alternatives available was set at 30 in the “few” alternatives condition and at 99 for the “many” alternatives condition based on guidelines provided in previous research (Widing and Talarzyk 1993). A pre-test indicated that subjects were able to complete the task in both conditions. In a second pre-test, subjects completed the experimental task with a certain number of alternatives (many or few) with no time constraint. The time pressure conditions were then created by multiplying the median time for task completion in each manipulation by 0.90 for the “low” and by 0.70 for the “high” time pressure condition based on guidelines provided in earlier studies (Ben-Zur and Breznitz 1981; Payne Bettman and Johnson 1988).

Experimental Procedure

One hundred and twenty undergraduate students participated in the study. Subjects were randomly assigned to the experimental conditions with approximately 15 subjects per cell. Each experimental session involved a single participant. The incentives for participation included extra course credit and a chance to win a $100 lottery. Subjects first undertook a training task to familiarize themselves with the navigational features of the web environment. Then, for the main task, subjects used the electronic decision aid to create a “shopping cart” consisting of “apartments that they would
Subjects were told that they could modify the “shopping cart” during the session, but were not told how many apartments were available or how many apartments they should select.

Dependent Variables

Number of Search Iterations. The web server tracked the number of queries elicited from the relational database. The number of search iterations was calculated by counting the number of queries in the log file of the web server.

Number of Alternatives Examined. The number of alternatives examined (i.e., inspected) was determined by an inspection of the log file of the web server.

Consideration Set Size. Consideration set size was determined by tallying the number of different alternatives placed in the “shopping cart.”

Heterogeneity of the Consideration Set. The heterogeneity of the consideration set (HCS) was measured by calculating the average weighted Euclidean distance between all pairs of alternatives included in the consideration set. The weights were based on self-reported attribute importance ratings collected before the experiment. Prior to estimation, the attribute importance weights were standardized to avoid over-weighting.

RESULTS

Manipulation Checks and Reliability Assessments

A GLM-ANOVA model, with the perceived number of alternatives as the dependent variable and the number of alternatives present (many vs. few), time pressure (low vs. high), and environment (web vs. web-auto), as the independent variables was used to assess the manipulation. As expected, a significant main effect for the number of alternatives manipulation (many vs. few) was found \( F(1,112)=4.72, p<.05 \). More alternatives were perceived to be present by subjects in the many alternatives condition (\( \bar{x}=6.6 \)) than in the few alternatives condition (\( \bar{x}=5.9 \)). Further, there was a marginally significant main effect for the time pressure (low vs. high) manipulation \( F(1,112)=3.42, p<.10 \). More alternatives were perceived to be present in the more time available condition (\( \bar{x}=6.0 \)) than in the less time available condition (\( \bar{x}=6.6 \)). Therefore, the manipulations were assessed to be successful. Table 1 provides the pair-wise correlations among the dependent variables. Table 2 provides descriptive statistics for the dependent variables.

Individual Hypotheses Results

Number of Search Iterations. H1 posits that there will be fewer search iterations environment as the number of alternatives increases. The main effect for number of alternatives was marginally significant \( F(1,112)=2.76, p<.10 \). Inspection of the marginal means shows that the number of search iterations was lower in the many alternatives condition (\( \bar{x}=7.3 \)) than in the few alternatives condition (\( \bar{x}=8.5 \)). Thus, H1 is weakly supported. H2 posits that there will be more iterations as time available increases. The main effect for time available was significant \( F(1,112)=4.93, p<.05 \). Inspection of the marginal means shows that the number of search iterations was significantly higher (t=-2.22, p<.05) in the more time available condition (\( \bar{x}=8.9 \)) than in the less time available condition (\( \bar{x}=7.3 \)). Thus, H2 is supported. The number of alternatives x time available interaction was not significant.

Number of Alternatives Examined. H3 posits that fewer alternatives will be examined for information as the number of alternatives increases. The main effect for number of alternatives was not significant \( F(1,110)=2.70, \) ns. Inspection of the marginal means shows that more alternatives were examined for information in the

<table>
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<th>TABLE 1</th>
<th>CORRELATIONS AMONG VARIABLES</th>
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many alternatives condition ($\bar{x}$=9.3) than in few alternatives condition ($\bar{x}$=8.0). Thus, H3 is not supported. H4 posits that as time available increases, the number of alternatives examined for information will increase. The main effect for time available was significant [$F (1,105)=4.67$, $p<.05$]. In the contrast comparisons, the number of alternatives examined increased in the expected direction as time available increased ($t=-2.16$, $p<.05$). Thus, H4 is supported. The time available x number of alternatives interaction was not significant.

