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Recommended Citation

Kyper, Eric S. and Blake, Roger H., "An investigation of the intention to share files over P2P Networks" (2009). *AMCIS 2009 Proceedings*. 738.

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An investigation of the intention to share files over P2P networks

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ABSTRACT

In this research we take a comprehensive view of file-sharing over peer-to-peer (P2P) networks in order to develop a model of the intention to share files. P2P file-sharing once consisted largely of music files which, when downloaded, were an infringement of copyrights. For this reason models of file-sharing intentions often included factors and constructs representing ethical concerns. However, these models did not produce a broad agreement about whether or not those ethical concerns had significant effects on intentions. Furthermore, files now shared over P2P networks represent a significant portion of both legitimate and non-infringing files. The model we propose applies to P2P file-sharing of all files, regardless of media type, and regardless of whether they are shared legally or illegally. Lastly we present the factors from the model that were suggested to be significant from an initial pilot study.

Keywords

File-sharing, P2P networking, Theory of Planned Behavior, decomposed Theory of Planned Behavior

INTRODUCTION

P2P file-sharing networks arose in part in response to the shutdown of server-based Napster in 2002. By using de-centralized catalogs and files that are transmitted directly between users, P2P networks avoid reliance on a single, centralized server. Server-based networks are more vulnerable to failure, and to the extent they are used for files shared illegally, they are more readily identified. Regardless, once introduced, P2P file-sharing grew rapidly and while the rate of growth slowed starting in 2006, globally P2P file-sharing is estimated to account for 60% of upstream traffic on the Internet and over 20% of downstream traffic (2008).

Since inception a major concern about P2P networks has been for unauthorized and illegal file-sharing, files that have been copyrighted and remain the works of others. A series of law suits initiated by Recording Industry Association of America (RIAA) against providers of P2P file-sharing software culminated with a case against P2P software provider Grokster. In a 2003 ruling a Los Angeles court found that Grokster could not be held liable for the actions of others who using their software (Casadesus-Masanell, Hervas and Mitchell, 2006). Subsequently the RIAA turned to identifying and prosecuting individual users; after bandwidth enabled video files to be downloaded, the Motion Picture Association of America (MPAA) adopted this strategy as well.

Attempts by both groups to limit illicit file sharing by technological means have produced very mixed results. Digital Rights Management (DRM) is one of several standards that can potentially control how music and video files are used and copied; this and similar measures have frustrated customers by restricting access and limiting how media files could be copied and played. In many cases hackers have broken the underlying encryption and algorithms quickly after their introduction, rendering these methods ineffective (Faulhaber, 2006).

The two industry groups also face some difficulty in identifying files that are being downloaded illegally. Users can change file names, making identification complex. The number of files that may appear to be illegal but are seeded with other content confuses the identification of truly illegal downloads. One study found that up to 50% of the files available via P2P were "polluted" in this way (Liang, Kumar, Xi and Ross, 2005). Even the MPAA has had difficulty trying to estimate piracy, overestimating the amount of losses from piracy by college users by a factor of three (Anderson, 2008).

Motivated by concerns parallel to those of industry, researchers have focused on developing behavioral models of the intention to share files illegally over P2P networks, and particularly the intention to share files which are illegal. These models typically include some form of ethics as an antecedent to the intention to share files illegally. However, empirical tests of these models have not always yielded consistent results. For example, Gopal, Sanders, Bhattacharjee, Agrawal, and Wagner (2004) developed an ethical index to relate to the ethical intention to pirate music files. Tests of their model demonstrated this index to be have significant effects on intentions to pirate. Shang, Chen, and Chen's model of intentions to

share music files was an adaption of the widely used Hunt-Vitell's (1986) model of ethical consumer decision-making (Shang, Chen and Chen, 2008). Their model included separate factors for each of deontological and teleological ethical evaluations, and each was an antecedent of ethical judgment. In contrast to Gopal et al.'s study, Shang et al. concluded that ethical concerns about piracy were not a significant factor influencing the intention to share files illegally.

Beyond ethical concerns, legitimizing music shared on P2P networks might increase overall welfare (Faulhaber, 2006). According to this author's model, measures to stem P2P file-sharing, such as DRM, serve as incentives to the music industry to over-produce. Legitimizing all file-sharing would have the effect of reducing inefficiencies inherent in that over production, thus creating a net economic gain.

