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The role of attributional judgments when adopted computing technology fails: a comparison of Microsoft Windows PC user perceptions of Windows and Macs

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The bulk of research to date on diffusion of innovations and the user acceptance of computing technology has focused on modelling the factors that lead to a user's decision to adopt and use a technology, instead of how individuals use technology and experience it after adoption. The current paper explores how users rationalise failures in their adopted innovations; their biases in the assessment of competing technologies; and the ultimate influence of these attributions on their interpersonal word of mouth communication with other users. The findings of the research point to the mechanisms of ego enhancement and innovativeness influencing users' reactions to the failure of their adopted computing technology. Biases regarding competing technologies are, however, influenced by information presented in the mass media. Experienced users and users who are technologically innovative are more likely to exhibit biased optimism towards the technology they have adopted. When such users hear about the failure of the computing technology they have adopted, they are far more likely to blame other users for it. In contrast, less innovative, later adopters of a technology are far more likely to blame their adopted technology and consider it to be inferior.

Keywords: optimistic bias; third-person effects; diffusion of innovations; user acceptance; marketing; computing technology failure

Diffusion of innovation (DOI) theory (Rogers 2003) is the theoretical paradigm most commonly applied to the study of the proliferation and adoption of new computing technology. Later Information Systems (IS) models such as the Technology Acceptance Model (Davis *et al.* 1989) are fundamentally built on the DOI framework. While TAM and subsequent models in this vein explain user acceptance based on a few factors that are often measured and evaluated cross-sectionally, DOI theory is much broader in scope and explains the process by which potential adopters of new computing innovations become aware of the new technology and are influenced to adopt it.

Communication is central to the process of diffusion. Diffusion occurs because interpersonal information exchange between different adopters raises awareness, increases knowledge, reduces uncertainty, and generates excitement about the technology (Rogers 2003). This excitement spurs further information exchanges about the innovation and increases its rate of adoption.

Though diffusion and IS scholars appreciate the importance of communication, the bulk of research has focused on modelling the factors that lead to the actual user acceptance decision instead of the content of communication between potential user/adopter groups. Further, much of the research focuses on a single technology and its potential users rather than its present users, their estimates of the technology's performance, or their willingness to engage in positive or negative interpersonal, word of mouth (WOM) exchanges about the technology. Furthermore, the bulk of research in diffusion and IS continues to suffer from a pro-innovation bias (Rogers 2003) and focus on the positive attributes of technologies and their acceptance. Little follow-up research evaluates whether the technology actually performed as expected by the user; even less research has evaluated users' post-adoption interpersonal, WOM exchanges with other adopters, which the process of diffusion is contingent upon. Hence, our understanding of technology failure and the post-adoption behaviour of users remains limited.

Since users of a technology already experience it, a likely antecedent to their interpersonal, WOM exchanges in the event of the technology's failure is their inferences about its performance. A framework that is particularly useful to understand how computer users might deal with such failures is attribution theory. Attribution theory focuses on how people make sense of events and behaviours in their environment in an effort to understand the underlying causes (Weiner 2000, Hoffner *et al.* 2001). The types of attributional inferences made by computer technology users, the antecedents to these inferences, and their ultimate influence on interpersonal WOM, however, remain unexplored.

Another likely antecedent to user interpersonal exchanges in the event of technology failure is the user's

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judgment about the performance of competing technologies, especially technologies that are close complements to the one the user finally purchased or adopted. Such comparisons are spurred by the need to reduce the anxiety associated with post-adoption cognitive dissonance, rationalise the adoption decision, and maintain self-esteem (Rogers 2003). Attribution theory suggests that when faced with such comparisons, individuals' causal attributions are likely to be biased due to the individuals' need to maintain cognitive consistency (Heider 1958). A social-psychological theory often applied to explain the reason for such biases is optimistic bias (Weinstein 1980). How biased optimism influences the attributional inference process among computing technology users and the influence of such comparative inferences on their interpersonal WOM exchanges remains unknown.

The present study explores the influence of attributional biases on the users of computing technology, primarily users of Microsoft's Windows PC platform, and their perceptions of both Windows and Mac. The scope of our research, however, extends to other technological innovations particularly because the technology marketplace has become increasingly duopolistic. In almost every technology market there exist usually two top brands, platforms, or peripherals that compete for user acceptance. Besides Microsoft Windows and Apple's Mac OS platforms, competition between Android and Apple's iOS, cable TV versu Direct TV, TIVO versus DVR, Amazon Kindle versus Barnes and Nobles Nook, Sony Playstation versus Xbox are indicative examples. These choices involve high degrees of uncertainty among potential adopters particularly because users get locked into their decisions either through contracts or through the purchase of complementary peripherals that cannot be utilised across platforms. In such cases, users are potentially prone to biases in interpretation and rationalisation that manifests itself when the technology they adopt fails to perform as they anticipated. For instance, if an iPhone, which many users rate highly, fails to work as expected, what do its users feel: Do they immediately blame themselves? Or, do they blame the technology? What makes them blame one over the other? Is this a rational process and could it modelled and explained? These are the primary questions that drive the present research.

Given the number of competing technologies that could be evaluated, the present research focused on Microsoft's Windows users. This was done for two reasons. First, judging by the raging debate over the virtues of Microsoft Windows and Apple OS operating systems in almost every technology magazine and blog (Sumner 2007, Stevens and Georges 2008), it is clear that Windows users are in similar comparative environments as those of most other technologies. Its users are, therefore, likely to face similar levels of anxiety and engage in similar rationalisation processes as users of other technologies. Second, since Windows PCs are widely diffused in the marketplace, it is easier to access a relevant sample of its users. Moreover, a sample of Windows PC users are less likely to comprise only innovative individuals and are therefore far more likely to be representative of general technology users in the USA. In contrast, a study of only Apple's Mac users would potentially net more innovative individuals because Macs are in the relatively early phase of the diffusion cycle.

