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ABSTRACT: Battles for market dominance are intense in the information technology industry. The outcome of a standards war determines which technology will win and which will lose. This study proposes a conceptual model to explain the factors driving consumers to switch from one technology product to another based on the standards. This model was developed around three types of effects: pushing, pulling, and mooring. Smartphones, the most popular devices for m-commerce, were chosen as the study context. A survey study was conducted to examine the proposed model and hypotheses. Our findings show that the pull factor of relative advantage and the push factors of low satisfaction and disconfirmation positively influence a consumer's intention to switch technology products. Moreover, the mooring factors of inertia, switching cost, and network effect negatively influence switching intentions. Inertia and the network effect have effects on the push and pull factors. This model helps firms devise proper strategies to maintain their existing customer base and incite users of alternative standards to switch.

KEY WORDS AND PHRASES: Consumer switching intention, m-commerce, push-pull-mooring model, technology standards, standards war, smartphones, switching barriers.

The information technology (IT) industry is intensely competitive, and battles between competing technologies have a significant effect on today's economy. A situation in which incompatible technologies vie for market dominance is referred to as a "standards war" [60]. The outcome of a standards war often determines not only the fate of the winning and losing technologies but also whether the market for their complementary goods and services expands or shrinks. The winner of a standards war may capture a huge share of the market, resulting in a disastrous defeat for the competition. For instance, Microsoft overtook Netscape in the Web browser war, and Toshiba abandoned the HD DVD format when that standard lost out to its rival, the Blu-ray Disc.

Prior studies on standards wars have focused mainly on identifying the factors that influence the outcome of standards battles [62, 65]. In contrast with prior studies, the present study pays attention to consumers' switching intentions in a standards war. There are two major reasons for considering consumers' switching intentions in a technological domination scenario. First, alternative standards always exist. Winners in today's technological standards wars rarely capture the entire market [67]. Second, the firm factors of installation base and strategic maneuvering have more impact on the final outcome of a standards war [62]. Understanding the determinants of consumers' switching intentions can help firms devise proper strategies to maintain their installation base and incite users of alternative standards to switch.

The research objective of this study is to propose a conceptual model to explain consumers' switching intentions in a battle of standards. To provide a

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systemic view, we develop this model on the basis of the push, pull, and mooring (PPM) model [7]. Factors that act to push customers away, pull customers to one competitor or another, and facilitate or inhibit switching are considered in this model. Instead of considering a narrow range of factors, we chose factors based on solid theories. Prior PPM studies have not addressed the specific mooring factors of "inertia" and "network effects." Also, the effects of mooring factors on push and pull factors have never been examined well.

The mooring factor of inertia may cause an individual to perpetuate the status quo and resist the adoption of a new standard [53]. Individuals may rely on their past behavior to guide their perceptions and intentions. We expect inertia to bias a user's perceptions and behavior intentions regarding a standard. It may have an impact on both push and pull factors. The network effect refers to any case in which the utility a given user derives from a product or a service is dependent upon the number of other users who are in the same network [29]. The higher the number of users using a standard, the more valuable that standard becomes to every user. The network effect works as a mooring factor that may lock users into continuing the use of the incumbent standard. Furthermore, the network size can serve as a cue regarding quality credibility [22, 43] and therefore may bias users' perceptions of a standard's benefits.

Smartphones were chosen as the study case. A rapid increase in m-commerce was brought about by the release of Apple's iPhone in 2007 and Google's Android-based smartphones in 2009 [33]. According to cnet.com and findthebest.com, more than 170 smartphones were released in 2012. According to manufacturer HTC, the average "shelf life" (the amount of time before an item is considered unsuitable for sale, use, or consumption) for smartphones is about six to nine months [23]. In this highly competitive market, consumers frequently choose among multiple alternatives and make switching decisions. Thus, the smartphone market is a good study case to aid in understanding which factors influence consumers to switch in a standards war, particularly in a competitive market.

The rest of this paper is organized as follows: The next section reviews relevant literature. The third section develops the PPM model of standards-switching intentions and proposes relevant research hypotheses. The research methodology and data analysis results are described in the fourth and fifth sections. The paper concludes with discussions of the research findings and the theoretical and practical implications.

Literature Review

Customer switching refers to a migration of users from one provider to another. Keeping customers from switching is very important because the loss of a customer is an incremental loss of both profitability and market share and adds the cost of finding a new replacement customer [32]. Existing studies on customer switching focus mainly on push and pull factors. The PPM model underscores the importance of mooring variables as drivers of migration. Bansal et al. [7] compared customers' switching behavior with migration from

one geographic area to another and proposed a unifying theoretical framework for understanding consumer behavior regarding switching between service providers. They found that push, pull, and mooring factors all significantly influence consumers' switching intentions.

Push factors are defined as the factors that motivate people to leave a point of origination. They are the characteristics of the origination point that influence the migration decision. Pull factors are the characteristics of the destination that positively influence consumers' intentions to switch. Even when push and pull factors are strong, situational or contextual constraints may inhibit the individual from migrating. These "mooring factors" must be investigated in order to understand consumer switching behavior. Mooring factors are personal and social factors that facilitate or hamper the migration decision.

In addition to aiding in the understanding of consumers' switching behaviors regarding service providers, the PPM model has been used to explain consumer switching intentions toward Web browsers [72], blogs [74], and business applications [36]. Prior literature has focused mainly on two mooring factors: switching cost and subjective norm. Consumers may be reluctant to switch because of high switching costs or unfavorable subjective norms. However, the mooring factors of inertia and network effects have not been examined. Moreover, the effects of these mooring factors on push and pull factors have never been addressed. This study develops a research model based on the PPM model. The relationships between push, pull, and mooring factors are also investigated to help IT providers specify effective customer retention and acquisition strategies.

Developing the PPM Model of Intentions to Switch Standards

This study adopts the PPM model as a research framework to develop a model explaining consumer intentions to switch standards. Figure 1 illustrates the conceptual model. This section provides a theoretical rationale for these factors and develops the research hypotheses.

Push Effects

Push effects are the characteristics of the incumbent standard that push consumers away to alternative standards. In accordance with expectation-confirmation theory, the proposed model considers disconfirmation and low satisfaction to be the push factors.

