ATM user attitudes: a neural network analysis

Fiona Davies, Luiz Moutinho and Bruce Curry Cardiff Business School, University of Wales, Cardiff

Introduction

The ever-increasing competition within banking services, in terms of both costs and products, means that overall consumer satisfaction is playing a vital role in marketing management, owing to its influence on repeat sales, positive word-of-mouth recommendations and, most importantly, customer brand loyalty (e.g. Bearden and Teel, 1983).

The understanding of how consumers develop positive or negative attitudes towards products, services and brands, and how this is reflected in actual buying behaviour, is a central theoretical issue. For marketers, consumer satisfaction is one of the primary goals to strive for; without satisfaction, brand loyalty is unlikely.

There is a substantial volume of literature concerned with modelling constructs of product expectations, confirmation or disconfirmation of expectations in satisfaction behaviour (e.g. Hunt and Day, 1981; Tse and Wilton, 1988; Wilton and Nicosia, 1986), and numerous research studies have focused on the conceptual development and measurement of service satisfaction (Bearden and Teel, 1983; Bodur, 1977; Crosby and Stephens, 1987; Hoch and Deighton, 1989; Oliver and Swan, 1989; Swan and Martin, 1980; Westbrook, 1980).

The issue of satisfaction is also related to market segmentation, in that different consumer groups may have different expectations of a service, and thus different factors will be crucial in determining the degree of satisfaction felt with that service. Donner (1992) warned that in order to remain competitive, banks would have to segment their customer bases more actively and indeed over the last few years banks have increasingly invested in database technology in order to enable them to target specific customer segments more accurately (Burton, 1994, p. 37). Examples of segmentation variables used are income, age, employment classification, stage in life cycle, lifestyle and housing tenure. Meidan (1984, p. 22) pointed out as far back as 1984 that it was vital to understand the behavioural characteristics of the different segments, which are influenced (Evans and Beckman, 1974) by external and internal factors, as well as by the consumer process (the stages through which a consumer goes when contemplating a purchase). Of most relevance to this study are the internal factors, defined as motives, attitudes, learned behaviour and perception. Knight (1994) believes that the development of a deeper understanding of customer behaviour and attitudes should now be the most important aim of bank marketers.

This paper focuses on factors influencing satisfaction with automated teller machines (ATMs). It first reviews current literature on ATMs and satisfaction-related issues, then describes the neural network approach to data analysis and the research model, followed by discussion of the findings and finally implications for banks and for further research.

Literature review

Bank service automation is becoming a critical factor in the process of trying to attain cost-effectiveness which can be used as a strategic competitive weapon. Financial institutions have embarked on technology-driven strategies which they hope will be translated in terms of customer preferences and consequently, higher market penetration. ATMs have been playing a pioneering and pivotal role here. At the same time, bank marketing managers need continually to assess the customer’s decision-making process as well as the formation of attitudes, preferences and satisfaction with these new automated services (Moutinho and Curry, 1994). The banking industry has tried to take advantage of the productivity and customer service gains associated with technology by the provision of ATMs which consumers can use to carry out day-to-day banking transactions. Leonard and Spencer (1991) found that a great majority of customers perceived banks with ATMs as being either very or somewhat successful.

However, despite the advantages of these new technologies, there are still large numbers of consumers who are resistant to new ways of doing their banking – Murdock and Franz (1983), for instance, identified a large class of customers who found using ATMs...
“embarrassing and/or degrading”, implying that they preferred more personal service. Stemper (1990, p. 127), in discussing customer mindsets, cites two possible opposing views: a positive view of ATMs because interaction with them implies no value judgements, role playing, or non-verbal communication (as there may be between customer and teller), or a dislike of ATMs owing to fear of technology, vision problems, impersonality, or reluctance to change methods of banking.

