December 2004

A Model of 3G Adoption

Xu Xin
Hong Kong University of Science and Technology

A Model of 3G Adoption

Xu Xin
Dept. of Information and System management
Hong Kong University of Science and Technology
xuxin@ust.hk

ABSTRACT

In this paper we develop a model of end users' 3G adoption behavior based on the premise that 3G is not an entirely new innovation but rather an upgrade of mobile data services (MDS). Drawing theoretical foundations from the knowledge transfer paradigm in marketing research and based on the technological architecture of MDS, we hypothesize how beliefs about upgrading benefits and costs are formed and how they will influence 3G adoption intention. The empirical results support our hypotheses, based on which theoretical and managerial implications are discussed.

Keywords

mobile data services, knowledge transfer, upgrade, 3G.

INTRODUCTION

The global mobile market has grown rapidly to about 1.2 billion subscribers by 2003, with an approximate increase of 20% since 2001 (Source: UMTS Forum). It is also anticipated that there will be more than 2 billion mobile users between 2007 and 2010 (Source: UMTS Forum). With rapid growth of the customer base and intensified price competition among mobile carriers, the average revenue per user (APRU) of the voice service has been declining steadily over recent years and mobile data services (MDS) are considered as the source of future revenues and profits (Source: IDC). Particularly, the next generation of mobile data services (3G) are considered as such promising sources. Mobile user experience is expected to be greatly improved through technological advances such as broadband mobile network and application development tools (e.g., J2ME). The industry's embracement of 3G is evidenced by both the astronomical 3G licence fees of more than USD 100 billion by 2002 (Source: ITU) and the global launches of 3G services such as NTT DoCoMo's FOMA in Japan and Hutchison's "3" initiatives in Europe, Australia, and Hong Kong.

However, despite the spectacular movements taken by mobile carriers, the other side of the market – mobile users – show much less interests. In fact, both FOMA and "3" suffered slow take-off[1]. It is also reported that mobile users failed to see benefits from 3G, which is "too little, too soon"[2]. Given the huge amount of licence fees invested on 3G and the potential of it to meet various mobile user needs, the undesirable market outcomes suggest the importance of understanding end users' 3G adoption decisions, that is,

(1) what are the factors that influence end users' adoption of 3G, and

(2) what are the relative importance of those factors?

In the current research we develop a model of 3G adoption in order to address the two issues above. The rest of the paper is organized as follows. In section II we first discuss why a new model is needed for 3G adoption instead of traditional models such as TAM or TPB. We then formulate our model based on the knowledge transfer paradigm and the benefit-cost framework. Research method is described in section III. Results and implications are discussed in section IV.

THEORETICAL FOUNDATIONS AND HYPOTHESIS DEVELOPMENT

IT adoption has been extensively studied and a number of models have been applied such as TAM, extended TAM, or TPB (Venkatesh et al. 2003). Examples of the target IT examined include operating systems (e.g., Karahanna et. al. 1999), E-mail (e.g., Gefen and Straub 1997), proprietary systems for production management, financial portfolio management, and etc.

[1] See http://www.3g.co.uk/PR/Feb2003/4831.htm and http://afr.com/articles/2003/07/22/1058853064305.html.

[2] See http://www.vnunet.com/News/1134872 and http://www.vnunet.com/News/1135085.

(Venkatesh and Davis 2000). In this section, however, we argue that a new model is needed for 3G adoption that is different from those in previous research for three reasons: 1) 3G is an upgrade of MDS; 2) MDS consists of both base technologies and enabled services; and 3) end users need to pay for using MDS.

First, 3G is not an entirely new IT innovation but rather an upgrade of MDS. Before the launch of 3G, users have already been using previous generations of mobile technologies such as 2G (e.g., GSM) and 2.5G (e.g., GPRS). Because 3G is an upgrade, end users' decision should involve mainly comparisons between the existing generations and the new one. This is different from the adoption decision of a particular IT innovation, where beliefs about the technology such as relative advantages (perceived usefulness) is formed by comparing the innovation with other alternatives in general. In other words, users' prior knowledge about MDS based on their experiences with 2G and/or 2.5G plays a fundamental role in their decision making process of 3G adoption. Mobile users' prior experiences with early generations will influence their beliefs about 3G in two ways. On one hand, previous generations serve as the "reference points" by which technological advancements in the new generation are assessed, that is, how 3G is different from 2G and 2.5G in some aspects. For instance, a mobile user may compare the download time of a MP3 song by GPRS (2.5G) and by 3G (WCDMA). After he / she finds out that the download is much faster using 3G technologies, a particular belief about the advancements in bandwidth and data transfer technology of 3G can be formed. On the other hand, prior knowledge about MDS may also function as the source of information for assessment of the similarities between 3G and previous generations. For example, the level of ease of use of SMS may influence end users' beliefs about the complexity of 3G services.

