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WEBSITE CHARACTERISTICS AND THE IMPACT OF USER PERCEIVED VALUE ON USER BEHAVIOR IN WEB 2.0

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ABSTRACT

Web 2.0 is regarded as a new level of services on the Internet. According to O'Reilly (2005), the users' sustainable contribution is the main success factor for Web 2.0. In this paper, we argue that sustainable contribution of user behavior consists of users' loyalty intention and their contribution. Furthermore, we aim to examine the antecedents of the specific users' contribution behavior that makes a Web 2.0 website successful.

The main finding is that three website characteristics, namely, novelty, efficiency and complementarities, which are perceived by users, could positively influence the user loyalty and contribution intention through the hedonic and utilitarian values that are perceived by users.

INTRODUCTION

Migration from Web 1.0 to Web 2.0

The evolution of websites has so far consisted of two stages; namely, Web 1.0 and Web 2.0. With some common thread, many different characteristics still exist in these two kinds of websites. To understand and capture the potential value that users can obtain in Web 2.0, we need to further examine their behavior in order to create and manage new business models that are based on it.

The differences in terms of the definitions and features of Web 2.0 compared with those of Web 1.0 help to focus this paper's research endeavors. O'Reilly (2005) first proposed the concept of Web 2.0 in a conference brainstorming session in 2001 as a new type of value creation by websites whereby the users rather than the website managers generate the content as was previously the case with Web 1.0. O'Reilly (2005) has identified 7 characteristic differences between Web 1.0 and Web 2.0, including (1) the web as a platform, (2) harnessing collective intelligence, (3) the data is the next Intel Inside, (4) the end of the software release cycle, (5) lightweight programming models, (6) software above the level of a single device, and (7) rich users' experiences. Wikipedia is an example that can help us to understand these 7 characteristics of Web 2.0. Wikipedia is an

online encyclopaedia which was created by users' contributions through Wiki software. Everyone could access the platform, contribute to the content, and check existing content on the platform through the Wiki software. As Wikipedia accumulated more and more data, more and more users congregated and contributed to it. At the same time, more and more users used Wikipedia to search for the information that they wanted. In this case, we can see the characteristics of Web 2.0, including a platform, collective intelligence, data, software and users' experiences. It provides us with an example of a positive growth loop of Web 2.0. Obviously, the users' sustained contribution to the website is the source of the website value in terms of users' experiences and is enriched by the collective intelligence in the platform.

Users receive information from Web 1.0 for which the representative sites include DoubleClick, Ofoto, and Akamai. In this context, the website manager will be an information provider and handle the development direction of the website. There is also a lack of communication between the web manager and users. On the other hand, websites that are representative of Web 2.0 consist of Wikipedia, Flickr, and BitTorrent which serve as a public platform for users who are able to interact with the web manager and other users there. When using Web 2.0, the website manager will act as a platform manager rather than an information provider only. The main tasks for a manager of Web 2.0 are to manage the platform, collective intelligence and data well enough to enrich the users' experiences. This could result in a positive loop for website growth and its market value.

Since O'Reilly (2005) proposed the Web 2.0 concept, websites that fit in the concept of Web 2.0 have created high market value in several deals involving acquisitions. For example, Google paid up to 1.6 billion dollars to acquire YouTube in 2006 and Yahoo! also acquired Flickr and Wretch (a blog website in Taiwan) at a very high premium. These cases of acquisition reflect the high value creation of Web 2.0 which mainly hinges on a huge customer base because of users' sustainable contributions. By a sustainable contribution we refer to two different concepts. That is, firstly, "sustainable" means the users' loyalty to the website, and secondly, "contribution" means the content users contribute to the website. Loyal users will attract more users by contributing new content. Thus, users' loyalty and contribution are key factors for the success of Web 2.0 websites. For this reason, we would like to contribute by examining the antecedents of user behavior in Web 2.0, which is the purpose of this article and is discussed as follows.

The Importance of Users' Contribution Behavior and Loyalty Intention in Web 2.0

Regarding contribution and loyalty in the context of Web 2.0, O'Reilly (2005) stated that a website in Web 2.0 serves as a platform for users to accumulate content that everyone shares. It means that the users' contribution will be important because it is a prerequisite for successfully harnessing collective intelligence. Thus how to encourage users to contribute their works has become a cardinal issue for website managers in Web 2.0.

Although many scholars have focused on studying the participation of consumers in service innovations such as the Web 2.0 concept (Ram, Grocott & Weir, 2008; Rowley, Beata & Leeming, 2007), they have not yet addressed specific issues related to why users would participate in the Web 2.0 website. So there is a strong case for being concerned with recent e-business developments.

One thing that O'Reilly (2005) ignored is the users' loyalty which is an important topic of discussion in e-commerce. Loyalty is a very well explored issue in the e-commerce, marketing and consumer behavior fields (Macintosh & Lawrence, 1997; Shankar, Smith & Rangaswamy, 2003; Srinivasan, Anderson & Ponnavolu, 2002). As far as the source of sustainable collective intelligence and profit is concerned, we also consider the users' loyalty to be a crucial issue in terms of the users' contribution to website development in Web 2.0.

Web 2.0 websites should accumulate large volumes of accurate data to enrich users' experiences. There is, however, no way to ensure the quality of the database except by constantly making the users upgrade and correct the data themselves. So the users' contribution behavior and repeated use of the website are equally important. The ability to generate profits is the other issue in e-commerce. Web 1.0 sites always suffer from the lack of an efficacious profit model, and one of the reasons for this is that the website can not maintain the users' loyalty in eyeball economics. According to past experiences, we consider loyalty to be an issue requiring discussion in our study, and we will thus build an exploratory model to explain the users' loyalty intention in relation to a Web 2.0 website.

LITERATURE REVIEW

Our research model is based on studies that focus on loyalty, contribution and flow. Apart from the previous literature, this article also explores the possibility of new determinants in users' contribution and loyalty intention.

Contribution and Loyalty

Previous studies have concentrated on how customers' participation influences the service innovation process, but the relationship still remains inconclusive. Some researchers believe that a negative relationship exists between customer participation and service innovation (Bennett & Cooper, 1981; Christensen & Bower, 1996), while others consider that there is a positive relationship between customer participation and service innovation (Johnson, 1998; Martin & Horne, 1995). Although researchers have conducted several related studies on the issue of participation, most studies aim at participation, service development process and innovation performance rather than the antecedents of user behavior. However, how to manage the customers' participation is a critical determinant of the effect of customer participation (Blazevic & Lievens, 2008), which in turn has an impact on service innovation. In this paper, we focus on the formation of the user's contribution behavior.

Previous research in marketing has proposed that customer participation is able to bring about a positive outcome for companies, for example, cost reductions (Bowers, Martin & Luker, 1990) and increased economic efficiency (Lovelock & Young, 1979). This is similar to O'Reilly's (2005) view that Web 2.0 is a platform and an accumulated data base, where website users are able to create the data in a most efficient way (i.e., cost saving), which is similar to the self-service concept.

What is the user's contribution behavior that we have just referred to? According to the previous literature, user participation is a new way of creating value in a project (Dahlsten, 2004), regarding which a similar concept is co-production (Ramirez, 1999). The contribution we address here as well as co-production both emphasize the synchronic and interactive aspects, which are not linear as they are according to the traditional value chain view. We slightly amend the definition of user contribution for adaptation in the Web 2.0 context. *The definition of user contribution is that website users regard their synchronic and interactive participation with the website itself and other website users as being for self service fulfillment and create value for the website and other website users at the same time.*

There is an abundant literature on the issue of website loyalty that focuses on website management. In the Web 2.0 context, websites not only need users to contribute, but even the users' minute contributions (i.e., users' loyalty) generate a large database that enriches the users' experiment.

Several studies have put effort into the loyalty issue in the digital environment. Otim and Grover (2006) have pointed out that e-business success is closely related to its ability to foster customer loyalty. Other articles also provide similar ideas for loyalty in the context of business in the digital environment (Srinivasan, Anderson & Ponnavolu, 2002; Verona & Prandelli, 2002). Due to the fact that the Web 1.0 context has migrated to Web 2.0, we provide a model to explore the factors that possibly influence the users' contribution behavior and loyalty.

Flow Experience and Users' Perceived Value

Pace (2004) defines the flow concept by stating that "the term flow refers to a state of consciousness that is sometimes experienced by individuals who are deeply involved in an enjoyable activity." Since researchers have conducted much research in regard to human-computer interaction, they have used flow theory to explain the users' states of involvement with the computer interface (Huang, 2003; Woszczynski, Roth & Segars, 2002; Koufaris, 2002). According to previous studies, we consider that a flow is a critical intermediate variable in a behavioral model of website users' behavior.

Besides flow experience, perceived value is also an important variable that has been recognized by previous studies in website users' (shoppers') behavioral research (Childers et al., 2001). In general, website users' or shoppers' perceived value could have two dimensions, namely, hedonic value and utilitarian value. The former concerns the fun and playful characteristics of

websites, and the latter has to do with the usefulness and timely manner in which the website users achieve their goals (Wang, 2007).

Based on previous research results, we take the flow experience, users' perceived value, hedonic value, and utilitarian value as intermediate variables in our research model. In the next section, we will explore the possibly influential factors regarding the website users' contribution and loyalty in the Web 2.0 context. How these factors influence the contribution and loyalty through flow experience and the users' perceived value will be explained in the next section.

DEVELOPMENT OF HYPOTHESES

In our research model, we adopt three possible influential factors related to contribution and loyalty from the research by Amit & Zott (2001) regarding the creation of e-business value. In their research, Amit & Zott (2001) make inquiries regarding 59 e-business firms and conclude that there are four main factors that have an impact on e-business value creation. These four factors are novelty, efficiency, complementarities, and lock-in, and are defined from a firm's perspective. We remove the lock-in factor from this research because the lock-in effect has been regarded as a behavioral result rather than an antecedent (Johnson, Bellman & Lohse, 2000). In addition, we construct the relationships between these three factors and the users' behavior from the users' perceived perspective through previous studies.

Perceived Novelty by Users

In their paper, Amit and Zott (2001) put forward a statement to describe "novelty", that reads as follows: "while the introduction of new products or services, new methods of production, distribution, or marketing, or the tapping of new markets have been the traditional sources of value creation through innovations." They propose the importance of novelty to value creation from the firm's perspective. From the user's perspective, novelty could be regarded as the web attribute that is perceived by web users as comprising novel experience and information (Bianchi, 1998). It is new services or new methods of production supported by technology that create such novelty.

In Web 2.0, new business models (services) may be the most important source of novelty. For example, YouTube was established in 2005. Today, it is able to attract six million guests everyday. YouTube is a conspicuous instance of the success of a novel business model. It offers a new service which we have never seen before, and it helps users effectively store and share their short videos. The other conspicuous example is Flickr, which provides a novel service for users to share their individual photos. Until now, users of YouTube and Flickr have continued to upload their short videos and photos. In these two cases, we can obviously observe that the novelty would be a crucial attribute of such websites in terms of the users' contribution behavior and loyalty intention.

As we have discussed above, the flow experience and users' perceived value are the important intermediate variables in web behavior research. Flow experience refers to the enjoyable

experience, and positively affects the users' perceived value, especially their hedonic value. Huang (2003) has proposed that relationships exist among novelty, flow experience, and hedonic value, and has empirically shown that novelty positively influences the users' hedonic value through flow experience. To facilitate the discussion, the hypotheses about novelty are listed as follows:

H1a: Novelty positively influences the users' hedonic value.

H1b: Novelty positively influences the flow experience.

H1c: Flow experience positively influences the users' hedonic value.

H2:   The users' hedonic value positively influences the users' loyalty intention.

H3:   The users' hedonic value positively influences the users' contribution behavior.

Perceived Efficiency of Users

Since users regard the website as an information processing system, the website's performance can be measured on the basis of system availability, reliability, responsiveness, and system flexibility (Lin & Lu, 2000). The performance is also referred to as "system quality" which refers to the efficiency from an engineering perspective. In order to understand the users' psychological side, the efficiency concept needs to be described based on the overall user experience. Previous research has pointed out that efficiency has a significant effect on internet consumer behavior (Khalifa & Limayem, 2003). In Khalifa and Limayem's (2003) model, efficiency is divided into transaction and navigation efficiency both of which have significant effects on actual internet shopping. Although researchers have discussed the efficiency concept from the system itself or the users alone, it is not appropriate to capture the full interaction mechanism within the context of Web 2.0 where the efficiency is still in need of a holistic view and entails a comprehensive concept which this paper aims to achieve.

According to Scharl, Gebauer and Bauer (2001), efficiency refers to either output maximization for a given input or the minimization of input for a given output. We use this general definition of efficiency as a conceptual definition in our research and further define the input as the users' devoted efforts to use the website in order to appease the users' demand. In other words, we define efficiency as the ease in achieving the users' usage goals. Users have attached a very high degree of importance to the efficiency concept in website service design using Web 1.0, and Web 2.0 is no exception. That Amazon.com was the origin of the "one click" is a good example for this argument. This can largely increase the efficiency in terms of website usage. The other instance is Google's search engine, for the efficiency of the search engine can help users precisely find the

information they need. So we build Hypothesis 4 regarding the perceived efficiency and utilitarian value as follows:

H4:   Perceived efficiency positively influences the users' utilitarian value.

Previous studies regarding online shopping have demonstrated that utilitarian value has a significantly positive effect on satisfaction and satisfaction positively influences loyalty (Jason & Fairhurst, 2005). Thus we can refer to the relationship between the users' utilitarian value and loyalty intention according to the research results. Hypothesis 5 is as follows:

H5:   The users' utilitarian value positively influences the users' loyalty intention.

The users' contribution behavior is a distinct characteristic in Web 2.0, for users can interact with website managers and other users. Users can gain access to the content creation and correction. Wikipedia is the fruit of the online users' contribution behavior. It has briskly accumulated website content which has almost reached 2.5 million articles.

From a social exchange perspective, whether or not users are willing to devote efforts is based upon future feedback rather than immediate benefits (Blau, 1964). By taking this viewpoint, we could imagine that if the website users could expect a rich and valuable database, they would be willing to devote their time and effort to the website to realize the future benefit. If future benefits could accrue to the user who has better user experience, the users would then commit to the website through contribution behavior. So our hypothesis regarding utilitarian value and contribution behavior may be expressed as follows:

H6:   The users' utilitarian value positively influences the users' contribution behavior.

Perceived Complementarities by Users

Classical economics has proposed the concept of complementarities to analyze the consumer's choice regarding the pattern adopted by the consumer to maximize the individual's utility and how one product market changes to influence the other product market equilibrium. This concept can be also applied to other academic areas. For instance, Milgrom and Roberts (1990) have defined the concept clearly from modern manufacturing and argue that if "*the levels of any subset of the activities are increased, then the marginal return to increase in any or all of the remaining activities rises.*" In other words, one product, service or activity could increase the values of other products, services or activities when they are used jointly, which is exactly the concept of complementarities.

We have observed that the wave of Web 2.0 could boom because of its complementarities to other websites or users' daily activities. We also introduce this concept to explore how the complementarities of Web 2.0 sites influence users' behavior through their perceived value. YouTube and blog services are good examples of Web 2.0 sites' complementarities. YouTube provides a platform for users to up-load and share short videos, while blogs provide a platform for users to record and share their daily feelings. Blog service providers offer the function that enables users to embed short videos from YouTube in their blogs, and therefore Blogger can share much richer information by embedding videos from YouTube, and Blogger and YouTube can obtain more and more users generally. A similar case regarding complementarities concerns the complementarities that exist between a map service website and a restaurant information sharing website in which website managers can mash up these two services to provide more precise information for users as they search for restaurant information, and then increase the website utility rate.

From what we have mentioned above, we can infer that the website's complementarities are able to enhance its utility for users, i.e., the users' perceived utilitarian value. The hypothesis regarding complementarities is as follows:

H7:   Perceived complementarities positively influence the users' utilitarian value.

Loyalty Intention and Contribution Behavior

As we discussed earlier, one of the important characteristics of Web 2.0 sites is the users' contribution in terms of generating more content for other users. A Web 2.0 site could not grow without the users' contribution behavior.

In order to develop the users' contribution behavior, attracting the users' repeated use of the website would be a step in the right direction. From a consumer socialization perspective, Moschis and Churchill (1978) have pointed out that the consumer's socialization is a process designed to develop consumer-related skills, knowledge, and attitudes. According to their original definition, socialization is a process which makes users learn the virtual society's rules, norms and use skills, i.e., the contribution to the collective intelligence. Therefore, socialization could help users learn related skills and enhance the contribution behavior. Thus we hypothesize the relationship between loyalty intention and contribution behavior in the following way:

H8:   The users' loyalty intention positively influences their contribution behavior.

By means of the literature, real cases and logical inferences, we propose a research model that focuses on the Web 2.0 users' behavior as Figure 1 shows. In what follows, we will describe the research process and the results of our study.

Figure 1 Research model
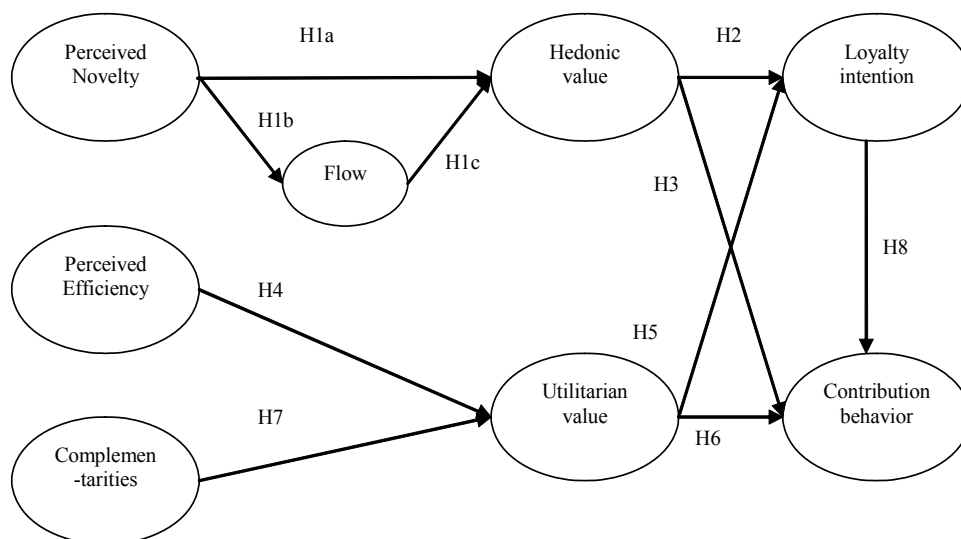
RESEARCH METHOD

To test these hypotheses empirically in our research model, we use a multiple-item scale which is pre-tested before conducting the formal survey to measure the constructs and then collect data from a real Web 2.0 site. After collecting the data, we use PLS (partial least squares) as an analytical tool to depict the relationships among constructs and thereby test the hypothesis that we have proposed.

Measurement Design and Pretest

In our measurement scale, we designed the measurement items by ourselves according to the conceptual definitions of the constructs. Each measurement item was designed based on a 7-point Likert scale. All measurement scales were pre-tested through the collection of data from 77 university students. The results of the pretest showed that the measurement scales all met the criteria (i.e., Cronbach's alpha being greater than 0.6) for conducting a large survey in terms of the reliability and validity of each measurement item. The detailed results are shown in Table 1.

No.	Constructs	Number of Items	Scale mean	SD	Cronbach's alpha
		Table 1 Pretest results			
1	Perceived Novelty	3	3.8831 3.7403 3.6104	0.70662 0.80136 0.76358	0.849
2	Perceived Efficiency	3	3.3636 3.8961 4.0390	0.93061 0.52777 0.44253	0.666
3	Perceived Complementarities	2	3.8442 3.7792	0.67013 0.73670	0.632
4	Flow	2	3.1169 3.5974	0.90283 0.81531	0.677
5	Hedonic value	2	4.0130 3.7662	0.54996 0.87202	0.642
6	Utilitarian value	2	3.6104 3.7922	0.74615 0.69467	0.668
7	Loyalty	2	3.7143 3.8831	0.85620 0.68775	0.801

Note: Because Contribution is only a single item, it is not included.

Sample and Analytical Tools

After we had developed the measurement items, we conducted a large-scale survey from a Web 2.0 site in Taiwan. The website was founded in 2006, and it has a very innovative business model that combines a blog and a fleshpots information sharing platform to attract users to write their experiences of fleshpots on individual blogs and share the aggregated content generated by users through the website's search engine. To date, 9,200 members have been attracted to use and generate content voluntarily. The website has been visited 33,000 times per day and, as things stand, the number of members is still growing.

The website managers sent their own electronic messages to all members to request that they fill out our survey questionnaire on the Internet. A total of 173 questionnaires were collected within one week. After deducting 51 invalid questionnaires, there were 122 valid questionnaires available for our analysis.

The dataset was analyzed using Lohmoller's (1981) partial least-squares (PLS) algorithm. PLS is a useful tool for estimating the measurement model of latent constructs based on linear combinations of their empirical indicators and the structural model based on the relationships among constructs. Because PLS has flexible assumptions regarding the sample's distribution, we require

a smaller sample to estimate the model. This is a crucial advantage of PLS when the research only has a relatively small sample (Chin & Newsted, 2003). Therefore, PLS is an appropriate analytical tool that can be used in the estimation of this research model because of the smaller sample size.

RESULTS

We report some of the analytical results in this section including estimates of both the measurement model and structural model. In estimating the measurement model, we are concerned with the validity and reliability of the analysis, and the structural model empirically tests our hypotheses.

Assessments of Validity and Reliability

To construct the convergent validity, we need two conditions to be sufficient in PLS. The first is that the t-value for each item should be statistically significant at the p¡Õ0.001 level (Anderson & Gerbing, 1988). The second is that the average variance extracted (AVE) calculated by PLS should be greater than 0.5. We summarize the detailed results regarding the measurement model in Table 2. Each item has a significant t-value at the p¡Õ0.001 level, and the average variance extracted for each construct is also greater than 0.5. According to the results of the measurement model using PLS, it is shown that the convergent validity is established. To see this, please refer to Table 2.

In PLS analysis, we need to verify another discriminant validity issue. Discriminant validity means that a specified construct may be distinguished clearly from other constructs. We tested the discriminant validity based on Fornell and Larcker's (1981) criterion. This criterion points out that the discriminant validity is established if the square root of the average variance extracted from each construct is greater than the correlation between the construct and the other constructs. We show the correlation for each construct and the square root of the average variance extracted in Table 3, and the results of the PLS support the establishment of the discriminant validity.

No.	Constructs	Indicators	Standardized factor loadings	t-statistic	Composite reliability	Average variance extracted
1	Novelty	Nov 1 Nov 2 Nov 3	0.896 0.875 0.876	45.439*** 18.097*** 29.168***	0.91	0.77
2	Efficiency	Eff 1 Eff 2 Eff 3	0.839 0.895 0.870	32.737*** 23.480*** 20.423***	0.90	0.75

Table 2 Measurement model

No.	Constructs	Indicators	Standardized factor loadings	t-statistic	Composite reliability	Average variance extracted
			Table 2 Measurement model			
3	Complementarities	Comm 1 Comm 2	0.660 0.914	4.311*** 15.798***	0.77	0.63
4	Flow	Flo 1 Flo 2	0.931 0.921	59.463*** 42.405***	0.92	0.85
5	Hedonic value	Hed 1 Hed 2	0.895 0.839	43.354*** 17.884***	0.85	0.75
6	Utilitarian value	Uti 1 Uti 2	0.938 0.940	72.084*** 68.532***	0.93	0.88
7	Loyalty intention	Loy 1 Loy 2	0.958 0.959	74.409*** 85.450***	0.95	0.91
Notes: Because Contribution is only a single item, it is not included. ***significant at the 0.001 level						

Besides the validity, we also verify the composite reliability from the results of the PLS analysis in Table 2. The composite reliabilities of each construct are 0.75 or more. Overall, the results for convergent validity, discriminant validity and composite reliability suggest that the measurement model meets the standard of having good explanatory power.

