Understanding customer needs

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Abstract. Since many influences bear on customers' decisions to buy, an ongoing multivariate approach to understanding customers' needs is advocated for every organization. It is demonstrated here. Influences on art lovers' behavior in choosing a price to pay for a piece of art, on their art-buying habits, on their volunteering time to work at an art museum, and on their making financial donations to an art museum are examined. Factor analysis, the method used for data analysis, is tracked from its invention to current use. Folding insights about customers' needs into accomplishing and tracking appropriate innovations in an organization's operations, then assessing how the innovation affects organizational outcomes, is outlined. The methods and advice apply to organizations of every kind.

Keywords: Customer needs, factor analysis, multivariate, innovation adoption, decisions, correlation, multiple regression, organization, management

Henry Ford is reputed to have said in the 1920s: "A customer may have any color car he wants so long as it's black." In 1930, this scientist's parents, five years into their marriage, bought their first new car. It was a Chevrolet and maroon in color. Customers chose the direction of the auto industry and the Ford Motor Company gave up a large market share to competitors.

Studying customers' needs for art

On a warm summer evening in June 2013, my wife and I were seated in a tent outside the Museum of Northwest Art (MoNA) in LaConner, Washington. The Museum's twenty first annual "live art auction" (as distinguished from "silent auction") was about to begin, a fund-raising activity for the Museum. Artists and owners had contributed 313 works to the Museum, the largest and most expensive items being set aside for

sale in the live auction. Paintings, sculpture, works in glass and ceramics, and jewelry were being offered. Guests had several hours prior to the live auction to view its offerings in the Museum and enjoy fine food and drink. My wife had contributed a painting of her making and we attended as guests of the Museum, having a keen interest in seeing whether her painting would sell and what price it would bring. Doing research was far from my thoughts. The auction began. The first work was brought to the platform, was described in a brief announcement, and the auctioneer asked "Do I have an opening bid for $500?" Many objects were sold in a minute or less. The show's catalogue on my lap, my management consulting habits of five decades took over. I recorded the sale price and the bidder's number for the first sale. Soon I also was recording the hour and minute of the sale. My wife's piece was the eighteenth item to be sold that evening. She then was ready to start our hour's drive home. "You go. I'll hitchhike home. I'm collecting some interesting data," I said. She relented, staying at my side to the end of the three hour event.

A career in the behavioral sciences had taught me there are many influences leading to any one human decision, any one action. "What influences prompt the price paid for an object of art?" I wondered. The catalogue had many descriptors for each item – size, ma-

terials used, artist's name, brief artist's biography, the type of art, artist's asking price – along with a photo of the item from which I could derive other descriptors such as whether the art was realistic or abstract. Each of the 92 pieces being offered in the live auction was described. At home, a spreadsheet under construction, I realized I could go online with the artist's name and find other information – artist dead or alive, artist has a Wikipedia biography, has a Facebook account, has a LinkedIn account, is noted on a gallery's website as one of its artists. The starting auctioneer was relieved for a rest about mid auction and I marked the sales he had handled and the sales handled by his relief. I knew in what order each piece had been sold. My record showed whether a buyer purchased more than one object during the auction. I realized I'd like to know whether the buyer had art at home, was a member of the Museum's board of trustees, had a business in the town of LaConner, moored a boat in the town, shopped regularly in town, and what the buyer intended to do with the work of art just purchased. When gathering this information from the buyers proved to be out of reach, I designed a 65-item questionnaire seeking yes-no answers or ranks and asked neighbors, friends, family, and colleagues by email to describe their own behaviors with respect to art-buying, museum visiting, art-at-home, lecture attending, reading about art, donations to art museums, and volunteering at art museums. Their answers provided a benchmark with which to compare the buyers' behaviors during the auction. When data gathering was complete, I had 32 pieces of information about each of 92 purchases of art during the auction and 65 pieces of information from 39 questionnaire respondents in the benchmark sample. Altogether there were 5,479 pieces of data ... information that cannot be understood by mere inspection. I had a plan for analysis and, helped by colleagues, it worked.[2]