The knowledge transfer paradigm provides the theoretical foundation for the impacts of prior knowledge on the beliefs about the new generation (Gregan-Paxton and John 1997). It suggests that users develop beliefs and decisions about an innovation by making comparisons between the base (e.g., existing generations) and the target (i.e., the new generation). Moreau, Lehmann, and Markman (2001) suggested three phases of user decision making: 1) transferring prior knowledge from the base domain to the target domain, 2) making inferences about the target based on the extensive knowledge transferred, and 3) finally developing preferences toward the target based on the inferences. The process of knowledge transfer consists of three stages: access, mapping, and transfer (Gregan-Paxton and John 1997). The central focus of the knowledge transfer paradigm is on the comparison of one familiar domain (e.g., 2G and 2.5G) to another unfamiliar domain (e.g., 3G). Particularly, which domain will be activated in users' memory is important to the following stages of knowledge transfer. In this paper 3G can be regarded as the unfamiliar target while the base is users' prior knowledge about MDS. This is because 1) 3G is an evolutionary member within the MDS category that share similar visible attributes with 2G or 2.5G, e.g., the characteristics of mobile devices and the overlapped services (MMS, MP3, etc.); 2) in mass media and mobile carriers' marketing communications 3G is frequently compared with existing MDS technologies such as 2.5G[3].

Although the knowledge transfer paradigm helps to understand the mechanism by which end users form beliefs and preferences toward the new generation, it does not identify the relevant factors that influence adoption decisions. That is, what particular types of knowledge is important for end users' belief formation? This leads to the other two reasons why a different model is needed for 3G adoption – one is the "base-service" technological architecture of MDS (Lyytinen and Rose 2003) and the other is that MDS users are consumers who pay real money for using MDS. As discussed below, based on the nature of MDS architecture, we incorporate both radicalness of the new generation of base technologies and superiority of the new services as benefits from 3G adoption. And we also include both cognitive cost and monetary cost (price) of MDS in our 3G adoption model because of the fact that end users also need to pay subscription fees for MDS. In summary, under the premises that 1) 3G is a upgrade of MDS; 2) MDS consists of both base technologies and enabled services; and 3) end users need to pay for using MDS, we introduce a model of end users' 3G adoption that is different from existing IT adoption models such as TAM, TPB, etc.

Mobile data services such as MMS, MP3 download, or video phone calls are built upon a set of underlying technologies including mobile networking, data transfer (e.g., packet switched data), application development tools (e.g., J2ME). This conforms to the categorization of IT innovations as IT base, system development and the derived services (Lyytinen and Rose 2003). In the context of MDS, different generations of IT base can enable different families of services. For example, 2G mobile technologies can only enable voice, SMS, and WAP with low performance while 3G can support Java games, video clips, and phone calls. Thus the adoption of 3G represents not only the adoption of the new underlying IT base, but also a new portfolio of services. When end users evaluate the new generation, both the advancements in the base technologies and the superiority of the new services are important to their decision making. In the current research we accordingly formulate

[3] For example, see the market report by ARC Group (2003) – "Future Mobile Networks – From 2.5G to 3G and beyond" and http://www.3g.co.uk/PR/December2002/4617.htm.

two "adoption benefits" in our model to characterize the advancements in the new generation of technologies and enabled services – technology radicalness and service superiority.

Adoption Benefits: Perceived Superiority of Services and Perceived Radicalness of Base Technologies

We define *perceived superiority of services* as users' perceived benefits derived from using the new generation of services enabled by the new base technologies when compared to previous generations. Because it is the new services that end users have direct interactions with to satisfy their needs, users' adoption decisions should depend on how the new generation of services are superior to existing generations. Thus,

H1: the greater perceived superiority of services, the higher adoption intention toward the new generation (3G).