Disconfirmation

Confirmation, also referred to in the negative as "disconfirmation" in the marketing literature, is the extent to which consumers' expectations are confirmed [10]. According to expectation-confirmation theory, consumers form

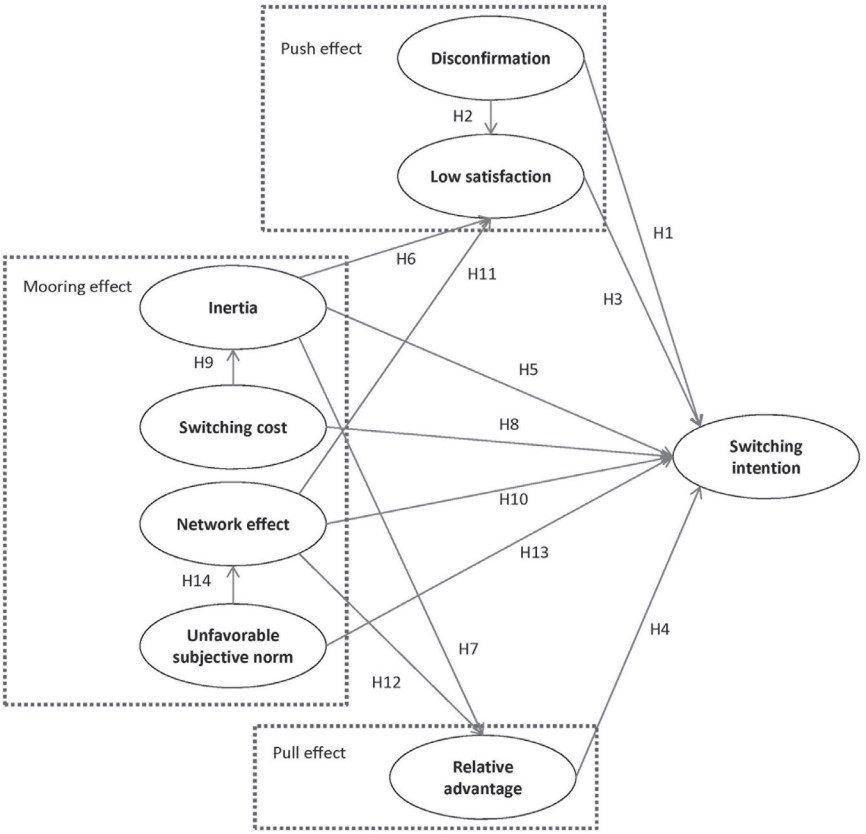

Figure 1. PPM Model of Intentions to Switch Standards

an initial expectation of a specific product or service prior to purchase, and then, following a period of initial consumption, they form perceptions about its performance. The discrepancy between the performance outcomes and the original expectation is confirmed to one extent or another. Lower expectations and/or higher performance lead to greater confirmation, which, in turn, positively influences customer satisfaction and use continuance intention. The opposite is also true: Higher expectations and/or lower performance lead to decreased confirmation and negatively influence satisfaction and use continuance intention. Prior studies on information systems (IS) use continuance have also conceptualized satisfaction as a combination of the confirmation of expectations [10, 13, 14, 24]. Considering this, we posit that expectation disconfirmation is a push factor that is positively related to consumers' intentions to switch standards. Disconfirmation of expectations regarding the standard is positively related to low satisfaction. Thus, the following hypotheses are developed:

> ***Hypothesis 1:*** *The push effect of expectation disconfirmation regarding the incumbent standard is positively related to switching intention.*

Hypothesis 2: *The extent to which consumers' expectations are disconfirmed is positively related to low satisfaction with the incumbent standard.*

Low Satisfaction

Satisfaction is an emotional response resulting from a cognitive evaluation process comparing personal expectation to a product's perceived performance [10]. Oliver [48] indicated that satisfaction can be seen as an additive combination of the expectation level and the resulting disconfirmation. Oliver and Linda [50] examined the impact of satisfaction and its antecedents on behavioral intention and found that intention is almost exclusively a function of satisfaction. Furthermore, Bhattacherjee [10] demonstrated that user satisfaction is a strong predictor of IS use continuance intention. With regard to switching behavior, user satisfaction with the incumbent IT product is negatively associated with the intention to switch [72, 73]. For this reason, we posit that consumers tend to switch to an alternative standard if they are highly dissatisfied with the incumbent standard.

Hypothesis 3: *The push effect of low satisfaction with the incumbent standard is positively related to switching intention.*

Pull Effects

Pull effects are the characteristics of the alternative standard that pull consumers from the incumbent standard. The proposed model considers the pull factor of relative advantage in accordance with the diffusion of innovations theory.

Relative Advantage

Rogers's [56, 57] diffusion of innovations theory is a fundamental technique to examine how the acceptance of a new technology spreads. Five innovation attributes—relative advantage, compatibility, complexity, trialability, and observability—are used to explain the adoption of innovations. Among those attributes, most empirical studies have used relative advantage, compatibility, and complexity as the most important innovation characteristics when examining the factors that impact innovation adoption [15, 26, 45, 54]. Because relative advantage can be the function of compatibility and complexity [66], this study focuses on the relative advantage factor.

Relative advantage refers to the degree to which adopting an innovation is perceived as being better than continuing the practice it supersedes [56, 57]. Shapiro and Varian [60] noted that a quality advantage is meaningful to both the consumer and the provider. Providers will have an easier time getting consumers to use their product if the quality is good. In addition, providers will capture consumers and lock them in quickly, earning more profit. If

the relative advantage of an alternative is better than that of the incumbent product, the alternative will be much more likely to induce users to switch to it. Thus, we propose the following hypothesis:

> ***Hypothesis 4:*** *The pull effect of the relative advantage of alternative standards is positively related to switching intention.*

Mooring Effects

Mooring effects refer to personal and social factors that can either hold consumers to the incumbent standard or facilitate switching to the alternative standard. The mooring factors of inertia, switching cost, and network effect are considered in the proposed model in accordance with status quo bias theory and lock-in theory. In addition, the factor of unfavorable subjective norm is considered in accordance with the theory of planned behavior.