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[2]Factor analysis was accomplished with the *pro bono* help of George Yancey, colleague and friend, at Emporia State University [11,12], Kansas, using IBM's SPSS. The work could not have been done to the level of detail and confidence in the insights without his help. Providing further help, Jerry Kehoe, colleague and friend, critically examining the sample size of $N = 39$ for the benchmark sample, pointed to the work of MacCallum et al. [3] whose analyses showed that replicated and stable factor structures in new samples of data depend on much more than the sample size. They also depend on the degree to which each factor is defined by several variables, the size of the communalities emerging from the data, and the ratio of the number of variables to the sample size. Replicable factor structures can emerge from small samples of data providing other essentials are in place. The communalities emerging from both the sales and benchmark samples were high (0.7 to 0.9). I calculated the mean

Reducing complex data to believable simplicity

Factor analysis – a statistical procedure – operates upon a correlation matrix and, in orthogonal solutions, finds a small set of uncorrelated "factors" that reduce the observed correlations to residuals not different from zero. Factor analysis and science share a core intent: explain what you see in the simplest possible terms. When Charles Spearman invented factor analysis, Pearson's correlation coefficient [6] had been known for about two decades and knowledge of multiple regression had been in hand for a decade [13]. Spearman invented factor analysis about 1904 [9], Thurstone improved it [10], both Spearman and Thurstone working as psychologists seeking to understand the multiple dimensions of human intelligence and related skills. The arrival of digital computers supported improvements in processing methods yielding the factor analysis methods available today [5].

An overview of today's use of factor analysis and multiple regression is available by examining all articles published in the peer-reviewed *Journal of Applied Psychology* from March 2013 through November 2014, eleven issues of the journal and a total of 139 articles published immediately prior to developing this summary. Of the 139 articles, 111 (80 percent) presented a correlation matrix, the largest number of variables studied being 24 and the mean number of variables studied being 9. Thus most of these scientists/authors see the world as multivariate ... but they study rather few variables. Multiple regression, creating an equation seeking to forecast or at least explain an outcome, was used in 60 articles (43 percent). Factor analysis, seeking to find the simplest possible explanation for observations in a complex setting, was used in 6 articles (4 percent), none of those articles presenting a factor matrix. The first-named author for 133 articles (96 percent of the 139 articles) was university employed, 118 (85 percent) of the articles having all its authors employed in a university. Four articles had one author, all others having multiple authors often employed in multiple universities. Psychology as a discipline, the birthplace of factor analysis, is using

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rank order of perceived influences on the price paid for art emerging from the first seven respondents in the benchmark sample. It correlated $r = 0.9$ with the mean rank order developed from the second seven respondents, similarly high correlations occurring as each successive batch of seven responses arrived. Given that consensus, I became satisfied that the findings by McCallum et al. [3] and the repeated consensus observed in these responses justified studying and reporting findings from the benchmark sample.

the method infrequently a century later. In the study of influences potentially affecting the behavior of art lovers described here, over 60 variables were examined to understand customer behavior. That's a giant step – and, I argue, a necessary step – beyond the average of nine variables being studied in current research. Since professors and graduate students of psychology doing publishable work are not using factor analysis, newly arrived students are not seeing factor analysis in use. At least as unfortunate, factor analysis is seldom used in other fields of applied science ... climate science, medicine, economic modeling, modeling of political behavior, studies of appropriate investments, space exploration, crime prevention, hacking into data files, identity theft ... outcomes in all these matters being influenced by many variables. A powerful tool for statistical analysis, known for a century, is not being used. Unhappily, oversights of this kind in human history are all too common [4]. Cultural learning is possible and has occurred to the benefit of humanity as Pinker shows [7]. The rate at which cultures learn, adopting innovations that produce benefits, can be improved. See the means for promoting innovation adoption described below.