Along similar lines Gayer and Shy (2006) also argued that the network effects from removing copyright restrictions for file-sharing would generate a net benefit. Their model showed that any lower profits accruing to publishers by removing restrictions would be outweighed by spillover effects that would benefit artists, such as from live performances. Gayer and Shy concluded that efforts to reduce music piracy, including law suits, would ultimately hurt, rather than help, authors and artists. These models are supported by the empirical findings of Oberholzer-Gee and Strumpf (2007) who found that the effects of P2P file sharing on record sales were not significantly different from zero.

The suggestion that removing copyright restrictions on file-sharing will create a net benefit is also consistent with a survey of customers who share and also buy music. Compared to users who do not share files from P2P networks, users who share have been found 4.5 times more likely to also buy music from online music stores (Mennecke, 2005).

Equally as important, legitimate file-sharing is becoming a significant portion of all P2P file-sharing and expected to increase (Multimedia Intelligence, 2008). Growth in legitimate file-sharing is in part to the increasing number of artists encouraging their works to be openly available on P2P networks. Several business models have been proposed for P2P file-sharing; one example is the Open Music Model in which P2P networks are used to share an unlimited number of files for a fixed subscription fee (Ghosemajumder, 2002).

With the difficulty of identifying illegal downloads, a questionable negative impact of those downloads, and the increasing amount of legally shared files over P2P networks, an examination of the intention to share all types of files on P2P networks, and one including more than ethical considerations, is important. To our knowledge there has not yet been such a study.

A comprehensive model of the file-sharing intentions can be of benefit to IT managers seeking to find how, and by whom, their bandwidth is being consumed. Such a model is also important to developers of file-sharing software in order to better understand the characteristics of their users, and to better tailor their software.

The remainder of this paper starts with a review of the models of behavioral intention to adapt or use technologies from which ours is drawn. Next the theoretical background for each of the factors in our model is discussed. Our experimental design and survey instrument are shown, followed by the preliminary results we have found from our pilot study and our plan for continuing this research.

LITERATURE REVIEW

Background

The technology acceptance model (TAM) was presented by Davis in 1989. Over the last two decades it has been applied in numerous academic studies involving everything from university lab usage to aspects of the World Wide Web. TAM is a powerful adaptation of the theory of reasoned action where intention is determined by attitude towards usage and the indirect effects of perceived usefulness and perceived ease of use (Taylor and Todd, 1995). In TAM attitude is comprised of two beliefs (perceived usefulness and perceived ease of use), and has no component for subjective norms. Since its inception TAM has been extended in many ways, even by Davis himself who proposed TAM2 (Venkatesh and Davis, 1996; Venkatesh and Morris, 2003) by adding antecedent external variables. TAM extensions have frequently been augmented with a decomposed theory of planned behavior model (TPB). There are two important reasons for this: TAM doesn't include a measure for perceived behavioral control which needs to be a factor in many contexts, and the decomposed TAM is more readily translated to managerial actions (Taylor and Todd, 1995).

When TAM, TAM augmented with TPB, and TAM augmented with decomposed TPB have been compared, no model clearly dominates. Predictive ability comparisons of TAM, TPB, and TPB decomposed have shown mixed results depending on context (Madden, Ellen and Ajzen, 1992; Mathieson and Keil, 1998). In our study perceived behavioral control is very

important due to the limitations imposed upon user bandwidth, blocked P2P traffic on some networks and by some ISPs, and content limitations outside users' control. The theory of planned behavior is an extension of the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975) so that TPB is able to account for conditions in which an individual does not have complete control over their actions (Ajzen, 1985). TPB states that behavior is a direct consequent of behavioral intention and perceived behavioral control. Behavioral intention is a consequent of attitudes (feelings towards performing a behavior), subjective norms (pressure to perform a behavior), and perceived behavioral control (constraints on performing a behavior) (Ajzen, 1985; 1991).

Empirical research has found TBP's explanatory power to compare favorably with that of TAM or TRA for several contexts including intention to use WAP services (Hung and Chang, 2005), software (Mathieson, 1991), online shopping (Vijayasarathy, 2004), and PDA's by medical professionals. We follow and develop our model from successful applications of TPB, as described next.