Inertia

Status quo bias is one reason that people will continue an incumbent action rather than choose a superior action [59]. Often manifested as inertia, status quo bias is defined as the attachment to—and persistence of—existing behavioral patterns even in the presence of better alternatives and incentives to change [53]. Inertia is expressed as an unwillingness to give up the status quo no matter how much better the alternatives may get in the future. Inertia negatively influences one's intention to use a new technology. It is a key barrier to the success of that technology. Inertia is considered an antecedent or component of brand loyalty and is defined as the tendency to both continue purchasing a brand that was purchased in the past and not to seek variety [8, 42].

Polites and Karahanna [53] conceptualized inertia as having cognitive and affective components. Individuals experiencing cognitive-based inertia will continue to use a system consciously although they believe that it might not be the most efficient or effective way for completing a given task. Affective-based inertia occurs when individuals continue using a system because they enjoy doing so, they feel comfortable with it, or they have a strong emotional attachment to the current way of doing things and feel stressed regarding the change. No matter which type of inertia occurs, users tend to continue to use the incumbent standard. Hence, we posit that inertia is a mooring factor that is negatively related to switching intention.

> ***Hypothesis 5:*** *The mooring effect of inertia is negatively related to switching intention.*

Inertia may occur because people enjoy, feel comfortable with, or have developed a strong emotional attachment to the current way of doing things [53, 58]. Given this fact, we posit that an inertial user has a better emotional response

to the current standard and is therefore less likely to be dissatisfied with it. Thus, the following hypothesis is developed:

> ***Hypothesis 6:*** *Inertia is negatively related to a low level of satisfaction with the incumbent standard.*

As inertia sets in, people may draw from past decisions to guide present and future choices [59]. Moreover, if people do not want to give up their current way of doing things, they may justify viewing that alternative negatively to avoid suffering cognitive dissonance [19]. Thus, inertial users rationalize continuance in the status quo and bias their perceptions of a new system downward [53]. We expect that when consumers have high levels of inertia, they will perceive the alternative standard as having a lower relative advantage. This study proposes the following hypothesis:

> ***Hypothesis 7:*** *Inertia is negatively related to the relative advantage of alternative standards.*

Switching Cost

Switching costs refers to all the costs that a consumer must bear when abandoning the current provider or brand of product for an alternative. Switching costs arise as a result of prior commitments to the incumbent provider in terms of specific physical, informational, artificially created, or psychological investments [35]. Using switching costs to lock in consumers is a typical approach for constraint-based consumer relationship development.

Switching costs can be broken down into transition costs and sunk costs [59]. Transition costs include the procedural cost and contract lock-in associated with the change. They are the time, effort, and fees required to switch to a new situation. Sunk costs are retrospective costs that have already been incurred and cannot be recovered. The more one has invested in an existing course of action, the more likely one will be to continue down that path in the future because of the reluctance to cut the losses. These costs make a switch from the status quo much less likely to occur.

Perceived switching costs relate positively to loyalty [5, 12] and usage [26]. We posit that if the time and effort required to evaluate, learn, and set up another standard are perceived as being high, and the time and effort already invested in learning the incumbent standard and purchasing accessories and applications are also high, consumers will be less likely to switch to use an alternative standard.

> ***Hypothesis 8:*** *The mooring effect of switching cost is negatively related to switching intention.*

Switching costs make a switch from the status quo much less likely to occur [59]. If consumers perceive the time and effort required to learn another system as being high, or if they have already invested more time and effort in

learning the incumbent system, they will be more likely to exhibit inertia [53]. Thus, we propose the following hypothesis:

> ***Hypothesis 9:*** *Switching cost is positively related to inertia in a standards war.*

Network Effect

The network effect, sometimes called "network externality," refers to any case in which the utility a given user derives from a product is dependent upon the number of other users who are in the same network [29]. A product becomes more valuable as its user base expands; in other words, the value of a product for one user increases as more users adopt the product [31]. Expectations about the future installation base—and the resultant benefits of the phenomenon of "the more, the merrier"—play a critical role in consumers' product adoption decisions [37].

In contrast to switching cost, the network effect comes from other users who are in the same network, thus creating an external lock-in. Several studies have proposed that the network effect is one of the most important environmental factors determining technology adoption [2, 39]. Studies of innovations show that adoption likelihood is sensitive to critical mass and consumers' anticipation of future network size [37, 44, 60]. We posit that consumers will not switch to an alternative standard if they expect that the critical mass of the incumbent standard will arrive in the near future.

> ***Hypothesis 10:*** *The mooring effect of the network effect is negatively related to switching intention.*

The greater the network effect, the more value the product creates for the user. Positive network effects include product quality improvements, intensification of ongoing service, and reductions in usage costs [18]. Users' perceptions of value have a positive effect on their satisfaction [27, 41, 47]. Thus, we posit that the network effect has a positive effect on satisfaction with the standard, and the following hypothesis is developed:

> ***Hypothesis 11:*** *The network effect is negatively related to a low level of satisfaction with the incumbent standard.*

If a product/service is expected to become dominant, a bandwagon effect occurs and customers rush to adopt the product/service [17, 30]. People rely on the bandwagon heuristic especially when they make choices in an environment of information overload and uncertainty. This heuristic is a popularity cue that insinuates social endorsement and confers quality credibility [22, 43]. The acceptance of the technology by others may signal the importance and advantages of the technology and motivate the consumer to imitate the acceptance behavior [68]. Thus, we posit that customers will infer that a standard has higher quality if it has a large user base, and they will perceive the

alternative standard as having a lower relative advantage. This study proposes the following hypothesis:

> ***Hypothesis 12:*** *The network effect is negatively related to the relative advantage of alternative standards.*

Unfavorable Subjective Norm

According to the theory of planned behavior, subjective norm is a predictor of behavior intention. Subjective norm refers to the perceived social pressure to perform or not to perform the behavior [1]. This factor has been widely considered in studies on technology acceptance. It has also been found to be an important determinant of online service continuance [25, 34, 46] and consumers' instant messaging technology choices [40]. Consumers tend to share knowledge about technologies through interactions with people in their social network. Thus, knowledge and opinions from relevant others strongly influence their usage and switching decisions. We posit that consumers' intentions to switch standards will be inhibited if relevant others have unfavorable opinions about the switch.