Windows PC users thus provide an ideal subject pool for understanding the influence of attributional biases. Windows PC users' causal inferences about the reasons for PC failure provide a gauge of the attributional mechanism among its adopters. Windows users' perceptions of other Windows users and of other Mac users provide an insight into the operation of optimistic bias and social comparison in the attribution process. The adopters' comparative estimates across the two platforms are used to develop a research model and simultaneously test the affects of adopter attributions, optimistic bias, and social comparison on interpersonal WOM exchanges. We begin the next section with an overview of attribution theory and optimistic bias, followed by an explication of our research model.

1. Theoretical premise

1.1. Attribution theory

Attribution theory focuses on the inferential process of when, how and why individuals attribute blame to a general, specific, or individual event or source (Weiner 2000). The origins of this area of exploration lie in the differentiation between the phenomenological and behaviourist approaches' determinations of how individuals make sense of, or explain, their reality (Heider 1958).

The attribution theoretic approach to judgment is similar to the DOI and user-acceptance approaches in two important ways. First, similar to user-acceptance research's focus on the subjective judgment of potential adopters, the attribution approach also focuses on the naïve, subjective inferences, rather than any objective set of performance criteria. The difference is, however, in the focus of the inferences. In DOI and user acceptance research the judgments are about a software's or innovation's performance while in attribution theory the focus is on the perceived causes and effects of a particular event or incident that the user encounters. Second, similar to the DOI and use acceptance research, attribution theory views individuals as rational information processors. Their causal inferences are therefore thought to be an outcome of a fairly logical and analytical process, with specific predictors and specific behavioural consequences. Dispositional factors such as ability and experiential factors such as effort are key predictors of the causal inferences individuals make; expectancies, affect, and behaviour are some of the key outcomes (Weiner 2000).

Causal inferences are, however, not limited to inferences about one's own adopted technology. Adopters potentially consider the likelihood of similar events, in this case failures, occurring to users of competing innovations as well.

Attribution theory suggests that in situations involving such comparisons, users' causal attributions tend to be biased and distorted (Heider 1958). Users are inclined to attribute their own actions to situational requirements and those of comparative others to stable personal characteristics (Jones and Nisbett 1972). A theory that explains the underlying reasons for such distortions in causal attributions is Optimistic bias.

1.2. Optimistic bias

Optimistic bias represents people's overly optimistic beliefs about their own future experiences compared to others. The theory is often applied in communication research where the focus is on comparisons between individuals (Andsager and White 2007, Li 2008). Optimistic bias theory suggests that in such situations, individuals will perceive that they face a lower risk of experiencing a negative event, while others experience a greater risk. Additionally, individuals perceive a greater chance of experiencing a positive event, while they perceive that others will face a lower chance (Weinstein 1980).

The central explanation for optimistic bias is event desirability (Weinstein and Klein 1986). Rooted in social comparison and social evaluation theories, event desirability stems from the individuals' motivation for self-enhancement; a motivation driving comparisons with others and rating oneself as being superior (Brown 1986). This motivation is thought to be a function of egocentricism, because individuals need to maintain a sense of self-esteem and control (Weinstein and Lachendro 1982), and an uncertainty reduction technique, because individuals need to reduce personal anxiety by viewing oneself as being less personally vulnerable to negative events (Taylor and Brown 1988).

The influence of optimistic bias in the post-adoption context, however, remains unknown. Because users have already committed to the technology by deciding to adopt, they are emotionally connected to the technology and therefore the need to rationalise failures in the technology in order to maintain self-esteem and reduce anxiety is potentially higher. Because of this, the likelihood of biases in attributions is potentially stronger among technology adopters. Furthermore, the decision to adopt involves the comparison of technologies, where adopters compare a target technology with other competing innovations and with complementary peripherals and enhancements they have already adopted. Hence, biases in attributions potentially extend beyond one's adopted technology to competing innovations. Such biases are also likely to manifest interpersonal WOM exchanges about the technologies and thereby influence how the technology is framed and presented to other potential adopters. Since technology diffusion takes place because of interpersonal exchanges among users, biases in attributions have the potential to influence the entire diffusion process. The influence of attributions and comparative biases on the interpersonal WOM exchanges are tested through a research model presented in the next section.

1.3. The research model

The research model, presented in Figure 1, extends the information processing perspective of behavioural change to the study of biases in adopter attributions, its antecedents, and consequences. Based on this, individual beliefs and perceptions are considered endogenous factors that mediate the influence of external factors, such as exposure, personality, and demographics, on behaviour. This framework is fundamental to most behavioral models and forms the basis for DOI and user acceptance models (Davis *et al.* 1989).

Following this framework, the research model treats user attributions for one's own computer platform (Windows) and the competing innovation (Mac) as perceptual factors mediating the influence of adopter personality, media use, and demographics, on the adopter's positive and negative interpersonal WOM exchanges about the technology. Because the focus of the model is on the theoretical relationships between attributional biases and user WOM, the measurement model controls for demographic variables (age, education, gender).

Research on the attribution of blame has identified three dimensions of causal inferences: locus of causal responsibility, controllability, and temporal stability (Folkes 1988). The locus of causal responsibility dimension is concerned with the individuals' judgments about the source of the failure (Hunt *et al.* 1982). The controllability dimension captures the perceived degree of control individuals attribute to an entity or source over the outcome of a given event. The last dimension, temporal stability, is concerned with the perceived repeatability, reoccurrence or permanence of a given event. Together, the three dimensions have been shown to influence product satisfaction, confidence with an organisation or product, and consumer complaining behaviour (Folkes 1984, Oliver and DeSarbo 1988).

From a technology failure standpoint, adopters could infer causal responsibility to the user or the manufacturer. In the present context, Windows PC adopters could blame other Windows users for PC problems, or blame Microsoft for the problems with Windows PCs. The second dimension, controllability, in the technology failure context translates to the perceived responsibility of the organisation, producer, or disseminator of the innovation in mitigating or preventing its failure. In the present context, this translates to whether Windows PC users believe Microsoft could have prevented the problem encountered by Windows users. The final dimension, temporal stability, in the context of the technology failure, translates to the perceived likelihood of reoccurrence of problems with the technology. In the current research, this translates to how much of Windows PC problems its users believe are transient.