Constructs	Scale mean	SD	1	2	3	4	5	6	7	8
			Table 3: Correlation and average variance extracted of constructs							
1. Novelty	5.46	1.02	**0.88**							
2. Efficiency	5.39	0.89	0.52(**)	**0.87**						
3. Complementarities	5.29	0.94	0.39(**)	0.34(**)	**0.79**					
4. Flow	4.21	1.28	0.47(**)	0.29(**)	0.17	**0.92**				
5. Hedonic value	5.01	1.00	0.37(**)	0.41(**)	0.17(*)	0.56(**)	**0.87**			
6. Utilitarian value	3.42	0.62	0.42(**)	0.59(**)	0.36(**)	0.38(**)	0.64(**)	**0.94**		
7. Loyalty intention	5.52	0.99	0.42(**)	0.52(**)	0.37(**)	0.24(**)	0.60(**)	0.76(**)	**0.95**	
8. Contribution	4.97	1.10	0.22(*)	0.20(*)	0.11	0.23(*)	0.35(**)	0.42(**)	0.43(**)	*1*
Notes: ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).										

Results of Structural Model Estimation

As predicted, the estimates obtained using the structural model support the view that the novelty has a significant effect on hedonic value ($\beta_i \times 0.153$, $p_i \tilde{O} 0.1$) and the flow experience ($\beta_i \times 0.477$, $p_i \tilde{O} 0.01$) is also supported and found to be positively significant in relation to hedonic value by our data ($\beta_i \times 0.494$, $p_i \tilde{O} 0.01$). The hypothesis regarding novelty, flow and hedonic value (H1a, H1b, H1c) is supported, too.

We initially predicted that hedonic value would positively influence the loyalty intention and contribution behavior. According to the results obtained, these hypotheses have been partially supported. We have found that hedonic value has a positively significant effect on loyalty intention ($\beta_i \times 0.219$, $p_i \tilde{O} 0.01$), but we find no significant relationship between hedonic value and contribution behavior ($\beta_i \times 0.219$, $t = 0.976$). The main reasoning we have proposed for this result is that the web users would probably be free riders, and they therefore do not need to commit to a relationship between themselves and the website with regard to future transactions.

Fig. 2. Structural model
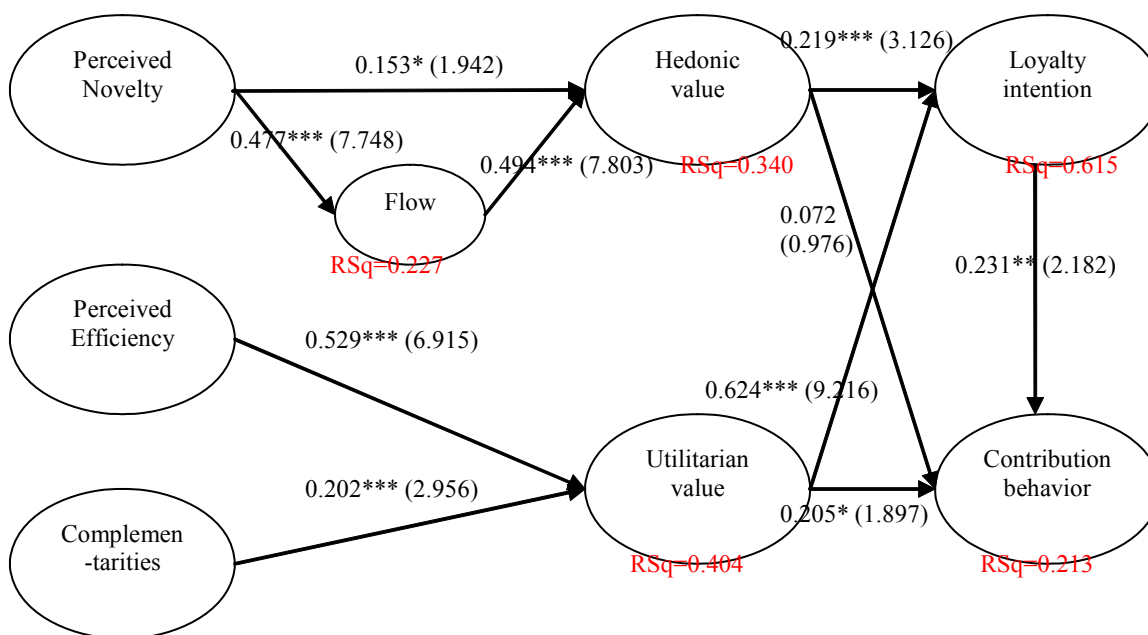
*p < 0.1 **p < 0.05 ***p < 0.01

The perceived efficiency and complementarities are both supported by the results of the estimation, and the relationship between perceived efficiency and utilitarian value is significant (β = 0.529, p< 0.01). The complementarities also have significant effects on utilitarian value (β = 0.202, p < 0.01). Hypotheses 4 and 7 are also supported by the data. This means that if the website service could complement other web services or their daily life activities with excellent operational efficiency, the users' perceived utilitarian value could be increased.

The data also support the view that utilitarian value is able to positively influence the users' loyalty intention (β=0.624, p < 0.01) and contribution behavior (β=0.205, p < 0.1), which is exactly what we suggest in Hypotheses 5 and 6. The last supposition is Hypothesis 8 which considers how the users' loyalty intention positively influences contribution behavior, and it is also supported (β=0.231, p < 0.05).

DISCUSSION

Through this survey study, we have empirically tested our model to identify three crucial factors that influence user behavior as well as the way in which they influence this behavior. These three factors are novelty, efficiency and complementarities. In fact, we could further divide these factors into two categories—the usefulness and funny factors. The funny factor refers to novelty, and as a result the flow experience is a crucial mediation factor, and even a partial mediator rather than a full mediator. The direct effect of novelty on hedonic value is only 0.153 at the p¡Õ0.1 level, but the novelty has a strong and significant effect on hedonic value through flow experience. It means that the existence of flow experience largely influences the effect of novelty on hedonic value, and then loyalty intention in the Web 2.0 context. Related studies on how to design websites for users' flow experiences have been conducted to add some relevant knowledge where such knowledge has been lacking (Rettie, 2001).

An issue worth discussing here is the relationship between hedonic value and contribution behavior. That a non-significant relationship exists between hedonic value and contribution behavior was not something we expected at the outset. On the contrary, the utilitarian value could directly or indirectly influence the users' contribution behavior. In practice, the managerial implication to the website manager is that "*In the Web 2.0 context, enabling users to get usefulness or utility is encouraged more in terms of the users' contribution than just focusing on fun, unless we are able to create web loyalty.*"

The other category relates to the usefulness factors—efficiency and complementarities. Both of these are able to influence the users' perceived utilitarian value, especially perceived efficiency. To find an efficient way of satisfying the users' need for the website may be more important than we previously thought. The complementarities could offer us a criterion for designing or choosing our service which we would offered on the website. For example, designing a web service to complement other popular services may be an effective way of creating a new business.

The final issue concerns the users' contribution behavior in Web 2.0. Two main factors that could influence the users' contribution behavior are utilitarian value and loyalty intention, but hedonic value has a slight influence on contribution behavior through loyalty intention. That could be a managerial implication to foster the users' contribution in terms of long-term and short-term strategies. A long-term strategy refers to fostering contribution behavior through building web loyalty which needs long-term investment. A short-term strategy refers to service and web design through utilitarian value as discussed above. The two strategies seem to spread conceptually. In fact, such a strategy must be reinforced at the same time because of the complex relationships among these factors.

LIMITATIONS AND FUTURE RESEARCH

In this study, we have discussed the differences between Web 1.0 and Web 2.0 and have highlighted the importance of user behavior in Web 2.0. In addition, we have constructed a research model for user behavior and conducted a survey study to test the relationships between the variables that we proposed. This study has a limitation which is due to the small size of the sample, in that it may cause potential bias. To deal with this potential bias, we adopt a proper tool, namely, PLS (partial least squares), to analyze the data. In the future, large sample surveys will be necessary to enhance the development of theory.

In actual fact, Web 2.0 still calls for a comprehensive concept that contains several distinct characteristics from Web 1.0. So far, there has been a lack of a rigorous taxonomy in terms of their service, business model or other dimensions. This taxonomy could help us further examine users' behavior in a more precise manner.

Perhaps there exist other factors that could also predict users' behavior. In the future, if we could create a complete Web 2.0 site taxonomy framework, it would provide us with an opportunity to refine the theoretical model by exploring new concepts for each specific category. All in all, more researchers need to get involved in creating new knowledge for Web 2.0 management.

APPENDIX A. MEASUREMENT SCALE USED		
Construct	Indicators	
Novelty	Nov 1 Nov 2 Nov 3	This website is creative. Using this website seems to be exploring a new world. Using this website seems to be an all new experience.
Efficiency	Eff 1 Eff 2 Eff 3	Using this website could easily enable me to achieve my purpose in using this website. I feel that the design of this website is easy to understand. I feel that the website is easy to use.
Complementarities	Comm 1 Comm 2	Using this website is related to other daily activities. Joint use of this website and other websites could more effectively enable me to achieve my original purpose (for example, by embedding a video from YouTube to my blog)

APPENDIX A. MEASUREMENT SCALE USED		
Construct	Indicators	
Flow	Flo 1 Flo 2	Using this website gives me the sense of escaping from the real world temporarily. The process of using this website enables me to forget the worries in my life.
Hedonic value	Hed 1 Hed 2	I use this website because I am interested not only in the services it provides. I use this website because it is fun rather than for other purposes.
Utilitarian value	Uti 1 Uti 2	I could be satisfied by the services that I need through this website. This website has sufficient information that I need.
Loyalty intention	Loy 1 Loy 2	I will continue to use this website in the future. I am willing to introduce this website to my friends.
Contribution behavior	Con 1	How many articles will be posted each month on this website?

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DEVELOPING AN EFFICIENT WAREHOUSING OPERATION SYSTEM: AN EXPERT SYSTEM APPROACH

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ABSTRACT

Distribution systems for miscellaneous case goods stored and retrieved in public or private warehousing offer an excellent opportunity to study and document rules for efficient warehousing operation. A study of a large distribution center having over 100,000 storage locations for general and special merchandise was conducted. The warehouse contained storage for general merchandise as well as segregated areas for items requiring special handling such as liquids, food and fabric items. The study included documenting and developing decision rules depending on the product handled and pallet strategy used.

INTRODUCTION

The operations management within distribution systems must continually move toward more productive systems which are dependent to a large extent on the simple, ubiquitous wooden pallet (Morabito, Morales, and Widmer, 2000; Rouwenhorst, Reuter, Stockrahm, van Houtum, Mantel, and Zijm 2000). Pallets are common and inexpensive, and they continue to be a measurable and manageable factor in distribution operations (Broekmeulen, 1998). The objective of this research was to study the applicability of an expert system that can assist in optimizing the palletizing and temporary storage of a variety of merchandise. The development of a primitive expert system for the decision rules was undertaken and comparisons were made with available commercial systems.

The knowledge base of an expert system captures, cumulates, classifies and codifies human expertise so that it can be made available to various levels of users to improve their decision making effectiveness (Turban, 1988; Turban and Watkins, 1988). Expert systems incorporate the knowledge of experts to advise users who must make these classifications and other decisions and permit flexibility, growth and expansion of this knowledge to improve and support these decisions (Ng, Cung, and Chicharo, 1989; Turban, 1988; Turban and Watkins, 1988).

The potential benefits of an expert system include:

1.   Improved quality - the knowledge base of an expert system improves decision quality by providing consistent advice with reduced errors.
2.   Efficient knowledge usage - assigning an expert system repetitive, routine decision tasks so that the actual expert's may be more efficiently utilized elsewhere in a more beneficial and productive manner.
3.   Cost reduction - a frequently used expert system is far less expensive than the frequent use of an expert.
4.   Increased output - an expert system can perform significantly reducing the decision making process by seventy five percent or more.
5.   Capturing expertise - the knowledge of experts should be documented before they change positions, leave or retire.
6.   Flexibility - changes in procedures and parameters can be easily incorporated.
7.   Reliable - an expert system does not experience boredom, sickness, or absenteeism.
8.   Educational benefits - an expert system is an effective training tool for now and the future.
9.   Organization - an expert system provides a quicker understanding of the organization; assists in delegating decision making to more appropriate levels.
10.   Enhances problem solving - the "what-if' features allow alternatives to be tested

For this study, a computer program was developed by the authors to help solve a function of a distribution center or DC. It performs in a manner similar to a human expert because it contains and applies the knowledge of an expert. Large amounts of specific problem domains inherent in the materials handling knowledge (Sprague and Watson, 1993), such as combinations of carton sizes, pallet sizes, weights, and classifications, are embedded in the system and are retrieved in accordance with the input data and decision rules. The customized program was developed with the understanding that most commercial expert system computer programs are generally hard to expand, maintain and difficult to sell to management (DeSanctis, 1984). The visual interactive figurative displays have been seen as application tools for operations management (Bell, 1985; Carlson, 1988). To build the knowledge base for this study, tables were constructed which, together with the program logic, *displays* a recommended solution. To satisfy the criterion of providing a visual output for the employees, it was decided to prototype the situation with fundamental programming in preference to the innumerable If-Then-Else rules required by most expert system shells such as EXSYS (*FlexSystems Ltd*).

Figure 1. Sequence of Activities
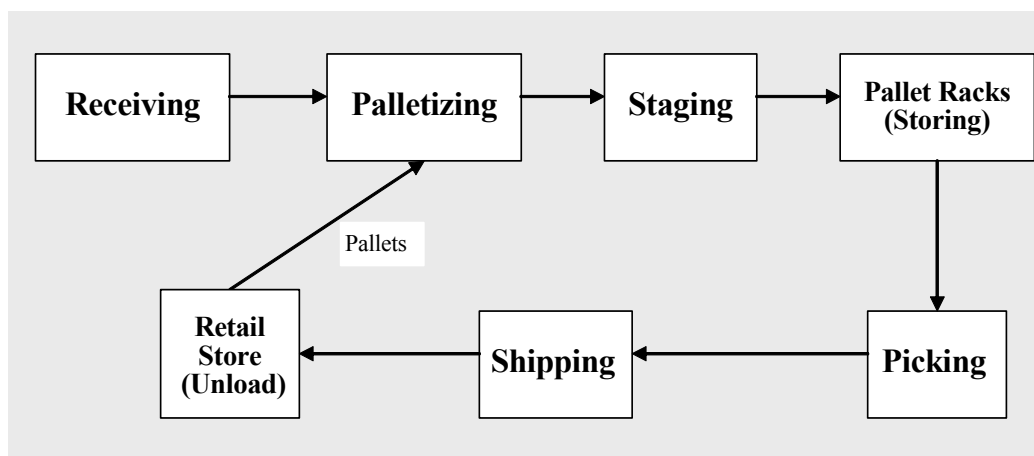
The specific warehousing operations studied are part of the overall activities of a large corporation specializing in the purchase, distribution and retail sale of imported and "close-out" merchandise primarily for home use. Their retail stores operate throughout the United States, selling items that are relatively small, inexpensive, and found in areas such as the kitchen, bath, or laundry.

The predominant activity sequence (shown in Figure 1.) is as follows:

♦ Cases or cartons of merchandise arrive in truck trailers and are identified by their bills of lading or manifests.

♦ The items are classified into product groups, and a quick calculation is made regarding the number of pallets required for storing and moving these case goods. There are no multi-item or mixed item pallets.

♦ From its database for empty locations, a computer prints out a ticket for each pallet with a semi-randomly assigned location.

♦ The cases are palletized manually and the pallets are staged for movement into their assigned pallet racks.

♦ When the cases are to be shipped, the computer prints the list of pallet locations for the item.

♦ The pallets are retrieved and delivered to the picking area where the cartons are placed individually on picking conveyors for transport to the shipping area.

♦ The cartons are sorted, combined into their orders, and palletized for shipment to individual retail stores.

The computer monitors the inventory locations and their content in addition to employing logic for assigning locations and orders for retrieving the pallets (Yao and Carlson, 1999). To avoid

accidents and other interference problems, receiving, palletizing and storing in the reserve racks is done during the day. Retrievals or replenishments for the order-filling (picking) are performed at night.

PRESENT PALLET UTILIZATION

Overall warehouse utilization is a function of purchasing and sales yielding turnover statistics which are complex and company-specific measurements of performance (Gagliardi, Ruiz, and Renaud, 2008; Mason, Ribera, Farris, and Kirk, 2003; Van den Berg and Zijm, 1999). The questions of storage rack and pallet utilization were posed by management and a quick survey was made by sampling of 1,000 out of the 100,000 pallet locations. Since cost and responsiveness improvement are associated with the pallet utilization increment (Baker, 2008; Gagliardi, Ruiz, and Renaud, 2008; Mason, Ribera, Farris, and Kirk, 2003) as well as the overall pallet-rack utilization again being dependent on the purchasing and distribution functions, seasonal variations and merchandise availability (Cormier and Gunn, 1992; Frazelle, 2001), only the *pallet* utilization was considered for the study.

During data collection of the occupied, pallet rack positions, only the *height* of the cartons and the *height* of each of the 1000 pallets were used as a surrogate for volume or "cube". The samples were taken from several aisles and each of the five storage levels to detect any statistical differences as a function of aisle or level. A simple experimental design was included in the selection of samples.

The results indicated that over 15% of the pallets could have been stacked with one or more additional layers of merchandise. There could be more pallets with capacity for additional layers but they may be restricted by the following: (a) the pallet *weight* limit might be exceeded, (b) the *condition of* the cartons, or (c) a resultant partial or trailing (last) pallet from the truck trailer loads. Although the stacking pattern was not specifically noted at the time, there was an obvious inconsistency in these patterns which caused the pallets to be under-utilized. All stacking pattern decisions were left to the experience of the palletizing personnel.

THE STUDY OBJECTIVES

The study for pallet stacking and movement required:

1. Eliciting knowledge from the supervisory experts and documenting specific rules and classifications for storage and retrieval.
2. Developing prototype interactive program calculations and assisting decisions required by receiving personnel.
3. Visually displaying the recommended stacking pattern and other data for the users to interpret and act upon.

OPTIMUM PALLET PATTERNS

Commercial pallet pattern software is available for costs in excess of $10,000 and is often worthwhile for companies with especially high volume palletization for storage in pallet racks or shipment. For example, FlexSystems of Greendale, Wisconsin (FlexSystems Limited) developed a Pallet Pattern Calculator which uses an algorithm to generate symmetric and/or irregular patterns for any size pallet dimensions. The user can select one or more of the patterns listed. A graphic display of the chosen pattern is displayed, and a hardcopy can be printed when desired. Although several patterns may yield the same results, other criteria such as visual symmetry or ease of stacking would assist the decision. TOPS Engineering Corp. in Richardson, Texas (TOPS Engineering Corporations) has a number of optimizing programs including TOPS Pro, MaxLoad Pro, and MixPro which, in addition to developing optimizing patterns, calculates carton compression values and maximum allowable pallet load stacks from the standards for corrugated cartons.

Primary reasons for the development of a customized pallet pattern expert system by the authors rather than using commercial pallet pattern software are:

- to allow online exchange of carton width/height and/or length/height dimension inputs
- to change top layer pattern to load additional cartons when possible
- to determine the total pallets needed for a quantity of incoming cartons
- to determine from weight or height calculations if half-height racks can be used
- to display the expert's "best" solution rather than selecting from alternatives

In the study of this distribution center's operations, truck load(s) of corrugated carton of merchandise are received and manually unloaded. Employees' judgment is necessary to determine if the condition of the cartons is adequate for them to be stacked in an estimated number of layers which may be limited by the carton weight. After loading or stacking pallets, they are wrapped with a plastic stretch-wrap for stability. The objective, therefore, is to quickly and graphically display, communicate and execute a pallet loading pattern which maximizes the use of the pallet area and height and eventually its 'cube' (in cubic feet).

Schematics of patterns for widths of 9.1 to 10.0" and the range of lengths allowable is found in Figure 2.

Figure 2. Patterns for Width = 9.1 to 10"

10x(10-12)=D16   10x(12.1-14)=E14   10x(14.1-16)=D12   10x(16.1-19)=E10   10x(19.1-24)=C8

10x(24.1-28)=E6   10x(28.1-31)=E5   10x(31.1-38)=E5nc   10x(37.1-48)=D4nc
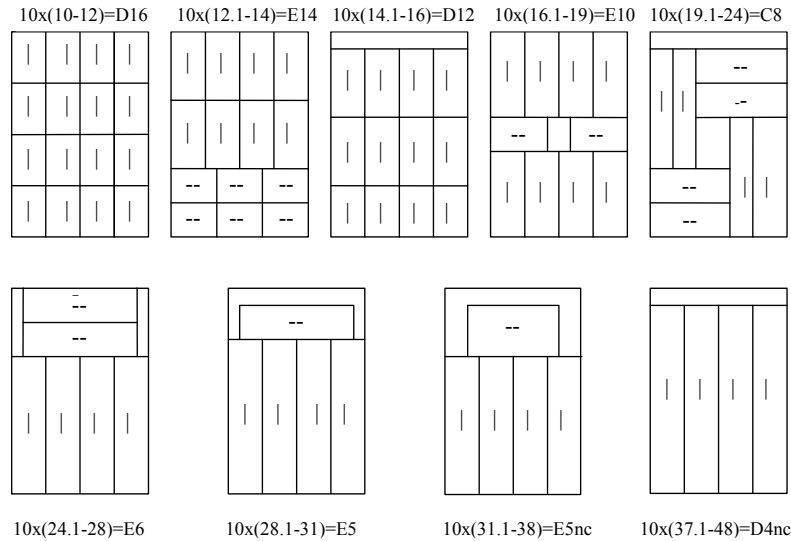
DATA INPUT

A descriptive name or specific product identity is entered and the item class is selected. The data input screen with its prompts and class code table are found in Table 1. For general merchandise, the computer program must interpret the carton size data to discover if the cartons can be conveyorized when the subsequent picking activity is performed. If the cartons are too few, too small, too light, too long or too high, they may have to bypass the conveyor and moved in another manner to shipping. Messages to this effect are retrieved and displayed with the output.

TABLE 1. INPUT DATA: PALLET PATTERNS & CALCULATIONS		
Item Name/ID:	BRACKET	G ---General Merchandise
Item Class:	General Merchandise	P -- Pre-Palletized
No. of Cartons:	120 Cartons	W --Wine
Width of Carton:	10.0 In.	C --- Candy
Length:	13.0 In.	F ---Flowers
Height:	8.0 In.	S --- Soft Goods
Weight:	20.0 Lbs.	T --- T-Bin Item
		L --- Liquid
		X --- Fragile

Parts of the palletizing rules used in the system logic for cartons' data entry are as shown in Table 2. If the cartons contain liquid or fragile items, these items should bypass the conveyor. Special items such as wine, candy, artificial flowers or soft goods have their own dedicated areas and bypass the conveyors. Items not packaged in cartons such as small chairs must be stored in special bins and bypass the conveyor system. About 30% of the merchandise arrives on pallets and can be stored as is if they meet the pallet size (42x48) dimensions and the carton weight or pallet weight limits or other criteria, such as load stability, are satisfied.

OUTPUT AND COMPARISON with FLEX SYSTEMS

The output display and printout repeats the input, and it shows the results of the computations such as cartons per pallet, number of pallets, number of layers, etc., and a recommended pallet stacking pattern. The palletizing personnel use mirror images for subsequent layers to interlock the cartons and provide stability for the stack. A sample output display is shown in Table 3.

TABLE 2. EXAMPLE OF RULES

Examples of Rules

➢ Rules of Pallets
- ◆ Weight Rule < 1500 lb
- ◆ Size Rule < 42" x 42" x 78"
- ◆ Quantity Rule. Too Few < 11
- ◆ Height Rule < 33"

➢ Rules for Items:
- ◆ Weight Rule: Too Heavy, Too Light
- ◆ Length Rule: Too Long
- ◆ Size Rule: Too Small, Too Big
- ◆ Box Condition Rule: Too Soft, Non-Conveyable
- ◆ Assignment Rule: Wine, Candy, Flower.