At the very moment I recognized the opportunity to investigate the influences on price paid for art in June, 2013, I knew that factor analysis would be my method for extracting the simplest possible explanations for observed outcomes. Two correlation matrices were calculated to describe the observations, one with 32 variables derived from the sales sample and the other with 30 variables describing the benchmark sample. George Yancey and I [11,12][2] extracted principal components, retained components explaining amounts of variance believably larger than statistical noise (components having eigenvalues of 0.75 and greater), and rotated those components to simple structure. Thirteen factors emerged from each of the two data sets. Four outcomes were studied. (1) The price paid for art was studied using the sales sample. (2) The habit of buying art, (3) The practice of making donations of money to art museums, and (4) Volunteering time to work at art museums were studied using the benchmark sample.

A bucketful of surprises

Asked to identify the most important influences on the price paid for an object of art, respondents in the benchmark survey ranked (1) the buyer's income, (2) the buyer's affinity for art, (3) the art's impact on the

viewer, and (4) the buyer's knowledge/experience with art as the most important in that order. They ranked (22) where the buyer purchased the art, (23) the buyer's intent to sell the art, (24) the buyer's wish to support tourist visits to town, and (25) the buyer's loyalty to the town in descending order at the very bottom of a list of influences. The benchmark respondents are well educated (20 percent hold doctorate degrees, 95 percent are college graduates), are buyers of art (41 percent had purchased two or more objects of art in the past twelve months), are frequent visitors to art museums and galleries, read books about art and artists, and have made donations to art museums (72 percent had made donations in their lifetime). They are the kinds of people one expects to find on the boards of trustees of art museums. Findlay [1], an art expert, says that size of the work, materials used, cost of fabrication, and use of color rather than presenting monochromatic images affect the price in the primary art market, that moment when a work of art leaves the artist's inventory and moves to its first owner. Examination of influences on price paid during the 2013 art auction in LaConner showed that 49 percent of the price variance was explained by the buyer's trust in the price-judgment of the purveyor of art (the art museum, on this occasion), 9 percent was explained by the artist having used traditional materials in presenting realistic scenes, 9 percent was explained by the time in the evening that the work was offered for sale, 4 percent was influenced by the gender of the artist, the work of male artists winning a higher price (to this observer's astonishment for this early 21st century's moment in time), and 4 percent was influenced by the fact that the work being purchased was a painting ... artists producing other types of art seeking and winning lower prices on average. These five influences on price paid accounted for 75 percent of the total variance in price. It is reasonable to estimate that 20 percent of the variance in price paid can be attributed to error. Let's do a thought experiment. Any piece from the sale, sold again in a similar auction to a similar crowd of buyers on the day after the first sale, surely would differ somewhat, sometimes differ a lot, from the price obtained in the first auction, indicating that the price paid is at least somewhat in error. With the explanations now in hand, a residual of only 5 percent of price variance (75 + 20 + 5 = 100 percent of price variance) remains to be explained by the buyer's income, the buyer's "liking the art," or the buyer's knowledge/experience with art ... the influences thought to be most important by respondents to the benchmark

survey. All of art-expert Findlay's named influences on price [1, pp. 15–17] were examined in this research, yet none of the elements he named emerged as price-influential in MoNA's auction in June 2013. Neither collective wisdom derived from the benchmark sample nor expertise from a highly-respected, Christie-auction-house-experienced expert [1] identified the influences on price paid that an analysis of behavior disclosed! Which are you going to hold as true about influences on customer behavior: the common wisdom from sophisticated buyers and onlookers in the benchmark sample, the wisdom of the career expert in art sales, or the partitioning of the influences on price paid derived from behavioral research?

Using knowledge of customers' needs in organizational decisions

How do organizations – art museums, corporations, governments, census bureaus, professions, libraries, hospitals, etc. – convert knowledge of customers' needs into effective organizational practices and new products?

First, you collect information about customers' needs using methods producing answers that you can believe! The study of influences on the buying behavior of art lovers described here should convince any reader that gathering information needs to be a continuous and ongoing activity using competent methods and analyses, thus acquiring believable information. To maintain organizational success (as Henry Ford learned), understanding customers' needs is essential. Few organizations now have that information or know how to get it. Scientists qualified to guide such work are few in number and can be found in interstices of the behavioral and management sciences . . . psychology, management, education, political science, economics, statistics, etc. Not everyone who claims to have done work of this kind has done high quality work. Kahneman [2] reports that most decisions by individuals are made quickly based on habits acquired over a lifetime, some decisions being made slowly following a more thoughtful process. Clearly, decisions about an organization's next innovations, whether made by an individual or by a board, need to be done by "thinking slowly," in Kahneman's terms, and founded on believable information about customer needs.