> ***Hypothesis 13:*** *The mooring effect of unfavorable subjective norm toward using the alternative standard is negatively related to switching intention.*

Identifying influential customers and aggressively marketing them can be an effective way to enlarge an installation base [60]. If others who are important to the consumer accept a particular standard, the consumer may predict that this standard will have a larger installation base. Thus, we develop the following hypothesis:

> ***Hypothesis 14:*** *The mooring effect of unfavorable subjective norm toward using the alternative standard is positively related to the network effect of the incumbent standard.*

Research Methodology

Research Settings

Smartphones were chosen as the study case because two major standards dominate the smartphone market: Google's Android and Apple's iOS (i.e., the iPhone). Each has its advantages, and consumers may switch between them. According to International Data Corporation (IDC), in 2012, Android phones accounted for 68.8 percent of the worldwide smartphone market and iPhones comprised 18.8 percent (www.idc.com). In the Taiwanese smartphone market, Android phones accounted for 79 percent and iPhones took 19 percent in the first quarter of 2013. The size of Android's larger market share makes examining its network effect more interesting. Thus, this study investigates the major factors influencing Android users' intentions to switch to iPhones and examines

the proposed model in that context. In Taiwan, mobile communications companies usually provide a two-year contract for a smartphone. An early termination fee will be charged if a user breaks the contract within two years; the fee decreases as the period elapses. Since the market shares and contract type of smartphones in Taiwan are similar to those in other countries, we believe that the research findings are sufficiently generalizable to other markets.

Measures

Based on the conceptual research model and a detailed review of the related literature, a 43-item questionnaire was devised as a measurement scale for the study. To the extent possible, previously published items were adopted or adapted. This study adopted the Likert scale, allowing the participants to choose one of seven levels of agreement with anchors ranging from 1 (strongly disagree) to 7 (strongly agree). The constructs and operational definitions are described in Table 1.

After the draft was designed, in order to clarify any ambiguities, a pretest was performed on five users and three experts familiar with smartphones. Based on the respondents' feedback, the questionnaire was adjusted to improve readability and ensure its accuracy and appropriateness.

The questionnaire was then adopted in a pilot test. Seventy part-time MBA students from a university in Taiwan completed the questionnaire. They were asked to answer each item according to their judgment of Android phones and iPhones. We also collected their suggestions as to where the survey could be clarified and their opinions on other areas in which the survey could be improved. We then performed exploratory factor analysis using SmartPLS 2.0 M3 to conduct principal component factor analysis with varimax rotation on all constructs in order to obtain a number of factors and determine the indicators of each factor. Among the initial 43 items, a total of 11 factors were extracted. Two indicators of contract termination cost and two indicators of relative advantage had loadings lower than 0.7 and were therefore eliminated [21]. Thus, participants in the formal survey could clearly understand each question, and content validity was ensured.

Sample and Data Collection

We conducted an Internet survey in June 2012. To recruit participants who had an Android smartphone, we posted an announcement for three weeks on the Mobile Communication forum on PTT (ptt.cc), the largest and most well-known bulletin board system in Taiwan. Visitors to this particular forum share their experiences regarding mobile phones, contracts, monthly fees, and service providers. The announcement stated the purpose of the study and the qualifications for participating in the survey. To preserve confidentiality, all participants were informed that their responses would remain anonymous and would be used for academic purposes only. The questionnaire asked them to state their smartphone brand and how long they had used their Android phone to ensure that all survey respondents were current Android users. The

Table 1. Operational Definitions.

Construct	Definition	Instrument
Switching intention	The intention of an individual to switch to use an alternative in the future.	4-item scale adapted from Davis et al. [16].
Low satisfaction	Users' negative feelings about prior use of Android phones.	3-item scale adapted from Bhattacherjee [10].
Disconfirmation	Users' perception of the incongruence between their expectations of Android phone use and its actual performance.	3-item scale adapted from Bhattacherjee [10].
Affective-based inertia	Users enjoy or feel comfortable continuing to use an Android phone or that it would be stressful to change.	3-item scale adapted from Polites and Karahanna [53].
Cognitive-based inertia	Users consciously continue to use an Android phone even though they are aware that it might not necessarily be the best, most efficient, or most effective way of doing things.	4-item scale adapted from Polites and Karahanna [53].
Sunk cost	Investments related to the Android phone that will be lost as the result of switching to an alternative.	4-item scale adapted from Burnham et al. [11] and Jones et al. [28].
Procedural cost	The time and effort required to adapt to an alternative.	4-item scale adapted from Burnham et al. [11] and Jones et al. [28].
Contract termination cost	Early termination fees and losses associated with the termination of the smartphone contract.	5-item scale adapted from Burnham et al. [11] and Jones et al. [28].
Network effect	The utility that a given user derives from an Android phone, which depends upon the number of other users who are in the Android network.	3-item scale adapted from Katz and Shapiro [29], Shapiro and Varian [60], and Strader et al. [61].
Unfavorable subjective norm	User's perception that most people who are important to the user think the user should continue to use Android phones.	3-item scale adapted from Fishbein and Ajzen [20] and Polites and Karahanna [53].
Relative advantage	The degree to which adopting an alternative is perceived as being better than using the Android phone.	7-item scale adapted from Rogers [56] and Teo and Pok [64].

effective sample size was 296. The demographic information of these respondents is shown in Table 2.

We obtained the demographic data from late respondents (latest one-fourth) and compared them with those of the early respondents (earliest one-fourth). A chi-square test was used to compare the demographic attributes of the late respondents and those of the early respondents. The results revealed no significant differences, suggesting no substantive nonresponse bias.

Data Analysis and Results

Measurement Model

The reliability of the scales can be ensured through examining composite reliability (CR), Cronbach's alpha, and average variance extracted (AVE).

Table 2. Sample Demographics.