From the dimensions of the cartons, the layout pattern for 14 cartons was retrieved and the number of layers was calculated. Using the pallet weight constraint of 1500 pounds, the pallet should hold only 75 cartons (fifteen hundred pounds divided by 20 pounds per carton) which could organize 5 layers of 14 cartons or 70 cartons for five layers plus an additional five cartons on the top layer (6th layer) per pallet. For a 120 carton scenario, only 2 pallets are required. The second pallet

becomes a partial pallet of 45 cartons. The personnel responsible for palletizing have at least 3 options:

1. Accept the results as shown or
2. Add the 5 from the top layer of the first pallet to the 45 of the second or last pallet or
3. Divide the 120 cartons equally between the 2 pallets (an unnecessary option)

TABLE 3. PALLET (W42" X L48") CALCULATIONS & PATTERN			
Item Name/ID:	BRACKET	Cartons/Full Layer:	14 cartons
Item Class:	G	Layers/Pallet:	6 layers
Carton Width:	10.o in.	Cartons/Pallet:	75 cartons
Carton Length:	13.0 in.	Lbs/Pallet:	1500 lb.
Carton Height:	8.0 in.	Heights/Pallet:	53 in.
Carton Weight:	20.0 lbs.	Full Pallet Ht/78 in.:	68 %
Carton on Arrival:	120 cartons	Pallets Required:	2
		Cartons/Last Pallet:	45
Note: To avoid an overweight pallet, only 5 cartons on top layer Last Pallet height <33", put in half pallet rack?			
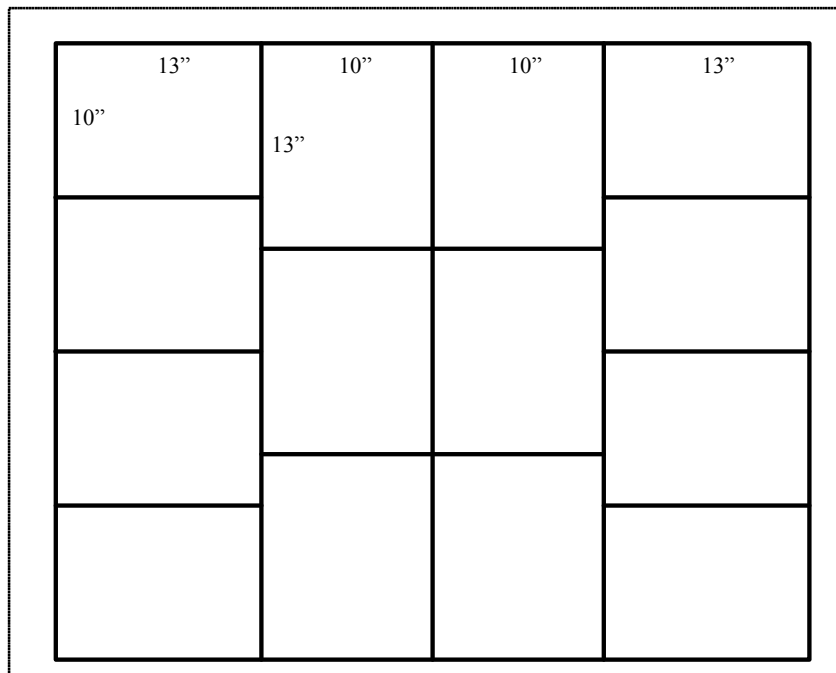
In comparing the inputs and outputs of the customized program and the FlexSystems program, the following is noted:

The input requirements are identical except that the customized program permits entering total cartons of an item to be received which computes the total pallets required and the *last* pallet carton quantities.

In the customized program, an optimum is selected for the user so the pattern can be immediately displayed and 'what-if trials can be conducted. The FlexSystems's preliminary output lists all possible combinations of patterns including one or more optimum patterns. Therefore, the user needs to make a decision regarding which pattern to use and print it out. The output data and display are almost identical except for all the special notes for the special item handling, the disposition governed by the conveyor constraints and the last pallet data.

In option 1, although the second (i.e. last) pallet meets the height constraint for the half pallet area, these half racks may already be full and the computer must assign it to the full pallet area --but that's an easy and quick computer decision. However choosing options 2 or 3 requires the worker to perform some elementary calculations which may impact the loading of the pallets and whether one or both can qualify as a half pallet. In any event, the results of the computer logic computations should allow users to avoid having to make decisions that can impact the effective utilization of the pallets and pallet racks.

Using a consistent logic of width x length combinations and simple visual representations, a table can be generated as shown. The block patterns are used for side by side carton stacking either along the width of the pallet or its length. For example, if the width is 16", 48/16 allows 3 cartons side by side on the 48" side of the pallet. If the carton length is less than 22", 2 columns of cartons can be stacked on the pallet. If the length is between 22" and 28", the cartons can be stacked in a square or pinwheel pattern, alternating the pattern for each layer for stability. If the length is greater than 28", only 3 can be stacked on each layer. With some combinations of width and length, a multiple block pattern yields an optimal pallet layout. A section of the table of patterns is shown in Table 4. The total table covers carton widths of 5. 1" to 24", the conveyor/combiner limit, and lengths of 5.1" to 31", the conveyor/combiner limit.

TABLE 4. PALLET PATTERN CODE & LAYOUT (For Ranges of Widths & Lengths) Partial Pallet Pattern Table						
		W I D T H				
		to 6	6.1-7	7.1-8	8.1- 9	9.1-10	10.1-11
L E N G T H	to 6	a56					
	6.1 - 7	a48	d36				
	7.1 - 8	d42	d36	a30			
	8.1 - 9	b36	d30	d24	a20		
	9.1 - 10	a32	d24	d24	a20	d16	
	10.1 - 11	a32	d24	d24	a20	d16	d16
	11.1 - 12	d28	d24	b22	d16	d16	d16
	12.1 - 13	a24	d18	a18	a15	e14	e14
	13.1 - 14	a24	d18	a18	a15	e14	d12
	14.1 - 15	d21	d18	d15	c12	d12	d12
	15.1 - 16	d21	d18	d15	c12	d12	d12
	16.1 - 17	e18	e16	b14	c12	e10	c8
	17.1 - 18	e18	e14	b14	a10	e10	c8
	18.1 - 19	c16	e14	c12	a10	e10	c8
	19.1 - 20	c16	e14	c12	a10	c8	c8
	20.1 - 21	a16	c12	a12	a10	c8	c8

SUMMARY

For most merchandise, manifests with the carton specifications and quantities are available before trucks arrive. In place of deciding the stacking pattern at the moment the shipment arrives, the pallet data and layout patterns are available in advance through the use of an expert system, reducing the need for last minute decisions from supervision. An expert system also allows for efficient use of limited resources and increased productivity at the distribution center operations by applying the knowledge of experts. This study described the major elements of the customized expert system, which was applied to the distribution center operations of the merchandise for home use, and compared it with other commercial expert system software. The customized expert system offers many advantages over the commercial software. It facilitates quick and accurate information sharing by allowing online exchange of carton information, helps achieve a high level of efficiency by providing an optimum pallet pattern, and visually displays the expert's best solution rather than simply offering a number of alternatives. In particular, a graphic display of the optimum pallet

loading pattern provides easy interpretation of the output so that the resulting visual representation of the pallet pattern is very meaningful and logical for all concerned. Supervision has difficulty keeping up with all necessary paperwork, generating location tickets, allocating pallets and directing the efforts of the palletizing personnel -- some of whom have little or no education. Although the palletizing positions are often filled by low-paid employees, the total warehousing cost can be significant if the pallets are not fully utilized.

The benefits of the customized expert system described in this paper are possible by utilizing the carton quantity and specifications input. Unlike other commercial software, it permits entering total cartons of an item to be received. With this additional input, the customized expert system is able to compute the total pallets required and the last pallet carton quantities.

It is noted that there are two or three different sizes of pallets in use. This led to additional research to validate the results of the customized expert system. We found that, if a 42x42 inch pallet was used in place of a standard 42x48 pallet, one-eighth (12.5%) of the rack space utilization was lost. The pallet recycling available should not allow this to occur. Similar studies can be done with different sizes of pallets.

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THE CYNICAL PIRATE:
HOW CYNICISM EFFECTS MUSIC PIRACY

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ABSTRACT

Music piracy has a huge detrimental effect on the music recording industry, lowering revenue and profits and potentially changing the structure of the industry. The little research that has been conducted on music piracy has noted its similarities to software piracy. This paper tests whether the Theory of Reasoned Action(TRA) (Ajzen & Fishbein, 1980), which previously has been found to describe software piracy, adequately describes music piracy in the same fashion that it describes software piracy. The Theory of Reasoned Action hypothesizes that a behavior can be predicted by a person's attitude toward the behavior and their perceptions of what other people think (social norms). TRA is modified by adding a cynicism factor to test whether levels of cynicism are associated with the extent of piracy behavior.

The model is tested using responses to a survey given to university students. As expected, the models for music and software piracy are similar. Attitude and social norms are associated with piracy behavior, but only social norms related to perceptions about peers. Perceptions of authority figure attitudes toward music piracy are not associated with music piracy behavior. Cynicism is associated only with attitude, and not with social norms. Attitude and social norms are also correlated with each other. Students are more accepting of music piracy than of software piracy. These findings may apply in practice and research.

INTRODUCTION

Since early in the 1990's, software publishers have been concerned about their losses from software piracy. The music recording industry now faces a much larger threat than the software industry. Its very existence is in question as music is extensively pirated through internet downloads and copying CD's. The total cost of pirating music is estimated at $12.5 billion annually, of which $5 billion is a direct cost to the recording industry. The recording industry has experienced dropping profits and has lowered employment because of the effects of music piracy (Blyth, 2008). Many argue that as a result of music piracy, the structure of the industry must change and the era of both big record labels and superstar bands is ending (Dvorak, 2003). Nevertheless, many people, especially college students, do not seem to regard music piracy as unethical. Understanding consumer attitudes may be an important step in developing a solution to the economic problem of music piracy. This study develops a model based on the Theory of Reasoned Action (Fishbein &

Ajzen, 1975) to promote further understanding of attitudes toward music piracy and how those attitudes influence music piracy behavior.

Music piracy is a socially accepted illegal practice. Understanding attitudes toward music piracy can lead to greater understanding of people's relationship to their society. It may be useful for the recording industry in determining strategies. It gives greater understanding of a significant phenomenon on college campuses and how it influences students on the campuses. The results of a survey reported in this paper show that the Theory of Reasoned Action is descriptive of attitudes toward music piracy. It finds that college students frequently pirate music and that students' peers have a large influence on their piracy behavior, but that other referent groups do not. However, people that are more cynical toward business are more likely to engage in music piracy than other students.

SOFTWARE AND DIGITAL MUSIC PIRACY

Both software and digital music are intellectual rights products. A purchaser of software or digital music does not purchase ownership of the software or digital music, but rather purchases the right to use the product. The cost of both products is primarily in the original production; manufacture of multiple copies only slightly increases cost. Piracy consists of copying and/or distributing unlicensed copies of music or software productions. Because both music and software can be copied without physically taking the media on which they are stored, the loss associated with software and digital music piracy differs from traditional theft in that the cost is an opportunity cost of lost sales rather than a physical loss. Software piracy has been a concern for two decades, but music piracy is a comparatively recent problem. Software piracy has been extensively studied, but digital music piracy has not yet been subjected to the same level of research.

Music and software productions are protected by copyright law and electronic copies are further regulated by a variety of laws including the Digital Performance Right in Sound Recordings Act of 1995, the No Electronic Theft Act of 1997, and the Digital Millennium Copyright Act of 1998 (Imfeld & Ekstrand, 2005). The two primary methods employed to pirate music are to copy music from purchased CDs and to download music files from the internet. Music files differ in several significant ways from software files: music files are smaller than software files (and thus more easily copied and transferred), but legal music files are less expensive than software applications; unlike pirated software, pirated copies of music often are inferior to copies legally purchased on CDs (Gopal et al., 2004).

Music piracy is destroying the music industry. Between 2003 and 2006, 800 music stores went out of business (Keen, 2007). Many experts believe that the music industry must change its structure, and that the era of music production is over (Dvorak, 2003). The music industry, represented by the Recording Industry Association of America (RIAA) has followed a variety of strategies to combat downloading of unlicensed copies of music. Recording companies have successfully sued to close a variety of internet sites used to distribute music electronically (Green,

2008). The music industry also uses technology to limit the ability to copy legal music files. Initial indications are that music piracy has declined in the short-term, but the extent of music piracy is still highly significant with unknown future ramifications to the recording industry (Rainie & Madden, 2004). Much of music piracy happens on college campuses. Most students do not regard it as wrong to pirate music files (Rosencrance, 2003). Because the potential loss of each music piracy is much less than the loss for each software piracy, people may view music piracy as more morally ambiguous. Music piracy is also easier than software piracy because of the greater portability of music files. Student piracy behavior and attitudes are expected to be more accepting of digital music piracy than of software piracy.

> *Hypothesis 1a:*   *Attitudes are more favorable toward digital music piracy than toward software piracy.*

> *Hypothesis 1b:*   *Digital music piracy is practiced more than software piracy.*

A variety of research seeks to explain piracy. Most of this research is modeled on similar research on software piracy. Research of software piracy primarily seeks to determine what factors are associated with or cause piracy behavior. This research has been primarily macro-economic (Gopal & Sanders, 1998; Ki et al., 2006), cultural (Husted, 2000), demographic (Bhatacharjee et al., 2003; Sims et al., 1996), or behavioral (Goles et al., 2008; Christensen & Eining, 1991). In behavioral research, ethical or moral individual characteristics (Gopal et al., 2004; Goles et al., 2008) and attitude (Cronan & Al-Rafee, 2008) are associated with music piracy. In piracy research, attitude is usually considered as a component of either the Theory of Reasoned Action (TRA) (Eining et al., 1991; Woolley & Eining, 2006) or of its derivative, the Theory of Planned Behavior (TPB) (Goles et al., 2008). Both TRA and TPB include both attitude and social norms, whereas TPB also included perceived behavioral control. Cronan and Al-Rafee did not find an association between social norms and piracy. Some studies show only weak support for social norms (Eining et al., 1991), whereas other research shows a stronger relationship (Woolley & Eining, 2006). This paper uses TRA, which has been validated in the context of software piracy, to describe music piracy.

THEORY OF REASONED ACTION

The Theory of Reasoned Action (Ajzen & Fishbein, 1980) is a model in which attitude and social norms predict a behavior mediated by an intention toward the behavior (Figure 1). Attitude is a person's opinion about whether to be in favor of or against a behavior. An attitude is a function of a person's beliefs about a behavior: e.g., the consequences of the behavior or the relation of the behavior to values. A person's attitude toward music piracy may be shaped by an opinion about

benefits received, whether the behavior is ethically acceptable, and any perceived dangers of practicing the behavior.

Social norms are a person's perception of the social pressures to behave in a certain way. They result from a person's normative beliefs or perceptions about a) what other people, or referents, think is a desirable behavior and b) how important it is to comply with other people's beliefs. In the context of software piracy, referents may include peers and authority figures such as parents, the university, employers, law enforcement, and the recording industry. As the TRA has fit in models of software piracy, I also expect it to fit music piracy.

Figure 1 Theory of Reasoned Action
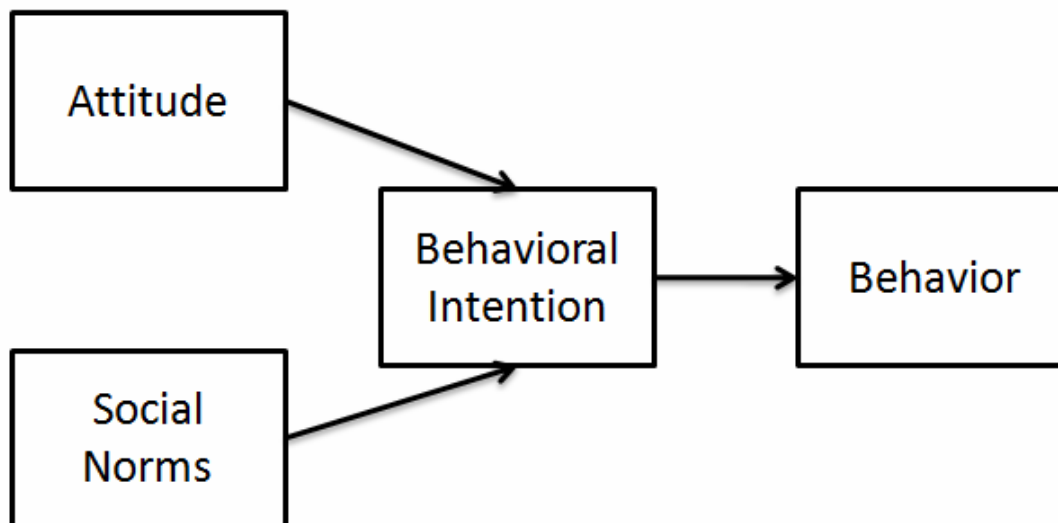
Hypothesis 2: The Theory of Reasoned Action describes music piracy behavior

Research on software piracy has generally found strong support for the relationship between attitude and behavior or behavioral intention, but little support for the relationship between subjective norms and behavior (Eining et al., 1991; Thong & Yap, 1998; Peace et al., 2003). If subjective norms are not important in a model of piracy, than it is difficult to see how pressure exerted by others could have any positive influence in reducing piracy. Advertising or policy communication, for example, may not have any effect on piracy behavior.

Different referent groups may have different levels of influence on piracy, however. Historically, peers have more influence than parents on adolescent behavior (Fletcher et al., 1995; Harris, 1998). Reducing social norms to perceptions of opinions of peers results in a strong

relationship between subjective norms and software piracy behavior (Woolley & Eining, 2006). Woolley and Eining excluded normative beliefs regarding authority (school or work). They also found, unlike predicted in TRA, that social norms and attitude were correlated with each other. This can be interpreted either as attitudes are influence by perceptions of peers' opinions or that perceptions of peers' opinions are influenced by attitude. Based on that study, and the similarity of results in other studies between attitudes toward software and music piracy, we expect to test the following hypotheses.

Hypothesis 3:   *Social Norms from peers influence music piracy behavior.*

Hypothesis 4:   *Attitude and social norms are correlated with each other.*

In this paper, I have asserted that music piracy is socially acceptable. This assertion may be modified, however, in that people's attitudes and social norms may be influenced by people's perception of society. People that are more cynical toward the music industry may be more likely to be accepting of music piracy. Cynicism refers to a lack of trust in the motives of other parties. In specific, many people may question the motives of the music industry, and believe that music piracy is ethical because the party being hurt, the music industry, has anti-social motives. Furthermore, people that are more cynical toward music piracy may believe that their peer group is also more accepting of music piracy than less cynical people. The complete hypothesized model is shown in Figure 2.

Hypothesis 5: Cynicism influences attitudes and social norms toward software piracy.

Figure 2 Hypothesized model
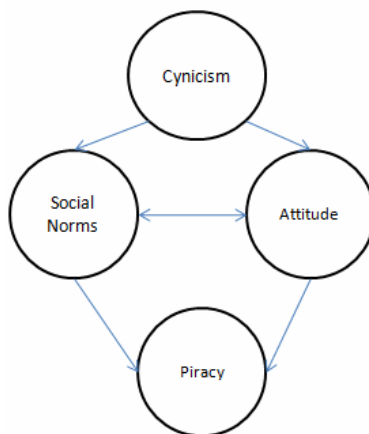
METHOD

A variety of studies have used questions related to piracy attitudes, social norms, and behavior (Goles et al., 2008; Cronan & Al-Rafee, 2008). This study uses questions adapted from Woolley and Eining (2006) as they have already been validated and distinguish between peer groups and authority groups for social norms. The questions also have the advantage of not artificially increasing latent variable recognition by simply reversing the wording of the questions (Brown, 2006). Each question is distinct from other questions used to measure the latent variable. Three out of the eleven questions from a cynicism measure were also included (Turner & Valentine, 2001). The three selected questions refer specifically to business. The questionnaire is included in the appendix. In addition to the questions related to music piracy, the survey included parallel questions related to software piracy that have been used by Woolley and Eining (2006).

The survey was administered to two sections of an introductory accounting course at a public university. The course is required for all business students and also for some non-business programs. Of the 246 responses, 39 incomplete surveys were eliminated from further analysis. The students that participated completed the survey in one class sitting for nominal extra credit. Demographic information is presented in Table 1. The only observed relationship between demographic data and piracy behavior is that married students are less likely to pirate music (r = -.23).

Table 1: Demographic data	
Mean Age	20.35
Mean GPA	3.27
Freshmen	12%
Sophomores	55%
Juniors	26%
Seniors	7%
Female	42%
Single	94%

RESULTS

The survey was analyzed using principal components with Varimax rotation. Principal components examines the correlation matrix of the survey questions to find a set of components or factors that decrease the number of variables from the number of survey questions (Foster et al., 2006). The factors should be theoretically based. Survey questions are assigned to different factors by their loadings on the factor. A loading is the correlation between a factor and a question.

Questions related to attitude, social norms-peer, and cynicism were included in the factor analysis. As social norms-authority has been determined to not influence piracy in prior research (Woolley & Eining, 2006), related questions were not analyzed. An Eigenvalue is total amount of variance explained by a factor. Eigenvalues greater than one explain more variance than a single question and are used to select factors to be considered. The survey questions loadings for digital music are shown in Table 2. Three factors had Eigenvalues greater than one. The three factors corresponded with TRA and prior research on software piracy by finding factors for attitude and social norms. The selected factors explain 70% of the total variance. A piracy latent variable is also included in the model with a Cronbach's Alpha of .737. The model for software piracy has been validated in past research (Woolley & Eining, 2006) and is qualitatively equivalent to the digital music model.

Table 2: Factor Loadings for Digital Music Piracy			
Question	Cynicism	Attitude	SN-Peer
C1	.819		
C2	.772		
C3	.732		
Att1		.863	
Att2		.859	
SN-Peer1		.883	
SN-Peer2		.842	
Eigenvalue	2.269	1.649	1.015
Percent of Variance	26 %	23%	22%
Cronbach's Alpha	.681	.712	.683

The same factors formed in a similar manner for software piracy. As expected, the measures for both music piracy and music piracy attitude are significantly higher than the measures for software piracy (See Table 3). Study participants are more accepting of music piracy than of software piracy and also pirate music more than software.

The next step in evaluating the fit of TRA is to test the relationships between the factors. Table 4 demonstrates the correlation between the factors for both digital music and software. As expected, Attitude and Social Norms-Peers are significantly correlated with music piracy behavior and with each other. Cynicism is also correlated with Attitude and Piracy, but not with SN-Peers.

Table 3: Comparison of Music and Software Piracy			
Means (standard deviations in parentheses)			
	Music	Software	t-score
Piracy	4.82	3.04	16.18**
	(1.73)	(1.35)	
Attitude	4.04	3.74	3.16**
	(1.70)	(1.55)	
** p < .01			

Table 4: Factor Correlations for Digital Music Piracy				
Factor	Attitude	SN-Peer	Cynicism	Piracy
Attitude	1.00			
SN-Peer	.26**	1.00		
Cynicism.	27**	.00	1.00	
Piracy	.39**	.46**	- .19**	1.00
** p <= .01				

The next step in the evaluation is to regress Attitude, SN-Peer, and Cynicism on Piracy. The stepwise regression method includes Attitude and SN-Peer (Table 5). Although the independent variables are correlated, the level of correlation is sufficiently low to remove concern about multicollinearity. The interaction between Attitude and SN-Peer is insignificant, which suggests a mediating rather than a moderating relationship with Piracy behavior. However, the direction of mediation is unknown and not suggested by theory. Beyond validating the application of TRA to piracy behavior, the results show three significant findings. First, the model is very similar for both software piracy, as shown in prior research, and digital music piracy. Second, Social Norms is significant when limited to peer referents. In prior research on piracy, social norms has either been insignificant or much weaker than attitude. Third, social norms and attitude are associated with each other. Cynicisms link to piracy is weak and was not hypothesized. The final step is to examine the model using path analysis.