We define *perceived radicalness of base technologies* as the perceived degree of novel technological process content embodied in the new base technologies when compared to previous generations. Although base technologies are transparent to end users by our definition, it does not prevent them to acquire knowledge about the underlying core technologies. In fact, one of the communication strategies frequently used by mobile carriers is to establish in mobile users' mind the relation between the base technologies and the superior services supported. For instance, NTT DoCoMo advocates its 3G technology (WCDMA) when promoting its 3G services – FOMA. We hypothesize that perceived radicalness of base technologies influences end users' adoption decision in two ways. First, because base technologies determine the variety and performance of services (Norton and Bass 1987; Sawhney 1998), radical enhancement can support services of greater variety and much better performance. Thus,

H2a: the greater perceived radicalness of base technologies, the greater perceived superiority of services.

Secondly, the radicalness of the new based technologies can have direct impacts on adoption intention. When a new generation of base technologies are introduced, the full potential may not be realized, that is, the new base technologies may enable future "killer applications" that are not foreseen by people at the time of introduction. Thus visionary users will adopt 3G simply because the potential benefits of the base technologies (Moore 1999). The direct impact of technology radicalness can also be partly explained by the real option theory (John, Weiss, and Dutta 1999). With rapid advancement in technology, end users often take a wait-and-see attitude when they face some incremental technological innovations. This is because they expect price declines and bug fixes in the near future when even further improvement emerges. Thus they tend to "bypass" some of the incremental upgrades. However, when a radical innovation is introduced, users expect sharp breaks with the past and realize that there is less to be gained in terms of savings in switching cost by staying at the current generation to "keep options open". Therefore the likelihood of users' wait-and-see attitude is diminished and they become more inclined to upgrade. Therefore,

H2b: the greater perceived radicalness of base technologies, the higher adoption intention toward the new generation;

Adoption Costs: Cognitive Cost (Perceived Ease of Use) and Out-of-pocket Cost (Perceived Monetary Value)

The third reason for which the model of 3G adoption is different from those in previous research is that end users are at the same time individual consumers, not employees in business organizations. When they subscribe MDS, they not only need to spend time and effort to learn how to use the services (i.e., cognitive cost), but also need to pay the ongoing usage fees. Following Zhao, Meyer, and Han (2003), we define two types of adoption costs that fit in the situation where end users need to "pay" the cost over time. The first one is the cognitive cost operationalized in our model as perceived ease of use of MDS, and defined as the extent to which mobile data services are perceived as being easy to understand and use (Davis, 1989). Perceived ease of use has been shown to have consistently significant impacts on IT adoption intention. Thus:

H3: the greater perceived ease of use of MDS, the higher adoption intention toward the new generation.

The second is the out-of-pocket cost paid by individual end users for using MDS, such as subscription fees. In this paper we adopt the concept of perceived monetary value from marketing literature and define perceived monetary value of MDS as the cognitive tradeoffs between the quality of MDS and the monetary sacrifice for using them (Dodds et al., 1991). The perceived monetary value (PMV) is positive when perceptions of quality are greater than perceptions of sacrifice, which in turn results in positive impact on behavior intention. Thus,

H4: the greater perceived monetary value of MDS, the higher adoption intention toward the new generation.

By defining the adoption benefits and costs in the model, we essentially adopt a net-benefits framework for the model of end users' 3G adoption. End users are assumed to base their adoption decisions on perceived benefits gained from adoption and expected costs incurred. This framework has been applied in the context of innovation adoption (e.g., Mukherjee and Hoyer

2001; Moreau, Lehmann, and Markman 2001; Zhao, Meyer, and Han 2003). For example, Mukherjee and Hoyer (2001) suggested that consumers evaluate novel attributes in products by making inferences about both the additional benefits and the learning costs associated with the new attributes. Moreau, Lehmann, and Markman (2001) defined net benefits as the difference between relative advantages (Rogers 1995) and risks (Bauer 1960). Relative advantages were measured by the no. of properties of the new product satisfying a positive goal or failing to satisfy a negative goal, while risks were defined as the opposite. Zhao, Meyer, and Han (2003) examined the "enhancement bias" when users make adoption and usage decisions about an upgrade version of a product. They defined the net utilities from upgrading as the difference between the enhancement in the new generation and the upgrading costs – both the learning cost and the out-of-pocket cost. In the current research we follow a similar framework with Zhao, Meyer, and Han (2003). Figure 1 is a graphical representation of the model and hypotheses.