There is a considerable body of satisfaction research in the field of ATMs (e.g. Leblanc, 1990; Marr and Prendergast, 1990; Moutinho, 1992; Moutinho and Brownlie, 1989; Moutinho and Curry, 1994; Moutinho and Meidan, 1989; Murdock and Franz, 1983). Moutinho and Brownlie (1989) found that high levels of satisfaction were directly related to the location and accessibility of ATMs. Their respondents’ evaluation of ATM services indicated a surprising willingness to accept new functions and services provided through ATMs (i.e. loan requests, credit card payments and transfer of funds). However, bank customers seemed to be only moderately satisfied with the service of withdrawal of money from ATMs – this may be due to the recognition of a routinized behaviour or to occasional errors in bank statements. Having to queue to use an ATM was associated with a low level of satisfaction. These authors also draw attention to the important role of ATMs in conditioning customers’ perceptions of the services offered by banks. The move away from proprietary networks offers banks a way of sharing installation costs and providing more availability and convenience. However, Howcroft (1991) found that bank customers emphasized breakdown of ATMs as an important source of service dissatisfaction.

The reasons for loyalty to a bank are changing owing to increased competition and the use of new technology in bank service provision. Not only is it becoming easier to switch banks or to make use of the services of several banks, but consumers are becoming more willing to do so (National Opinion Poll/Financial Research Service findings report cited in Thomson, 1992). Young people are particularly inclined to have accounts at more than one financial institution – Lewis and Bingham’s (1991) research among 16-24 year-olds in the Manchester area found that nearly a quarter of those surveyed had an account at more than one bank. Reasons given included locational convenience, greater choice of services and more ATMs. Young people are also most inclined to switch financial providers (Meller, 1993). These facts, linked with the Inter-Bank Research Organization’s (1985) findings of increasing use of ATMs by the under 30 age group, indicate that endavouring to ensure satisfaction with the ATM service may be an important part of a bank’s strategy in attracting and retaining younger customers.

### Neural networks

The original inspiration for the neural network (NN) approach came from physiology and psychology. The aim is to work with a direct analogy of the human brain as a set of interconnected processing nodes operating in parallel, copying the lower level computational actions (as opposed to cognitive operations) carried out by the brain. The approach is in contrast to the main alternative philosophy of artificial intelligence which seeks direct representation of human knowledge. NNS do not require the construction of a knowledge base, nor do they require an explicit inference procedure to be developed and encoded. Knowledge is acquired by the NN through a process of learning from examples presented to it, and thus NNS can be viewed not only in terms of the replication of human intelligence but also as a mechanism for machine learning.

The most basic NN model is the “Perceptron”, originally suggested by Rosenblatt (1958) and further examined by Minsky and Papert (1969). This consists of a layer of input nodes each of which is potentially connected to each node in a layer of outputs. The network is trained from a set of “examples”, some of which may be kept aside for testing purposes. Where examples consist both of input layer and output layer values, learning is said to be “supervised”, a condition equivalent to statistical estimation. “Unsupervised” learning corresponds to the statistical problem of classification or discrimination. For the Perceptron model the most common scheme for supervised learning is through an iterative procedure known as the “Delta” rule, whereby the weights for each node are adjusted in proportion to the difference between the given values of the output nodes in the training set and the values generated or predicted by the network.

However, the simple Perceptron model suffers from serious limitations – in particular, Minsky and Papert showed that it is incapable of dealing with a simple “XOR” structure. The model was thus extended to allow one or more “hidden layers”, as in Figure 1.

Where a network has a single hidden layer, each node in this layer may receive signals from each node in the input layer and may in turn pass on signals to each node in the
The most common learning scheme for NN implementations with supervised learning, and the one used in the model discussed in this paper, is known as the “back-propagation algorithm”. This is an extension of the “delta rule”, whereby the weights for each node are adjusted in proportion to the “errors”, which represent the differences between the given values of the output nodes in the training set of examples and the values predicted by the network. It is of course impossible to compute prediction errors for the hidden layer nodes. The algorithm circumvents this problem by calculating imputed values for these errors at each stage, by dividing the output layer error pro rata between the hidden nodes. Back-propagation refers to this process of calculating errors by working backwards from the output nodes.