Table 5: Theory of Reasoned Action Regression Formula					
	Constant	Attitude	SN-Peer	Cynicism	Adj. R Squared
Coefficients	.096	.267	.491	.161	.289
T-Scores	.159	4.14**	6.31**	1.865*	
** p<.001 * p<.010					

The model was tested using the Amos structural equations analysis software (Arbuckle, 2008) using the maximum likelihood estimation method. The final model is shown in Figure 3, with un-standardized weightings, similar to regression coefficients, shown on each path. Cynicism is not linked to Subjective Norms, the only finding that differs from a hypothesis. A model with Cynicism linked directly to piracy does not have adequate goodness of fit statistics. A variety of measures may be used to test the adequacy of the model. The measures are presented in Table 6, with a column for the model's measures and a second column for values that indicate an adequate model fit.

Figure 3:   Tested Model
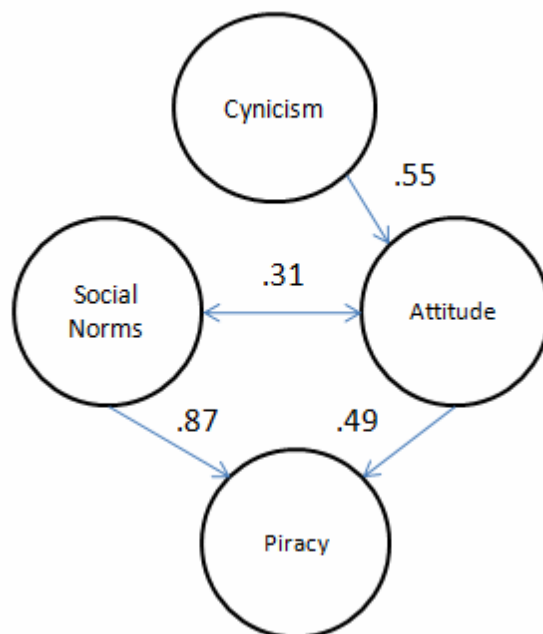
Table 6: Structured Equation Goodness of Fit Measures		
Measure	Model Measure	Adequacy cutoff
χ^2	.475	>.05
GFI	.97	>.90
NFI	.94	>.90
RMSEA	.00	<.05

DISCUSSION AND CONCLUSION

The primary finding is of this paper is that the Theory of Reasoned Action describes both software and music piracy behavior. Students' attitude toward piracy and their perceptions of their friends' attitudes and behavior regarding piracy in a large part determine their piracy behavior. Education and advertising through schools, employers, and various media may have little effect on piracy levels, as shown by the lack of association between SN-Auth and Piracy. A more fruitful strategy for the music industry may be to target attitudes and perceptions of what is acceptable by college-age students. The music industry may also attempt to educate the public to reduce the amount of cynicism found in the respondents of this survey.

Another item of significance is the significance of social norms in the model. Research on software piracy finds little or no association between social norms and piracy behavior. In the case of this study, limiting social norms to perceptions of peer attitudes and behaviors results in a significant relationship between social norms and music piracy. Future research may want to consider the effect that perceptions of different referent groups have on people on different stages of their lives. For example, authority-related social norms may be more influential on professionals than on college students, and family or religious norms may be more influential on some demographic groups than on others.

The results leave the direction of the relationship between Attitude and SN-Peers undetermined. TRA does not specify this relationship, but it would seem to be common sense that attitudes are influenced to some extent by perceptions of what other people think. Similarly, perceptions of what other people think or do may be influenced by a person's own attitude. It would be interesting to find or develop a theory that predicts a causal direction in the relationship, and to develop a research instrument that tests the direction of causality.

The students had more lenient attitudes toward music piracy and are more likely to engage in music piracy than in software piracy. This survey did not find the reasons for the difference, but some determinants can be conjectured. Music is more easily pirated than software. Students are more likely to listen to music on a daily basis than software. Many students have computers that are pre-loaded with the software they use most often, and the price of software is probably lower now than when software piracy was a larger domestic concern in the United States in the 1990's.

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APPENDIX – SURVEY QUESTIONS

Att1:	There is nothing wrong with copying music as a student since students have limited financial resources.
Att2:	There is nothing wrong with making a copy of music if I am just seeing if I like it.
SNPeer1:	My friends think that it is wrong to copy music.*
SNPeer2:	My friends make copies of music and share it with others.
C1:	Companies are only interested in sales, not in what is fair.
C2:	Big companies make profits by taking advantage of consumers.
C3:	Businesses profit at the expense of their customers.
Piracy1:	I make copies of music that my friends have purchased.
Piracy2:	I have allowed people to copy music I have purchased.
Piracy3:	I have obtained one or more music items by renting or borrowing the item and then making a copy to keep.

*Reverse scored

ASSESSING THE LEVEL OF INFORMATION TECHNOLOGY (IT) PROCESSES PERFORMANCE AND CAPABILITY MATURITY IN THE PHILIPPINE FOOD, BEVERAGE, AND TOBACCO (FBT) INDUSTRY USING THE COBIT FRAMEWORK

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ABSTRACT

A grounded literature on how information technology (IT) processes are being managed is imperative in an industry with an increasing reliance on IT for its strategic and operational undertakings. This study seeks to provide a comprehensive assessment of the level of IT processes performance and capability maturity in the Philippine food, beverage, and tobacco (FBT) industry by applying the theory of benchmarking and the CobiT framework on IT governance. After administering the 167-item survey instrument to 22 publicly-listed companies in the FBT industry, represented by respondents composed largely of IT managers and administrators and subjecting the results to statistical tests and IT experts' validation, it was found out that the FBT industry currently has a maturity score of 2.05. At this maturity level, IT processes have developed to the stage where similar procedures are followed by different people undertaking the same task but there is no formal training of communication of standard procedures. To be able to evolve to the next immediate level where IT processes are standardized, documented, and communicated through training, companies in the FBT industry should bank on their key strength in the Acquire and Implement (AI) domain and improve on their weakness in the Monitor and Evaluate (ME) domain.

Keywords: Benchmarking; Capability; Domain; Governance; Maturity.

INTRODUCTION

The advent of information technology has significantly influenced and changed how businesses are being managed and monitored today (Hunton, Bryant & Bagranoff, 2004). It has brought both positive and negative impacts to the business world. As such, a term double-edged sword is often used to describe it.

To ensure smooth management of the new business set-up, the concept of corporate governance was redesigned to include information technology as a major part of it. New governance

and internal control frameworks came up just for this concern to be addressed. This resulted to an increased awareness that IT governance is a major ingredient in achieving every organization's goal of value creation.

In spite of the availability of new governance and internal control frameworks, many organizations still compromised their going concern because of poor enterprise-wide governance. The collapse of Enron in 2002 and the recent 2009 Satyam scandal in India are among the proofs of this predicament. Much more alarming is that in 2008, Satyam was the winner of the coveted Golden Peacock Award for Corporate Governance under Risk Management and Compliance Issues. Because of this, the awareness for both corporate and IT governance must be heightened and taken more seriously.

THE STATE OF THE FBT INDUSTRY

Over the last few years, the global food, beverage and tobacco (FBT) industry group has exhibited modest growth, with growth particularly low in the tobacco and beverage markets. The industry group generated total revenues of $4,140.3 billion in 2005, this representing a compound annual growth rate (CAGR) of 2.9% for the five-year period spanning 2001-2005 (Datamonitor, 2006).

Figure 1: Global food, beverage & tobacco industry group value: $billion, 2001-2005

Source: Datamonitor

DATAMONITOR
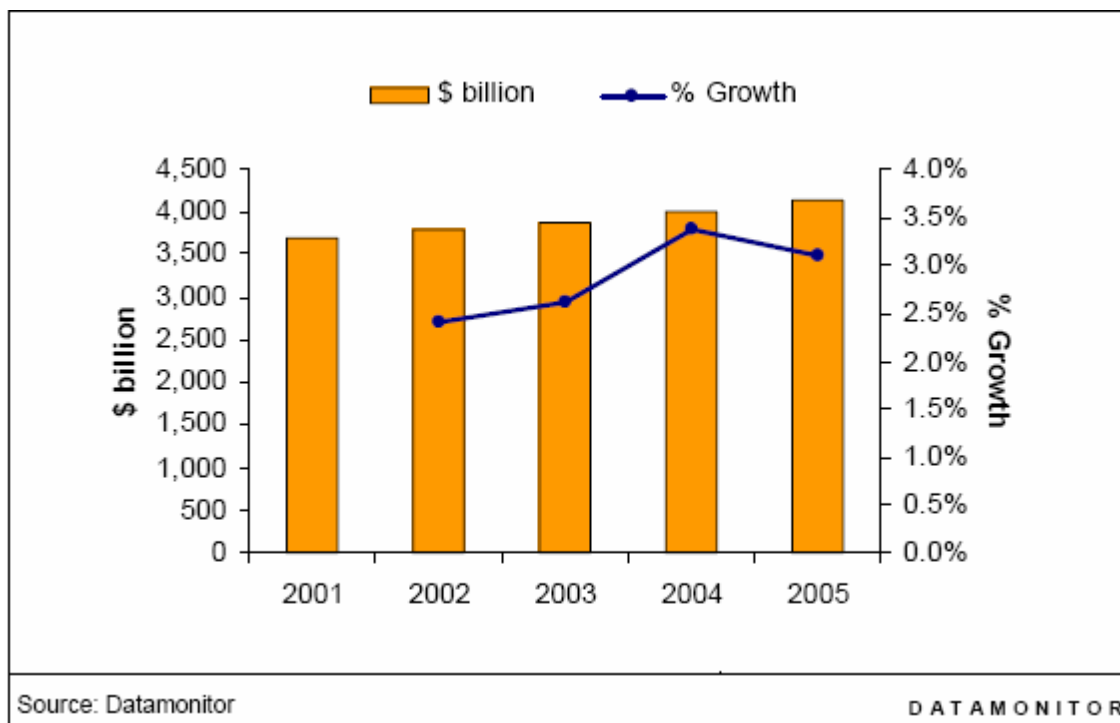
The leading revenue source for the global FBT industry group is the sale of food products, which generated total revenues of $2,634.3 billion in 2005, equivalent to 63.6% of the overall industry value. In comparison, beverage sales accounted for $1,035.4 billion in 2005, which represents 25% of the industry value. However, the increasing global population will drive demand up, while rising income levels in many economies allow increased spending on added-value processed, packaged, and luxury items in this category. The global consumption volumes of tobacco are steadily falling, as the health risks become more widely understood, although in some countries, such as India, volume growth remains positive (Datamonitor, 2006).

But looking forward, the global FBT industry group is expected to accelerate from its current value growth position. With an anticipated CAGR of 3% over the 2005-2010 period, the industry is expected to reach a value of $4,805.5 billion by the end of 2010. The drivers operating during the last five years are set to persist for the next five (Datamonitor, 2006).

In the Philippines, the FBT industry belongs to the industrial sector. There are 23 publicly-listed companies under the FBT industry (Philippine Stock Exchange (PSE), 2009). It is a highly regulated industry particularly the tobacco companies. A study by RNCOS in New Delhi on September 13, 2008 on the Philippine FBT Market Forecast until 2011 showed the patterns in consumption behavior in the different food segments. The study indicated five key results about the sub-industry: (1) because of the strong increase in consumer expenditure during 2001 to 2006, a rise of 7.5% is also expected from 2007 to 2011; (2) the increase in the working hours of employees, increase in number of employees and diverse eating habits has lead to a high consumption of ready-to-eat meals; (3) the demand for organic food will increase at a growth rate of 10% to 20% because of the growing middle class population; (4) an increase in disposable incomes and demand fro imported alcoholic beverages; and (5) there is an inadequate water supply and healthy drinking concerns that have resulted in the growth in the bottled water industry (Dy, Ha, Gan & Alba, 2009).

DEPENDENCE OF FBT COMPANIES ON IT

According to Siethe and King (1994), in the market where the existence of perfect competition restricts generation of a reasonable profit, successful implementation of IT systems plays a crucial role in order for organizations to maintain a competitive standing.

Since all the major players in the FBT industry group source ingredients and sell their products all over the world, the current high oil prices are significantly increasing transportation costs by way of inflated petroleum prices. Companies have begun to combat such problems by driving efficiency within their regional distribution networks. By monitoring demand within a particular global region, companies have been able to minimize transportation, thus mitigating their exposure to these rising costs (Datamonitor, 2006).

The use of information technology to manage its supply chain and distribution channels can be viewed as an opportunity in this case (Romney & Steinbart, 2008). Likewise, the heightened regulation set by the Bureau of Internal Revenue in terms of point-of-sale (POS) registers for FBT

companies also presents an opportunity for IT to be maximized. Because of this, to support the expected increase in consumer expenditure, the IT infrastructure and utilization is expected to cater to the growing volume of transaction processing to support daily business operations.

VALUE OF INVESTING IN IT

Investing in IT aids in surpassing competition by improving productivity, profitability, and quality of operations (Devaraj & Kohli, 2003). Likewise, according to a study conducted by Dewan and Kraemar (2000), when the World Bank provided assistance amounting to $1 billion annually to companies which want to invest in developing their existing systems, it turned out that the gross domestic product (GDP) growth of countries wherein there is a rampant utilization of IT systems is considerably higher compared to the GDP growth of countries where companies are non-IT users.

But according to a study conducted by Willcocks and Lester (1997), investment in IT systems alone does not assure companies that they will reap the full benefits that these systems promise. Instead, it is accompanied by the danger that improper application of such could be detrimental to the organization. With this, there is more reason for the need to ensure IT governance more specifically to ensure its alignment with business strategy.

IT GOVERNANCE: A FOCUS ON COBIT

According to Simonsson and Johnson (2006), the existing literature on IT governance has inherited much from the discipline of corporate or enterprise governance but it has been able to develop itself into a discipline of its own (Dy, Ha, Gan & Alba, 2009). This is evidenced by several professional groups and organizations created for the purpose of establishing new internal control frameworks that primarily focus on IT governance.

Information Systems Audit and Control Association (ISACA) is one of the professional groups established for this purpose. In 1998, the Information Systems Audit and Control Association (ISACA) established the Information Technology Governance Institute (ITGI) to advance international thinking and standards in directing and controlling an enterprise's information technology (ITGI, 2007). The institute exists to clarify and provide guidance on current and future issues pertaining to IT governance, control, and assurance (Hunton, Bryant &Bagranoff, 2004). The framework that this institute developed emphasizes that an organization first sets its objectives, and then follows a continual process in which performance is measured and compared against those objectives. One its products is the Control Objectives for Information and related Technology (CobiT) which provides guidance on IT governance by setting the structure that links IT processes, IT resources, and information to enterprise strategies and objectives. While CobiT was once a tool primarily for auditors to use, the increasing criticality of IT governance has caused it to evolve into a management resource (Hunton, Bryant & Bagranoff, 2004).

Though at present, there is still lack of consensus on how IT governance is viewed; CobiT is the most renowned framework for support of IT governance concerns. It is based on best practice, focusing on the processes of the IT organization and how its performance can be assessed and monitored. This framework is maintained by an independent, not-for-profit research institute, drawing on the expertise of its affiliated association's members, industry experts, and control and security professionals. Its content is based on ongoing research into IT good practice and is continuously maintained, providing an objective and practical resource for all types of users. It provides good practices across a domain and process framework and presents activities in a manageable and logical structure. However, it is important to emphasize that CobiT framework is a model of IT governance only and not of organization as a whole (ITGI, 2007).

CobiT defines IT activities in a generic process model with four domains and 34 generic control processes. These domains are Plan and Organize (PO), Acquire and Implement (AI), Deliver and Support (DS), and Monitor and Evaluate (ME). The domains map to IT's traditional responsibility areas of plan, build, run, and monitor (ITGI, 2007). PO domain covers strategy and tactics, and concerns the identification of the way IT can best contribute to the achievement of the business objectives. AI domain addresses the aptness and likelihood of providing solutions that will meet business needs. DS domain is concerned with the actual or physical delivery of required services, which includes service delivery, management of security, and continuity, service support for users, management of data and operational facilities. ME domain addresses performance management, monitoring of internal control, regulatory compliance and governance. Across these four domains, CobiT has identified 34 IT processes where links are made to the business and IT goals that supported (ITGI, 2007). The four domains and 34 IT processes largely represent a comprehensive dimension of an organization's IT processes performance and capability that needs to be managed.

Figure 2: The four interrelated domains of CobiT
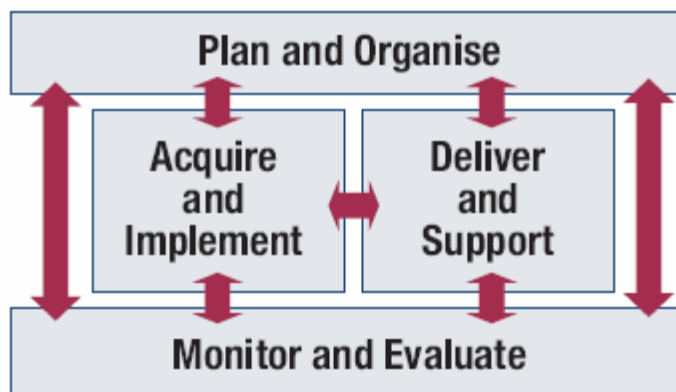
Moreover, the United States (US) Securities on Exchange and Commission (SEC) mandated the use of a standard internal control framework established by a body or group that has gone through due-process procedures, including the wide distribution of the framework for public comment, and made particular mention to the Committee of Sponsoring Organizations of the Treadway Commission (COSO) Internal Control – Integrated Framework, which was issued in 1992. COSO is widely accepted as the authority on internal controls and is incorporated into policies, rules, and regulations that are used to control business activities (Romney & Steinbart, 2008) and CobiT is the generally accepted internal control framework for IT (ITGI, 2007). Using the CobiT framework, an organization can devise a system of IT controls to conform with Section 404: Management's Report on Internal Control over Financial Reporting (Yu, Rogacion, Perez & Lichengyao, 2006).

Furthermore, the Public Company Accounting Oversight Board (PCAOB) Auditing Standard No. 2 states that because of the frequency with which management of public companies is expected to use COSO as the framework for the assessment, the directions in the proposed standard are based on the COSO framework.

VALUE OF IT GOVERNANCE

The huge amount of capital expenditures in IT systems emphasizes the importance of proper governance in organizations. Once this is achieved, the full potential of IT is maximized. The single most important determinant of whether an organization will gain the full value of IT is through an effective IT governance structure (Robinson, 2005)

Melnicoff (2002) highlighted various benefits of investing in effective IT governance. First, it adds value to the business. Effective IT governance takes into account the rate changes of the industry where the business belongs. The governance could also add value by providing the company with a competitive advantage. Another advantage involves the concept of accountability. Lines of responsibility among different management positions would be clear since authorizations of IT decisions are defined. Moreover, Melnicoff (2002) provides that an effective, business-specific IT governance model is an essential tool for executives struggling with the challenge of leveraging the full potential of IT as a generator of sustainable business value. It allows top managers to readily evaluate their company's existing governance structure and to determine if the IT environment needs to be altered (Dy, Ha, Gan & Alba, 2009).

COBIT AND THE MATURITY MODEL

Companies need an objective measure to assess where they are and identify where improvement is required. Answers to this are provided by CobiT by means of benchmarking of IT process performance and capability, expressed as maturity models, derived from the Software Engineering Institute's Capability Maturity Model (CMM), goals and metrics of the IT processes

to define and measure their outcome and performance based on the principles of Kaplan and Norton's balanced business scorecard, and activity goals for getting these processes under control, based on CobiT's control objectives (ITGI, 2007).

The three dimensions of process maturity are capability, coverage, and control as illustrated in figure 3 (ITGI, 2007).

Figure 3: The three dimensions of maturity
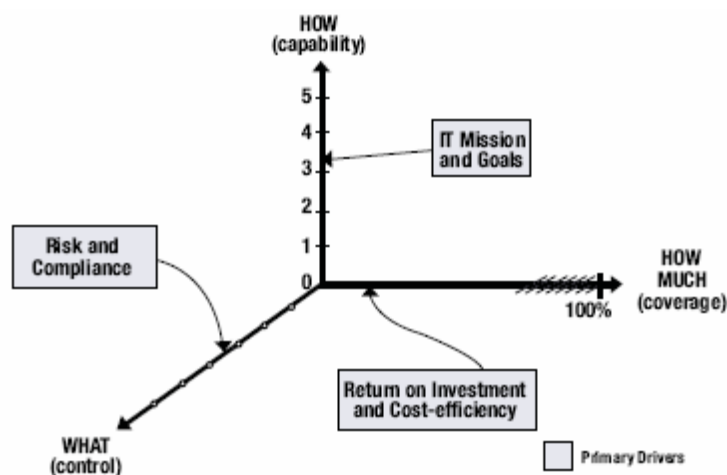
The three-dimension model is a way of measuring how well developed management processes are. How well developed or capable they should be primarily depends on the IT goals and the underlying business needs they support. How much of that capability is actually deployed largely depends on the return enterprise wants from the investment. On the other hand, the degree and sophistication of controls that need to be applied in a process are more driven by the enterprise's risk appetite and applicable compliance requirements (ITGI, 2007).

CobiT provides maturity models to enable benchmarking and identification of necessary capability improvements. Maturity modeling for management and control over IT processes is based on a method of evaluating the organization, so it can be rated from a maturity level of non-existent (0) to optimized (5). This approach is derived from the maturity model that the Software Engineering Institute (SEI) defined for the maturity of software development capability. Although concepts of the SEI approach were followed, the CobiT implementation differs considerably from the original SEI, which was oriented toward product engineering principles, organizations striving for excellence in these areas and formal appraisal of maturity levels so that software developers could be "certified" (ITGI, 2007). The maturity models primarily focus on how well a process is managed.

The CobiT maturity levels are designed as profiles of IT processes that an enterprise would recognize as descriptions of possible current and future states. They are not designed for use as a threshold model, where one cannot move to the next higher level without having fulfilled all conditions at the lower level. The maturity models primarily focus on how well a process is managed. With CobiT's maturity models, unlike the original SEI CMM approach, there is no intention to measure levels precisely or try to certify that a level has exactly been met. A CobiT maturity assessment is likely to result in a profile where conditions relevant to several maturity levels will be met (ITGI, 2007).

The right maturity is influenced by the enterprise's business objectives, the operating environment and industry practices. Specifically, the level of management maturity depends on the enterprise's dependence on IT, its technology sophistication and the value of information (ITGI, 2007).

BENCHMARKING

Robert Camp (1989) developed a 10-step model moving sequentially through for phases. Kearns, along side, defined benchmarking as the continuous process of measuring products, services, and practices against toughest competitors or those companies recognized as industry leaders (Moriarty, 2008). Watson (1993) views benchmarking as a continuous process that searches for and applies significantly better practices for the purpose of achieving superior competitive performance (Moriarty, 2008). Yu, Rogacion, Perez and Lichengyao (2006) defined benchmarking as a comprehensive technique that can be used to identify operational and strategic gaps, and to look for best practices that eliminate such gap. Benchmarking has an "internal dimension" whereby the organization critically examines itself searching for best practices and an "external dimension" whereby the organization explores its industry and other relevant areas outside of its own industry in order to identify those best practices that may be applicable in its own operating environment (Yu, Rogacion, Perez & Lichengyao, 2006).

Moreover, Watson (1993) provided another perspective of benchmarking. This unconventional perspective approaches benchmarking as a process of organizational adaptation, not adoption – not simply a question of copying others, but learning how to improve by sharing ideas (Moriarty, 2008).

