

Consumer Perception of Color Depicted on E-Commerce Websites: An Exploratory Study

Philip S. Nitse, Ph.D.
Professor of Marketing
208-282-3707
nitsphil@isu.edu

Kevin R. Parker, Ph.D.
Assistant Professor of Computer Information Systems
208-282-
parkerkr@isu.edu

Both available at
Idaho State University
College of Business
Campus Box 8020
Pocatello, ID, USA
Fax 208-282-4367

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Abstract

Although the number of fashion items purchased over the Internet increases each year, the problem of inaccurate color representation on the Web continues. Color inaccuracy has many negative consequences, including loss of sales, increased returns and complaints, and customer defections. This research paper communicates the findings of a survey conducted as part of an initial investigation into consumer opinions about fashion-merchandise purchasing over the Internet. Results indicate that consumers are aware of the color inaccuracies on e-commerce sites and that they are likely to take action that will negatively impact the marketer. Eleven colors were evaluated as to their accuracy in a web-based environment. Increased dissatisfaction on the part of consumers leads to greater costs in both customer service and reverse logistics. The paper concludes with suggestions for future research.

Introduction

Global B2C e-commerce sales for 2003 are estimated to vary from 144 to 380 billion US dollars, according to a report by OECD. The report is based on a variety of sources including Boston Consulting Group, Giga Information Group, Forrester Research, Dataquest, Gartner Group, Warburg Dillon Read, and Pro Active (OECD.org, 2001). Global B2C e-commerce is expected to hit USD 562 billion by 2006 (Sharrard, 2001). Internet sales of non-travel related products in the United States have reached \$988 million a week, with apparel and home items experiencing a greater increase than other items (Purente, 2002). According to one study, the Internet will influence \$400 billion in U.S. retail sales in 2003 and as much as \$1 trillion by 2006, and the study indicates that half of the online shoppers report that they first researched goods on the Internet and then purchased the items over the telephone (IMRG.org 2003). Apparel has been one of the top eight industries involved in Internet shopping in the United States (Krantz, 1998). According to a 2002 UCLA study, 48.2% of new users (less than one year Internet experience) and 41.8% of experienced users (greater than six years of Internet experience) reported making online clothing purchases (Lebo, 2003).

The increasing number of e-commerce transactions involving fashion merchandise requires that detailed product information be provided to potential consumers before they are comfortable with making a purchase. A critical component of that information is the color of the products being considered for purchase. Color information can consist of both verbal information (e.g., a description of a product as

being royal blue) and graphical information (e.g., a jpeg or other graphic format showing the product in royal blue). Purchasers can use the web to see the entire selection of colors in which a product is available. For the purpose of this paper, fashion merchandise is defined as both clothing and accessories for people, and fashion items for the home, such as indoor and outdoor furniture and home decor.

Anyone who has looked at fashion items depicted on websites is likely aware that color representation on e-commerce sites is often inaccurate. These inaccuracies can lead to several possible outcomes for consumers. First, the consumer may not trust the colors that are depicted on his or her monitor and not order the product, thus leading to a loss of e-sales. Second, the consumer may order the product with the hope that the actual product matches the color depicted. If it does not, they may return it, again leading to a loss of sales, along with the added costs of reverse logistics and restocking. Third, the consumer may order the product and keep it even though they may not be completely satisfied. In the latter two cases, the unhappy consumer may complain to the company as well as friends about the lack of quality control, which may lead to a loss of future sales due to the negative word-of-mouth. This paper examines the consumers' perception of color inaccuracies on the web and outlines an approach to research the problem.

It is important to note that consumers who utilize the Internet may proceed in any one of four purchase scenarios. These scenarios include (1) visiting stores to evaluate a product or to gather information prior to purchasing on-line, (2) using the Internet to locate the product and/or a local retailer, and then going to the store to make the purchase, (3) using a catalog in conjunction with the Internet website for making the purchase decision, and (4) making both the purchase decision and the actual purchase using only on-line resources. According to a UCLA study, a vast majority (over 60%) of Internet purchasers surveyed in 2002 followed either the first or second scenario (Lebo, 2003). These consumers may shop on-line to find a product or to see if a local store has the product, and then go to the store to purchase it in order to avoid paying shipping and handling or to avoid the delayed gratification associated with shipping delays. In this case, an item's color may be initially selected on-line but later confirmed or rejected prior to purchase upon examination of the actual item, again minimizing the impact of color inaccuracies. In the third scenario, consumers may refer to a catalog to help with color selection prior to on-line purchase. Here, the color selection may be influenced more by the catalog than by the web site representation, since the color of products in catalogs may be perceived to be fairly accurate due to sophisticated color correction techniques available in print media. In the fourth scenario, the web site representation provides the sole basis for product selection. This research focuses on the last scenario because the e-commerce site provides the only frame of reference for color selection.