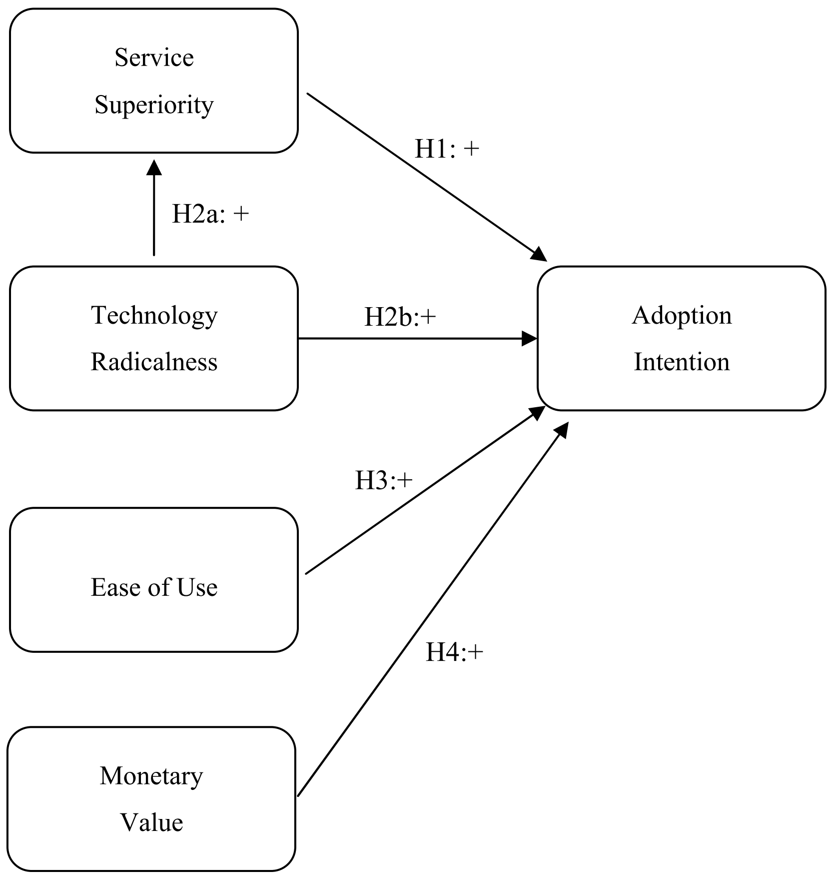

Figure 1. The Model of End Users' 3G Adoption

RESEARCH METHODOLOGY

Instrument Development and Data Collection

Measurement items for perceived radicalness of base technologies are adapted from Gatignon et al (2002) to fit the MDS situation. Indicators for perceived superiority of services are developed by the authors based on literature about technology innovation (McGrath 1995; Sawhney 1998; Norton and Bass 1987). We develop three items for this construct that cover three aspect of service superiority, namely greater variety of services, better quality (performance) of services, and more value of services. The scale for perceived ease of use is adapted from Venkatesh et al (2003) and the scale for perceived monetary value is adapted from Dodds W. et al (1991). Finally, a single item is used to measure end users' adoption intention. All items are on a seven-point Likert scale.

All items were submitted to a pretest for content validity (Straub 1989). The subjects were a group of university staffs who have extensive experiences with MDS. After the pretest, an online survey was conducted to collect the data. The questionnaire was administered on a non-profit public web portal run by the Hong Kong government. It is run on a membership basis and membership is free for any permanent residents in Hong Kong. An email soliciting participation in the survey was sent to members of the portal. In the e-mail, a direct link to the electronic questionnaire was embedded. To encourage participation, incentives were provided such as free mobile phones and mobile services packages. To prevent a respondent from answering the questionnaire for several times, we asked for their mobile phone numbers as unique identifiers. Because we claimed that mobile phone numbers would be used to contact the respondents if they won the lucky draw, it was meaningless to fake multiple mobile numbers to increase the chance of winning. Thus in this way, we insured the answers were not faked.