PREVIOUS STUDIES

The 2008 IT Governance Global Status Report, a research conducted by ITGI through PricewaterhouseCoopers (PwC), revealed that though the importance of IT continues to increase and organizations know who can help them implement IT governance, appreciation for the available expertise and delivery capability is only average. But on a positive note, 92% of IT users are aware

of problems with the use of IT and the need to do something about them and 88% of the same IT user community recognizes the IT governance is the solution.

Moreover, separate studies on IT practices conducted by Yu, Rogacion, Perez and Lichengyao (2006) and Acosta, Samson, Tan and Tecson (2009) yielded maturity scores of 2.97 and 2.70 for listed expanded and non-expanded commercial banks and selected life insurance companies in the Philippines, respectively.

Yu, Rogacion, Perez and Lichengyao (2006) developed a 167-item that was taken from the four domain and 34 IT processes of the CobiT framework with the level of perceived importance as an added dimension to at least compensate, indirectly, for the level of centrality of IT to business operations and the level of IT to business strategy. The level of importance served as the weight to get a more accurate assessment of the IT practices. The survey instrument was a product of classroom conceptual inputs under the researcher's tutelage and was validated with select group of IT Security and Audit Practitioners using the Delphi Method. The results of the study were further validated by practitioners in the banking industry and were presented to the Accountancy department of the De La Salle University (DLSU).

Nonetheless, the following trends were identified in the study of Yu, Rogacion, Perez and Lichengyao (2006): (1) overall fair ME domain was due to consistency of performance; (2) fair score of the DS domain was largely attributable to outliers; (3) high absolute score of the AI domain was somewhat attributable to outliers; (4) consistent low performance in the PO processes and low overall performance for the PO domain; (5) overall industry strength in core operations processes; (6) overall strategic weakness in strategic processes; (7) decentralization of managing IT resources and processes leads to lower overall IT governance maturity; and (8) poor performance in earlier domains in the IT governance life cycle leads to poor performance in related processes in subsequent domains.

EXCLUSION OF OUTLIERS

The study of Yu, Rogacion, Perez and Lichengyao (2006) considered the effect of outliers in the results. Outliers are points of data that lie outside of the range of reasonably expected values. Based on the concept of the Capability Maturity Model Integration (CMMI), in the area of IT governance maturity in the Philippine financial services industry, no firms have yet to achieve the Managed and Optimized levels. The latest appraisal dated December 15, 2005 the organizations which were identified as having achieved the Managed level and which were identified as candidates for the Optimized level in the future, do not include the banks within the population of the study of Yu, Rogacion, Perez and Lichengyao (2006). The list also did not include the companies in the Philippine FBT industry.

RESEARCH PROBLEM AND SIGNIFICANCE

A shortcoming recognized in the previous studies conducted by Yu, Rogacion, Perez and Lichengyao (2006) and Acosta, Samson, Tan and Tecson (2009) was the non-conclusiveness of their findings with respect to the industries chosen.

By making use of 22 (of which 21 responded) out of 23 (one was excluded) publicly-listed companies in the FBT industry, this study provides a comprehensive assessment of the current level of IT processes performance and capability maturity.

Furthermore, this study provides answers to the following questions:

1,   What are the industry's key strengths?
2.   What are the industry's weaknesses and what are the reasons behind these?
3.   How does the industry fare with respect to other industries?
4.   What maturity level does the industry need to be at and how can it get there?

Moreover, one of the short-term plans of the Philippine government is to create a new executive office that caters specifically to the information and communication technology issues that face the country. This research study has the potential to provide a globally accepted direction in terms of assessing IT management maturity levels of the local government units and the national agencies.

ASSUMPTIONS AND SCOPE

This study is working under the assumption that the survey instrument adopted passed instrument validation and the assessments provided by the respondents generally represent the current states of how IT processes are managed in their respective companies and they aware of the level of centrality of IT to business operations and the level of centrality of IT to business strategy. Variables not covered in the operational framework are excluded from the scope of this study. Likewise, quantitative techniques applied are not intended to be mathematically rigorous but are used primarily to aid in the qualitative analysis. Companies not publicly listed under the FBT industry are also excluded from the scope of this study.

FRAMEWORK OF ANALYSIS

This is study is grounded on benchmarking theory by Robert Camp (1989) and the IT processes performance and capability maturity of the CobiT framework with the level of importance as an additional dimension to indirectly address the level of centrality of IT to business operations and the level of IT to business strategy.

Figure 4: Framework of analysis
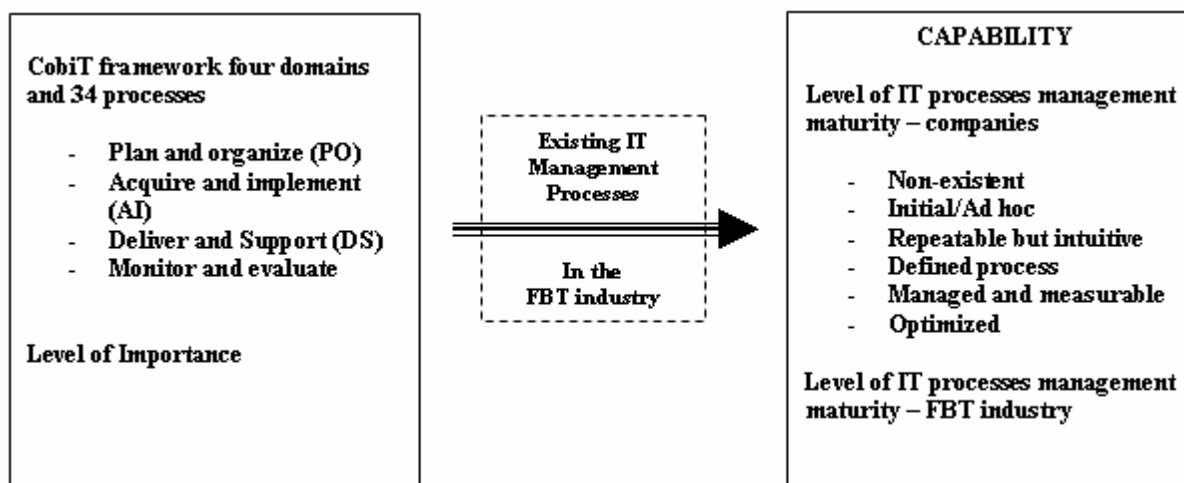
Benchmarking takes place in two phases; (1) it begins as the search for best practices, and (2) culminates with mapping of current practices to these established best practices. According to Camp (1989), the process of benchmarking is divided into 10 steps (table 1) which progress through four phases.

Table 1: 10-step benchmarking model developed by Camp
Phase 1 – Planning
1. Identify what is to be benchmarked. 2. Identify comparative companies.
Phase 2 – Analysis
3. Determine data collection method and collect data. 4. Determine current performance levels.
Phase 3 – Integration
5. Project future performance levels. 6. Communicate benchmarking findings and gain acceptance.
Phase 4 – Action
7. Establish functional goals. 8. Develop action goals. 9. Implement specific actions and monitor progress. 10. Recalibrate benchmarks.

The steps applicable to this research study are steps one to six, encompassing planning, analysis, and integration phases of Camp's general methodology. Phase four, the Action phase, constitute the use as intended of the results of the study by the companies in the FBT industry.

The maturity level of an organization presents a means to foresee the future performance of an organization contained by a certain discipline or set of disciplines. Practice has revealed that organizations do their best when they concentrate their process-improvement efforts on a controllable number of process areas that entail more and more sophisticated effort as the organization improves. A maturity level is a definite evolutionary table of process improvement. Each maturity level evens out a significant fraction of the organization's processes. The maturity levels are determined by the accomplishment of the specific and general goals that relate to each pre-defined set of process areas. There are six maturity levels, each a layer in the base for constant process improvement (ITGI, 2007).

The first step in improving a process is to know the limits of the process to be improved. The process could be any process and it will be a mixture of people, tools, technologies, and methods used to finish a job. Once the operational entity is definite, a clear understanding of the operational entity's principle and objectives directs improvement efforts. A lot of times, the principle and objectives are maintained in strategic planning documents. A clear understanding of the principle and objectives will maintain improvement efforts next to strategic needs and will keep away from burning up significant resources on improvement efforts that don't contribute to those needs. Together with understanding the operational entity's objectives, it is essential to understand how to know if objectives are achieved. The objectives of an operational entity are defined first so that some level of confirmation can be performed to verify that improvement efforts help to achieve those objectives. If the operational entity requiring improvement is known and its point is clearly understood, limits and risks are more simply identified and attended to. The present state of the operational entity could be measured against its objectives to identify current and possible barricades to attaining those objectives. Improvement plans would then be made and applied to deal with these hindrances. Operational process improvement using this maturity type model is just an organized approach to naming and addressing these limits and risks and improving the operational entity to more successfully attain its objective (Camp, 1989).

IT processes performance and management capability is interpreted using six levels of maturity (figure 5) are 0 for non-existent, 1 for initial /ad hoc, 2 repeatable but intuitive, 3 defined process, 4 managed and measurable and 5 optimized. This is best viewed as a guide on how enterprises can evolve from a non-existent to an optimize process.

Figure 5: Graphic representation of maturity models

Table 2 briefly explains each maturity level according to CobiT's generic model of maturity (ITGI, 2007).

Table 2: Generic Maturity Model	
0 Non-existent	Complete lack of any recognizable processes. The enterprise has not even recognized that there is an issue to be addressed.
1 Initial/Ad hoc	There is evidence that the enterprise has recognized that the issues exist and need to be addressed. There are, however, no standardized processes; instead, there are ad hoc approaches that tend to be applied on an individual or case-by-case basis. The overall approach to management is disorganized.
2 Repeatable but intuitive	Processes have developed to the stage where similar procedures are followed by different people undertaking the same task. There is no formal training or communication of standard procedures, and responsibility is left to the individual. There is a high degree of reliance on the knowledge of individuals and, therefore, errors are likely.
3 Defined process	Procedures have been standardized and documented, and communicated through training. It is mandated that these processes should be followed: however, it is unlikely that deviations will be detected. The procedures themselves are not sophisticated but are the formalization of existing practices.
4 Managed and measurable	Management monitors compliance with procedures and takes action where processes appear not to be working effectively. Processes are under constant improvement and provide good practice. Automation and tools are used in a limited or fragmented way.
5 Optimized	Processes have been refined to a level of good practice, based on the results of continuous improvement and maturity modeling with other enterprises. IT is used in an integrated way to automate the workflow, providing tools to improve quality and effectiveness, making the enterprise quick to adapt.

The advantage of a maturity model approach is that is relatively easy for management to place itself on the scale and appreciate what is involved if improved performance is needed. The scale includes 0 because it is quite possible that no process exists at all. The 0 to 5 scale is based on a simple maturity scale showing how a process evolves from a non-existent capability to an optimized capability (ITGI, 2007).

RESEARCH METHODOLOGY

Applying the first six steps of Camp's benchmarking model, the first step of the model is complete at this point. The second step is the identification of participating companies. After discussing the survey instrument in class, students in Computer Information Systems (CIS) were grouped and tasked to identify one publicly-listed company each group belonging to the FBT industry as a requirement for the course. The researcher took care of other companies not chosen by the groups.

Twenty-three publicly-listed companies composing the Philippine FBT industry were considered. Out of the 23, one company was automatically removed because its business office is not located in the National Capital Region or Metro Manila. All 22 companies were invited to participate.

Step three is the determination of data collection method and collection of data. The design of the survey instrument was based on the four domains and 34 processes of the CobiT framework with a level of importance scale on the left-hand side of every item. The latter served as the weight per process in computing the maturity score. The researcher, with the help of CIS students, gathered primary data through the administration of a 167-item survey instrument developed by Yu, Rogacion, Perez and Lichengyao (2006). One company refused to participate and two companies did not continue to answer the survey instrument due to absence of formal IT processes in place. Automatically, the latter two companies were given a maturity score of 0.

Step four is the determination of current maturity levels. Accomplished survey tools were tallied per domain and summarized for each company. Likewise, maturity scores of each company were summarized per domain and per overall total to determine the industry's current maturity score. Likewise, profiles of the respondents and the participating companies were also considered in this step.

Step five involves in-depth analysis to develop recommendations. This was accomplished by analyzing process-level and domain-level results and drawing implications to identify opportunities for industry-wide IT processes management maturity level improvement. Similar to the study of Yu, Rogacion, Perez and Lichengyao (2006), the researcher also excluded outliers. Companies that were assessed (overall) with managed level score (4.0) or higher were considered outliers in accordance with the appraisal conducted by CMMI in 2005.

Data collected and tabulated were tested for normality using Stata .sktest before the obtained values and adjusted values were subjected to t-test to determine the significance of differences

between them, both per domain and per overall maturity score, using PHStat. Since the quantitative equivalents of the six levels in CobiT's maturity model are all whole numbers, the overall maturity scores of both obtained value and adjusted value were compared to the whole number equivalent of the assessed level and likewise tested for significance of differences using PHStat. This was done to ensure that the maturity score as assessed is indeed the maturity level of the industry as per CobiT's maturity model.

The conclusion and recommendations at this point were reviewed to ascertain that overall results would be value-adding and that the recommendations are practicable before final results were sent to the participating companies. IT auditors' and practitioners' validation was sought to carry out this sixth step.

RESULTS, DISCUSSION AND CONCLUSION

The respondents were composed of senior technical managers, wide area network (WAN) and data administrators, management information systems managers, and corporate IT managers. Based on the 2008 audited financial reports obtained from the PSE website, the total assets of publicly-listed companies in the FBT industry range from P237 million to P339 billion. Of the industry's total assets of P579 billion, 98.34% was from the respondent-companies. Of the 21 respondent-companies, 18 were audited by a Big 4 firm.

Table 3: Overall and per domain mean and standard deviation (obtained and adjusted)				
	Obtained mean	*Standard deviation*	***Adjusted mean***	*Standard deviation*
Plan and organize (PO)	2.51	*1.28*	***2.09***	*1.03*
Acquire and implement (AI)	2.71	*1.46*	***2.26***	*1.23*
Deliver and support (DS)	2.46	*1.41*	***2.02***	*1.15*
Monitor and evaluate (ME)	2.41	*1.60*	***1.83***	*1.16*
Overall level	2.52	*1.39*	***2.05***	*1.08*

The FBT industry registered a 2.52 maturity score but removing the outliers as employed in the study of Yu, Rogacion, Perez and Lichengyao (2006), the FBT industry would have an adjusted maturity score of 2.05. The sets of data used in computing for both means passed the normality test. To determine the significance of differences between the overall and per domain obtained and adjusted maturity scores, they were subjected to two-tail t-test using 0.01 level of significance.

Table 4: Tests of significance overall mean and per domain mean (obtained and adjusted)					
	Overall	PO	AI	DS	ME
t Test Statistic	1.1469	1.0951	1.0111	1.0506	1.2416
Two-Tail Test					
Lower Critical Value	-2.7194	-2.7194	-2.7194	-2.7194	-2.7194
Upper Critical Value	2.7194	2.7194	2.7194	2.7194	2.7194
p-Value	0.2589	0.2807	0.3186	0.3004	0.2224
Do not reject the null hypothesis (NR)	NR	NR	NR	NR	NR

At 0.01 level of significance, the null hypotheses could not be rejected. Thus, the overall and per domain obtained and adjusted means do not significantly differ from each other. Though the removal of outliers does not result to any significant difference in the maturity score, such would make identification of the maturity level easier as the adjusted maturity score is nearer to a maturity level that is denoted by a whole number.

To ensure further that the overall obtained and adjusted means do not significantly differ with respect to the maturity level assessed at 2.0, they were subjected to an upper-tail t-test using 0.01 level of significance and 0.05 level of significance.

Table 5: Tests of significance overall mean (obtained and adjusted) and maturity level				
	Obtained	Obtained	Adjusted	Adjusted
Level of significance	0.01	0.05	0.01	0.05
t Test Statistic	1.7276	1.7276	0.1980	0.1980
Upper-Tail Test				
Upper Critical Value	2.5279	1.7247	2.5834	1.7458
p-Value	0.0497	0.0497	0.4227	0.4227
Do not reject the null hypothesis (NR)	NR	R	NR	NR
Reject the null hypothesis (R)				

At 0.01 level of significance, the null hypotheses could not be rejected. But at 0.05 level of significance, only the adjusted mean hypothesis could not be rejected. It is at this point that removal of the outliers has a significant effect in the determination of the maturity level. The adjusted maturity level of 2.05 is closer to level 2, denoted by the whole number 2.0, than the obtained maturity level of 2.52. It is, therefore, safer to say that the FBT industry is currently at level 2 using the adjusted mean.

As such, the adjusted figures, with lower standard deviation, would be used in the subsequent analysis and discussion of the results.

Figure 6: Maturity score per generic process
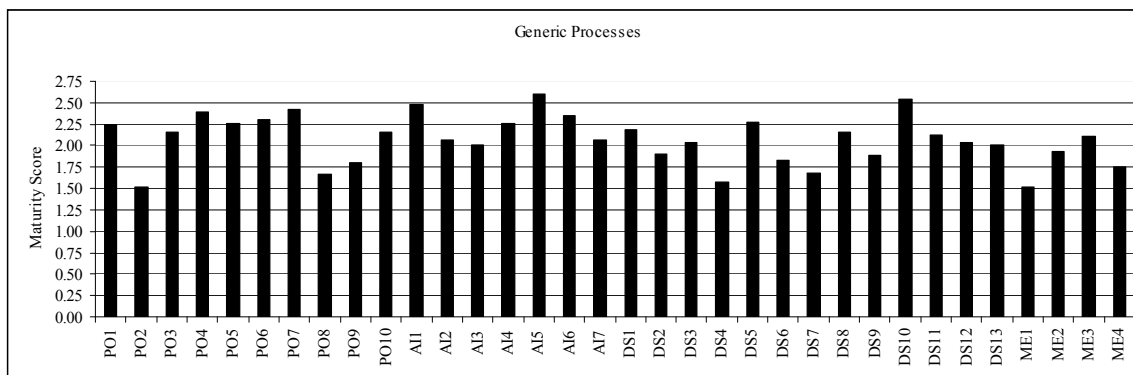
In the PO domain, the industry scored the highest (2.42) in managing IT human resources (PO7) and the lowest (1.52) in defining the information architecture (PO2). The PO7 score, though not that high, can be attributed to the local laws enforced that govern recruitment, training, promotion, and termination practices. The PO2 score can be attributed to the communication problems between business and IT.

In the AI domain, the industry scored the highest (2.60) in procuring IT resources (AI5) and the lowest (2.01) in maintaining technology infrastructure (AI3). The AI5 score can be attributed to procurements that management is fully aware of but the AI3 score is an indication that once these resources are procured, less emphasis is given to their maintenance thereby reducing efficiency of use over time.

In the DS domain, the industry scored the highest (2.55) in managing problems (DS10) and the lowest (1.58) in ensuring continuous service (DS4). The DS10 score tends to compensate the low AI3 score; poor maintenance means more problems to manage. Because of this, continuous service (DS4) is compromised since most of the resources are used up in troubleshooting.

In the ME domain, the industry scored the highest (2.12) in ensuring regulatory compliance (ME3) and the lowest (1.51) in monitoring and evaluating IT performance (ME1). The ME3 score, though not that high, can be attributed to the awareness of potential financial liability once regulations are not complied with. But this still indicates a lack of full understanding of all issues related to these requirements. Moreover, the low score in ME1 can be attributed to the costs related to monitoring controls and the absence of a culture geared toward continuous improvement.

On a domain level, the FBT industry scored the highest (2.26) in Acquire and Implement and the lowest (1.83) in Monitor and Evaluate. The high score in AI domain can be attributed to the

anticipated compound annual growth rate of 3% over the 2005-2010 period in the FBT industry. This increasing demand tends to compel companies to provide solutions that will meet business needs through IT initiatives. Slowly, these companies should view this as an opportunity to grow and maximize the use of their existing IT infrastructures. This result is consistent with the study of Yu, Rogacion, Perez and Lichengyao (2006) and that of Acosta, Samson, Tan and Tecson (2009). Banks and selected life insurance companies scored also the highest (3.17 and 2.86, respectively) in this domain.

The low score in the ME domain is not consistent with the maturity scores obtained by Yu, Rogacion, Perez and Lichengyao (2006). Banks scored 2.97 in this domain and 2.73 in the PO domain, its lowest. But this low score is consistent with that of Acosta, Samson, Tan and Tecson (2009). Selected life insurance companies scored 2.53 in this domain. Though both banking and FBT industries are regulated (tobacco, in particular), banking regulations tend to be more established, structured, and implemented. The Bangko Sentral ng Pilipinas (BSP) which oversees and monitors strict compliance to these regulations plays a huge part in this. In addition, the BSP has a dedicated group that supervises and examines solely the IT component of the banking industry. This set-up, though may exist in the FBT industry, tends to be not strictly followed and observed.

Moreover, analyzing the results by identifying the number of IT processes that scored below the adjusted maturity score in each domain, the PO domain has three out of 10 (30%), the AI domain has three out of seven (43%), the DS domain has six out of 13 (46%), and the ME domain has two out of four (50%). In the PO domain, these are defining the information architecture, managing quality, and assessing and managing IT risks. In the AI domain, these are acquiring and maintaining architecture software and technology infrastructure, and installing and accrediting solutions and changes. In the DS domain, these are managing third party services, ensuring continuous service, identifying and allocating costs, educating and training users, managing the configuration, and managing operations. In the ME domain, these are monitoring and evaluating IT performance and providing IT governance. Among the generic IT processes, ME1 has the lowest score of 1.51 and AI5 has the highest score of 2.60.

The overall maturity score of FBT industry is 2.05. This is an indication that IT processes performance and capability maturity level in the Philippine FBT industry is repeatable but intuitive. This maturity score is below the maturity scores of banks and selected life insurance companies as assessed by the first two previous researches. Banks and life insurance companies are under compliance reporting with specific laws that make them controls and risk sensitive. Likewise, the nature and the core of business of these two industries highly involve processing of information and reports that are mission-critical, sensitive, and crucial. It follows, therefore, that to be able to cope with these, they should maximize the use of IT. The FBT industry, on the other hand, has its core business processes in the manufacturing and the delivery of a tangible good. Though, at present, there have been trends of automating production lines, the industry is still in the transitional stage in spite of companies in this industry to have been in existence, in an average, for more than 15 years.

As companies in the FBT industry aim to a higher maturity level, they usually just stick to a repeatable but intuitive process first. This maturity level is only temporary as these companies may choose to improve on their internal setup. A reason why companies undergo this level is the absence of a concrete set of formal procedures on how processes are performed. IT procedures are usually established by middle- or low-level management. However, if new processes are set, then it would only follow that the proper procedures are yet to be established for these new processes. Having the proper IT processes is a matter of discovery for most companies. Then they will realize that these become the best practices. It then takes numerous revisions to the manuals before the most effective and efficient means of executing the process is discovered. With this, it takes a while for a company to reach the level where a defined IT processes are already documented, in place, and practiced.

RECOMMENDATIONS

But companies in the FBT industry may fast track reaching the next immediate level. To move to the next level, companies need to; (1) continually refine a common language for goal setting, stating these in business terms so that IT process improvement measures now well understood by senior management and enterprise stakeholders; (2) make annual planning a cross-organizational team effort where the common goal is maximizing IT value delivery and managing IT-related risks. This includes regular steering group evaluation and assessment of IT capabilities and projects that have been completed and that have, whether or not, delivered real improvements to its performance; and (3) develop meaningful service level agreements for both internal services to users and external service providers.