Information on Color

According to Stone (2001, p. 1), color perception is problematic for a variety of reasons:

- Color is subjective: It's perfectly obvious that color is an intrinsic feature of an object: Grass is green, the sky is blue, the paint on

your living room wall is peach, and so on. As obvious as this may be, however, it's not so. Color is actually a sensation, just like touch. And the colors you see are purely subjective, as interpreted by your visual system and your brain.

- Lighting affects color: The color of an item--including, for example, a printout--will vary depending on the light, so it will look different under incandescent light, florescent light, and daylight, for example.
- Identical colors can be metameric pairs: Two items that are the same color under one light can be different colors under another light.
- Colors affect colors: Your perception of a color will change, depending on the colors around it, an effect called simultaneous contrast. Paint a small square of green on a blue background, and the green will have a yellowish tinge. Change the background to yellow, and the green will have a blue tinge.
- The human eye is different from a scanner or camera: The sensors in scanners and cameras are sensitive to specific frequencies of light in different proportions than the color sensitive cones in the human eye.
- Different devices have different color gamuts: Monitors can show colors that printers can't print, and printers can print colors that monitors can't show. Cameras and scanner sensors can register colors that neither monitors nor printers can produce.
- Different devices use different color models: A color model is simply a mathematical way to represent colors. When different devices use different color models they have to translate colors from one model to another, which often introduces errors. This is a particular problem for device-dependent models, meaning models defined strictly in terms of a specific printer, monitor, scanner, or camera.

The factors noted above indicate that the adverse effects of inaccurate color representation afflict not only on-line shopping sites, but also more traditional means of shopping for fashion products, such as retail stores and printed catalogs. The problem is actually more a matter of perception than representation and this gives rise to the difficulty in accurately portraying the color to the consumer. Color is a sensory perception related to the frequency of the light waves being reflected from the item being viewed and not an intrinsic property of that item. This is why it is entirely possible that two items viewed in a retail store, say under fluorescent lighting, may appear to be the same color yet when viewed outside, under natural sunlight, may appear to be different colors.

Printed catalogs introduce yet another set of lighting factors that impact the consumer's perception of a fashion product's color. An image of the item appearing in the catalog is created under one set of lighting conditions, yet may be viewed under an entirely different set of lighting conditions. Even though the image may be painstakingly

color corrected to match the original item, the catalog producer has no control over the lighting conditions under which that image will ultimately be viewed. An additional problem associated with catalogs is that the colors represented in the printing process are a close approximation produced by color composites. Most printers utilize the CMYK color model, which approximates colors in terms of the amounts of each color of ink—cyan, magenta, yellow, and black. The color gamut that a printer is able to represent is much smaller than the entire range of colors that the human eye can perceive, thus the approximation is often lacking in precision.

Images of fashion products presented on the web are subject to the same lighting issues as catalog images during their creation and viewing, as well as to a host of hardware and software factors. Some of these factors include the graphic file format in which the image is stored, the type, brand, and age of the monitor on which the image is viewed, the graphics card to which the monitor is attached, and operating system settings for number of colors to be displayed and the resolution of the display. Personal computers owned by consumers vary in image presentation due to differences in graphics cards and monitor resolution capabilities (Imation.com, 2001; Businesswire.com, 1999).