Attribute	Categories	*N*	%
Gender	Male	168	56.8
	Female	128	43.2
Education	High school	10	3.3
	Associate degree	5	1.7
	Bachelor's degree	146	49.3
	Master's degree	130	44.0
	Doctorate	5	1.7
Monthly income (New Taiwan dollars)	< 10,000	163	55.0
	10,001 -20,000	45	15.2
	20,001 -30,000	20	6.8
	30,001 -40,000	17	5.7
	40,001 -60,000	35	11.8
	60,001 -80,000	11	3.7
	> 80,001	5	1.6
Smartphone brand	Google	4	1.4
	Samsung	60	20.3
	HTC	136	46.0
	Sony Ericsson	47	15.9
	Motorola	18	6.0
	Others	31	10.4
Apps	< 25	135	50.2
	25 -50	109	40.5
	50 –100	41	15.2
	> 100	11	4.1
Age	< 20	20	6.8
	20 -25	200	67.6
	26 -30	43	14.5
	31 -35	15	5.0
	36 -40	7	2.4
	> 40	11	3.7
Occupation	Student	201	67.9
	Nonstudent	95	32.1
Frequency of changing cell phones in a year	0	59	19.9
	1	206	69.6
	2	23	7.8
	3	5	1.7
	>3	3	1.0
How long have you used your Android phone?	< 3 months	64	21.6
	3 -6 months	64	21.6
	6 –12 months	86	29.0
	1 -2 years	68	23.0
	> 2 years	14	4.8
How much time per day do you spend on smartphone activities other than the function of conversation?	< 1 hour	91	30.7
	1 -3 hours	147	49.7
	3 -5 hours	38	12.8
	5 -8 hours	15	5.1
	8 –12 hours	5	1.7

These three values should be greater than 0.7, 0.7, and 0.5, respectively [4, 21]. The results are shown in Table 3 and indicate that the scales have good reliability.

Convergent validity should be ensured when multiple indicators are used to measure one construct; this can be examined by item-total correlation (ITC), factor loading, and AVE [21]. Convergent validity requires that ITC, factor loading, and AVE be greater than 0.3, 0.7, and 0.5, respectively. The results are shown in Table 3 and indicate that the scales have good convergent validity.

To achieve adequate discriminant validity, the correlation coefficients among variables should be less than 0.9, and the square root of AVE should be greater than the interconstruct correlation coefficients [21]. Descriptive statistics and the correlation matrix are shown in Table 4 and suggest that discriminant validity is satisfactory.

Common Method Variance

Common method variance (CMV) might have been a concern in this study because both independent and dependent variables were collected simultaneously from the same respondents [3]. We followed Podsakoff et al.'s recommendations and adopted a single-common-method-factor approach to controlling for CMV [52]. The PLS marker variable approach [55] was used to create a method factor. First, we selected three items that were collected in the same survey but are not included in the model being tested: (1) "Once I've come to a conclusion, I'm not likely to change my mind"; (2) "I don't change my mind easily"; and (3) "My views are very consistent over time" [51]. These were used as marker indicators. Second, we calculated the mean correlation between the marker items and the study items and found that the mean correlation is 0.027 (i.e., < 0.05), which means that method variance is most probably not an issue with the data. Third, a method factor was created using the marker indicators as an exogenous variable predicting each endogenous construct in the model. Finally, we compared the method factor model with the baseline model and found that the significant paths in the baseline model remain significant in the method factor model. Thus, we can conclude that the data do not have a CMV problem [55].

Testing of the Research Model and Hypotheses

We tested the hypotheses via partial least squares (PLS) regression analyses using SmartPLS with a bootstrapping algorithm (resample 300). Switching cost and inertia were conceptualized as second-order formative, first-order reflective multidimensional constructs. The dimensions of switching cost are sunk cost, procedural cost, and contract termination cost. The dimensions of inertia are affective-based inertia and cognitive-based inertia. We used the two-stage approach to estimate the hierarchical latent variable model because this study focuses on the relationships between higher-order constructs [9]. The explanatory power of the structural model is evaluated by the R^2 value.

Table 3. Factor Analysis Results.

Construct	Items	Factor Loading	Factor ITC
Disconfirmation CR = 0.964 Alpha = 0.944 AVE = 0.899	My experience with using the Android phone does not meet my expectations.	0.952	0.891
	The Android phone is unable to meet my expectations.	0.951	0.888
	Overall, most of my expectations regarding using the Android phone were disconfirmed.	0.942	0.868
Low satisfaction CR = 0.966 Alpha = 0.948 AVE = 0.906	Overall, using the Android phone makes me feel unsatisfied.	0.952	0.887
	Overall, using the Android phone makes me feel unpleased.	0.957	0.902
	Overall, using the Android phone makes me feel not delighted.	0.946	0.882
Switching intention CR = 0.916 Alpha = 0.881 AVE = 0.734	I intend to continue using an Android phone rather than discontinue its use (reverse coded).	0.932	0.807
	My intentions are to continue using an Android phone rather than use any alternative phone, e.g., iPhone (reverse coded).	0.906	0.747
	If I could, I would like to discontinue my use of the Android phone.	0.785	0.701
	If I could, I would like to switch from the Android phone to an iPhone.	0.797	0.713
Switching cost: Sunk cost CR = 0.886 Alpha = 0.829 AVE = 0.661	A lot of time, energy, and effort have gone into using and getting proficient with the Android phone.	0.774	0.593
	I have spent a lot of money on the Android phone.	0.786	0.573
	All things considered, I've put a lot into previous dealings with the Android phone.	0.824	0.714
	Overall, I have invested a lot in the usage of the Android phone.	0.865	0.759
Switching cost: Procedural cost CR = 0.949 Alpha = 0.927 AVE = 0.822	It's hard for me to switch from the Android phone to an iPhone.	0.904	0.823
	It's complicated for me to switch from the Android phone to an iPhone.	0.936	0.879
	It's hard for me to accommodate an iPhone.	0.916	0.846
	It's difficult for me to adapt to an iPhone.	0.807	0.776
Switching cost: Contract termination cost CR = 0.909 Alpha = 0.847 AVE = 0.769	Switching to an iPhone will generate a huge contract loss.	0.852	0.711
	Switching to an iPhone will make it hard for me to deal with the contract.	0.865	0.722
	The loss from switching to an iPhone is serious for me.	0.815	0.678
Unfavorable subjective norm CR = 0.964 Alpha = 0.943 AVE = 0.898	My friends think I should continue to use an Android phone	0.950	0.889
	My relatives think I should continue to use an Android phone.	0.937	0.857
	My colleagues or schoolmates think I should continue to use an Android phone.	0.957	0.901