Further, in the longer run, there is also a need to: (1) achieve full transparency of IT activities, senior management has complete confidence in the strategic role of IT and in how decisions are made; (2) fully optimize the direction of IT activities toward real business priorities, and the value being delivered to the enterprise can be measured and steps taken on a timely basis to correct significant deviations or problems; (3) have a standardized performance measurement process, such as balanced scorecard, is fully understood and embraced by the organization; (4) have the practice of continuous improvement of IT capability embedded in the culture and this includes regular external benchmarking and independent audits providing positive assurance to management and that the cost of IT is monitored effectively and the organization is able to achieve optimal IT spending through continuous internal improvements; and (5) have an effective outsourcing of selected services and effective negotiation with vendors such that when dealing with external business partners or service providers, the organization is able to demonstrate first-class performance and demand best practices from others.

Companies should also realize that the industry's core business is related to manufacturing goods. It is recommended, therefore, to continue improving and investing in systems related to manufacturing processes and streamlining production line since this is the industry's key strength. However, with regard to its back office operations, it is recommended to look at the possible option

of outsourcing them as they are not the core business of the industry. In this case, companies will be more focused on allocating its budget and resources to producing goods more efficiently and in high quality through sophisticated automated manufacturing processes.

In addition, regulatory agencies should revisit and review existing policies and regulations that govern the FBT industry and devise means on how to increase compliance and adherence to those in a doable and practicable fashion.

Finally, it is recommended that more research be conducted in this discipline – and more on to the empirical type of research – that will serve as a jump-off point to enrich further existing literature in applied IT governance. Variables of key interest for future researches range from selecting a comparable industry type to relating maturity levels to different quantitative and qualitative factors.

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EXHIBITS

	Exhibit A: Maturity scores (per generic process per domain)	
		Maturity Score
	PLAN AND ORGANIZE	
PO1	Define a Strategic IT Plan	2.25
PO2	Define the Information Architecture	1.52
PO3	Determine Technological Direction	2.15
PO4	Define the IT Processes, Organization and Relationships	2.4
PO5	Manage the IT Investment	2.26
PO6	Communicate Management Aims and Direction	2.3
PO7	Manage IT Human Resources	2.42
PO8	Manage Quality	1.67
PO9	Assess and Manage IT Risks	1.79
PO10	Manage Projects	2.15
	ACQUIRE AND IMPLEMENT	
AI1	Identify Automated Solutions	2.48
AI2	Acquire and Maintain Application Software	2.07
AI3	Acquire and Maintain Technology Infrastructure	2.01
AI4	Enable Operations and Use	2.26
AI5	Procure IT Resources	2.6
AI6	Manage Changes	2.35
AI7	Install and Accredit Solutions and Changes	2.07
	DELIVER AND SUPPORT	
DS1	Define and Manage Service Levels	2.19
DS2	Manage Third-Party Services	1.91
DS3	Manage Performance and Capacity	2.03
DS4	Ensure Continuous Service	1.58
DS5	Ensure Systems Security	2.28
DS6	Identify and Allocate Costs	1.83
DS7	Educate and Train Users	1.68
DS8	Manage Service Desk and Incidents	2.15
DS9	Manage the Configuration	1.89
DS10	Manage Problems	2.55

Exhibit A: Maturity scores (per generic process per domain)		
		Maturity Score
DS11	Manage Data	2.12
DS12	Manage the Physical Environment	2.03
DS13	Manage Operations	2.01
	MONITOR AND EVALUATE	
ME1	Monitor and Evaluate IT Performance	1.51
ME2	Monitor and Evaluate Internal Control	1.94
ME3	Ensure Regulatory Compliance	2.12
ME4	Provide IT Governance	1.76

Exhibit B: Participating companies	
FBT Company	*Office Address*
AgriNurture, Inc.	35 Gasan St., Masambong, San Francisco Del Monte, Quezon City
Alaska Milk Corporation	6F Corinthian Plaza, 121 Paseo de Roxas, Makati City
Alliance Tuna International, Inc.	Suite 1205 East Tower, PSE Center, Exchange Road, Ortigas Center, Pasig City
Bogo-Medellin Milling Company, Inc.	30F Citibank Tower, 8741 Paseo de Roxas, Makati City
Central Azucarera de Tarlac, Inc.	J. Cojuangco & Sons Bldg., 119 dela Rosa cor Palanca, Jr. Sts., Legaspi Village, Makati City
Cosmos Bottling Corporation	1890 Paz Guazon Ave., Otis, Paco, Manila City
Ginebra San Miguel, Inc.	3F & 6F, San Miguel Properties Center, St. Francis Ave., Mandaluyong City
Jollibee Foods Corporation	10F Jollibee Plaza Bldg., Emerald Ave., Ortigas Center, Pasig City
Liberty Flour Mills, Inc.	Liberty Bldg., 835 Arnaiz Ave., Makati City
Pepsi-Cola Products Philippines, Inc.	Km. 29 National Road, Tunasan, Muntinlupa City
Philippine Tobacco Flue-Curing & Redrying Corporation	802 A. Bonifacio St., Balintawak, Quezon City
RFM Corporation	RFM Corporate Center, Pioneer St., Mandaluyong City
Roxas and Company, Inc.	6F Cacho Gonzalez Bldg., 101 Aguirre St., Legaspi Village, Makati City
Roxas Holdings, Inc	6F Cacho Gonzalez Bldg., 101 Aguirre St., Legaspi Village, Makati City
San Miguel Brewery, Inc.	40 San Miguel Ave., Mandaluyong City

Exhibit B: Participating companies	
FBT Company	*Office Address*
San Miguel Corporation	SMC Complex, 40 San Miguel Ave., Mandaluyong City
San Miguel Pure Foods Company, Inc.	JMT Corporate Condominium, ADB Ave., Ortigas Center, Pasig City
Swift Foods, Inc.	8F, RFM Corporate Center, Pioneer St., Mandaluyong City
Tanduay Holdings, Inc.	348 Nepomuceno St., San Miguel District, Manila City
Universal Robina Corporation	43F Robinson Equitable Tower, ADB Ave., Ortigas Center, Pasig City
Vitarich Corporation	Unit 30 2F, Facility Center, 548 Shaw Blvd., Mandaluyong City

Exhibit C: Participating IT experts	
Name	*IT-related certification*
Villuerbanne C. Ave	CPA, CISA
Caroline D. Guadana	CPA, CISA
Christian P. Soriano	CPA, CISA

COULD DECISION TREES HELP IMPROVE FARM SERVICE AGENCY LENDING DECISIONS?

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Jozef Zurada, University of Louisville
Douglas K. Barney, Indiana University Southeast

ABSTRACT

This study examines whether a statistically derived decision tree could serve as a means to improve U.S.A. Farm Service Agency lending decisions. The study is a substantial extension and reanalysis of an earlier work by Barney, Graves and Johnson, (1999). Results indicate that a decision tree could be a valuable tool for Farm Service Agency employees in their lending decisions. The decision tree provides as good or better predictive accuracy than neural networks and logistic regression models at reasonable cutoff levels of Type II to Type I costs of lending. The decision tree also meets the transparency criteria for Farm Service Agency purposes by providing logical, understandable rules for lending decisions.

INTRODUCTION

The Farm Service Agency (FSA) directly loans, or guarantees loans to farmers totaling billions of dollars. The need for an understandable, accurate decision tool to assist FSA employees in their lending decisions is as great today as in the past. This article describes a substantial extension and reanalysis of an earlier work by Barney, Graves and Johnson (1999) examining Farmers Home Administration (FmHA) (predecessor of the FSA) lending decisions. Also, see Barney (1993) for a full description of the background and analysis. We do not recommend a loan classification system for immediate FSA use. Rather, we test whether a decision tree could potentially improve FSA lending practices, make lending decisions more transparent and be easily understood by applicants and the FSA staff. This study extends the earlier work by examining additional logistic regression models and neural networks and by investigating whether a decision tree could improve FSA lending decisions. This new analysis indicates that a decision tree could aid FSA employees in their lending decisions. The decision tree provides as good or better predictive accuracy than other methods, and provides logical, understandable rules for lending decisions.

Section 2 ties this study to the prior Barney, Graves and Johnson (1999) study, briefly reviews FSA lending, and summarizes relevant literature. Then, research methods are described in Section 3, followed by discussion of results in Section 4 and conclusions in Section 5.

LITERATURE REVIEW

Relationship of This Study to Barney, Graves and Johnson (1999)

The authors of the 1999 study used the newest methodology of that time (i.e. neural networks) to develop a model for FmHA use. This study investigates whether a better, possibly more accurate, fully transparent and interpretable methodology could now be applied by the FSA. This work extends the earlier work of Barney, Graves and Johnson (1999) by comparing a data mining technique, the decision tree, with the methodologies used in the 1999 study. Also, different logistic regression models and neural networks than those used in the 1999 study are developed.

Two factors are central to a technique's usefulness for the FSA: (1) ability to clearly and accurately categorize potential farm borrowers between those who will make scheduled debt payments and those who will not make timely debt payments, and (2) transparency and understandability to borrowers and FSA employees. The FSA is subject to the provisions of the Equal Credit Opportunity Act (1975) and therefore must be able to provide a clear explanation to borrower applicants when the FSA denies them a loan. The 1999 study found that the neural network produced predictive accuracy superior to criteria developed internally by the FmHA (FSA), criteria developed by Price Waterhouse, logistic regression and ordinary least-squares regression models. Even so, operation of the neural network model was not transparent to FSA employees and borrowers.

A neural network tends to work as a "black box" which would render lending decisions less subject to manipulation by loan applicants. However, that aspect of neural networks would make justifying a loan denial more difficult because FSA employees could not point to particular criteria as reasons for the denial. A decision tree may well serve as a lending decision tool as accurate as a neural network, but with the transparency of more traditional models and less subject to manipulation than the FSA model.

Also, the Barney, Graves and Johnson (1999) study concentrated entirely on two techniques: logistic regression and neural networks. In both methods they used all 14 input variables for building the models and testing their classification accuracy rates. The decision tree techniques and stepwise linear regression used in this study are classification and variable reduction techniques at the same time. Our best model, the chi-square decision tree, identified only four variables as relevant in predicting future loan payments, and pruned the remaining ten variables. Similarly, the stepwise linear regression method identified only three variables (out of 14) as significant. Because Barney, Graves and Johnson (1999) included all variables in his analyses, he developed a large neural network with a dozen neurons in the hidden layer. Such a large network can cause overtraining, i.e., memorizing the training patterns to produce almost perfect classification results on the training set, but less desirable performance on the test set. In this study, we used a small neural network with 2 neurons in the hidden layer to prevent overtraining.

Farm Service Agency Lending

What was once the Farmers Home Administration (FmHA) was merged into the Farm Service Agency (FSA), along with several other federal agencies, in 1995. While the name of the government entity changed, its function, at that time, remained basically unaltered (Farm Service Agency, 2006). Today, as in the early 1990s, the FSA is a lender of last resort for farmers. This means that the FSA will lend to individuals who are unable to obtain funding at reasonable terms from a commercial lender, (i.e. commercially risky borrowers).

Because the FSA is the "lender of last resort" it would expect higher default rates than commercial lenders. For example, the default rate was approximately 27.8% for loans from the early 1990s examined in this study. In contrast, general farm-level data from the Illinois Farm Business Farm Management Association from 1995 to 2002 contained a default rate of 0.567% (Katchova & Barry, 2005). Also, the Seventh Farm Credit District (Arkansas, Illinois, Indiana, Kentucky, Michigan, Minnesota, Missouri, North Dakota, Ohio, Tennessee, and Wisconsin) total loan accounting data base for 2001 contained a total default percentage of 1.83% (Featherstone, Roessler & Barry, 2006).

In comparison, according to Anne Steppe, a loan officer with the FSA, the FSA's direct loan default rate was 10.55% at the end of September 2008 and 16.1% at the end of April 2009 (per email communication on October 16, 2008 and phone conversation May 18, 2009). While this rate is certainly lower than the default rate in Barney's study, the rate is higher than that for other agricultural lenders, as would be expected from the lender of last resort. In addition, the FSA has experienced increased demand for its farm loans as a result of the 2008 lending/financial market crisis (per phone conversation with Tracy Jones, FSA Senior Loan Officer, Washington DC, May 13, 2009).

The FSA has two major farm borrowing plans. Originally, the FSA mission was to directly lend money to farm borrowers. More recently, the FSA has attempted to reduce its direct loan program and focus its activities more on guaranteeing loans made to farmers by commercial banks. Under the guaranteed loan program farmers start the loan process by requesting a loan from a commercial lender. If the commercial lender sees the loan as borderline, the lender then approaches the FSA about guaranteeing the loan. The FSA program will guarantee up to 95% of a farm loan.

The FSA has clearly moved away from making direct loans and emphasizes its guaranteed loan program. For example, at December 31, 1990 (shortly before data collection for the 1999 study) the FmHA held approximately $17 billion in direct loan debt, approximately 13% of all outstanding farm debt. At December 31, 2007, the FSA held approximately $5 billion in direct loan debt, approximately 2.3% of all outstanding farm debt. (Amounts calculated from information at http://www.ers.usda.gov/Data/FarmBalanceSheet/fbsdmu.htm.) Consequently, the relative overall importance of the FSA in direct agricultural lending has declined. However, the FSA continues to guarantee much outstanding farm debt.

From fiscal 2000 to 2004, 98,000 unique farmers and ranchers received 137,000 FSA direct and guaranteed loans totaling $16.3 billion. Direct programs accounted for only about one-fourth of all dollars obligated, but because of their lower average loan size accounted for half of all borrowers served. (Farm Service Agency, 2006, p. 25)

The decision to guarantee a loan should require diligence by FSA employees similar to that expended in evaluating a direct loan. Thus, finding an adequate decision criteria/tool may be as important today as in the early 1990s.

Lending Criteria

Despite changes in the focus of FSA lending, discussed above, the process of direct lending at the FSA has undergone only minor changes since the original data was collected in the early 1990s. The FSA (FmHA) for decades used the same, primarily unaltered, form to collect farm financial data. This form, the FHP, provided some current balance sheet and projected income statement information. In 2005, new forms replaced the FHP nationwide. The FSA now uses the information on these two forms (FSA 2037 and FSA 2038) to develop the Farm Business Plan. The Farm Business Plan is very similar in content to the Farm and Home Plan, which it replaced. Both required considerable information about expected production operations (e.g. acres of corn, number of cows), revenues and expenses. To verify the reasonableness of the expense estimates on the Farm Business Plan, the FSA now also expects the borrower to provide up to five years of tax returns, if available. Lack of tax return data to support the expense estimates does not disqualify a borrower from receiving a loan and the tax returns are not otherwise used in the lending decision.

At the time of the Barney, Graves and Johnson (1999) study, the FmHA lending decision process was based on one number (a score for projected repayment ability) developed from actual and projected financial statements. Because projected repayment ability was based entirely on projected data, it was highly subject to manipulation. The FSA still uses only one number to make the loan decision, the Margin After Debt Service (MADS). This number is calculated in essentially the same manner as projected repayment ability. MADS is calculated by subtracting all projected operating and living expenses and next year's principal and interest payments from projected total farm income.

In the past, the FSA tried to change both the financial statements required of borrowers and the criteria used in the lending decision. In the late 1980s the FmHA attempted to switch to GAAP-based farm financial statements. Negative feedback from farmers (and from some FmHA employees) was so harsh that Congress passed a law forbidding the FmHA to use those statements further.

Also in the 1980s, the FmHA engaged Price Waterhouse to develop a lending model. After considerable time and expense, Price Waterhouse developed several credit screens, for different

types of loans. In addition, for several years the FmHA tested and used internally (not for making or denying loans, but solely for evaluation purposes) a four ratio evaluation model somewhat similar to the Price Waterhouse model. The FmHA never used the Price Waterhouse or internally developed models in its lending decisions.

Despite not adopting either the Price Waterhouse screening tool or its own internally generated model, the FSA evaluated these methods based on the FSA's two primary criteria: discriminatory power to separate borrowers who will repay FSA debt from those who will not, and transparency. Transparency, in essence, means that the decision criteria are understandable by both potential borrowers and the FSA local staff. Thus, the method used should provide clearly identified criteria for why a borrower received or was denied a loan.

Decision Trees as a Possible Improvement

Barney, Graves and Johnson (1999) examined the accuracy of different techniques/models at predicting whether farm borrowers would make farm loan payments as scheduled one year hence, based on data from the FHP and the past two years of repayment history. They found that a neural network could predict loan repayment (based on model accuracy measured in Type I, Type II, and total errors) better than the internally developed FmHA, Price Waterhouse, logistic regression, and ordinary-least-squares regression models.

Classification/predictive ability is an important criterion for any technique/model used. The previous discussion indicates that understandability of the loan decision process is also important to the FSA. Research with publicly traded companies has noted the same issue. Consequently, decision trees may be appealing because they produce easily interpretable results which could be understood by participants in the FSA lending process. For example, data mining literature specifically endorsed decision trees as an analytical method to generate easily understood and explained decisions in the form of if-then rules (Berry & Linoff, 1997; Kantardzic, 2003). Decision trees offer other advantages over alternative predictive methods, including that they do not require an excessive amount of computation, and unlike neural networks, easily identify the most important predictive variables (Berry & Linoff, 1997). If decision trees can be effective in predicting repayment or default on loans, they may be useful tools to help the FSA evaluate the ability of farmers to repay loans.

To attempt to find the best predictive techniques, prior research with public companies has compared several different methods, including decision trees. During the financial crisis of the late 1990s, critics of South Korean financial institutions' loan decisions believed that those decisions themselves determined whether a company survived or entered bankruptcy (Kyung, Chang & Lee, 1999). According to Kyung, Chang and Lee (1999), financial institutions' reliance on arbitrary judgment or a complicated statistical method would not satisfy business and political leaders who would prefer to hear well-defined, understandable decision rules for lending decisions. Consequently, they evaluated the predictive ability of a decision tree for data from corporations

listed on the Korea Stock Exchange. They concluded that the decision tree performed well, with substantially higher predictive accuracy rates than a multiple discriminant model under crisis conditions and slightly higher predictive accuracy under normal conditions.

Koh (2004) compared the ability of a logistic regression model, a neural network, and a decision tree to accurately classify 165 U.S. companies that became bankrupt from 1980 to 1987 and 165 matching U.S. companies. Similar to Kyung, Chang and Lee (1999), Koh (2004) observed better overall classification rates produced by the decision tree than the logistic regression model or neural network. Consequently, research in the corporate setting indicates that the decision tree technique may provide a viable alternative tool for loan screening by the FSA.

METHODS

Data Collection and Variables

The data set used in Barney (1993) and Barney, Graves and Johnson (1999) was collected from FSA employees (FmHA loan officers) randomly across the United States. Loan officers provided anonymous (borrower personal information was deleted) copies of FHPs. The data set and variables used in this study are the same as were used in the 1999 study. (See Barney, Graves & Johnson, 1999; Barney, 1993 for a more complete explanation of the variables and the data collection process used.)

The FHPs included financial operating results for 1990 and balance sheet balances at 1 January 1991. (Variables are defined in Table 1.) Whether the related borrowers made scheduled debt payments on 1 January 1992 was also noted by the loan officers. Lending officers reported a total of 261 observations. These observations were randomly divided into 196 training set observations and 65 test set observations. After eliminating 17 observations with incomplete data, the training set contained 184 observations (130, 70.7% repayments and 54, 29.3% defaults) and the test set contained 60 observations (46, 76.7% repayments and 14, 23.3% defaults).

Table 1[a] Prediction model variables[b]		
Dependent Variable:	FmHA loan payment on 1 January, 1992 (PAY92) = 0 if missed, 1 if made	
Independent Variables:		
Current Ratio (CR)	=	$\dfrac{\text{1991 Total current farm assets}}{\text{1991 Total current farm liabilities}}$
Working Capital (WC)	=	1991 Total current farm assets - 1991 total current farm liabilities
Debt-to-Assets (DEBT/ASSETS)	=	$\dfrac{\text{1991 Total debts}}{\text{1991 Total assets}}$

<table>
<tr><td colspan="3">Table 1.^a Prediction model variables^b</td></tr>
</table>

Debt-to-Equity (DEBT/EQUITY)	=	$\dfrac{\text{1991 Total debts.}}{\text{1991 Total assets - 1991 Total debt + 400,000}}$
Return on Farm Assets (RFA90)	=	$\dfrac{\text{1990 Total cash farm income from operations - operating expenses - family living expenses}}{\text{1990 Beginning total farm assets}}$
Return on Equity (RRE90)	=	$\dfrac{\text{1990 Total cash farm income - operating expenses - interest expense - family living expenses}}{\text{1990 Total assets - 1990 Total debt + 400,000}}$
Operating Proft Margin (OPM90)	=	$\dfrac{\text{1990 Total farm income - actual operating expenses - family living expenses}}{\text{1990 Total farm income}}$
Projected Debt Repayment ratio (PDR91)	=	$\dfrac{\text{Total debt and interest payments due on 1991 FHP}}{\text{1991 Projected total cash farm income + Non-farm income}}$
Debt Repayment Ratio (DR90)	=	$\dfrac{\text{Total debt and interest payments due on 1990 FHP}}{\text{1990 Total cash farm income + Non-farm income}}$
Asset Turnover (AT90)	=	$\dfrac{\text{1990 Total cash farm income}}{\text{1990 Beginning total farm assets}}$
Operating Expense (OE90)	=	$\dfrac{\text{1990 Total operating expenses}^{c}}{\text{1990 Total farm income}}$
Interest Expense (IE90)	=	$\dfrac{\text{Total 1990 actual interest expense paid}}{\text{Total 1990 farm income}}$
Dummy Variable (REST90)	=	0 if restructured on 1 January, 1990; 1 otherwise
Dummy Variable (REST91)	=	0 if restructured on 1 January, 1991; 1 otherwise

a   From Table 1 of (Barney, Graves, & Johnson, 1999)
b   Unless stated otherwise, all ratios are calculated after restructuring and new loans.
c   Unless stated otherwise, operating expenses do not include interest expense.

Analytical Methods

Logistic regression models, neural networks, and decision trees were used to analyze the data. A more detailed description of decision trees than the other techniques follows because use of the decision tree technique is the main extension provided by this study. Because many research studies involving use of categorical dependent variables have used logistic regression and neural networks, readers may see Press and Wilson (1978, Hosmer and Lemeshow (1989) for a complete description of logistic regression, and Hagan, Demuth and Beale (1996), Han and Kamber (2001), Giudici (2003), Kantardzic (2003) and SAS Enterprise Miner at http://www.sas.com) for a detailed and theoretical description of neural networks.

Logistic Regression

We will only briefly discuss logistic regression because many previous research studies with categorical dependent variables have used logistic regression. Logistic regression is included in

several statistical packages. We performed analysis using the Statistical Analysis System (SAS) which uses an iteratively reweighted least squares algorithm to compute maximum likelihood estimates of the regression parameters (SAS Institute, Inc. 1999). SAS uses the following model to classify farmers into the missed payment or made payment categories:

$$g(Y) = \ln [P(\text{PAY92}=0 \mid x) / P(\text{PAY92} =1 \mid x)] = \beta_0 + \Sigma\beta_i \, x_i + \varepsilon \qquad (1)$$

where: PAY92 = 0 if the farmer missed payment due January 1, 1992; and
1 if the farmer made payment due January 1, 1992.

The independent variables included in the analysis are denoted with the general expression, x.

Neural Networks

Popular data mining tools include neural networks. Neural networks have been used in a variety of business applications. Neural networks are simple computer programs that build mathematical models of the connections in the human brain by trial and error during data analysis. The computational property, the architecture of the network, and the learning property characterize neural network models (Hagan, Demuth & Beale, 1996).

The computational properties of a neural network are defined by the model of a neuron and weights connecting neurons. Typically, each neuron includes the summation node and the nonlinear activation function of the sigmoid $o = \dfrac{1}{1+\exp(-\lambda s)}$ form and/or hyperbolic tangent form

$o = \dfrac{\exp(s)-\exp(-s)}{\exp(s)+\exp(-s)}$.

where $s=\mathbf{W}\mathbf{x}$ is the scalar output from a summation node;
l is the steepness of the activation function;
$\mathbf{W}$ is a weight matrix and $\mathbf{x}$ is an input vector.