The assessments across the three dimensions for similar problems encountered on Macs provide the Windows

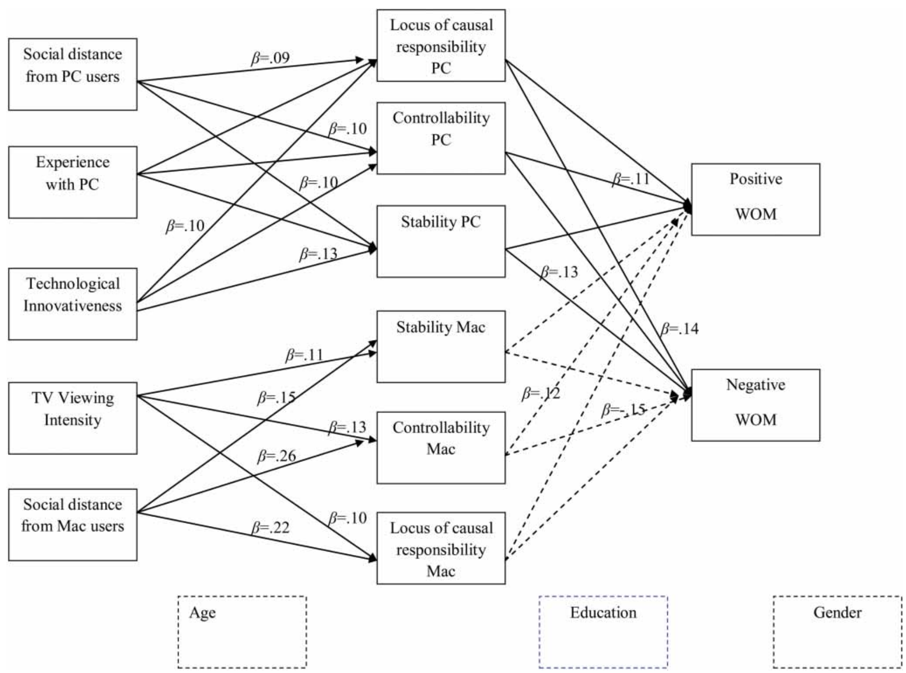

Figure 1. Research model examining the role of attributional biases on adopters' positive and negative WOM.
Note. Age, Gender, Education were controls. Dotted lines indicate paths that were estimated separately. Errors of all endogenous variables are constrained. Standardized betas are presented for all significant paths; any path with a $CR > 1.96$ is considered significant.

PC users' comparative attributions. That is, on the locus dimension, Windows PC adopters' assessments of who is to blame (other Mac users or Apple); on the controllability dimension, their assessments of whether Apple could have prevented problems; and on the stability dimension, their assessments of the transience of the similar problems with Macs, provide an estimate of optimistic bias in the users' attributions.

At the onset, the manifestation of optimistic bias requires that individuals are aware of the existence of others and are able to make conscious distinctions between themselves and others in their social environment (Tyler and Cook 1984, Glynn *et al.* 1995). Scholars have operationalised the distinction between self and others through the construct of social distance (Cohen *et al.* 1988). Social distance represents the perceived similarity between the individual and the comparative other. Using this construct, scholars have identified over 30 types of socially different others ranging from discernable, self-referent groups such as family and friends to non-discernable general referent groups such as the public at large (Andsager and White 2007). Because the tenability of this assumption is central for the activation of optimistic bias, we expect Windows PC users to perceive themselves as being similar to other Windows users and socially distant from Mac users and pose the following hypothesis:

> *H1*: Windows PC users will perceive themselves to be more similar to other Windows users and significantly different from other Mac users.

Social distance is particularly important because the degree and direction of optimistic bias is significantly impacted by the perceived social distance from the comparative other (Brosius and Engel 1996, Harris *et al.* 2000). Depending on the type of outcomes evaluated, individuals who are perceived as being more socially distant are often believed to be more likely to face negative events or consequences. Conversely, individuals who are more similar are thought of as being more homophilous and thereby more likely to face similar situations (Borkenau and Mauer 2006). Hence, in the research model, we would expect Windows PC users' perceived social distance from other Windows PC users to significantly influence their causal attributions for Windows' failure across the three dimensions. We would also expect Windows PC users' causal attributions for the failures of Mac to be significantly influenced by their perceived social distance from Mac users.

> *H2*: Windows PC users' perceived social distance from other PC users will significantly influence their causal attributions for Windows PC failures across the three dimensions (locus of causal responsibility, controllability, and stability).

> *H3*: Windows PC users' perceived social distance from Mac users will significantly influence their causal attributions for Mac failures across the three dimensions (locus of causal responsibility, controllability, and stability).

Attribution theory posits that people are inclined to attribute their own actions to situational requirements and those of comparative others, depending on their perceived social distance, to stable personal characteristics (Jones and Nisbett

1972). If similar biases influence computer users, we would expect Windows PC users to attribute the reasons for Windows' failure to be other PC users rather than to Microsoft. Further, from the user acceptance, PC adopters' strong emotional connection with their adopted technology (Windows PC) could bias them to support their innovation and consider it to be superior to a competing innovation (Mac). Hence, we would expect Windows PC users to believe that Windows PC problems are transient and short term, and we would expect Windows users to believe that Microsoft could not have prevented the problem encountered by PC users, i.e. it was the Windows *users' fault*. For these same reasons, we would expect Windows PC users to consider Mac to be an inferior innovation and thereby blame Apple for Mac users' problems, believe that the problems with Apple would reoccur, and believe that Apple could have prevented the problems encountered by Mac users. Together these suggest the following testable propositions:

> *H4*: When they find out that someone's PC has failed, Windows PC users will blame the user (other Windows PC users) for their problems with a PC but blame Apple for Mac users' problems.

> *H5*: Windows PC users will believe that PC problems are transient while Apple problems are likely to reoccur.

> *H6*: Windows PC users will believe that Microsoft could not have prevented the problems encountered by PC users, but Apple neglected to prevent the problems encountered by Mac users.