Construct	Items	Factor Loading	Factor ITC
Relative advantage CR = 0.891 Alpha = 0.850 AVE = 0.627	To me, the interface of the iPhone feels friendlier than that of Android phones.	0.832	0.654
	It is easier for me to use an iPhone than an Android phone.	0.851	0.683
	I like the aesthetics of the iPhone better than those of Android phones.	0.730	0.665
	The iPhone feels to me as if it has better quality than the Android phones.	0.751	0.710
	The response of the iPhone feels faster to me than that of Android phones.	0.753	0.652
Inertia: Affective-based inertia CR = 0.912 Alpha = 0.851 AVE = 0.777	I will continue using an Android phone . . .		
	. . . because it would be stressful to change.	0.729	0.538
	. . . because I am comfortable doing so.	0.947	0.805
	. . . because I enjoy doing so.	0.951	0.818
Inertia: Cognitive-based inertia CR = 0.972 Alpha = 0.961 AVE = 0.896	I will continue using an Android phone . . .		
	. . . even though I know it is not the best way of doing things.	0.925	0.869
	. . . even though I know it is not the best-quality system.	0.967	0.938
	. . . even though I know it is not the best-quality interface.	0.952	0.913
	. . . even though I know it does not have the best quality and number of apps.	0.943	0.898
Network effect CR = 0.940 Alpha = 0.904 AVE = 0.839	In comparison to the iPhone, I predict that Android phones will have more users in the future.	0.934	0.836
	I predict that the market share of the Android service network will grow constantly in the future.	0.903	0.784
	I predict that Android phones will be the final winner in the future.	0.911	0.809

In addition, in order to determine whether each hypothesis is supported, this study assessed the *t*-statistics of the standardized path coefficients. All path coefficients and explained variances for the model are shown in Figure 2.

As indicated, the relationships between push factors and switching intention were all found to be significant. Specifically, disconfirmation ($\beta = 0.189$, $p < 0.05$) and low satisfaction ($\beta = 0.189$, $p < 0.01$) have positive influences on switching intention. In addition, disconfirmation is positively associated with low satisfaction ($\beta = 0.652$, $p < 0.001$). The relative advantage pull factor has a positive influence on switching intention ($\beta = 0.117$, $p < 0.05$). Therefore, H1, H2, H3, and H4 are supported. The mooring factors inertia ($\beta = –0.311$, $p < 0.001$), switching cost ($\beta = –0.097$, $p < 0.05$), and network effect ($\beta = –0.110$, $p < 0.1$) are negatively associated with switching intention, but the relationship between unfavorable subjective norm and switching intention is insignificant. H5 and H8 are supported, H10 is marginally supported, and H13 is not supported. An unfavorable subjective norm toward using the alternative standard is positively related to the network effect of the incumbent standard ($\beta = 0.495$, $p < 0.001$);

Table 4. Descriptive Statistics and Correlation Matrix.

Construct	Mean	SD	ABI	CBI	CC	DC	NE	LS	PC	RA	SC	SI	USN
ABI	4.41	1.34	**0.88**										
CBI	4.72	1.38	0.48	**0.95**									
CC	3.79	1.65	0.18	0.20	**0.88**								
DC	2.82	1.32	-0.61	-0.40	-0.01	**0.95**							
NE	4.17	1.33	0.45	0.30	0.21	-0.33	**0.92**						
LS	2.79	1.26	-0.68	-0.49	-0.09	0.81	-0.39	**0.95**					
PC	3.81	1.63	0.58	0.32	0.43	-0.27	0.37	-0.32	**0.91**				
RA	4.67	1.40	-0.48	-0.05	-0.05	0.31	-0.38	0.30	-0.37	**0.79**			
SC	4.03	1.43	0.11	0.03	0.10	0.02	0.18	-0.02	0.19	0.12	**0.82**		
SI	2.82	1.52	-0.71	-0.53	-0.17	0.64	-0.50	0.68	-0.47	0.39	-0.11	**0.86**	
USN	3.95	1.10	0.47	0.27	0.22	-0.27	0.50	-0.29	0.34	-0.28	0.22	-0.43	**0.95**

Notes: The diagonal line of the correlation matrix (in boldface) represents the square root of AVE. SD: standard deviation; ABI: affective-based inertia; CBI: cognitive-based inertia; CC: contract termination cost; DC: disconfirmation; NE: network effect; LS: low satisfaction; PC: procedural cost; RA: relative advantage; SC: sunk cost; SI: switching intention; USN: unfavorable subjective norm.