In SAS Enterprise Miner, which was used in this simulation, the hyperbolic tangent and sigmoid are the default activation functions used in the hidden and output layers, respectively.

Neural networks are built from many neurons, organized in layers, because single neurons have limited capability. The typical neural network contains a hidden layer and an output layer. Using a numerical connection called a weight, each neuron in the hidden layer connects with every input and neuron in the output layer, if the neural network is fully connected. The strength of the connection and the relative importance of each input to the neuron are represented by the weights.

Because the network learns through repeated adjustment of the weights, they are crucial to neural networks' operation. Knowledge gained by the network during learning is encoded by the weights.

Neural networks come in several architectures. One of the most common architectures used in financial/accounting applications is the two-layer feed-forward network with error back-propagation. In such a network, signals propagate through the two layers from input to output.

Neural networks learn by experience from training patterns, typically in a supervised mode. A neural network is presented with many training patterns, one at a time. Each of the training patterns is marked by the class label of the dependent variable. After seeing enough of these patterns, the neural network builds the response model which reads in unclassified cases not seen during training, one at a time, and updates each with a predicted class.

Neural networks use a nonlinear activation function to model nonlinear behavior. Consequently, researchers often employ neural networks to solve sophisticated tasks and approximate functions in which relationships and interactions between variables are complex and nonlinear. One of the drawbacks of neural networks is the fact that the explicit mathematical equation estimated by the network to classify data is unknown; the neural network's knowledge is encoded in the numerical connections, called weights. Consequently, if/then rules that represent the relationships between inputs and outcomes cannot be easily constructed, making the produced results difficult to explain.

In our study we used a feed-forward network with back-propagation, default learning algorithm, and standard deviation normalization for input variables, all available in SAS Enterprise Miner. We tested several networks with different number of neurons in the hidden layer and one neuron in the output layer. The network with 2 neurons in the hidden layer apparently yielded the best classification results.

Decision Trees

Decision trees can also perform efficiently in classification tasks. Decision trees consist of flow-chart-like tree structures, where tests on the attributes are represented by nodes, conditions are represented by branches, and classes are reported in leaf nodes. Decision trees learn from input data in a supervised mode. For classification, the attribute values of an unknown sample are tested against the decision tree. The tree traces a path from a leaf node predicting a specific class back to the tree root for that sample.

Each unique path from the root to a leaf is represented by a rule. From the tree, if-then rules can easily be constructed to represent relationships between the dependent and independent variables. These rules can be very useful by providing insight into the model's operation and a compact explanation of the data. Reported at each node is the number of observations entering the node, the classification of the node, and the percent of cases correctly classified.

In decision trees, the type of splitting criteria available depends on the measurement level of the dependent variable. When the dependent variable is binary, the following three splitting

criteria are common: entropy reduction, Gini reduction and chi-squared test. One of the most common techniques for construction of entropy-based decision trees is the C4.5 algorithm which builds decision trees by a recursive, top-down, divide-and-conquer method (Quinlan 1993). The algorithm continually divides a data set into finer and finer clusters. The algorithm places the strongest predictive variable at the root of the tree.

The algorithm tries to produce pure clusters at the nodes by progressively reducing impurity in the original data set. Entropy (a concept borrowed from information theory) measures the impurity/information content in a cluster of data. The algorithm computes the gains in purity from all possible splits, and chooses a split that maximizes information gain. The process continues and the algorithm determines the least amount of splits to minimize the error rate on the training data set. Fewer splits, branches, and variables, produce a more understandable tree.

We now provide a brief introduction to the well-established concepts of entropy and information gain used to measure impurity. If a collection, *S*, contains positive (*yes*) and negative examples (*no*) of a target concept, the entropy of *S* in relation to that Boolean classification is:

$$Entropy(S) \equiv -p_{yes} \, log_2 \, p_{yes} - p_{no} \, log_2 \, p_{no} \tag{2}$$

In the equation, p_{yes} and p_{no} are the proportions of positive and negative examples in *S*, respectively.

The entropy of *S,* when the target attribute can take on *k* different values, is related to a *k*-wise classification defined as:

$$Entropy(S) \equiv \sum_{i=1}^{k} -p_i \, log_2 \, p_i \qquad \text{in the entropy reduction method, and}$$

$$Entropy(S) \equiv \left(1 - \sum_{i=1}^{k} (p_i)^2 \right) \qquad \text{in the Gini reduction method.}$$

Relative to a collection of examples *S, Gain(S, A),* the information gain of an attribute *A*, is defined as:

$$Gain(S, A) \equiv Entropy(S) - \sum_{v \in Values(A)} \frac{S_v}{S} Entropy(S_v) \tag{3}$$

In the formula, *Values(A)* represents the set of all possible values for attribute *A*, while S_v represents the subset of *S* when attribute *A* has the value *v* (i.e., $S_v = \{ s \in S | A(s) = v \}$

Chi-squared splitting criteria measure the reduction in variability of the target distribution in the branch (child) nodes. Specifically, the likelihood ratio Pearson chi-squared test statistic is a measure of association between the categories of the dependent variable and the branch nodes. This test statistic can be used to judge the worth of the split; it measures the difference between the observed cell counts and what would be expected if the branches and target classes were independent. We used a default significance level of 0.20 recommended by SAS for binary classification problems. (The 0.1 significance level produced exactly the same decision tree and the same classification rates for the training and test sets, whereas the 0.05 and 0.01 significance levels produced two simple trees with worse classification rates than the 0.2 significance level.

To summarize, logistic regression and neural networks embed their knowledge in their coefficients and weights, respectively, whereas knowledge in decision trees is represented in the form of linear and transparent rules. We discuss decision trees further in the following Results section. For a more thorough and comprehensive description of decision trees, see Giudici (2003; SAS Enterprise Miner at www.sas.com; Quinlan (1993); Dhar and Stein (1997; Kantardzic (2003).

RESULTS

Decision Tree

Because use of a decision tree is the focus of this study, we begin this section discussing results from the three decision tree methods. An advantage of using decision trees over neural networks is their ability to calculate the relative importance of input variables based on their predictive power and overall contribution to the classification tree (Breiman, Friedman, Olshen & Stone, 1984). The tree node incorporates the agreement between the surrogate split and the primary split in the calculation. The variable importance measure is scaled to be between 0 and 1 by dividing by the maximum importance. Thus, larger values indicate greater importance. Variables that do not appear in any primary or saved surrogate splits have importance equal to 0.

Table 2 presents the variables deemed important by the three decision tree methods. Panels A and B for the entropy reduction and Gini reduction methods, respectively, show that seven and ten variables, respectively, are important in those methods. The entropy reduction and Gini reduction methods consequently contain numerous splitting rules. In contrast, the results for the chi-squared test method, reported in Panel C, include only four important variables and relatively few splitting rules.

Table 2. Decision Tree - Relative Importance of Variables			
Panel A. Entropy reduction method			
Variable Name	Importance Value	Variable Role	Number of Splitting Rules Using the Variable
OE90	1.0	Input	4
REST90	0.798	Input	1
DEBT/ASSETS	0.62	Input	2
DEBT/EQUITY	0.62	Input	2
WORK_CAP	0.464	Input	1
AT90	0.458	Input	1
RFA90	0.349	Input	1
Remaining 7 variables	0.0	Rejected	0
Panel B. Gini reduction method			
Variable Name	Importance Value	Variable Role	Number of Splitting Rules Using the Variable
OE90	1.0	Input	2
REST90	0.906	Input	1
RRE	0.763	Input	2
DEBT/ASSETS	0.703	Input	2
RFA90	0.542	Input	1
IE90	0.528	Input	1
AT90	0.518	Input	1
DEBT/EQUITY	0.513	Input	1
DR90	0.458	Input	1
REST91	0.431	Input	1
Remaining 4 variables	0.0	Rejected	0
Panel C. Chi-square method			
Variable Name	Importance Value	Variable Role	Number of Splitting Rules Using the Variable
REST90	1.0	Input	1
OE90	0.951	Input	1
DEBT/ASSETS	0.528	Input	1
REST91	0.477	Input	1
Remaining 10 variables	0.0	Rejected	0

Table 2. Decision Tree - Relative Importance of Variables	
Dependent Variable:	PAY92 = 0 if missed, 1 if made
Independent Variables:	
REST90	= 0 if restructured on 1 January, 1990; 1 otherwise
REST91	= 0 if restructured on 1 January, 1991; 1 otherwise
DEBT/ASSETS	= 1991 Total debts/1991 Total assets
OE90	= 1990 Total operating expenses/1990 Total farm income
DEBT/EQUITY	= 1991 Total debts/(1991 Total assets - 1991 Total debt + 400,000)
WORK_CAP	= 1991 Total current farm assets - 1991 total current farm liabilities
AT90	= 1990 Total cash farm income/1990 Beginning total farm assets
IE90	= Total 1990 actual interest expense paid/Total 1990 farm income
RFA90	$= \dfrac{\text{1990 Total cash farm income from operations - operating expenses - family living expenses}}{\text{1990 Beginning total farm assets}}$
RRE	$= \dfrac{\text{1990 Total cash farm income from operations - operating expenses - family living expenses}}{\text{1990 Total assets - 1990 Total debt + 400,000}}$
DR90	$= \dfrac{\text{Total debt and interest payments due on 1990 FHP}}{\text{1990 Total cash farm income + Non-farm income}}$

All three decision tree methods find that OE90, REST90, and DEBT/ASSETS are three of the four most powerful predictive variables. The methods disagree on what other variables are important. The chi-squared method found REST90 to contain the most predictive power. Thus, REST90 serves as the root of the chi-square tree. The relative importance of this variable is 1. Then OE90, DEBT/ASSETS, and REST91, in that order, were used in the tree. All the remaining ten variables have been pruned because their presence does not increase the overall classification accuracy of the tree.

All else equal, the simpler the decision tree and the fewer splitting rules, the better, particularly for FSA use. The chi-squared test method produced the simplest tree. However, predictive accuracy is an important criterion for potential users of decision trees. The decision trees developed on the training set were applied to the 60 test cases not included in the training set. Table 3 reports the predictive accuracy at different cutoff probabilities for these 60 observations overall, for the 14 defaulted loans, and the 46 paid loans.

Cutoff probability [%]	DT Entropy reduction			DT Gini reduction			DT Chi square		
	O[1]	D[1]	P[1]	O	D	P	O	D	P
0	14 23.3	14 100.0	0 0.0	14 23.3	14 100.0	0 0.0	14 23.3	14 100.0	0 0.0
10	29 48.3	14 100.0	15 32.6	34 56.7	9 84.3	25 54.3	14 23.3	14 100.0	0 0.0
20	33 55.0	11 78.6	22 47.8	41 68.3	8 57.1	33 55.0	17 28.3	13 92.9	4 8.7
30	34 56.7	10 71.4	24 52.2	42 70.0	8 57.1	34 56.7	48 80.0	8 57.1	40 87.0
40	34 56.7	10 71.4	24 52.2	42 70.0	8 57.1	34 56.7	48 80.0	8 57.1	40 87.0
50	48 80.0	7 50.0	41 89.1	44 73.3	7 50.0	37 61.7	50 83.3	7 50.0	43 93.5
60	48 80.0	7 50.0	41 89.1	42 70.0	5 35.7	37 61.7	48 80.0	5 35.7	43 93.5
70	46 76.7	5 35.7	41 89.1	42 70.0	5 35.7	37 61.7	48 80.0	5 35.7	43 93.5
80	46 76.7	5 35.7	41 89.1	42 70.0	5 35.7	37 61.7	48 80.0	5 35.7	43 93.5
90	47 78.3	5 35.7	42 91.3	46 76.7	5 35.7	41 89.1	48 80.0	5 35.7	43 93.5

Table 3. Classification Accuracy Rates for the Test Set by Different Decision Tree Methods: Counts and Percentages Classified Accurately for Different Cut-off Probabilities.

DT - Decision tree
Of a total of 60 cases divided into 14 defaulted loans and 46 paid loans, counts and percentages for: O – Overall, D – Defaulted, P – Paid

Overall, the chi-squared method classifies loans as accurately, or more accurately, than the other two decision tree methods at all reported cutoff levels above 20 percent. The Gini reduction method is more accurate at the 20 percent and 10 percent cutoff levels. A 50 percent cutoff implies that predicting a repayment is just as important as predicting a default; the cost associated with lending money to a farmer who does not repay (Type II error) is equal to the cost of not lending

money to a farmer who would repay the loan (Type I error). A 30 percent cutoff implies that a Type II error is more costly than a Type I error.

In a research note, Hsieh (1993) estimated that capital investors considered not correctly predicting an actual bankruptcy 3.242 times more costly than falsely predicting that a nonbankrupt firm would become bankrupt. She recommended using a cutoff percentage of .3085 for corporate bankruptcy predictions (Hsieh, 1993). While the loss function of equity investors is certainly different than that for FSA lending decisions, Hsieh's findings provide a reference to estimate appropriate cutoff percentages.

The FSA has a dual purpose in lending money: (1) providing support to farmers and (2) protecting taxpayer dollars through judicious lending decisions. Consequently, a 50 percent cutoff criterion may be appropriate. If the FSA mandate calls more heavily on protecting taxpayer funds, a lower cutoff percentage (perhaps 30 or 40 percent) would be more appropriate. Cutoff percentages above 50 percent would imply the unlikely assumption that denying loans to farmers who could repay their loans (Type I error) is more costly than lending money to farmers who do not repay (Type II error).

We discuss the results for the chi-squared test method in more detail because it produced the best overall classification results on the test set at cutoffs of 30% or greater with the least complex tree in terms of the number of leaves, the number of splits, and the depth of the tree. The tree is easy to understand because it uses only five rules and four variables to classify the data. The tree diagram with results for the training and test sets is shown in Figure 1.

The decision branches and their split values in the tree make sense intuitively. The rules and classification rates produced by the tree for the training set follow. (N = number of cases entering the node). Remember that the dependent variable, payment of FmHA loan due on January 1, 1992, (PAY92) = 0 if missed, 1 if made, and REST90 and REST91 = 0 if farmer's FmHA debt was restructured and 1 if FmHA debt was not restructured in 1990 or 1991, respectively.

The tree generates five rules which use four variables only. As an example, the predicted values are calculated for a 50% cut-off. The tree first classifies loans to any farmers who did not restructure their farm debt on January 1, 1990 as expected to repay.

IF REST90 = 1
THEN Predicted value: 1

N	: 137 training cases	N	: 41 test cases
1	: 79.6% - 109 training cases	1	: 87.6% - 36 test cases
0	: 20.4% - 28 training cases	0	: 12.4% - 5 test cases

Figure 1. Decision tree.

Figure 1. Decision tree.
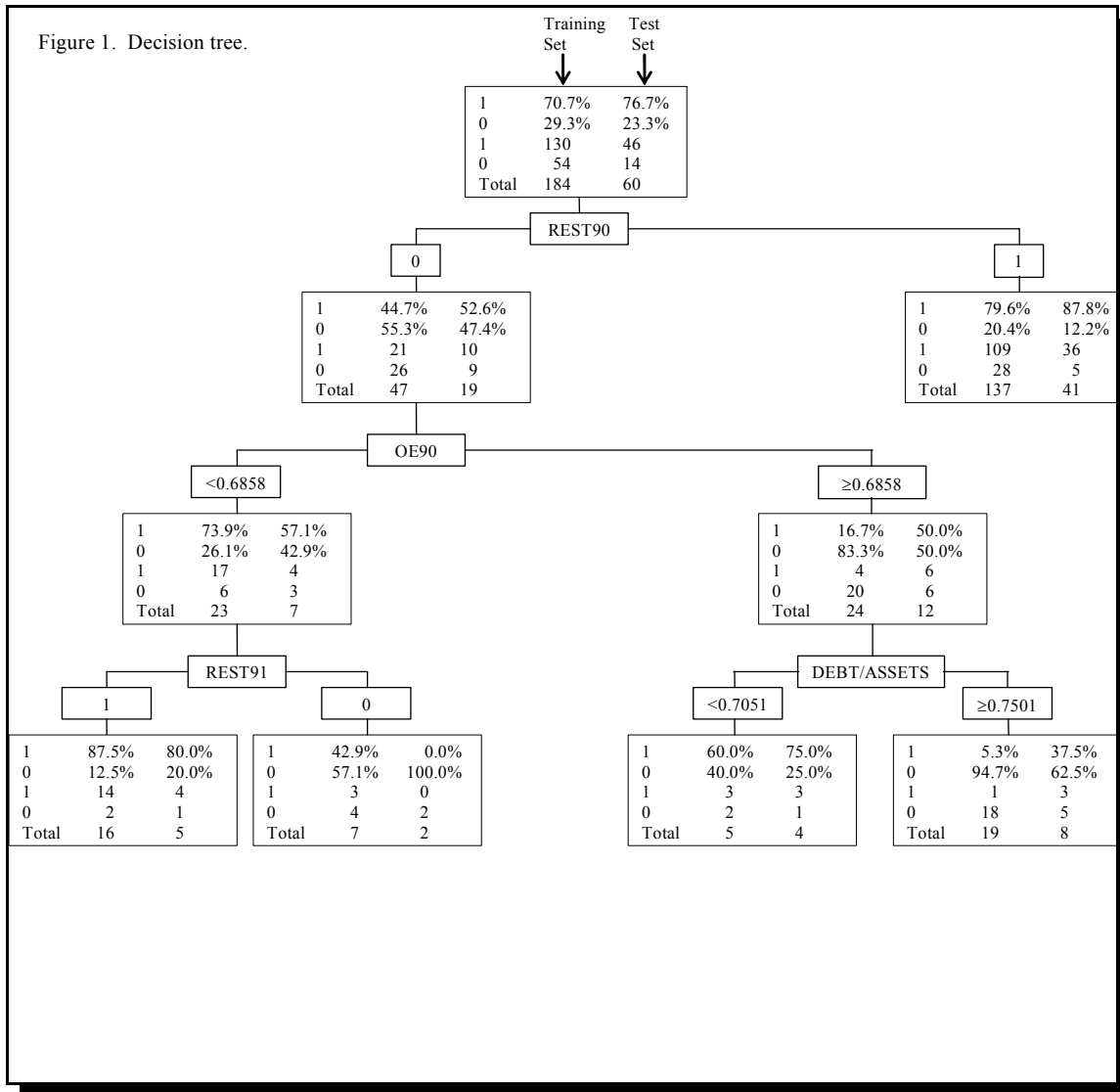
As can be seen in Figure 1, farmers unable to make loan payments in 1990 (REST90 = 0) also faced difficulty paying off the loan due in 1992. (More than half of the farmers with REST90 = 0 in the training set defaulted on the 1992 payment.) For loans to these farmers, the tree examines their operating expense ratio first. If the operating expense ratio is less than 0.6858, whether farm debt was restructured in 1991 becomes the determining classification factor. Farmers who did not restructure debt in 1991 were predicted to repay in 1992 while farmers who restructured in 1991 were not expected to repay in 1992.

IF REST90 = 0 AND OE90 < 0.6858 AND REST91 = 1
THEN Predicted value: 1

N	:	16 training cases	N	:	5 test cases
1	:	87.5% - 14 training cases	1	:	80.0% - 4 test cases
0	:	12.5% - 2 training cases	0	:	20.0% - 1 test case

IF REST90 = 0 AND OE90 < 0.6858 AND REST91 = 0
THEN Predicted value: 0

N	:	7 training cases	N	:	2 test cases
1	:	42.9% - 3 training cases	1	:	0.0% - 0 test cases
0	:	57.1% - 4 training cases	0	:	100.0% - 2 test cases

If farmers restructured debt in 1990 (REST90 = 0) and exhibited operating expenses $\geq$ 0.6858 of farm income (OE90 $\geq$ 0.6858), the likelihood of not paying off the loan increases to about 83%. In this case, the debt to asset ratio becomes the determining classification factor. Such loans exhibiting DEBT/ASSETS < 0.7051 are predicted to make their 1992 debt repayment, while observations with DEBT/ASSETS $\geq$ 0.7051 are predicted to not repay their debt for 1992.

IF REST90 = 0 AND OE $\geq$ 0.6858 AND DEBT/ASSETS < 0.7051
THEN Predicted value: 1

N	:	5 training cases	N	:	4 test cases
1	:	60.0% - 3 training cases	1	:	75.0% - 3 test cases
0	:	40.0% - 2 training cases	0	:	25.0% - 1 test case

IF REST90 = 0 AND OE ^{3} 0.6858 AND DEBT/ASSETS ^{3} 0.7051
THEN Predicted value: 0

N	:	19 training cases	N	:	8 test cases
1	:	5.3% - 1 training case	1	:	37.5% - 3 test cases
0	:	94.7% - 18 training cases	0	:	62.5% - 5 test cases

Neural Network and Logistic Regression

To fully evaluate the predictive ability of the decision tree, the data was also analyzed to select a logistic regression model and neural network that produced the best predictive results. Unlike Barney, Graves and Johnson, (1999) who included all available variables in their logistic regression model, three variable selection methods available in SAS were used to find the best logistic regression model: forward, backward, and stepwise. In the forward selection method, the best one-variable model is first chosen. Then the method selects the best two-variable model among those that contain the first selected variable. The process continues until no additional variables have

a *p*-value less than the specified entry *p*-value known as a significance level. In the backward selection technique, the process begins with all variables included in a model. Variables are then removed from the model until only variables with a *p*-value less than a specified significance level remain.

The stepwise method is a modification of the forward selection method. The difference is that variables already selected for the model do not necessarily stay there. The stepwise process may remove any variable already in the model that is not associated with the dependent variable at the specified significance level. The process continues until none of the variables outside the model has a *p*-value less than the specified significance level and every variable in the model is significant at that level.

We analyzed the data using the three methods. The stepwise selection method, at a specified *p*-value of 0.05, identified a model including three significant variables, DEBT/ASSETS, REST90, and REST91, that produced the best overall classification results for the test set for any logistic regression model. Of several types of neural networks examined, the best classification results were produced by a two-layer, feed-forward network with back-propagation having two neurons in the hidden layer available in SAS Enterprise Miner. Table 4 presents output from the best logistic regression classification model and neural network selected.

Table 4. Logistic Regression Model Output					
Panel A: Likelihood Ratio Test for Global Null Hypothesis: BETA=0					
	Chi-Square	DF	Pr > ChiSq		
Likelihood Ratio	37.2599	3	<.0001		
Panel B: Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Chi-Square	Wald Pr > ChiSq
Intercept	1	0.7643	0.7315	1.0916	0.2961
REST90	1	1.0551	0.3977	7.0366	0.0080
REST91	1	1.1170	0.4090	7.4596	0.0063
DEBT/ASSETS	1	-1.8589	0.6959	7.1354	0.0076

Dependent Variable:
     PAY92 = 0 if missed, 1 if made
Independent Variables:
     REST90 = 0 if restructured on 1 January, 1990; 1 otherwise
     REST91 = 0 if restructured on 1 January, 1991; 1 otherwise
     DEBT/ASSETS = 1991 Total debts/1991 Total assets					

Evaluation/Comparison of Results

Of primary interest is the predictive ability of the analytical methods on the test set -- the 60 observations not included in the training set. The logistic regression model, neural network, and decision tree developed on the training set were applied to the 60 test cases. Table 5 reports the overall classification accuracy for at different cutoff percentages for the FmHA's internally developed criteria, and the criteria developed by Price Waterhouse, reported in the original studies by Barney (1993) and Barney, Graves and Johnson (1999). Table 5 also reports the classification accuracy rates for the overall test set, defaulted loans, and paid loans for the chi-squared test decision tree, neural network, and logistic regression model.