The online survey lasted about four weeks from which a total of 7, 351 initial responses were obtained. We dropped respondents who stopped using MDS to maintain a subsample of 5, 074 respondents. After deleting invalid answers, a final sample of 4412 was used for final data analysis.

The Measurement Model

Confirmatory factor analysis by LISREL 8.50 is used to check instrument validity. The measurement model is revised by dropping items one at a time that share a high degree of residual variance with other items or cross-load onto other latent variables (Gefen et al. 2000; Anderson and Gerbing 1988). One item for the radicalness construct, one for the service superiority construct, and one for the perceived ease of use construct are dropped. To tackle the limitation of the single-item measurement of adoption intention, we take a "conservative" approach proposed by Anderson and Gerbing (1988). Accordingly, the error variance of the single indicator was set to be 0.15 (that of PEOU3) and the factor loading was set to 1. This approach has both the advantage of avoiding "naively" assuming that the measure is without error and thus skewing the analysis (Hayduk 1987) and the advantage of "being based on information specific to the given research context, that is, this indicator shares a respondent sample and survey instrument with the other indicators" (Anderson and Gerbing 1988).

The final measurement model shows a good fit (Table 1). NFI, NNFI, CFI, AFI, and AGFI are all above 0.90 (Bentler 1990, Joreskog and Sorbom 1989). RMSEA and SRMR are also below the threshold values of 0.06 (Hu and Bentler 1999) and 0.05 (Gefen et al. 2000; Hair et al. 1998) respectively. The large chi-square statistic is caused by its sensitiveness to sample size and is not used to evaluate the goodness of fit of the model (Bentler and Bonett 1980; Joreskog and Sorbom 1984).

Fit Indices	Thresholds	Measurement Model	Structural Model
Chi-sq (d.f.)		447.70 (45)	661.72 (47)
RMSEA	≤0.06	0.05	0.06
NFI	≥0.90	0.99	0.98
NNFI	≥0.90	0.98	0.97
CFI	≥0.90	0.99	0.98
SRMR	≤0.10	0.03	0.05
GFI	≥0.90	0.98	0.97
AGFI	≥0.80	0.97	0.96

Table 1. Fit Indices for the Measurement Model and the Structural Model

All standardized factor loadings are above the 0.71 cut-off point (Comrey 1973; Fornell 1982) except the reverse-wording item for technology radicalness (0.70). Composite reliabilities show reasonable values with the lowest to be 0.80 (Table 2). AVEs are all above 0.50 (Hair et al., 1995) which demonstrated convergent validities (Table 3). All shared variances among latent variables are lower than the corresponding AVEs (Table 3), which indicates discriminant validity (Fornell and Laecker 1981).

The Structural Model

The structure model is tested after the measurement model is established. The goodness-of-fit indices also show good fit (Table 3). The standardized path coefficients estimates and their significant level are shown in Table 4. To examine the relative importance of different factors, analysis for total effects is also conducted and results are listed in Table 4.

Construct Measurement	Mean	Standard Deviation	Standardized Factor Loading	Squared Multiple Correlation
Perceived Ease of Use	Composite Reliability= 0.92			
PEOU1	5.14	1.21	0.83	0.70
PEOU2	5.18	1.22	0.94	0.89
PEOU3	5.11	1.24	0.90	0.81
Perceived Monetary Value	Composite Reliability= 0.91			
PMV1	3.70	1.27	0.85	0.73
PMV2	3.83	1.22	0.90	0.81
PMV3	3.68	1.29	0.87	0.76
Technology Radicalness	Composite Reliability= 0.83			
PT1	5.03	1.30	0.70	0.49
PT2	4.92	1.29	0.85	0.72
PT3	4.99	1.22	0.83	0.70
Service Superiority	Composite Reliability= 0.80			
PS1	5.56	1.07	0.83	0.69
PS2	5.38	1.09	0.80	0.68
Adoption Intention	Composite Reliability= 0.91			
BI1	4.68	1.25	0.96	0.91