### Consideration Set Size
H5 posits that the consideration set size will increase as the number of alternatives increases. The main effect for number of alternatives was significant [$F (1,112)=3.63$, $p<.05$]. Inspection of the marginal means shows that the size of the consideration set was larger in the many alternatives condition ($\bar{x}$=4.8) than in the few alternatives condition ($\bar{x}$=4.2). Thus, H5 is supported. H6 posits that as time available increases, consideration set size will decrease. The main effect for time available was marginally significant [$F (1,112)=2.75$, $p<.10$]. In the contrast comparisons, the size of the consideration set decreased in the expected direction as time available increased ($t=-2.16$, $p<.05$). Thus, H6 is weakly supported. The time available x number of alternatives interaction was not significant.

### Heterogeneity of the Consideration Set
H7 posits that the alternatives in the consideration set will be more heterogeneous as the number of alternatives increases. The main effect for number of alternatives was not significant [$F (1,112)=0.04$, ns]. Inspection of the marginal means shows that there was little change in consideration set heterogeneity between the few alternatives available ($\bar{x}$=21.8) and the more alternatives available ($\bar{x}$=21.4) conditions, with higher values indicating more heterogeneous consideration sets. Thus, H7 is not supported. H8 posits that as time available increases, heterogeneity of the consideration set will decrease. The main effect for time available was not significant [$F (1,112)=0.01$, ns]. Inspection of the marginal means shows that there was no change in consideration set heterogeneity between the less time available ($\bar{x}$=21.6) and the more time available ($\bar{x}$=21.6) conditions. Thus, H8 is not supported.

## DISCUSSION
Overall, the results provide some support for the hypothesized relationships, with five of the eight hypotheses receiving partial or full support. The findings relating to search when many alternatives are available show that while consumers conduct fewer search iterations (weak support for H1), they do not actually examine fewer alternatives for information (lack of support for H3). In contrast, the findings relating to search when more time is available show that the number of search iterations conducted increases (support for H2) but so does the number of alternatives examined (support for H4). Thus, an increase in the time available has the predicted effect on search, while an increase in the number of alternatives does not. The empirical results relating to consideration set formation show that consumers form larger consideration sets when many alternatives are available (support for H5), but form smaller considerations sets when more time is available (support for H6) as predicted. The heterogeneity of the consideration set remains unaffected when either more alternatives or more time is available (lack of support for H7 and H8).
GENERAL DISCUSSION

Overall, the empirical findings offer qualified support for the conceptual framework. While not all hypothesized relationships were significant, the main prediction of the model that the two task environment factors have an important influence on information search and consideration set formation seems to be upheld. When more alternatives are available, consumers conduct fewer search iterations but yet develop larger consideration sets. When more time is available, they conduct more search iterations, examine more alternatives, but form smaller consideration sets. The two task environment factors seem to have independent effects on search and alternative evaluation in a web-based environment. In contrast, the two task environment factors are known to have an interactive effect in off-line settings, because more alternatives and less time are associated with task complexity. Further, when more alternatives are available consumers seem engage in risk-averse behavior, because such is implied by larger consideration sets (Roberts and Lattin 1993). But when more time is available, consumers engage in risk-taking behavior, because they form smaller consideration sets. Thus, as predicted by conceptual model, the two task environment factors seem to have the opposite effect in online settings compared to their influence in off-line decision environments.

An interesting pattern of inter-relationships can be observed among measures normally associated with decision quality and the two task environment variables. Decision quality seems to improve in a web-based environment as more alternatives are available and there is less time. A possible reason for such an effect is information underload in a web-based environment. In other words, when there are few alternatives available and plenty of time, the task becomes “difficult.”

An important implication that emerges from the study results is that electronic decision aids in web environments may impose new search costs on consumers that offset the overall lower search cost offered by these environments. These costs could have a detrimental effect for relatively straightforward choice tasks. As the task becomes more difficult, the unfavorable influence of new search costs can be expected to decline, thereby allowing the favorable influence of the overall lower search cost to have a greater impact on the decision process. Decision aids are often closely tied to the environments in which they are used because they are frequently “designed” for those environments. It seems that decision aids suitable for a particular environment may be ineffective in other environments (Olson and Widing 2002). Thus, marketers may need to build in more “flexibility” into their electronic decision aids so that they perform well at varying levels of task complexity. Anecdotal reports in the business press suggest that there is a movement toward the development of flexible electronic decision aids (Maes 1999; Perez 2002; Reda 2002).

REFERENCES