As the addition of hidden layers in a completely linear model would provide no additional representational power, it is also usual for an element of non-linearity to be brought in through the use of threshold levels for each hidden layer node. The threshold effect is modelled by a suitable continuous function, in this case the sigmoid function which maps values to a range of one to zero. For small input signals the function slopes steeply, but as the signal becomes stronger the differential impact becomes progressively lower (see Figure 2).

The research model

For this study, data were gathered by personal interview from a total sample of 380 ATM users. They were analysed using the NN software “NeuralWorks”, from NeuralWare, Inc. The aim was to investigate the contributions made by explanatory or exogenous variables (expectations of ATMs, perceived risk in using ATMs, confidence that mistakes will not be made, value for money (rating the ATM service in terms of charges paid to use it), and age of consumer) to four endogenous variables (degree of satisfaction with ATM service, likelihood of recommendation to others, and frequency and extent of use of ATM services). It was hypothesized that combinations of the exogenous variables would indicate intermediate variables (represented...
by the NN’s hidden layer) corresponding to respondent attitudes or types which could be identified and labelled, and which would affect the endogenous variables. The network was allowed to run until it appeared that no further improvement could be made to the quality of its predictions. At this stage $R^2$ values for the four output nodes were 0.29, 0.31, 0.10 and 0.14.

### Exogenous variables

Expectations: this construct is operationalized as a belief about the future, and evaluation of that belief (as Oliver, 1980). The measurement of the construct was related to specific service attributes, namely, transaction error, location, queueing, accessibility and machine processing time, and it was operationalized through the use of a single five-point itemized scale.

Perceived risk: the assessment of this construct was totally based on the measurement of perceived functional risk. A five-point itemized scale was used to evaluate two dimensions of the degree of functionality of the service (machine breakdowns and transaction errors).

Confidence: this measured the consumers’ assessment of the degree of risk associated with the use of ATMs and was measured on a five-point scale.

Age: age was measured using five brackets: under 18 (21 per cent of sample); 19-24 (32 per cent); 25-34 (31 per cent); 35-44 (7 per cent); and 45 and over (9 per cent).

Value for money: this was measured by a five-point itemized scale on which respondents rated the ATM service in terms of the charges paid to use it.

### Endogenous variables

Overall satisfaction: this was operationalized by asking respondents to rate their overall satisfaction with ATM use (itemized five-point scale from 5 highly satisfied, to 1 highly dissatisfied).

Recommend to other people: this measured the probability of individual consumers using word-of-mouth recommendation of ATM services to friends and relatives, and was measured on a five-point scale of likelihood.

Full use of services: this was measured on a five-point level-of-usage scale, from light users (less than twice a month) to heavy users (more than ten times a month).

### Findings

Table I shows network connection weights between the five input nodes, four hidden nodes, and four output nodes.

The signs (+ or –) and values of the network connection weights between the input and hidden layer nodes were used to deduce suitable intermediate attributes with which to label the hidden nodes. Table II shows the labels given.

#### Input layer/hidden layer connections
- The input node to hidden node connections show a clear division between an attitude of trust in the efficient functioning of ATMs (high expectations, much confidence that mistakes will not be made, low perceived risk) and a directly opposing attitude of mistrust – a perception of high risk in ATM use associated with low expectations and less confidence that mistakes will not be made.
- The “value for money” input node is linked positively with the “trust in ATMs” attitude in the connection to the third hidden node (thus labelled “pro-technology”), but is also
linked negatively with the same attitude in the connection to the fourth hidden node, labelled “cost conscious”. This implies the existence of an attitude that although ATMs are trustworthy and efficient they are still not good value for money.

• The links to the second hidden node indicate a mistrust of ATMs linked with a belief that they do not give value for money. This node was labelled “technophobic”, and was the only node showing a positive link with age.

• Hidden node 1 indicated mistrust and low expectations of ATMs linked with a belief that they were still good value for money. This node, the one linked most negatively with age, could be associated with young people such as students who get free banking and do not pay either directly or indirectly for ATM use, and was thus labelled “disaffected youth”.