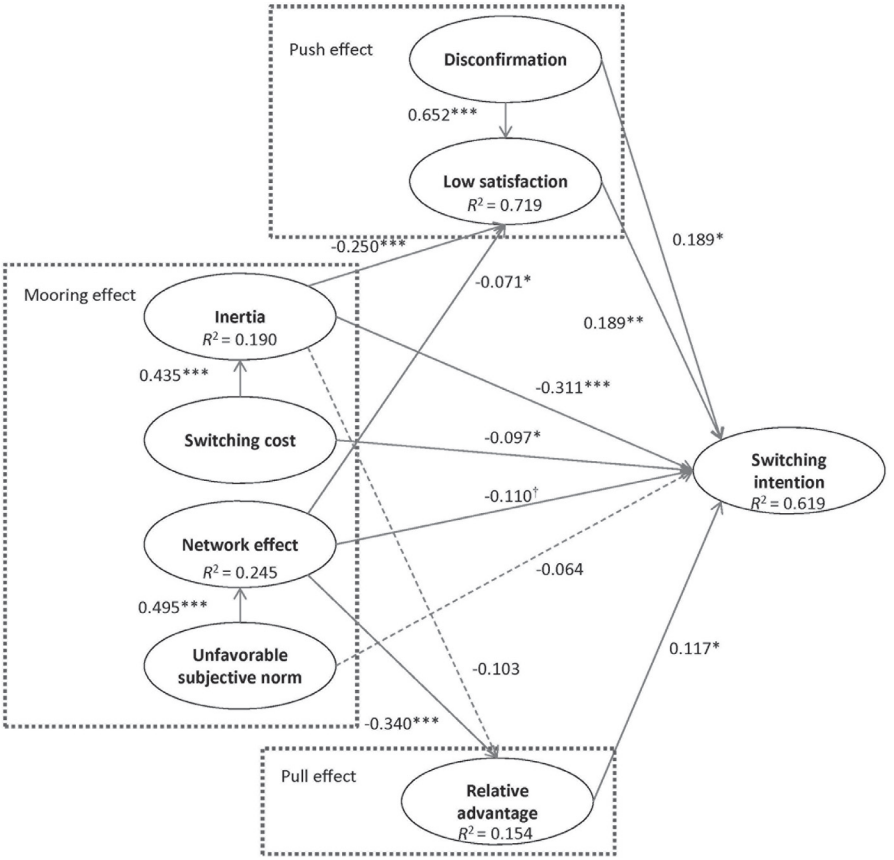

Figure 2. PLS Analysis of Research Model

† $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

the network effect is negatively associated with low satisfaction (β = –0.071, $p < 0.05$) and relative advantage (β = –0.340, $p < 0.001$). Thus, H11, H12, and H14 are supported. Switching cost positively influences inertia (β = 0.435, $p < 0.001$); inertia negatively influences low satisfaction (β = –0.250, $p < 0.001$). However, inertia does not have a significant effect on relative advantage. H6 and H9 are supported, but H7 is not supported. The push, pull, and mooring factors together explain 62 percent of the variance of switching intention. Users will have a higher intention to switch standards when their level of satisfaction with the incumbent is low, when their expectations cannot be met, or when they perceive the alternative as having a higher relative advantage. Furthermore, stronger inertia (including affective-based and cognitive-based inertia), higher switching costs (including sunk, procedural, and contract termination costs), and higher positive network effects are associated with lower switching intention. This study also identified the effects of the mooring factors on the push and pull factors. Inertial users are less likely to be dissatisfied with the current standard. If the network effect of the incumbent standard is high, the

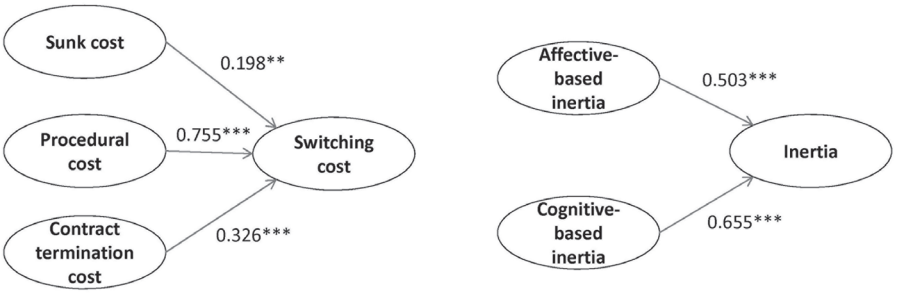

Figure 3. Path Coefficients Between First- and Second-Order Constructs

** $p < 0.01$; *** $p < 0.001$.

users are less likely to feel dissatisfied with the standard and will perceive the alternative standard as having a lower relative advantage.

Second-Order Constructs

Figure 3 depicts the relationships between first- and second-order constructs. The path coefficients from the dimensions to the aggregate second-order construct are weights. These weights are analogous to a multiple regression analysis, and thus indicative of each dimension's relative importance. The results show that procedural cost is the major switching cost in the smartphone context. Affective-based inertia and cognitive-based inertia are equally important to reducing customer willingness to give up the incumbent standard.

Discussion and Implications

The objective of this study was to examine the effects of the push, pull, and mooring factors on the intention-to-switch standards. In addition, the relationships between these factors were also examined. Our findings based on data from actual users of smartphones provide strong support for the PPM model proposed in this study. The push, pull, and mooring effects all influence consumers' switching intentions. The mooring factors (specifically inertia and the network effect) influence the push and pull factors.

Theoretical Implications

This study demonstrates that consumers' intentions to switch standards are, in fact, determined by push, pull, and mooring factors. These three types of factors have seldom been examined simultaneously in an IT context. In addition to the characteristics of incumbent and alternative standards, the personal and social factors, including inertia, switching cost, and network effect, have a

significant effect on switching intentions. Adding to the findings of prior PPM studies [7, 36, 72, 74], the present study found that inertia and the network effect play important roles in influencing standards switching.

Switching cost has been identified as a key factor of standards dominance [65]. This study demonstrates that, in addition to switching cost, inertia is another major inhibitor blocking consumers from switching to alternative standards. Few studies have paid attention to both factors as they relate to rational decision making (e.g., switching cost) and decision makers' psychological traits (e.g., inertia). Consumers may feel comfortable with the current standard and feel stress regarding a change. An inertial consumer is unwilling to give up the current standard despite the belief that it might not be the best choice. Furthermore, our study revealed the relationship between inertia and satisfaction. An inertial consumer has a positive emotional response to the status quo and therefore is less likely to feel dissatisfied with the incumbent standard. In contrast, inertia does not affect perceived relative advantage in the smartphone context. A possible reason is that consumers can easily obtain information on the advantages of each smartphone from the Internet, and therefore their past decisions are less likely to bias their perceptions of the relative advantages of alternative smartphones.

Prior studies on standards or IT switching have paid less attention to network effects. Our study shows that if consumers predict that their currently adopted standard will have more users and a bigger market share, they will be unwilling to give up the value created by the large user base and, hence, will have a lower level of switching intention. The network effect is an environmental factor and can be treated as an external lock-in. In contrast, inertia and switching cost are formed by the consumers themselves and therefore can be treated as internal lock-ins. In the smartphone context, however, the influence of the network effect on switching standards is smaller than the influence of inertia and switching cost. This is because users in the iPhone network can communicate with users in the Android network and vice versa. The direct network effect is weak in this context. Nevertheless, a larger user base can stimulate developers to produce complementary goods, for example, applications. The plenitude of complementary goods creates indirect network effects and increases the network value. As the Android phone user base has increased, the number of apps available in Google Play has also increased and, as of October 2012, had already matched the number of apps in Apple's App Store [70]. The quantity and variety of apps in the two platforms did not significantly differ in this study. This is another reason why the network effect is weaker in this study case. Even though the direct network effect is weak in the smartphone context, smartphone vendors cannot neglect the importance of the indirect network effect. For example, BlackBerry Messenger (BBM) is a highly effective app on the BlackBerry platform, and it was available exclusively on BlackBerry operating systems until September 2013. The popularity of the BBM app caused BlackBerry users to remain loyal. This study also identified the impact of the network effect on both push and pull factors. A standard's large user base creates more value, leading to higher satisfaction with the standard. The large user base is also a quality cue that makes customers perceive the alternative standard as having a lower relative advantage.