Choice Criteria versus Satisfaction Drivers

A distinction must be made between Choice Criteria and Satisfaction Drivers. Consumers may select a product using one set of criteria (Choice Criteria) and determine if they are satisfied with the product using a different set of criteria (Satisfaction Drivers) (Oliver, 1997). Choice Criteria for fashion items may include both basic product features and augmented product features. The basic product features include, but are not limited to, considerations such as size, fabric, style, and color. These features may also be Satisfaction Drivers since they will influence post-purchase behavior. For instance, a consumer may select a fashion accessory due to the color, and derive satisfaction since the item completes the stylish look that he/she was striving for in their ensemble. In such a case color is a Choice Criteria when making the purchase decision, and a Satisfaction Driver once the item has been received. In another example, a person may desire to purchase a blue suit for work and therefore limit their selection to only suits that are available in a range of blue. Once a suit in an acceptable shade of blue is found, other Choice Criteria, such as style, fabric and size, take over. When the customer receives the suit, their behavior is then driven by Satisfaction Drivers. The customer may be satisfied since the suit fits properly, looks stylish, and is of the correct blue color. Or, the customer may be dissatisfied because even though the suit fits correctly and is stylish, the blue is not the same color perceived by the customer on the e-commerce site. Various studies confirm that some features of a transaction drive pre-purchase behavior, while others clearly drive post-purchase behavior, while still others may drive both pre- and post-purchase behavior (Gardial et al., 1994 & Voss, Parasuraman and Grewal, 1998).

Not all researchers agree that specific attributes that characterize the shopping experience can be examined individually. Elliot and Fowell (2000) suggest that individual components of the on-line shopping experience, when examined in isolation, do not lead to a complete picture of the experience. Instead, they assert that the total experience must be examined in its entirety before it is possible to gain a complete

understanding. Burke (2002) also concentrates on the whole shopping experience. While he found that product information was an important factor for Internet sites to provide for shoppers, individual components that may influence the shopping experience, such as color depiction, are not considered. The only means of depicting the color of the products in the research are thumbnails, which are small product photographs, and/or detailed product photographs.

However, Burke did find that the level of “must have” product information ranged from a high of 78% for appliances to a low of 37% for books. Burke’s research also showed that 8% of the respondents preferred to use a variety of channels to investigate new products, and 74% use on-line searches to get product information to make comparisons and evaluate the alternatives. Further, the study showed that consumers prefer using a media that accurately portrays the specific product characteristics under purchase consideration. The Internet rated high for items that were not color sensitive, while catalogs and in-store visits rated high for items such as clothing and furniture, which have an important visual component, as well as for items that were classified as expensive, infrequent purchases such as paint and wallpaper. Consumers indicated that for on-line purchases of apparel, thumbnails (46%) and full-page photographs (41%) were important. While this study does not specifically target color considerations, the implications for color include

- the amount of "must have" product information associated with the on-line purchase of color-sensitive clothing would be relatively high
- consumers prefer a media that accurately portrays product characteristics, which is assumed to include color, and therefore are unwilling to rely on the Internet for an accurate depiction of items with a visual component such as color
- consumers who shop on-line consider the visual depiction to be important, and therefore color must be accurately represented.

Research performed by Griffith, et al., (2001) confirms a need to examine shoppers’ interactions with the Internet. Their study focuses on the fashion industry looking at the differences between catalogs and how products are depicted on the web. The findings support the concept that simple replication of the catalog on the web is not appropriate, and that the web version must have enhancements. Here again the study does not consider color as a variable.

Ariely and Carmon (2000) argue that satisfaction with the purchase process outweighs the satisfaction with the product information or even the product itself. This would indicate that web sites that do a poor job of depicting the color of a product would not be as well regarded as ones that do a good job of depicting color. This also has an effect on return visits to the site; the same way consumers become “regulars” at a traditional store (Alba and Hutchinson 1987). In fact, Dholakia and Bagozzi (2001) argue that there is a strong similarity between brand loyalty and site loyalty. Reibstein (2002) found that product representation, which may include color, was the third highest factor affecting likelihood to buy again from a particular on-line merchant. The only two factors rated higher were customer support and on-time delivery.

This study focuses on the Choice Criteria of color because industry studies have shown that color is a critical factor in the selection of fashion products

(Businesswire.com, 1999), and because color is one of a few basic product features that can be visually depicted on a monitor for Internet purchases. It is the only basic product feature that will vary from monitor to monitor, unlike other features, such as style, that will not vary when viewed on different monitors. Industry reports that stress the importance of color, in conjunction with the lack of studies that specifically address color, prompted this research.