Hidden layer/ output layer connections

• Connections from the technophobic and pro-technology hidden nodes to output nodes were, predictably, all negative and all positive respectively. Technophobes are less satisfied with ATMs, less likely to recommend them to others, use fewer services and use them less frequently. Consumers with strong pro-technology attitudes are more satisfied with ATMs, more likely to recommend them to others and to make full and frequent use of services.

• More cost-conscious consumers are also likely to be more satisfied with ATMs and to recommend them to others, and to use them more frequently, but they are less likely to make full use of their services. This may indicate a group of consumers who would prefer to pay less for a restricted menu of ATM services.

• Hidden node 1 (disaffected youth) is linked positively to frequency of use but negatively to all other outputs. This could indicate a segment of young consumers who use ATMs frequently for cash withdrawal only, but are not generally satisfied with ATMs.

• Assuming that responses on perceived risk and confidence are based on consumers’ experience of ATMs, it follows that high expectations which are confirmed lead to high levels of satisfaction, whether or not ATMs are perceived as good value for money. Low expectations which are confirmed lead to dissatisfaction. It was not possible to test a response to disconfirmation of expectations as no set of connections represented such a scenario.

• Perception of value for money, in this case, is not a good predictor of satisfaction. This may stem from the fact that charges are not generally made specifically for an ATM card or use of an ATM service, and bank charges levied depend on other factors such as amount of funds in account.

### Conclusions

**Implications for banks**

The analysis has shown clear divisions between four different attitudinal types of ATM consumer, only one of which (pro-technology) appears fully satisfied with ATM services. Banks need to use different methods to address the concerns of the other segments.

The cost-conscious consumers, who believe ATMs are not good value but who use few services, might prefer to pay less for a limited service. A better solution for banks might be to persuade these consumers of the benefits associated with the use of ATMs for purposes other than cash withdrawal: for instance, transactional convenience.

The disaffected youth segment appears to have had bad experiences of ATM use – as they use machines more frequently, they have probably experienced more closed, broken or vandalized machines, and maybe also errors on statements. Banks need to institute a programme to address the technological issues which have caused low expectations, in order to restore these consumers’ faith in ATMs.

Technophobes would need to have a major change in attitude to become satisfied ATM consumers. Banks could attempt this by making ATMs more user-friendly and personalized, in order to bridge the gap between human and machine interaction – for instance, by using forms of consumer identification which do not require the memorization of numbers, enabling consumer/ATM dialogue, or offering more help with carrying out transactions.

Consideration of the literature shows that there could be major advantages for banks in addressing some of these issues. The disaffected youth segment, for instance, may well include many students – a segment which banks put much effort into attracting for its future potential, as students who have been satisfied with their bank are likely to continue

### Table II

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<thead>
<tr>
<th>Hidden node</th>
<th>Labelling of hidden nodes</th>
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<tr>
<td>1</td>
<td>Disaffected youth</td>
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<tr>
<td>2</td>
<td>Technophobic</td>
</tr>
<tr>
<td>3</td>
<td>Pro-technology</td>
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<tr>
<td>4</td>
<td>Cost conscious</td>
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using it after graduation (Meidan, 1984, p. 41). Efforts made to attract the technophobe segment, who are inclined to be older, may also be profitable, as the over 35s are now the richest segment of the British population (Burton, 1994, p. 14).

Implications for further research
It would be interesting to carry out a similar analysis with a larger and more age-representative sample frame (this sample was heavily biased towards the under 35s).

In particular, the link between increased age and technophobia should be further investigated – the idea that older people are in general fearful and mistrustful of technology is one that is beginning to be refuted in other walks of life, and the large age range covered by the small sample of 45+ consumers in this study may hide important differences within the age group.

With an improved sample frame, a longitudinal approach could be adopted throughout a number of time periods, as ATMs evolve and banks address some of the technological and interactive factors which contribute to dissatisfaction with ATMs. Consumer reactions to different facets of new-generation ATMs could be studied for their impact on overall satisfaction with ATM service. Links between age and attitudes could also be monitored as the more technologically aware generations become older and there are fewer consumers for whom banking technology is something new and different.

References
Moutinho, L. and Meidan, A. (1989), "Bank customers' perceptions of innovation and new...