The mooring factor of subjective norm does not directly influence standards switching. One reason is that the main effect of subjective norm on intention might be weak if consumers have already developed their own attitude toward switching [6]. Another reason is that consumers can gather relevant information from the Internet when deciding whether to switch standards, and thus they are less reliant on the information provided by their referent groups [63]. However, this study found that subjective norm does indirectly influence standards switching mediated by the network effect. If a customer's friends, relatives, and colleagues suggest continuing to use the incumbent standard, the customer is likely to expect that the network size will increase and provide even more value.

Practical Implications

The proposed model can help IT vendors understand how consumers choose between technology products based on the standards. With this understanding comes the opportunity to design more effective customer retention and acquisition strategies.

Customer Retention Strategies

Expectation disconfirmation and a low satisfaction level motivate users of an incumbent IT product to switch to an alternative. IT vendors must understand and manage their customers' expectations and design products that can meet these expectations in order to increase customer satisfaction. Customers' needs constantly change, and their expectations vary accordingly. IT vendors must be flexible and continuously improve their technology in order to enhance user satisfaction. In addition, increased customer inertia and an expanding user base also improve customer satisfaction. Making customers feel comfortable with a product and feel stress if they have to change can relieve the effects of low satisfaction levels. For example, iPhone users cite Apple's extensive services (e.g., the app collection, iTunes, cloud services, and Siri voice recognition) plus seamless connection with other Apple devices (e.g., the iPad, Mac, and Apple TV) as a primary reason for satisfaction and loyalty. Furthermore, providers should continue to grow their user base to provide more value and gain the social endorsement that confers quality credibility so that customers will feel more satisfied and perceive the alternative as having a lower relative advantage.

In addition to improving customer satisfaction and confirming expectations, utilizing mooring factors to inhibit switching to alternatives is another practical customer retention strategy. Since inertia forms a barrier to switching, entering the market early can help a vendor create customer inertia and make customers reluctant to consider late entrants. Customers with high inertia are loyal customers who do not like to switch [49]. Therefore, vendors should provide better, more deferential service for those loyal customers in order to retain and continue to profit from them. Moreover, IT vendors are advised to lock in customers with switching costs. For instance, they could employ

proprietary technology, which would increase the costs of learning a new alternative, and contract termination fees, which would make it expensive for a customer to switch to a competing provider. To create external lock-ins, IT vendors must expand their network to create network effects by acquiring new customers and creating a larger market for complementary products. Moreover, consumers should be made to believe that the vendor will always support and invest in the standard, thereby increasing consumer confidence in the success of the product. Vendors need appropriate marketing and communication strategies to establish consumer expectations about the benefits of the technology investment [71].

Customer Acquisition Strategies

The present study has found that relative advantage is a pull factor that is positively related to switching intention. If customers find that the alternative standard possesses considerable advantages, they can be pulled away. By the same token, in order to acquire new customers, IT vendors need to create competitive advantages that outstrip all other standards available on the market. For instance, Apple's iPhone provides a better user experience by integrating hardware, software, services, and user interfaces. This advantage attracts consumers to use the iPhone and spend more time with their devices. Android smartphones are available from various manufacturers and come with a wide variety of options. Customers can freely choose the Android phone that best suits their needs and preferred brand.

Another strategy for attracting customers is to weaken the moorings of competitors' customers. For instance, inertia can be reduced by providing competitors' customers with incentives, information, and training to influence their decision-making process concerning alternative products [53]. Android phones have multiple devices at prices low enough to be affordable to the mass market. This incentive induces iPhone users to switch. IT vendors must reduce the cost of switching from their competitors. For instance, in order to attract PC users, Apple Mac computers are designed to work with PC files and peripherals, and they can run Microsoft Office, Windows, and other Windows-based applications, thereby decreasing the consumer's sunk cost in a PC. The iPhone's easy-to-use, intuitive operating system reduces the procedural cost. However, current iPhones do not support Android apps. Were Apple to provide adapters to enable iPhone users to run Android apps, the cost of switching from Android phones would be decreased and iPhone's network value would be increased.

To erode the network effect enjoyed by its competitors, an IT vendor can create social influence to increase the expectation that its network size will be getting larger, thus inducing competitors' customers to consider switching. Moreover, IT vendors can leverage their installation bases across interrelated product markets [69]. For example, Google's offering of the Android operating system as open source software provides manufacturers and developers with considerable freedom, so a lot of interrelated devices and apps have been developed, expanding Android's network effect and eating away at the Apple iOS network.

Limitations and Further Research

This research is a cross-sectional study. A longitudinal study of competitive standards would have clearer results and is thus recommended for future research. This study selected smartphones as its empirical context. Although smartphones possess various technology features, other types of standards need to be investigated to improve the generalizability of the proposed model. Since the study context focused on switching from a more dominant standard to a less dominant standard in a highly competitive market, the research findings may not be generalizable to other types of markets. Moreover, the majority of the participants in the Internet survey were young, low-income college students. They may not represent other segments of customers.

The proposed model does not distinguish partial and complete switches. For some standards (e.g., Web browsers), users are allowed to use multiple offerings concurrently. The predictive power of the proposed model on different types of switches is worthy of further evaluation. Moreover, this study focuses on switching behavior in the context of consumer standards rather than corporate standards. In organizations, any decision to switch standards must align with the organization's strategic goals and may be affected by external institutional pressures and resource availability [38, 75]. We believe the constructs considered in the proposed model remain important for predicting a corporation's intentions to switch standards; however, more corporate-specific constructs must be examined if we are to understand standards switching at the corporate level.

Conclusions

This study confirms that the push, pull, and mooring factors are all important to explaining a consumer's intention to switch standards. The pull factor of relative advantage and the push factors of low satisfaction and disconfirmation positively influence a consumer's intention to switch technology products. The mooring factors of inertia, switching cost, and network effect negatively influence switching intentions. Inertia and network effect are negatively related to a low level of satisfaction with the incumbent standard. Moreover, network effect is negatively related to the relative advantage of alternative standards. The present study found that inertia and the network effect play important roles in influencing standards switching. The push, pull, and mooring factors were chosen based on widely applied theories, and thus the proposed model provides a comprehensive view to explain why consumers switch standards.

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