Industry research has shown that while color is a critical factor in the selection of fashion products, customers have come to distrust color accuracy on the web (Businesswire.com, 1999). Although 76% of web users shopping for color related items indicate that color accuracy is an important characteristic, 60% of the users do not trust the item color as displayed in the product image (Businesswire.com, 1999). As a consequence of this lack of faith, approximately 30% of e-consumers will not purchase color-critical products because they doubt its actual color (Businesswire.com, 1999). This is especially true for those who shop for clothing and accessories, since color is often a critical factor in the selection of such items.

Not only can color inaccuracy discourage purchases, but it may also have post-purchase consequences. When the color of an item that is received does not match what the consumer expects, there is a likelihood that the item will be returned. Bunn (1999) estimates that 40% to 50% of items ordered over the Internet are returned. He also states these returns are estimated to constitute up to approximately 5% of the overall logistics costs within organizations, costs eventually passed on to consumers. According to one industry survey, 15% of color-critical items are returned (Businesswire.com, 1999). In addition, many consumers are dissatisfied but do not return the item for various reasons. According to industry surveys, between 66% (Imation.com, 2001) and 85% (Businesswire.com, 1999) of consumers who received products with an unsatisfactory color did not return the products in spite of their dissatisfaction. Quick (2000) reports that concerns over the ease of returning merchandise are among the main reasons for not shopping on-line.

In addition, dissatisfied customers may simply stop shopping rather than complain or return color-inappropriate fashion items. In fact, one study found that 95% of dissatisfied customers don't complain but simply stop buying from the merchant (TARP, 1986). Industry studies show that over 50% of on-line shoppers would not make future purchases from an on-line merchant that delivered an item in a color that was not what they expected (Imation.com, 2001). This is especially significant since Reichheld (1996) reports that a 5% reduction in the customer defection rate can increase profits by 25% to 85%, depending on the industry.

In summary, these academic and industry studies indicate that a substantial color inaccuracy problem does exist and does impact on-line purchasing behavior. When on-line customers are conditioned to distrust what they see on e-commerce sites, they may make complaints about unsatisfactory items, return those items, or even stop making on-line purchases altogether. The full effect of this problem needs to be investigated further and the nature of the problem validated. This study is an initial investigation into the pre- and post-sale ramifications of inaccurate color representation on the Internet. Due to the complexity of the color depiction problem, many approaches must be utilized to understand the full extent of the problem. This study focuses on a specific aspect of the problem.

Research Methodology

This investigation involved a survey structured to investigate respondents' assessments of color accuracy on the web. The data collection process involved a series of steps. First, a series of e-mail messages and telephone interviews were utilized to establish if industry leaders agree that the problem of accurate color representation on the web actually exists. The information gathered in this phase of the study confirmed that a problem exists and that only some Internet marketers are aware of it.

Next, the questionnaire was developed to assess the level of color accuracy depicted with respect to the actual swatch of cloth used to generate the digital image. A seven-point scale was used to capture the perceived level of accuracy of the digital image. Two other areas of interest included return behavior and complaint behavior. An item on the questionnaire asked if the respondent would return an item if the color of the actual product differed from its representation on the Internet. Those indicating that they would return the item were asked to use a four-point scale to indicate the likelihood that they would return the item. Another item on the questionnaire was designed to assess whether the respondents would complain about color discrepancies to the merchant. Again, for those indicating that they would complain, a four-point scale captures the likelihood that they would do so.

These questions were asked for each of the eleven swatches of colored fabric used in the study. The eleven colored swatches were selected at a fabric store using a simple criterion that limited the fabric to bold colors, plain fabric without design or heavy texturing, and commonly accepted colors. The colors used include red, navy blue, light blue, orange, black, yellow, grey, light green, dark green, purple, and rust.

The survey was administered in a computer lab where each respondent was given a packet of eleven folders and an instruction sheet. Each folder was numbered and contained a swatch of cloth. The respondents logged into the survey site with their unique student identification number and a password that was provided on the instruction sheet. The identification number was used to prevent the respondent from participating in the survey multiple times. The colored swatches were compared to the digital image on the screen and the accuracy of the image was rated on a seven-point scale, with one being very different and seven being identical. Standard demographic questions were included in the questionnaire for classification purposes.

Sample

The questionnaire was administered to university students because of the availability of a large number of subjects who represent a cross section of both experienced and inexperienced Internet shoppers. It is critical to involve experienced users since their familiarity provides them with a more realistic perspective of Internet shopping than inexperienced users. Other research dealing with Fashion Marketing on the web has used a similar sample (Griffith, et al., 2001). Three hundred questionnaires were collected from the students who participated in this study.