Model development

From Azjen we know the following about a model incorporating the theory of planned behavior (Ajzen, 1985; 1991):

$$B = w_1BI + w_2PBC$$

where behavior/use (B) is a weighted function of behavioral intention (BI) and perceived behavior control (PBC).

Behavioral intention is in turn a weighted function of attitude (A), subjective norms (SN), and perceived behavioral control. If all individual internal and external factors are known then this model is accurate within the limit of measurement error (Ajzen, 1991).

$$BI = w_3A + w_4SN + w_5PBC$$

Attitude (A) is the sum of the product of attitudinal belief (b_i) and desirability of that outcome (e_i):

$$A = \sum_i b_i e_i$$

For example, an individual may believe using file-sharing will result in efficient downloading of software, with a highly desirable result. Attitude is frequently represented by perceived usefulness and perceived ease of use as originally developed by Davis (1989). Since then perceived ease of use and perceived usefulness have been integral parts of every TAM study and studies have found significant in predicting intentions (Davis, 1993; Mathieson, 1991).

Subjective norms (SN) are the sum of the product of an individual's normative beliefs (nb_j) regarding a particular referent, and the motivation to comply with that referent (mc_j).

$$SN = \sum_j nb_j mc_j$$

For example, an individual may feel peer pressure to use peer to peer software, but that complying with those pressures has a low priority.

Research has not found that subjective norms play a clear role. Davis et al. (1989) found no significant relationship between subjective norms and behavioral intention, but the reasons for that are still unclear. More recently subjective norms have been found to be significant in studies using theory of planned behavior to model technology (Taylor et al., 1995). We would expect subjective norms to play a role in environments where an individual's actions (or lack thereof) have consequences. In our case if the purpose in using peer to peer is illegal the actions can have definite consequences.

Perceived behavioral control (PBC) is the sum of the product of control beliefs (cb_k) and perceived facilitation (pf_k) of the control belief. For example, if an individual may perceive a certain proficiency level is required to use a peer to peer software package and that proficiency is important in determining usage behavior. We also know from Ajzen (1991) that when an individual has complete control over a behavioral performance, intentions alone should be a sufficient predictor. However, in our case we can easily argue that many individuals don't have complete control over their behavioral performance. For instance most users have no control over the speed of their network or the files that may be available to share at any particular point in time. ISPs have recently blocked or increased the response time of P2P (Guevin, 2008). In those cases an individual may have the intention to file share but lack access to the technology. Because of these reasons perceived behavioral control is an essential component of our study, and a primary reason we chose TPB.

$$PBC = \sum_k cb_k pf_k$$

To develop our model (see Figure 1) we have adopted constructs successfully used in related studies. Specifically we are using attitude as being comprised of perceived ease of use and perceived usefulness as defined by Davis (1989) and subjective norms and perceived behavioral control as defined by Taylor and Todd (1995).

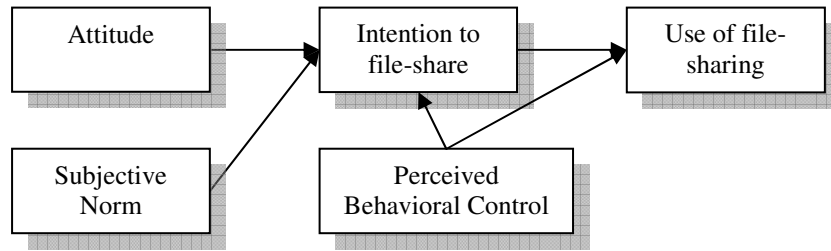


Figure 1: Proposed File Sharing Model

Instrument development

Our instrument is based on the decomposed Theory of Planned Behavior, following the structure and form of the model empirically and successfully tested by Taylor and Todd (1995). The corresponding survey instrument includes measures for attitudes, subjective norms, and perceived behavioral control and constructs for each. Table 1 displays our measures, constructs, and directly related prior work.