Table 2. Descriptive Statistics for Measurement Items

	BI	PEOU	PV	PT	PS
BI	0.91				
PEOU	0.14	0.80			
PV	0.07	0.08	0.77		
PT	0.16	0.08	0.02	0.63	
PS	0.23	0.16	0.03	0.47	0.66

Table 3. AVEs and Squared Correlations among Latent Variables

Note: BI – Adoption Intention; PEOU – Perceived Ease of Use; PV – Perceived Monetary Value; PT – Perceived Radicalness of Base Technologies; PS – Perceived Superiority of Services

The structural model shows a good fit by most of the fit indices (Table 1). NFI, NNFI, CFI, AFI, and AGFI are all above 0.90 (Bentler 1990, Joreskog and Sorbom 1984). RMSEA and SRMR are also below the threshold values of 0.06 (Hu and Bentler 1999) and 0.05 (Gefen et al. 2000; Hair et al. 1998) respectively. The large chi-square statistics is again caused by its sensitiveness to sample size (Bentler and Bonett 1980; Joreskog and Sorbom 1984) as in the measurement model. Hypotheses 1 to 4 were supported by the significance of all path coefficients at the 0.001 level (Table 4).

RESULTS AND DISCUSSION

The results from our model have both theoretical and managerial implications. The significance of all path coefficients and the good fit of the structural model support the internal validity of our model in the context of 3G adoption. Particularly, all the three new influential factors we have proposed – service superiority, technology radicalness, and monetary value – have significant impacts on adoption intention, indicating the parsimony of these three factors. Overall, the results from our model suggest variables other than those proposed by TAM, TRA, or TPB are parsimonious in the context of 3G adoption where the target IT is an upgrade that consists of both base technologies and enabled services, and end users need to pay monetary fees for using the services.

Equations	Estimates	Hypotheses	Total Effects	t values
Adoption Intention				
= Technology Radicalness	0. 10 ***	H2b: √	0.36	19.67
+ Service Superiority	0. 31 ***	H1: √	0.43	10.30
+ Perceived Ease of Use	0. 21 ***	H3: √	0.25	13.07
+ Monetary Value	0. 14 ***	H4: √	0.16	9.18
Service Superiority				
= Technology Radicalness	0. 66 ***	H2a: √	0.61	41.11

Table 4. Hypothesis Testing – Standardized Solutions

Notes: * - significant at 0.05 level; ** - significant at 0.01 level; *** - significant at 0.001 level.

Business, especially mobile carriers, can draw managerial implications from our total effect analysis. The analysis suggests that perceive superiority of services has the highest path coefficient (0.43). Thus variety and performance of 3G services are end users' primary concern. This implies mobile carriers should pay more attention to provide ender users with a portfolio of superior services through, e.g., fostering a productive developer community. In fact, both the success of NTT DoCoMo and the recent initiatives taken by Hutchison "3"[4] indicate the importance of variety and quality of 3G services.

Perceived technology radicalness has the second highest path coefficient and it has very strong impact on service superiority. This confirms the important role of users' perceptions of base technologies in their decision making, which contradicts the view taken by some people that the service is the only important determinant. Our results suggest the possibility that effective communication about the advancements in base technologies can lead to both favorable beliefs about the enabled services and greater likelihood of adoption.

Finally, the significance of monetary value suggest that mobile carriers should also pay attention to their pricing strategies. Not only the services should be designed to be easy to use, but also the prices of them should be perceived as reasonable or fair. In fact, recently Hutchison "3" keeps reducing the prices of both "3" mobile devices and services, which indicates the important impact of pricing on end users' adoption decisions.

REFERENCES

1. Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. "User Acceptance of Information Technology: Toward A Unified View," *MIS Quarterly* (27:3), 2003, pp. 425-478.
2. Karahanna, E., Straub, D. W., and Chervany, N. L. "Information Technology Adoption Across Time: A Cross-Sectional Comparison of Pre-Adoption and Post-Adoption Beliefs," *MIS Quarterly* (23:2), 1999, pp. 183-213.
3. Gefen, D. & Straub, D. "Gender Difference in the Perception and Use of E-Mail: An Extension to the Technology Acceptance Model," *MIS Quarterly* (21:4), 1997, pp. 389-400.
4. Venkatesh, V. and Davis, F.D. "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies," *Management Science* (46:2), 2000, pp. 186-204.
5. Gregan-Paxton, J. and John, D. R. "Consumer Learning by Analogy: A Model of Internal Knowledge Transfer," *Journal of Consumer Research* (24:3), 1997, pp. 266-284.
6. Moreau, C. P. Lehmann, D. R., and Markman, A. B. "Entrenched Knowledge Structures and Consumer Response to New Products," *Journal of Marketing Research* (38:1), 2001, pp. 14-29

[4] E.g., Hutchison "3" Hong Kong recently held a forum for application developers for its "3" mobile services.