Biases in attributions are a function of personality (egocentrism, self-esteem maintenance, anxiety), the context of the decision, and the individuals' connections with the target other (social distance) (Andsager and White 2007). The personality characteristic of interest in the technology acceptance/adoption context is technological innovativeness, defined as the degree to which the individual is relatively earlier in the adoption of a technological innovation compared to other members of the social system (Rogers 2003). Individuals who are relatively innovative tend to have higher tolerances for uncertainty and are better able to deal with abstractions (Rogers 2003). Hence, in the present study, we expect Windows PC users' personality-based innovativeness with Windows PCs to significantly influence their causal attributions.

> *H7A*: Controlling for demographics (age, education, and gender), causal attributions concerning one's own technology (Windows PC) would be significantly influenced by the users' innovativeness.

Innovators are considered to be more rational than later adopters because innovators use the most effective means to reach a given end (Rogers 2003). This assumes that all innovations are effective and confer its adopters an instrumental or social advantage over individuals who have yet to adopt the innovation. Not all technological innovations, however, provide such advantages to adopters, especially in the early stage of its diffusion. The early adopters of new technological innovations such as the first iPhones, the first PCs, and the early DVD players paid a significantly higher cost in terms of price, product size, and quality compared to adopters of later versions of the same technologies, while early adopters of laser disc players and pre iPad tablets ended up with failed technologies. Hence, not only did earlier adopters of these products require a higher uncertainty or risk threshold (Rogers 2003), they needed to also possess an internal mechanism to justify the risks and potential failures they experienced as a consequence. In the absence of such an internal dialogue, innovators would stop adopting newer technologies once they adopt a technology, especially if they adopted technology fails. When faced with the failure of an adopted technology, innovators are thus likely to externalise the blame, ascribing problems to factors outside of the technology such as blaming other users, believing the issues are unlikely to reoccur, or believing that the issues could be easily resolved. Hence, we posit that earlier adopters of technology are significantly more likely to exhibit cognitive biases when faced with the failure of their adopted innovation.

> *H7B*: Higher levels of innovativeness will result in significantly higher biases in causal attributions concerning one's adopted technology (Windows PC).

According to some scholars, when individuals are similar to the comparative group, their causal attributions are based on their own experience and their personality. But as the social distance between individuals and their comparative group increases, individuals tend to possess less knowledge about the comparison group and thereby rely on heuristics and stereotypes in their decisions (Hoffner *et al.* 2001, Paek *et al.* 2005). Such heuristics are formed based on information received from the mass media and other interpersonal sources. Thus, in the technology acceptance context, we expect the users' causal attributions about their adopted technology to be influenced by their personality, and we expect the causal attributions about a competing technology to be based on information the user receives through the mass media.

> *H8*: Controlling for demographics (age, education, and gender), the causal attributions concerning a competing technology (Mac) would be significantly influenced by the respondents' mass media use.

Finally, the research model posits that causal attributions would influence users' interpersonal WOM exchanges. That is, what the user believes is the reason for the failure of the technology would predict the extent of positive or negative WOM exchanges about the technology. Moreover, because users often compare competing technologies while rationalizing their adoption/purchase decision, we expect the attributions for the failure of competing technologies to also influence users' WOM exchanges. It is, however, unclear as to which causal dimension would influence WOM and to what extent. It is possible that because of their emotional connection with their adopted technology, Windows PC users, regardless of their perceptions, are less likely to engage in positive or negative interpersonal

WOM. It is also possible that Windows PC users are likely to engage in WOM concerning different aspects of Windows PCs and different aspects of Macs, that is, the causal dimension that predicts WOM regarding Windows PCs and Macs are different. In the absence of specific theory to guide hypotheses, the research explores the influence of Windows PC users' comparative attributions on their WOM through the following research questions:

> *RQ1*: How do Windows PC users' causal attributions regarding Windows PCs influence their interpersonal WOM exchanges?

> *RQ2*: How do Windows PC users' causal attributions regarding Macs influence their interpersonal WOM exchanges?

2. Method

The research model was tested on a representative sample of adult Windows PC users (18 years of age and older) in the City of Buffalo, NY, USA. A nationally prominent survey organisation collected responses through a computer-aided telephone interviewing facility using random digit dialers. At the time of this data collection, Windows Vista had been rated by technology bloggers as a poor operating system and Windows 7 was relatively new. Among all the Windows operating system versions, we focused our attention on only Windows Vista users because it gave us a normally distributed cross section of computer users. Apple's Mac OS was resurgent and there was a highly visible mass-media advertising campaign by Apple that was aimed directly at potential Windows PC users and the problems they faced. There was no supporting advertising campaign on television by Windows/Microsoft. The overall data collection netted 393 completed responses from PC users with an overall responses rate of 47%. A copy of the instrument used to collect the data is presented in the appendix.

2.1. Measures

2.1.1. Eligibility questions

Respondents in the survey were first screened for eligibility by asking them whether they were 18+ years of age and the name of the primary operating system they most regularly used. To ensure consistency in respondents experience levels, only respondents who provided the indicated Windows Vista were included in the survey. Respondents who used earlier Windows OS (XP or earlier), Linux, any other platform (Mac OS) as their primary operating system were excluded from the study; if respondents used both or combinations of operating systems, they too were excluded from the study. Respondents were then asked if they recalled viewing any advertising in the media promoting Apple's computers/operating system or the Window's operating system. Next, a question anchored between 1 = not at likely and 5 = very likely measured the respondent's likelihood to recommend the Windows operating system to a close family or friend. Using the same response scale, another question measured their likelihood to criticise this operating system to a close family or friend.

2.1.2. Attributional measures

Extant research that applies attribution theory tends to use single item questions that directly measure the attribution biases that influence individual attitudes, cognitions, or behaviours (Boysen and Vogel 2008). Following this, the next question in our survey asked respondents who they thought was responsible when a Windows PC crashes, stops working, or freezes. Respondents were provided a 5 point scale that ranged from 1 = surely the user of the computer, 3 = nobody's fault, 5 surely Microsoft's fault. This was followed by a question that asked them who they thought was responsible when a Mac computer crashes, stops working, or freezes. The same response scale as in the previous question was used with the name Apple replacing Microsoft in the anchors.