The respondents are college students who are attending full time (84.6%), and 71.5% were between the ages of 18 and 26. The gender distribution was 58.4% male and

41.6% female. Other demographic breakdowns include 53.8% single and 46.2% married students, and 63.3% have no children at home. Income level was on the lower end (56.8% under \$20,000), which was expected due to the age distribution and the fact that most are full-time students. The student population was deemed acceptable since the demographics of the school are not traditional, with an older than normal student body. In addition, almost half of the subjects (46.2%) are married, and about a third (36.7%) have children. Thus, the sample does not suffer from homogeneity to the degree that many student samples do. Another point is that 97.8% of the students reported that they are not color blind. The 2.2 who indicated color blindness were not considered in the analysis of color accuracy.

Data Analysis and Findings

Since the respondents used a computer-based web survey to answer the survey questions, the data is all within the appropriate ranges for the answer sets, since only acceptable answers were available to the respondents. Any missing data is automatically captured and coded accordingly. The Mean value of the perceived level of color accuracy was computed for each of the eleven colors and is presented in Table One. In this seven-point scale a score of 7 is an identical match, a score of 4.0 is neutral, and anything above that indicates a close match. Only five of the eleven colors scored above the mid-point. Those colors are navy blue, black, grey, light green and light blue. Black scored the highest with a mean of 5.88. Of the non-accurate colors, purple scored the lowest with a mean of 1.71.

TABLE 1
Color Accuracy
 Mean Value of Color Swatches
 (1=very different to 7=identical match)

Swatch Number	Color	Mean (n=268)
SW 1	Navy Blue	4.31
SW 2	Black	5.88
SW 3	Yellow	1.96
SW 4	Grey	4.18
SW 5	Orange	2.29
SW 6	Light Green	4.11
SW 7	Rust	3.84
SW 8	Light Blue	5.30
SW 9	Dark Green	3.09
SW 10	Purple	1.71
SW 11	Red	3.03

An examination of the probability that a respondent would complain due to the perceived accuracy of the color match clearly shows that for some colors,

the likelihood is very high. This is based on the percentage of respondents who indicated that they would complain. Generally the percentage of respondents who indicated that they would complain closely corresponds to the mean of the likelihood of complaining. Table Two shows the percentage of respondents who indicated that they would complain (column three) and the mean from a four-point likelihood to complain scale (column four). The table shows that not only were Yellow and Purple the colors that respondents would most likely complain about, but they also had the highest likelihood mean score. Black and Light Blue had the least number of potential complaints, although the respondents who would complain about those colors have a higher likelihood of complaining than do those who would complain about several other colors, including Navy Blue and Grey.

TABLE 2
Likelihood of Complaining
 Mean Value of Color Swatches
 (1=very likely to 4=very unlikely)

Swatch Number	Color	Percent	Mean (n=268)
SW 1	Navy Blue	42.9	2.25
SW 2	Black	8.0	1.76
SW 3	Yellow	85.1	1.62
SW 4	Grey	35.2	2.13
SW 5	Orange	78.2	1.80
SW 6	Light Green	37.5	1.94
SW 7	Rust	41.0	1.99
SW 8	Light Blue	9.6	1.96
SW 9	Dark Green	58.2	1.67
SW 10	Purple	83.9	1.41
SW 11	Red	62.8	1.85

An examination of the likelihood of returning an item based on the perceived accuracy of the color match clearly shows that for some colors, the likelihood is very high, as indicated by the percentage of respondents who stated that they would return. Generally, the percentage of respondents who indicated that they would return and the mean of the likelihood of returning correspond. Table Three shows the percentage of respondents who indicated that they would return and the mean from a four-point likelihood to return scale. Here the respondents indicated that Purple and Yellow are the colors that they would most likely return, and they also had the highest likelihood mean score. Black and Light Blue again had the least number of potential returns, although the respondents who would return items in the color black are more likely to do so than those returning items in several other colors. Light blue had the second lowest number of returns and the least likelihood of returning by those that would return the item.