Second, your organization needs to be in the habit of trying and evaluating innovations. Few organizations have that habit. A theory about innovation adoption by

organizations [8] was partly validated in a field study done in eight similar organizations (public school districts). To adopt a new practice, a new way of operating or thinking, an organization *must have both initiating mechanisms and sustaining mechanisms operating simultaneously*. Lacking either one, no innovation occurs. Initiating mechanisms are means for bringing new ideas into the organization. Sustaining mechanisms are attitudes within the organization or among its fans which welcome new ideas, giving them a try. The field study [8] verified that both mechanisms had been in place in organizations that were using new methods effectively. One or the other mechanism was found not to have been functioning in organizations that had not adopted new methods. Happily, there are various ways that initiating mechanisms and sustaining mechanisms can be brought to life if they happen to be dormant. See the original article for suggestions. The theory went on to speculate that *feedback mechanisms* determine the half-life of an innovation. Measures of organizational outcomes that are supposed to be affected by the innovation, put in place and monitored widely by many people in the organization, can cause a useless innovation to be abandoned quickly and a useful one to be extended in its use to other parts of the organization. As in understanding customer needs, getting a clear view of organizational performance requires many different measures of organizational outcomes. Watching only the organization's quarterly profit/loss statement is not sufficient . . . important though that measure of performance is to the organization's survival. Notice that the research project about art buying behavior in 2013 at the Museum of Northwest Art provided both initiating mechanisms (a source of ideas pointing to possible changes in practices) and feedback mechanisms (measures of the effectiveness of current practices).

Third, notice that the ideas presented here are not widely known . . . an understatement that some will see as humorous. The ideas need to be conveyed to organizational leaders if they are going to be put to use. To which organizational leaders are you going to send a note saying this is a must-read article? To which organizational leaders are they going to send a similar note? How else will these ideas be put to use?

References

[1] M. Findlay, *The value of art* (2012) Prestel Verlag, Munich, Germany.
[2] D. Kahneman, *Thinking, fast and slow* (2011) Farrar, Straus and Giroux, New York NY.

[3] R.C. MacCallum, K.F. Widaman, S. Zhang and S. Hong, Sample size in factor analysis, *Psychological Methods* **4** (1999), 84–99.

[4] T. Norton, *Imagination and a pile of junk: A droll history of inventors & inventions*, (2014) Hodder & Stoughton Ltd., London UK.

[5] J.C. Nunnally and I.H. Bernstein, *Psychometric theory* (1994) (Third Edition), McGraw Hill Inc., New York NY.

[6] K. Pearson, Mathematical contributions to the theory of evolution, III: regression, heredity, and panmixia, *Philosophical Transactions of the Royal Society of London* **187** (1896), 253–318.

[7] S. Pinker, *The better angels of our nature: Why violence has declined* (2011) Viking, New York NY.

[8] P.F. Ross, Innovation adoption by organizations, *Personnel Psychology* **27** (1974), 21–47.

[9] C. Spearman, General intelligence: Objectively determined and measured, *American Journal of Psychology* **15** (1904), 201–293.

[10] L.L. Thurstone, Multiple factor analysis, *Psychological Review* **38** (1931), 406–427.

[11] G. Yancey, Paul Ross – museum data ($N = 92$), (2014a), Paul F. Ross's data file (factor analyses) named mona_2014_sales_fa_0218.doc.

[12] G. Yancey, Paul's opinion data ($N = 39$), (2014b), Paul F. Ross's data file (factor analyses) named mona_2014_opinion_fa_0218.docx.

[13] G.U. Yule, On the theory of correlation, *Journal of the Royal Statistical Society* **60** (1897), 812–854.