Using a 5 point scale where 1 = not at all likely and 5 = very likely, respondents were then asked 'When a Windows PC crashes, stops working, or freezes', how likely it was to reoccur. The next question replaced Windows PC with Apple and measured the likelihood of reoccurrence for Macs.

Next, using a 5 point scale where 1 = strongly agree and 5 = strongly disagree, respondents were asked whether they believed that when a Windows PC crashes, stops working, or freezes, Microsoft could have prevented it. Another question replaced Windows PC with Apple in the question's stem and measured the same for Macs.

2.1.3. Social distance

Social distance was measured using 2 separate questions. Using a scale anchored between 1 = not at all similar and 5 = very similar, respondents were asked to rate how similar they thought they were to the average Windows user. A similar question measured the respondents' similarity to the average Mac user.

2.1.4. Experience and innovativeness

One item from Goldsmith and Hofacker's (1991) domain-specific innovativeness scale was used to measure innovativeness. Respondents were asked to what extent they agreed with the statement 'In general, you are the first among your friends and family members to purchase new technology products'. Respondents used a 5 point scale where 1 = disagree and 5 = strongly agree. Prior experience with PC in general was measured using a direct question that was rated on a 5 point scale ranging from 1 = extremely inexperienced to 5 = extremely experienced.

2.1.5. Mass media use

Since its launch in 1983, the Windows PC is well into its late adoption stage in the diffusion cycle. We therefore focused on a mass medium that had broad appeals across adopter categories. Because TV remains a major mass media source of news and information for early as well as later adopters (Rogers 2003), the research measured TV viewing intensity among respondents with a question that asked respondents the number of hours of TV they watched on an average day.

2.1.6. Demographic controls

Finally, respondents were asked their age in number of years; education was measured using a six point ordinal scale ranging from no degree to doctoral degree; and respondent gender was recorded by the interviewer. The median age of respondents across the entire sample ($N = 393$) was 47 years (SD = 13.7). The median education level was 4 year college graduate, and 51% of the respondents were male.

3. Results

The research model was evaluated using maximum likelihood in AMOS. The measurement model controlled for the influence of age, education, and gender. Next, in order to extract the dependency between the attributional measures across the two innovations (i.e. three attributional dimensions for PC and three attributional dimensions for Mac), their residual terms were correlated (Pitts *et al.* 1996). For the same reason, the residual terms for positive interpersonal WOM and negative interpersonal WOM were also constrained. Finally, in order to eliminate multicollinearity between the three attributions for Windows PC and Mac, the influence of each set of attributions on positive and negative WOM was estimated separately.

The model's goodness of fit was estimated using a combination of four fit indices: chi-square (χ^2), relative chi-square (χ^2/df; Bentler and Bonett 1980), comparative fit index (CFI), and root mean square error of approximation (RMSEA; Browne and Cudeck 1993). The overall model achieved an excellent fit: $\chi^2 = 69.36$, df = 37, $p < 0.05$; $\chi^2/\text{df} = 1.88$, CFI = 0.97, RMSEA = 0.04. The research model predicted 13% of the cumulative attributions for Windows PC and 39% of the cumulative attributions for Macs.

Dependent *t*-tests were used to test Hypotheses 1 and 4–6. Significance testing of paths in the structural model provided the tests for Hypotheses 2, 3, 7, and 8 and the answers to the two research questions. Standardised loadings with critical ratios (CRs) greater than 1.96 are statistically significant at the 0.05 level. Table 1 presents the means and standard deviations of key measures.

3.1. Hypothesis 1

Hypothesis 1 stated that users of Windows PC would view themselves as being similar to other Windows users and significantly different from Mac users. Respondents' mean social distance from other Windows PC users was 3.54 (SD = 1.15), and their mean social distance from other Mac users was 2.68 (SD = 1.37). This difference in social distance was significant ($t = 10.47, p < 0.05$) and therefore in support of Hypothesis 1.

3.2. Hypothesis 2

Hypothesis 2 posited that Windows PC users' perceived social distance from other Windows users would significantly influence their causal attributions for Windows failures across the three dimensions (locus, controllability, and stability). The structural paths from social distance from Windows users to locus of Windows PC failure was significant ($\beta = 0.09$); the path from social distance to controllability was also significant ($\beta = 0.10.$). The path from social distance to PC stability was, however, not significant ($p = 0.48$).Hence Hypothesis 2 was partially supported.

3.3. Hypothesis 3

Hypothesis 3 posited that Windows PC users' perceived social distance from other Mac users would significantly influence their causal attributions for Mac failures across the three dimensions (locus, controllability, and stability). The structural paths from social distance from Mac users to locus of Mac failure was significant ($\beta = 0.22$); the path from social distance to controllability was significant ($\beta = 0.26$); and the path from social distance to Mac stability was significant ($\beta = 0.15$). Hence Hypothesis 3 was supported.

3.4. Hypothesis 4

Hypothesis 4 posited that Windows PC user would blame other Windows PC users for their problems with a PC but blame Apple for Mac users' problems. The mean for locus of Windows PC was 3.28 (SD = 1.15) and the means for locus of Mac was 3.98 (SD = 1.71). The difference in causal attribution was significant ($t = -8.75$, $p < 0.05$), thus providing support for Hypothesis 4.

3.5. Hypothesis 5

Hypothesis 5 posited that Windows PC users would believe that Windows PC problems are transient while Apple problems are likely to reoccur. The mean for stability or reoccurrence of PC problems was 3.62 (SD = 1.31) and the means for locus of Mac was 4.20 (SD = 1.60). The difference in causal attribution was significant ($t = -6.77$, $p < 0.05$) and therefore Hypothesis 5 was supported.

3.6. Hypothesis 6

Hypothesis 6 posited that Windows PC users would believe that Microsoft could not have prevented the problems encountered by PC users, but Apple neglected to prevent the problems encountered by Mac users. The mean for controllability of PC problems was 3.25 (SD = 1.32) and the means for locus of Mac was 3.91 (SD = 1.63). The difference in causal attribution was significant ($t = 9.57$, $p < 0.05$, and the data were in support of Hypothesis 6.