Measurement	Construct	Source
Attitude	Perceived ease of use	Davis (1989)
	Perceived usefulness	Davis (1989)
Subjective norms	Peer influences	Taylor and Todd (1995)
	Superior influences	Taylor and Todd (1995)
Perceived behavioral control	Efficacy	Taylor and Todd (1995)
	Facilitating conditions – resources	Taylor and Todd (1995)
	Facilitating conditions – technology	Taylor and Todd (1995)

Table 1. Model measurements, constructs, and sources

Items to measure perceived usefulness and ease of use were based on scales developed by Davis (1989). Subjective norms, perceived behavioral control, facilitating conditions, and self-efficacy items were adopted from Taylor and Todd (1995). Our adaptations were double checked using the procedures suggested by Ajzen (1985, 1991). In accordance with recommendations by Ajzen and Fishbein (1980) all survey items relate specifically to the use of P2P technology rather than general computer usage or alternate file-sharing technologies. Our initial instrument had 64 items including direct and indirect measurements.

PILOT STUDY AND PRELIMINARY ANALYSIS

Our pilot study data was collected from MBA students at two separate universities, with approximately ten respondents at each school. While college students are a convenient sample it is reasonable to expect they are also representative of a large portion of file sharing users. Some evidence does exist to support using younger age ranges. For example a 2005 NPD Group study reported that younger demographics are more likely to file share on P2P networks (2005). Our full study will include undergraduate and graduate students in business and economic programs at Universities in the Midwest, Northeast, and Mid-Atlantic. The graduate students add an important element because their average age is higher than that of undergraduates allowing us to try and be more representative of the general population, but specifically they allow us to capture some elements of file sharers over 22 years old. The surveys will be administered in class and completed on a completely voluntary basis. The anonymous surveys will then be recorded and analyzed as a single group.

Our initial items were developed based on existing scales validated empirically by Davis (Davis, 1993) and Taylor and Todd (Taylor et al., 1995), with individual items were modified to reflect our specific technological context. Once our initial

questionnaire was completed a pilot test was conducted to refine our scales and identify any problems that may exist with our instrument.

We collected twenty pilot surveys for our pilot study and preliminary analysis. Our first step in the preliminary analysis was to conduct a reliability analysis. Based on Cronbach's alpha scores we dropped three items from our survey (resulting in 61 survey items); with these eliminated the reliability coefficients from our pilot study are shown in Table 2 table below:

Construct	Chronbach's Alpha
Perceived ease of use	.84
Perceived usefulness	.82
Peer influences	.85
Superior influences	.78
Efficacy	.69
Facilitating conditions – resources	.78
Facilitating conditions – technology	.38

Table 2. Chronbach's alpha for each construct

With the exception of the coefficient for facilitating conditions - resources, all were acceptable values. However, in the model testing in our pilot study we have only two items for the construct. We find his number insufficient and are planning to develop and test at least one new item.

The next step in our preliminary analysis was to aggregate our data using the method prescribed by (Francis, Eccles, Johnston, Walker, Grimshaw, Foy, Kaner, Smith and Bonetti, 2004) test the following regression model:

$$BI = A + SN + PBC$$

where BI, A, SN, and PBC are defined as above. The results we found for this regression model are shown in Table 3:

Construct	Beta	t	p
Intercept		1.7216	0.1108
A	-0.3619	-1.7441	0.1067
SN	-0.0186	-0.0862	0.9327
PBC	0.7754	3.7916	0.0026

Table 3. Regression model results

Our regression results found significance for only PBC, with an adjusted R2 of .47. However, our sample size is very small and only intended for exploratory purposes. So far we have enough to justify completing the full study. Almost half the variation in intention to file share is explained by perceived behavioral controls. In our full study we are measuring Intention directly and will then be able to test the additional model:

$$B = BI + PBC$$

where B, BI, and PBC are defined as above.

This will require the testing of a mediated model in the form shown in Figure 1 above. We are considering two options to test our full models: the first being Baron and Kenny's method for testing partial and full mediation. The second is to construct a structural equation model (Baron and Kenny, 1986).

PRELIMINARY CONCLUSIONS

The preliminary results provide enough insights to justify a full project, where we will attempt to have a minimum of 208 usable surveys to test a structural equation model. This minimum sample size will result in a power of .80 (3 factors, 14 variables) for our study. We will attempt to obtain a cross-section of college students at both the graduate and undergraduate levels spanning at least two universities.

The results from our theory of planned behavior model should lead to insights regarding the antecedents of behavioral intentions. These insights could lead to suggestions for techniques to mitigate bandwidth consumption on some networks, or to use file-sharing to promote the distribution of certain content. In addition, we will focus on possible explanations as to why, or why not, certain segments do not participate in file-sharing.

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