7. Lyytinen, K. and Rose, G. M. "The Disruptive Nature of Information Technology Innovations: The Case of Internet Computing In Systems Development Organizations," *MIS Quarterly* (27:4), 2003, pp. 557-595.
8. Norton, J. A. and Bass, F. M. "A Diffusion Theory Model of Adoption and Substitution for Successive Generations of High-Technology Products," *Management Science* (33:9), 1987, pp. 1069-1086.
9. Sawhney, M. S. "Leveraging High-Variety Strategies: From Portfolio Thinking to Platform Thinking," *Academy of Marketing Science Journal* (26:1), 1998, pp. 54-61.
10. Moore, G. A. Crossing the Chasm: Marketing and Selling Technology Products to Mainstream Consumers 2nd Ed., Hypercollins Publishers, New York, 1999.
11. John, G., Weiss, A. M., and Dutta, S. "Marketing in Technology-Intensive Markets: Toward a Conceptual Framework", *Journal of Marketing* (63: Special), 1999, pp. 78-91.
12. S. Zhao, R. J. Meyer, and Jin Han, "The Enhancement Bias in Consumer Decisions to Adopt and Utilize Product Innovations," Working Paper, 2003
13. Davis, F. D., Bagozzi, R. P., and Warshaw, P. R. "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models," *Management Science* (35:8), 1989, pp. 982-1002.
14. Dodds, W. B., Monroe, K., and Grewal, D., "Effects of Price, Brand, and Store Information on Buyers' Product Evaluation," *Journal of Marketing Research* (28:3), 1991, pp. 307-319.
15. Mukherjee, A. and W. D. Hoyer, "The Effect of Novel Attributes on Product Evaluation," Journal of Consumer Research, 28(Dec), 2001.
16. Rogers, E. M. *Diffusion of Innovations,* 5th Ed., Free Press, New York, 1995.
17. Bauer, R. A. "Consumer Behavior as Risk Taking," *Dynamic Marketing for a Changing World*, Robert S. Hancock ed. Chicago: American Marketing Association, 1960, pp. 289-398.
18. Gatignon, H., Tushman, M. L., Smith, W., and Anderson, P. "A Structural Approach to Assessing Innovation: Construct Development of Innovation Locus, Type, and Characteristics," *Management Science* (48:9), 2002, pp. 1103-1122.
19. McGrath, M. E. Product Strategy for High-Technology Companies, 1995, Homewood, IL: Irwin.
20. Straub, D. W. "Validating Instruments in MIS Research," *MIS Quarterly* (13:2), 1989, pp. 147-169.
21. Gefen, D., Straub, D. W., and Boudreau, M. C. "Structural Equation Modeling and Regression: Guidelines for Research Practice," *Communications of the Association for Information Systems* (4:7), 2000, pp. 1-70.
22. Anderson, J. C. and Gerbing, D. W. "Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach," *Psychological Bulletin* (103:3), 1988, pp. 411-423.
23. Hayduk, L. A. *Structural Equation Modeling with LISREL*, London: John Hopkins, 1987.
24. Hu, L. T., and Bentler, P. M. "Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives," *Structured Equation Modeling* (6:1), 1999, pp. 1-55.
25. Hair, J. F. J., Anderson, R. E., Tatham, R. L., and Black, W. C. *Multivariate Data Analysis with Readings*, Prentice Hall, Englewood Cliffs, NJ, 1998.
26. Bentler, P. and Bonett, D. "Significance Tests and Goodness of Fit in the Analysis of Covariance Structures," *Psychological Bulletin* (88:3), 1980, pp. 588-606.
27. Joreskog, K. G., and Sorbom, D. LISREL VI: Analysis of Linear Structural Relationships by the Method of Maximum Likelihood, Chicago: National Educational Resources, 1984.