3.7. Hypotheses 7A and 7B

Hypothesis 7A posited that Windows PC users' causal attributions concerning Windows PC would be significantly influenced by the users' technological innovativeness. The average level of innovativeness among respondents was 3.45 (SD = 1.04), and the average level of Windows PC experience among respondents was 3.25 (SD = 1.25). The paths from experience to locus of Windows PC problems, experience to Windows PC stability, and experience to controllability were not significant. The path from technological innovativeness to locus of Windows PC problems ($\beta = 0.10$), from innovativeness to stability ($\beta = 0.13$), and from innovativeness to controllability of Windows PC problems ($\beta = 0.10$), were all significant ($p < 0.05$). Hence, Hypothesis 7A was supported.

Hypothesis 7B posited that higher levels of technological innovativeness would result in significantly higher biases in causal attributions concerning one's adopted technology (Windows PC). The positive path coefficients from technological innovativeness to locus suggested that the more innovative the respondents were, the more likely they were to blame other users rather than Microsoft. The positive paths from innovativeness to stability suggested that more innovative respondents were also more likely to believe the problems with their Windows PC would be transient and not reoccur. The positive path from innovativeness to controllability suggests that the more innovative the respondents were the more they believed Microsoft could have prevented the problems with their Windows PC. Hence, the data suggested that technologically innovative respondents were significantly more susceptive to biases in attributions.

3.8. Hypothesis 8

Hypothesis 8 posited that Windows PC users' causal attributions concerning Macs would be significantly influenced by their television use. The average intensity of TV viewing reported among respondents 2.39 was (SD = 0.94). The path from TV viewing to locus of Mac problems ($\beta = 0.10$), from TV viewing to Mac stability ($\beta = 0.11$), and from TV viewing to controllability of Mac problems ($\beta = 0.13$), were all significant ($p < 0.05$). Hence, Hypothesis 8 was supported.

3.9. Research question 1

To answer the research question, the path coefficients from the three attributional dimensions of Windows PC to positive and negative interpersonal WOM, respectively, were evaluated. The average likelihood of positive WOM reported was 4.03 (SD = 1.21) and negative WOM was 2.37 (SD = 1.39). The overall model predicted 2% of positive WOM and 6% of negative WOM associated with Windows PCs. The path from locus of Windows PC to positive WOM was not significant; the path from locus to negative WOM was significant ($\beta = 0.14$). The path from controllability of Windows PC to positive WOM was significant ($\beta = 0.11$), but the path from controllability to negative WOM was not significant. Finally, the path from stability to positive WOM was not significant, but the path to negative WOM was significant ($\beta = 0.13$).

Table 1. Descriptive statistics of key measures in the model.

Measure	Mean	Std. Deviation
Locus of causal responsibility PC	3.28	1.15
Controllability PC	3.25	1.32
Stability PC	3.62	1.31
Locus of causal responsibility Mac	3.98	1.17
Controllability Mac	3.91	1.63
Stability Mac	4.20	1.60
Social distance from PC users	3.54	1.15
Social distance from Mac users	2.68	1.37
Experience with PC	3.25	1.25
Technological innovativeness	3.45	1.04
Television viewing	2.39	0.94
Likelihood of positive WOM	4.03	1.21
Likelihood of negative WOM	2.37	1.39

3.10. Research question 2

To answer research question 2, the path coefficients from the three attributional dimensions of Mac to positive and negative WOM, respectively, were evaluated. The overall model predicted 2% of positive WOM and 6% of negative WOM associated with Macs. The paths from locus of Mac to positive WOM and negative WOM werey non-significant. The paths from stability of Mac to positive and negative WOM were also non-significant. Finally, the path from controllability of Mac to positive WOM was significant ($\beta = 0.12$), and the path from controllability to negative WOM was also significant ($\beta = -0.15$).

4. Discussion

Successful user-acceptance and diffusion of a computerised technology is contingent upon factors that maintain the social momentum of adoption (Rogers 2003). Primary among the factors from a DOI standpoint are interpersonal exchanges among the technology's users. While past research has focused almost exclusively on the pre-adoption determinants of user-acceptance, the influence of justifications and rationalisations after adoption and its influence of future interpersonal exchanges remain unexplored. The need for such rationalisation is potentially stronger when the adoption decision is flawed, when the adopted technology fails, or when one compares an adopted technology with another. The present research makes an important contribution to IS and communication theory by focusing on these critical elements in the user-acceptance process.

The tests of Hypotheses 1–3 revealed that users do connect and identify with their adopted technology and its other users. They are also able to differentiate between themselves and users of other, competing technologies. This distinction significantly influences their perceptions of the technologies and how they interpret the reasons for each technology's performance. The ability to distinguish between one's in-group and others is necessary for the operation of optimistic bias.

Tests of Hypotheses 4–6 revealed that technology users tend to blame others in their in-group (of similar technology users) for problems with their adopted technology. When it comes to a competing or comparative technology, however, users tend to blame the competing technology for failures. Furthermore, users believe that the problems with their adopted technology are transient or short term and that these problems were because of the users rather than the technology. In contrast, adopters are more likely to interpret problems with competing technologies as being long-term issues stemming from the technology or its manufacturer. Together, the ability to perceive differences between one's in-group and others and the consistency in attributing failure to one source over another suggests that technology users demonstrated biased optimism in their causal attributions.

While some of these findings could be attributed to a branding or image effect, it is important to note that at the time of this data collection Windows Vista was considered a failed innovation by technology bloggers and Microsoft was thought of as a relatively less innovative brand (Asay 2009). In contrast, Apple products were and continue to be perceived as being on the cutting-edge of new technological ideas. Furthermore, Microsoft did not have any advertising campaigns promoting its Vista operating system in the local market while Apple had a campaign aimed solely at criticizing Vista's flaws. Considering all these influences, the consistency with which adopters of Vista supported it and blamed other users for issues with Vista, suggests that upon adopting an technology, regardless of the technology's brand equity, its users tend to exhibit optimism in its performance perhaps because they might have already conducted an exhaustive review of its abilities before they decided to adopt the technology. In other words, the effects of branding might be stronger prior to adopting a technology and seems to attenuate after the adoption decision is made. Hence after adopting the innovation, adopters might disregard a technology's actual performance and exhibit biased optimism.