TABLE 3
Likelihood of Returning Item

Mean Value of Color Swatches
(1=very likely to 4=very unlikely)

Swatch Number	Color	Percent	Mean (n=268)
SW 1	Navy Blue	33.1	1.92
SW 2	Black	9.6	1.87
SW 3	Yellow	83.1	1.51
SW 4	Grey	34.5	2.00
SW 5	Orange	77.4	1.47
SW 6	Light Green	39.1	1.99
SW 7	Rust	40.6	1.88
SW 8	Light Blue	10.0	2.08
SW 9	Dark Green	63.2	1.62
SW 10	Purple	83.9	1.31
SW 11	Red	65.1	1.83

We found no significant differences with regard to gender, age or income with regard to the perception of inaccuracy of color representation using computer display.

Conclusion and Discussion

Internet marketers of fashion items must be more aware of the consequences of color inaccuracies on an e-commerce site. Conversations with Internet marketers during the initial stages of this undertaking revealed that many think a vast majority of consumers are not concerned with color accuracy when considering making purchases from an e-commerce site. These e-tailers indicated that they assume that their customers normally refer to catalogs when they shop on-line. Although this may have been a valid assumption in the early days of Internet fashion marketing, this study found that it is no longer the case, with only 6.8% of the respondents indicating that they always use a catalog in conjunction with the computer monitor when ordering, as opposed to 28.8% who never use a catalog when shopping on-line. This would support research by Griffith et al. (2001) and Elliot and Fowell (2000) in that marketers must design their websites to appeal to users and not rely on other forms of product representation, since users are moving away from using catalogs in conjunction with the Internet.

Shoppers must trust that the product they order will closely resemble what they receive. However, in this study only 34.7% of the respondents indicated that they trusted the color accuracy displayed on their monitor. When asked about purchase intention, 23% of the respondents indicated that they would not purchase the item of interest if the color were in doubt. This supports the concept that reliability is the most critical dimension to service quality as proposed by Berry, Zeithaml and Parasuraman (1990) and Parasuraman and Grewal (2000).

Increased dissatisfaction on the part of consumers leads to greater costs in both customer service and reverse logistics. For those respondents who made an on-line purchase in the last year, 11.8% have complained to the on-line merchants if they received an unsatisfactory color. Further, 12.7% of those same respondents have

returned an item that was delivered in a color different from what was expected. This is another indication that companies will incur additional costs if the colors of items on the web are not accurately represented. This clearly supports the research presented by Imation (2000) and Businesswire.com (1999) as well as complaint behavior research by Singh (1988) and return behavior research by Bunn (1999).

Another area of grave concern is customer retention. Many respondents indicated that they neither complain nor return unsatisfactory items, but simply keep the product and refrain from making future purchases from that web site, which again supports Imation (2000) and Businesswire.com (1999). With 22.1% of the respondents indicating that they have had personal experience with inaccurate color on the web, approximately half either complained or returned the item as shown above. This finding lends support to the research of Boulding et al. (1993), Richins (1983) and Scaglione (1988). As discussed earlier, the impact of poor customer retention can be substantial, so much so that the issue must be addressed.

This research will lead to better management of e-commerce through better understanding of the benefits and drawbacks of presenting goods via computer display. This research spotlights the necessity of collaboration between departments within organizations such as information systems, marketing, and operations. This will allow organizations to work more efficiently, leading to improved customer satisfaction and ultimately allowing e-commerce to be more competitive. E-tailers who can offer better color representation on their web portal can gain a competitive advantage since they will offer a better value to on-line shoppers.

Future Research

This study reveals a need for future research in multiple directions. With respect to technology, there are several avenues that need exploration:

- Determine the causes of color inaccuracy when images are viewed.
- Determine the causes of color inaccuracy when images are captured.
- Investigate the impact of computer monitors, video cards, image file types, and other technical factors that may influence the delivery and display of color on the Internet.

With respect to marketing, there are several avenues that need exploration:

- Determine the significance of color accuracy on the overall purchase and post-purchase satisfaction.
- Further examine consumer complaint behavior in terms of personal values and propensity to complain.
- Determine the extent to which color inaccuracy contributes to reverse logistics costs.
- Investigate purchasing behavior in a multi-channel environment, especially in cases where a catalog is used in conjunction with the Internet website for making the purchase decision.

- Determine the extent of the correlation between risk aversion and a customer's unwillingness to purchase color-critical products from an e-commerce site if color accuracy is in question.

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