The research model also tested the antecedents of these biases and their ultimate influence on users' interpersonal WOM exchanges. The model fit the data rather well and the model-theoretic variables explained a significant amount of variation in user attributions. The path model supported the notion that biases regarding one's adopted technology stems from internal factors such as individual technological innovativeness. The intensity of these biases is further tempered by the users' perceived similarity with other users of their technology.

Interestingly, the model testing suggested that while facing comparisons with one's in-group, users of a technology do not rely on their own experience. Instead they rely on their personality-based innovativeness. Moreover, technology innovators were much more likely to exhibit an optimistic bias while later adopters were quick to blame their adopted technology for any failures. This overt optimism of innovators probably stems from their higher ego needs and their decision-making styles. Innovators often make adoption decisions in the absence of prior users; they also have more social cachet as their opinions are often sought by later adopters and opinion seekers (Rogers 2003). This, perhaps, puts pressure on innovators to perceive their adopted technology as the better choice over another, thereby increasing their attributional biases.

When it comes to competing innovations, users rely on external factors such as the mass media for their attributions. Their perceived social distance from the adopters of the competing technology again, tempers these attributions. This suggests that in the absence of additional information about the competing technology, the user makes attributional judgment based on heuristic cues and stereotypes that are derived from the mass media.

Next, the research model tested the influence of attributions on positive and negative interpersonal WOM exchanges. The path model suggested that when it comes to their adopted technology, users were more likely to engage in negative WOM than positive. This supports the framing perspective from decision theory (Kahneman and Tversky 1984) and suggests that negative information is more salient and often the basis of social communication about technological innovations rather than positive information. In the present study, when Windows PC users believed it was Microsoft's fault and when they believed the problem would reoccur, they were far more likely to criticise the technology to others in their personal network. Only when they believed the problem was not preventable by Microsoft were they likely to recommend the system to their peers. In contrast, there tends to be less interpersonal WOM exchanges about a competing innovation and user's tend to criticise or recommend another operating system only if they believe that the manufacture was culpable and the problems in the technology could have been prevented.

In light of the earlier findings about the influence of innovativeness on attributional biases, this set of findings suggests that later technology adopters, who are less likely to be optimistically biased about their technology, are more likely to criticise their adopted technology. These negative WOM exchanges between later adopters and their peer-group and friend networks (who, based on homophily theory, would be later technology adopters as well) might explain why the DOI curve levels off at the later stages of a technology's diffusion. In contrast, in the early stages of a technology's diffusion, its early adopters/users tend to be optimistically biased about its performance. These early adopters tend to overlook failures, often explaining it away by blaming other users or assuming the problems would be short-term and transient. Such biases permeate through to other users of the technology through interpersonal exchanges between innovators and their peers. This perhaps explains why a technological innovation rapidly diffuses and reaches critical mass in the early stages of its diffusion, but adoption slows down as the technology diffuses and reaches later adopters. This might also explains why many new technologies, such as Laser Disc and Video CD players, that eventually failed to diffuse were still adopted by many technology innovators.

Conclusions based on the present research need to consider the following limitations. First, the research focused on just one technology and its users' perceptions. A more complete understanding of comparative attributional biases could be had by studying the users of the competing technology as well. The technology marketplace pose particular challenges in realizing this because it is difficult to find user segments for two or more competing technologies that are normally distributed in terms of their technological innovativeness. Second, by focusing only on Windows versus Mac, the study results are probably limited to comparative technology innovations such as Blackberry versus iPhone, DBS versus Cable TV. How these findings extend to other, non-technological innovations or to technological marketplaces with more than two competing technologies remains unknown and is a topic for future study.

Third, although the study controlled for Microsoft users, it is possible that respondents self selected themselves as Windows users while in reality they were using a Windows machine with different software in it. Hence, it is possible that people were conflating the platform with the software, a scenario more likely with some computing technologies than others. Fourth, it is unclear why respondent self-selected themselves as PC/Microsoft users. There are potentially multiple reasons for why someone would use Windows ranging from objective metrics such as cost of hardware and software to social-psychological factors such as innovativeness, learning curves, tolerance for uncertainty and such.

Finally, in order to enhance signal (in this case, causal attributions), the study focused the users' the research model tested in our research focused on theoretical relationships and constrained the effects of demographics and other external factors that could also explain some of the variance in the observed relationships.

Most of these limitations can be overcome in future research. Future research could compare the findings of the present study against a sample of Mac users. If Mac users are more innovative, their attributions should parallel those of the subgroup of innovative Windows PC users in the present study. Such research could also compare technologies against non-technological innovations and explore their users' attributional biases. Researchers could examine the content of list-serves, blogs, and message boards and survey individuals who leave feedback espousing the superiority of one brand over another to examine whether these individuals exhibit similar levels of judgment bias. Finally, future research could also explore whether attributional biases influence pre-adoption perceptions of new technological innovations and whether it is activated even before a new technology is adopted.

Overall the research points to mechanisms of ego enhancement and personality driven innovativeness influencing users' reactions to the failure of their adopted technology. Users who are technologically innovative are more likely to exhibit biased optimism towards the technology they have adopted. When they hear about the failure of a technology they have adopted, they are far more likely to blame other users for such a failure. In contrast, when they hear about the failure of a competing technology, they are more likely to blame the technology or brand. In closing, the present research is among the first to study the consequences of the failure computing technology on its users and the process by which technology users internalise the effects of such failures. This research is also among the first to extend theories of attribution and examine user biases in the process of interpretation and internalisation of the technology failure. In doing so, the research enhances scholarship in this area and expands the scope of our understanding of the post-adoption user acceptance and continuance process.

The research therefore has important implications for theory and practice. From a diffusion scholarship perspective the research points to the importance of understanding how adopters internalise the performance of their adopted technology. This issue has received little attention because most researchers focus on individuals' pre-adoption beliefs and performance expectations about a new innovation instead of how individuals conceptualise, interpret, and internalise the actual performance of an innovation. Moreover, much of this research assumes that all adopters apply similar, if not the same, valuation schemas while judging the value of all innovations. The present research, however, points to important difference in the psychology of early and later adopters and extends a new theoretical paradigm – that of biases in causal attribution – to the understanding of technology adoption. Thus the research calls for a shift in the focus of research away from focusing on expectations to one of biases in interpretation and its influence on actual use and subsequent communication about the technology. This new theoretical lens can be used to understand how users compare various technologies, how they develop and apply judgment heuristics, and how their personality-based innovativeness influences their interpersonal exchanges about the technology with other adopters.

From a practical standpoint our study suggests the need to use different communication strategies to target different adopters at different times during the diffusion process. When innovators are the targets, in the early stages of a product's diffusion, communication needs to help early adopters form heuristics about competing technologies, perhaps by informing early adopters about how much more superior the new technology is to competing technologies, or how a competing technology is more prone to failure because of issues with that technology rather than its users. In contrast, any problems in the new technology could be blamed on user errors instead of the technology itself—a strategy adopted by Apple Inc., when explaining the network connection problems experienced by iPhone 4 users because of the phone's faulty antenna design. During the later stages of diffusion or when the technology is being positioned towards later adopters, policy makers need to focus on reducing any negative communication about the technology because such exchanges influence the subsequent diffusion of the technology. This could be achieved by monitoring technology blogs and websites, evaluating any user feedback on these websites, and creating targeted communications about the technology that stymie any negative communication and replace them with positive heuristics that shift the blame away from the technology. Such strategies along with regularly introducing newer versions of the technology and thereby constantly attracting early adopters, who are more positively inclined and open to the innovation, could keep the technology viable and help it rapidly diffuse through the social system.

In closing, this research was inspired by a discussion between the co-author, a rather innovative Mac user, and I, a relatively late technology adopter and PC user. While discussing the merits of the two operating systems, my co-author advised me about the poor quality of PCs, their high failure rates, and the relative complexity of the PC operating system in comparison with her Mac. As a Mac user, her experiences with PC were rather dated and based on her heuristics about PCs in general. Yet, I, who had no experience with Macs, agreed with her assessments of PCs, and the superiority of Macs!

The findings of the current research explain why. As a relatively innovative person, my co-author's assessments of Macs were based on her rationalisation of Mac/Apple issues. Any problems experienced with the Mac system were assessed as being rare, non-systematic, and short term; reports of any problems were rationalised as being because of the users' inability to cope with its superior operating system. Her reflections of PC's relatively difficult usability were based on Mac's television commercials that position Apple Mac's as easy to use computers. I, for my part, being less innovative was more likely to blame my operating system for the problems with my innovation. And, hence, I agreed with the assessment that her Mac was indeed better than my PC.

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Appendix. Items used in the survey

Screening questions

1. Are you 18 years of age or older? [Response scale: Yes, No] (*Only respondents who were* 18 + *years of age were allowed to participate*)
2. What do you consider as your primary operating system on your computer? [Response scale: Windows Vista, Windows XP, Windows 2000, Windows 98, Apple/Mac OS/Snow Leopard, Linux, Don't have a computer, Don't have a primary operating system, Other Response (recorded separately)] (*Only respondent who said Windows Vista were allowed to complete the survey*)

3a. Do you recall any advertising on television that presented Apple/Mac's computers/operating systems in a positive light? [Yes, No]
3b. Do you recall any advertising on television that presented Window's operating systems in a positive light? [Yes, No]
4a. How likely are you to recommend your Window's operating system to a close family member or friend?
4b. How likely are you to criticise your Window's operating system to a close family member or friend?
5a. Who do you believe is responsible when a Window's computer crashes, stops working, or freezes? [1 = surely the user of the computer, 2 = probably the user, 3 = nobody's fault, 4 = probably Microsoft's fault, 5 = surely Microsoft's fault]
5b. Who do you believe is responsible when an Apple computer crashes, stops working, or freezes? [1 = surely the user of the computer, 2 = probably the user, 3 = nobody's fault, 4 = probably Apple Inc.'s fault, 5 = surely Apple Inc.'s fault]
6a. When a Window's computer crashes, stops working, or freezes, how likely is it reoccur? [1 = not at all likely, 2 = somewhat unlikely, 3 = neither likely/nor unlikely, 4 = somewhat likely, 5 = very likely]
6b. When an Apple computer crashes, stops working, or freezes, how likely is it reoccur? [1 = not at all likely, 2 = somewhat unlikely, 3 = neither likely/nor unlikely, 4 = somewhat likely, 5 = very likely]
7a. When a Window's computer crashes, stops working, or freezes, do you believe that Microsoft could have prevent it? ? [1 = strongly disagree, 2 = somewhat disagree, 3 = neither agree/nor disagree, 4 = somewhat agree, 5 = strongly agree]
7b. When an Apple computer crashes, stops working, or freezes, do you believe that Apple Inc. could have prevented it? ? [1 = strongly disagree, 2 = somewhat disagree, 3 = neither agree/nor disagree, 4 = somewhat agree, 5 = strongly agree]
8a. How similar to you believe you are to the average Window's PC user? [1 = not at all similar, 2 = somewhat similar, 3 = neither similar/nor dissimilar, 4 = somewhat similar, 5 = very similar]
8b. How similar to you believe you are to the average Apple/Mac user? [1 = not at all similar, 2 = somewhat similar, 3 = neither similar/nor dissimilar, 4 = somewhat similar, 5 = very similar]
9. In general, are you the first among your friends and family member to purchase new technology products?
10. In general, how experienced are you in the use of personal computers? [1 = extremely inexperienced, 2 = somewhat inexperienced, 3 = average, 4 = somewhat experienced, 5 = extremely experienced]

11. How many hours of television do you watch on an average weekday? [Open ended response]
12. What is you age in years? [Open ended response]
13. What is the highest level of education you have attained? [1 = no diploma or degree, 2 = less than high school, 3 = high school diploma, 4 = Bachelor's degree, 5 = Master's degree, 6 = Doctoral degree or more]
14. Finally, your gender? [Male, Female]