Table 5. Classification Accuracy Rates for the Test Set by Different Methods: Counts and Percentages Classified Accurately for Different Cut-off Probabilities											
Cutoff probability [%]	FmHA[a][b]	PW[a][c]	LR[d]			NN[e]			DT[f]		
	O[g]	O	O	D[g]	P[g]	O	D	P	O	D	P
0	15	17	14	14	0	14	14	0	14	14	0
	25.0	28.3	23.3	100.0	0.0	23.3	100.0	0.0	23.3	100.0	0.0
10	16	25	15	14	1	22	12	10	14	14	0
	26.6	41.7	25.0	100.0	2.2	36.7	85.7	21.7	23.3	100.0	0.0
20	18	29	42	14	28	26	12	14	17	13	4
	30.0	48.3	70.0	100.0	60.9	43.3	85.7	30.4	28.3	92.9	8.7
30	20	30	46	12	34	46	5	41	48	8	40
	33.3	50.0	76.7	85.7	73.9	76.7	35.7	89.1	80.0	57.1	87.0
40	24	37	47	10	37	47	5	42	48	8	40
	40.0	61.7	78.3	71.4	80.4	78.3	35.7	91.3	80.0	57.1	87.0
50	28	39	49	9	40	47	5	42	50	7	43
	46.6	65.0	81.7	64.3	87.0	78.3	35.7	91.3	83.3	50.0	93.5
60	35	43	53	8	45	47	5	42	48	5	43
	58.3	71.7	88.3	57.1	97.8	78.3	35.7	91.3	80.0	35.7	93.5
70	43	43	51	5	46	47	5	42	48	5	43
	71.6	71.7	85.0	35.7	100.0	78.3	35.7	91.3	80.0	35.7	93.5
80	43	44	47	1	46	47	5	42	48	5	43
	71.6	73.3	78.3	7.1	100.0	78.3	35.7	91.3	80.0	35.7	93.5
90	45	44	46	0	46	46	4	42	48	5	43
	75.0	73.3	76.7	0.0	100.0	76.7	28.6	91.3	80.0	35.7	93.5

<table>
<tr><td colspan="1">Table 5. Classification Accuracy Rates for the Test Set by Different Methods:
Counts and Percentages Classified Accurately for Different Cut-off Probabilities</td></tr>
</table>

[a]Adapted from Table 17 in (Barney, Graves & Johnson, 1999)
[b]FmHA – Farmers Home Administration internally developed criteria in 1992
[c]PW – Price Waterhouse model developed for the FmHA
[d]LR - Logistic regression model
[e]NN - Neural network
[f]DT - Decision tree – Chi-square method
[g]Of a total of 60 cases divided int

The chi-squared test decision tree, neural network, and logistic regression model perform better (significantly) overall than the FmHA criteria at the 30 percent through 60 percent cutoffs. These methods are also significantly better than the Price Waterhouse selection criteria at the 30 percent and 40 percent cutoffs. The decision tree and neural network are significantly better at the 50% cut off. Table 6 presents the null hypothesis and the proportional z-statistics for comparisons of the overall accuracy rates of the techniques. The decision tree produces the highest overall classification accuracy rates for the 30, 40, and 50 percent cutoffs. However, the overall classification accuracy rates between the three analytical methods are not significantly different for cutoff percentages 30 percent and higher.

Table 6. Overall Classification Rate Comparisons Z-scores for the Test Set.										
					Cutoff %					
Comparison:	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
FmHA v. PW	-0.41	-1.74*	-2.05**	-1.86*	-2.38**	-2.03**	-1.54	-0.01	-0.21	0.21
FmHA v. DT	0.22	0.42	0.20	-5.16**	-4.47**	-4.21**	-2.57**	-1.07	-1.07	-0.66
FmHA v. LR	0.22	0.20	-4.38**	-4.78**	-4.27**	-4.01**	-3.71**	-1.78*	-0.85	-0.22
FmHA v. NN	0.22	-1.19	-1.51	-4.78**	-4.27**	-3.59**	-2.35**	-0.85	-0.85	-0.22
PW v. DT	0.63	2.15**	2.25**	-3.45**	-2.21**	-2.29**	-1.06	-1.06	-0.87	-0.87
PW v. LR	0.63	0.56	0.55	-3.04**	-1.98**	-1.62	-0.83	-0.83	-0.64	-0.43
PW v. NN	0.63	1.94**	-2.42**	-3.04**	-1.98**	-2.07**	-2.27**	1.77**	-0.64	-0.43
DT v. LR	0.00	-0.22	-4.57**	0.44	0.23	0.23	-1.24	-0.72	0.23	0.44
DT v. NN	0.00	-1.60	-1.71**	0.44	0.23	0.70	0.23	0.23	0.23	0.44
LR v. NN	0.00	-1.39	2.95**	0.00	0.00	0.47	1.47	0.95	0.00	0.00

Note: Z-score for null hypothesis that: (the proportion properly classified by the first method mentioned – the proportion properly classified by the second method mentioned) = 0.
  * Significant at p ≤ 0.05.
  ** Significant at p ≤ 0.01										

A weakness of the decision tree is that the technique predicts relatively poorly for very low probability cutoffs, those that consider the cost of a missed payment (Type II error) extremely high compared to the cost of not lending to a farmer who could repay the loan (Type I error). The Price Waterhouse model, logistic regression model, and neural network all performed significantly better than the decision tree at the 20 percent and/or 10 percent cutoff probability. However, given the mission of the FSA, a cutoff percentage lower than 30% would not likely be considered. Another weakness could be that the overall accuracy rates for the decision tree (80.0 and 83.3 percent at the 30 percent and 50 percent cut off probabilities, respectively), while relatively high compared to other methods, are not much higher than the 76.7 percent of loans in the test set that were repaid. A naïve, but unrealistic assumption that all loans will be repaid would produce a 76.7 percent overall classification accuracy rate. The decision tree achieves its accuracy rates while properly classifying 50.0 and 57.1 percent of loans that are not repaid at the 50 and 30 percent cut off probabilities, respectively.

CONCLUSION

The aim of this study is not to recommend a loan classification system for immediate FSA use. Rather, we build, test, and present a viable and transparent model, the decision tree, which could potentially improve FSA lending practices, making lending decisions more transparent and easily understood by applicants and the FSA staff. With loan default percentages varying over time, we discuss classification accuracy rates at several possible cut-offs. At the most likely relevant cut off percentages, a decision tree, neural network, or logistic regression model would significantly improve classification accuracy rates over the internally developed FmHA (FSA) criteria and perform better than the criteria developed by Price Waterhouse at much government expense. While the chi-squared test decision tree performs comparatively as well as the neural network and logistic regression model, its clarity when used in practice is a major advantage.

Once the decision tree determines the variables indicative of loan repayment or default and determines the appropriate cutoff point for those variables, the tree accounts for relevant possible combinations of those variables. In this manner, the decision tree accounts for all possible input observations and provides clear, understandable predictions (more so than other analytical methods). Then, the model or its user can determine into which group a loan application falls to predict repayment or default. FSA employees, farmers, and legislators could all understand the decision rules and evaluate the results of lending decisions based on those rules.

The decision tree technique should be considered in any revision of the FSA lending program because of its great potential to improve the FSA's lending practices and make them more transparent. Analysis with a more recent and larger data set would be an appropriate extension of this study as would performing more tests and implementing k-fold cross-validation to obtain more reliable and unbiased classification error estimates. The decision tree could be updated annually

based on actual repayment data from recent years. Assembling national data on repayment and default rates by farmers would be essential to improving and maintaining the system.

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EXPLORATORY RESEARCH TO APPLY LEADERSHIP THEORY TO THE IMPLEMENTATION OF RADIO FREQUENCY IDENTIFICATION (RFID)

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ABSTRACT

Radio Frequency Identification (RFID) applications bring risks to a company. Leadership theory suggests that leaders adopt innovative technologies and take risks in doing so. Further, leaders share their involvement in these ventures publicly.

In this exploratory project we identify two hundred ninety-three USA private companies, government and non-profit entities, and public companies as implementers of RFID over the period 2003-2006. We examine the websites and annual reports of the seventy-nine public company implementers for communications of their involvement with RFID using "content analysis." We found that thirty-four of the seventy-nine (43%) communicate their involvement with RFID on their websites, in their annual reports, or both. We label these company implementers "special leaders." The 57% that have implemented RFID but have not publicly communicated their involvement, we label them "leaders." Limitations of the research and potential future projects are also discussed.

INTRODUCTION

Radio Frequency Identification (RFID) represents the next generation of supply chain management technology. An RFID system typically includes tags, tag readers, antenna, middleware, and application software, providing a much more efficient way to track, locate, and manage objects than bar coding. This technology presents certain risks to companies and the general public, such as consumer privacy invasion, lack of regulations and legislation on data sharing, system failures, loss of data, and tag or reader malfunction (Higgins and Cairney, 2006).

Company managers adopting, or planning to adopt, this innovative technology must decide upon a level of communication with current and potential investors and the general public. Common channels of communication include annual reports and website messages in the form of news releases. Researches have examined the role of company leaders in managing the risks associated with the adoption of innovative technologies, primarily through company performance. Company leaders take specific actions to facilitate innovations and exhibit specific behaviors to make possible

the adoption in the face of external threats (Yuki and Lepsinger, 2006). According to Pfeffer (1981), language is one of the important elements in sharing beliefs and values.

The purpose of this paper is to apply leadership theory to how USA public companies communicate their involvement with RFID. For purposes of this paper RFID is identified as an innovative technology.

BACKGROUND – LEADERSHIP AND THE SUPPLY CHAIN

Bar coding replaced the manual processing of inventory-related data collection and significantly reduced the time and increased the accuracy of the data entry process. This mature technology has been constantly compared to RFID because they both belong to the automatic identification (Auto ID) group. Certain features of bar coding still outperform RFID, yet RFID systems provide information that bar coding systems do not. Table 1 shows a comparison of bar coding and RFID (Brown, 2007, Murray, 2006, and Wyld, 2006).

Logistically, a RFID system can capture, integrate, and utilize data. Although data is not a physical component of the system, it is the most essential element. When a load of cargo passes through readers, tags attached to boxes respond to the signal broadcasted from the readers. The information captured by a reader forms a database. This database is then managed and filtered by the middleware to generate accurate, reliable, and timely information for later use in ordering, warehousing, and customer service.

In the competing values framework constructed by Quinn, et.al (2003), a successful leader at any level must be socially and skillfully competitive. The leader must be capable of foreseeing changes and always looking for innovative ways to make things better. He or she is also able to communicate their ideas to stakeholders effectively. If stakeholders cannot see the benefit of adopting the ideas, they may reject them when risks shield the potential advantages. These organizational leadership skills are also applicable in the internal organization context. RFID is an innovative technology. It is new and risky. Not many companies are willing to assume the risk of fully adopting the technology, even though the benefit is calculable, at least theoretically.

Quinn, et.al (2003) points out that a successful leader must also be an innovator who must be flexible, risk-taking, and able to respond to changes in the external environment. In this information technology century, technology innovations are vital to the growth and survival of companies. Although companies may survive in the short term without adopting the new technology, they will eventually lose. For example, because of the mandate of major retailers, many manufacturers fulfilled the requirement by adopting the "tag-and-ship" application method of RFID. Although it is the fastest way of putting RFID technology in place, the true benefits of RFID in the business process are not obtained. Also, if a company is an innovator, it is able to understand that RFID technology is only a partial solution (Brown, 2007). RFID cannot improve productivity significantly without the simultaneous modification of the existing IT system and business process.

As a result, it is meaningless to evaluate the ROI of RFID. An innovative company should be able to anticipate that the RFID implementation is a strategic move.

Table 1: Comparison of Bar Coding and Radio Frequency Identification (RFID)		
Comparison Criteria	Bar Coding	RFID
Cost	Cheap. Currently, a bar-code sticker costs less than 1 cent.	Expensive. Tag manufacturers will be able to bring down the cost of a RFID tag to 5 cents by 2009.
Technology	Optical laser scanning.	Radio Frequency signal reading.
Readability	▸ In the incident of system failures, bar codes can be manually recorded because of the visible printed numbers. ▸ The readable range is limited, usually less than two feet. ▸ Bar code is read only, i.e. information cannot be updated.	▸ Smart labels-the presenting combination of bar code and RFID technology can allow manually recording. ▸ The readable range of RFID tags can be read up to 300 feet. ▸ RFID tags are read or read/written. A RFID tag can be updated. It also can be programmed to record the environmental data, such as temperature, radiation, or moisture and perform calculations.
Traceability	Category/product-level identifier.	Object/item-level identifier.
Data Volume	The physical length of a bar code limits the memory capability. Relatively less data can be stored in a bar code.	RFID tags can hold a large volume of information.
Scanning method	▸ A bar-code scanner needs direct line-of-sight access to read a label. Bar codes are no longer readable if damaged or dirty. ▸ A bar-code scanner can process only one bar code at a time. ▸ Manual process is required.	▸ A RFID reader does not need direct line-of-sight to read a RFID tag. A RFID tag is still readable even when it is buried under layers of material such as dirt, paint, snow, or mud. ▸ A RFID reader can interpret multiple tags simultaneously. ▸ Data collection processes are automatic.
Durability	▸ A bar-code is degraded easily after it is used or handled. ▸ A bar code cannot be reusable.	▸ Microchips of tags are embedded in protective material. ▸ A RFID tag is reusable.

POSTULATION

Leadership is characterized by implementing innovation, taking risks, and communicating the involvement. In supply chain management, leadership is defined by use of radio frequency technology. In this research we introduce the term, "special leadership," to describe leaders who go

beyond implementation of RFID to those who publicly communicate their use of this technology. We use "content analysis" to determine the level of company communication regarding RFID.

We postulate:

1. Product driven public companies that implement RFID technology but do not publicly communicate their involvement demonstrate leadership in supply chain management.

2. Product driven public companies that implement Radio Frequency Identification (RFID) and publicly communicate their involvement on the company's website and/or in the company's annual report demonstrate special leadership in supply chain management.

Given the exposure of RFID and the fact that its benefits have been widely disseminated, the focus here is on the risks of implementing this innovative technology.

RISKS OF RFID

Security and Privacy

Security and privacy issues are the most popular topics when discussing the risks of RFID technologies. Banks (2007) defines security as: "the ability of the RFID system to keep the information transmitted between the tag and the reader secure from non-intended recipients." Even though the message has not been decoded, it is considered a "breach of security." Banks (2007) defines privacy as, "the ability of the RFID system to keep the meaning of the information transmitted between the tag and the reader secure from unintended recipients." As a result, a third party not only receives the message, but also understands what it means.

Because of the tracking capability of RFID tags and the increasing use of RFID technologies, more physical objects, including humans, are exposed to the RFID infrastructure. As technologies advance, a chip can carry more detailed information inside a tag. Intruders can obtain what they want by simply intercepting unencrypted signals transmitted between a tag and its reader without accessing the database. Hence, the debate has begun on whether RFID tags invade the privacy right of consumers.

The public interest group, Consumers Against Supermarket Privacy Invasion and Numbering (CASPIAN), refers to RFID tags as "spychips," which can easily disclose a customer's whereabouts and their personal information (Albrecht & McIntyre, 2005). One powerful feature of RFID tags is that information can be communicated through solid objects, such as clothing, cardboard, or plastic. Each tag can be as thin as a piece of paper, and as tiny as a grain of sand. Tags can be easily hidden from the general inspection of shoppers. For example, Gillette's photo-snapping Smart Shelf and

Procter & Gamble's spy chipped lipsticks with a webcam on the shelves, provoked the fury of consumer privacy groups. The two companies have since modified their practices.

Item-level tagging increases the risk of data capture by information thieves. Although bar code data has been recorded at the point-of-sale terminals or cash registers for many years, RFID technologies, with a unique EPC ID and a link with a database which stores a consumer's personal information, highly increase the ease of forging an identity. The unique information a RFID tag carries can also expose the trail of where consumers have been, for how long and for what purpose, if the system is linked with a Global Positioning System (GPS). Consumers are concerned about how much, when, what, and where the data collected by RFID systems is used without their knowledge or consent. Some states, such as California, have introduced bills of legislation regulating the use of RFID technologies. The bills require business entities to notify customers on the usage of RFID, obtain customer's consent before gathering the information, and destroy tags after customers complete their purchases (Kelly and Erickson, 2005).

SAFETY

1)   System Malfunction:

In a working environment where conveyor belts or labeling rolls are common, electrostatic discharge (ESD) can be created easily and cause tags to malfunction. Also, when electric shortage occurs, data transmitted from an antenna and temporarily stored in an interrogator (reader) could be lost due to the reset procedures. Unlike the failure of a bar code reader, the malfunction of a RFID system can impact a business significantly (Glover & Bhatt, 2006). As a RFID system processes items at a high speed, once the computers are down, the manual process performed by workers for label reading and information updating can replace only a small amount of work performed by RFID systems within the same time limit. The impact is even more significant in the case of missing data. For example, if the bandwidth of a radio spectrum is narrow, it is susceptible to interference (Cooney, 2006). If a signal-to-noise ratio is not large enough to overcome the interferences from other RF sources, the interrogator is unable to understand the tag. The RFID system is "confused" and cannot provide accurate data. Sometimes, the inaccurate information is not easily detectable, and misleading information is used.

2)   Human accidents

There is a potential that people could be injured if the RF energy level is too high, especially when they get near an antenna where power is dense. Currently, there is no common agreement on what level is safe among various standardization agencies. People with medical implants equipped with RF signals should not be exposed to other high RF energy as the function of implants may be interrupted (Cooney, 2006).

RETURN ON INVESTMENT (ROI)

ROI is a financial analysis tool used to select the best investment opportunity among similar alternatives. Current applications of RFID technology are relatively new, and it is difficult to find comparisons for verifying the selection. Companies that have adopted the system are still in a "launch and learn" stage. Imperfections are expected, and more ideal technological solutions are likely to be developed. According to Brown (2007), when applying RFID technologies, retailers do not have to bear any ongoing costs while at the same time gaining improvement in inventory management and labor efficiency from the installation. Manufacturers, on the other hand, have to pay for tags used on every shipment and may see only minimum improvements in efficiency (Brown, 2007). However, major companies, such as Procter & Gamble and International Paper, have proven that if data captured by RFID are fully utilized, the benefit of having RFID out-weighs the risks of implementation. Also, RFID technologies still encounter competition from bar coding because RFID is relatively expensive. RFID infrastructure needs an upfront and large amount of capital investment, including the time and money spent on training employees, making existing information systems compatible, and modifying the physical environment. The cost and complexity of implementation are still obstacles to installing RFID systems (Murray, 2006).

LEADERSHIP IN IMPLEMENTING RFID

Risk-taking is the spirit of leadership. In March 2005, 137 suppliers of Wal-Mart, including 37 volunteer suppliers, joined the RFID mandate. Currently, the major mandates in the United States are Wal-Mart, The U.S. Department of Defense, Target, and Albertsons (Brown, 2007). Some suppliers are cautious about this new technology and perform the minimum toward fulfilling the mandate. These companies are not able to gain the strategic advantages, but they take part in the mandate safely. Businesses expect return from their investments; however, Hammonds (2002) in his article, *No Risk, No Reward*, points out that corporations must do "big" to win over their competitors. Doing a project safely does not mean doing it smart because saying "no" to a good strategy is as bad as saying "yes" to a bad strategy. Leading companies have failures over the years, but their successful work through taking risks brought them to their current positions. While some companies choose to ignore risks, their competitors do not and the competitors win. A new and big project, like RFID implementation, is risky (Hammonds, 2002). A bolder action, such as implementing RFID, is a weapon which may give a company a significant competitive advantage. Innovative technology is essential to all businesses. The California Institute of Technology (Caltech) produces many young entrepreneurs every year. Their secret weapon is that Caltech concentrates on cultivating science entrepreneurs more than developing business masters (Hammonds, 2002). It is also important to know what a company can get from taking such a big step. An organization must also be able to notice changes in the external environment and link them to their core business. RFID technology is an innovation which can modify business models forever. The changes RFID brings

to the marketplace will be much more shocking than what bar codes did thirty years ago. Companies which do not prepare to respond to these threats cannot be leaders in the business world (Yuki and Lepsinger, 2006). Leading companies perceive the benefits of RFID over its risks. They take the initiative and make changes. When they open their arms to embrace new technology, they create new opportunities. They believe it is a chance to further distance themselves from their rivals. Industry pioneers, such as Gillette, Kimberly Clark, Proctor & Gamble, Orco Construction Supply, and GTSI adopted RFID intensely into their business processes to gain competitive advantages. Leonard (1995) argued that companies should "…avoid riskless projects because a sure-thing holds no promise of competitive advantage, no opportunities to out-learn competitors." Without taking some calculated risks, a company will have no breakthroughs. In addition, a complex job, such as a RFID implementation, involves using the available knowledge to choose what it is worth to invest (Romig, 2001). Without the ability of thinking outside-the-box, another "more creative competitor will leave a company behind" (Romig, 2001).

Leading companies are not afraid of presenting strategic implementations, such as RFID technologies, to investors, other stakeholders, and competitors, even when the adoption of the new technology may cause negative feedback. Research indicates that the massive use of RFID tags is limited to the supply chain. Companies that are confident in their strategic decisions treat the announcement of the adoption of a risky technology as a way of building and maintaining position among competitors (Quinn et al., 2003). With these powers, a company can influence other businesses and keep the voice of authority within the industry. Furthermore, a company with excellent visionaries will understand the benefit of applying innovative IT to the company's operations. One can argue that because of the risks and worries of RFID, companies are afraid that the public holds adverse attitudes toward the implementation or pilot program of this technology even though RFID will potentially generate more benefit than harm toward the business in the long run. However, they are not afraid to show the investors and stakeholders in their annual report and websites that they are using a controversial technology.

EVALUATION OF LEADERSHIP IN THE RFID CONTEXT

Pfeffer (1981) says language is an important element to share beliefs. He suggests that through the analyses of language used in company-related publications, such as annual reports, one is able to study a company's concerns and how the company reacts to the concerns. Publicly held companies are required to disclose operating results to stockholders annually. Most companies use annual reports as a tool to formally communicate with investors. In addition to certain requirements of Securities and Exchange Commission (SEC), such as a letter to shareholders from the Chief Executive Officer (CEO) or the chairman, the philosophy of the company, a set of financial statements, a report of operations, and an auditor's letter, voluntary information, such as the adoption of an innovative technology, is optional. Most companies use the annual report as an opportunity to present what is important to the company now and in the future. In addition, due to

the emergence of electronic-commerce, company websites have become a critical information channel.

RESEARCH DESIGN AND METHODOLOGY

Research Method

This research project uses content analysis to determine if and/or how sample companies communicate their involvement with RFID technology. Content analysis searches specific messages or subject matter communicated by authors. Observations rendered by the analyzer(s) are recorded, and collected information is transformed into quantitative statistical data. This method is widely used in the social sciences to understand meanings, consequences, and intentions communicated by media. According to Krippendorff (1980), "content analysis is a research technique for making replicable and valid inferences from data to their context." Holsti (1969) has a boarder definition of content analysis: "Content analysis is any technique for making inferences by objectively and systematically identifying specified characteristics of messages.

Researchers have used content analysis to study annual reports and websites. Peslak (2005) used form-oriented content analysis to investigate the importance of information technology toward the Fortune 50 companies by reviewing their annual reports. Lee (2005) used quantitative content analysis to evaluate Fortune 100 companies' career websites.

In this project we use qualitative content analysis to determine the relationship between RFID in textual content and company leadership. Qualitative content analysis focuses on making inferences from implications and intentions of textual content.

Data Collection

RFID Journal is a leading publication in the RFID industry. It was first introduced on March 1, 2002 and aims at providing businesses with information about Radio Frequency Identification (RFID) technology. The journal provides resources to those who want to understand the usefulness of RFID or to implement the technology in their business. Its website supplies "timely, accurate, unbiased news" about RFID. It keeps businesses informed of the latest news about RFID, such as standards, product innovation, and new implementations. It reports RFID applications and new developments of tags and systems around the world. *RFID journal* is not supported by advertisements.

Two thousand one hundred and sixty items of news were reviewed from *RFID Journal* articles over the period 2003-2006 to identify RFID related companies or organizations. A total of 1,045 company names were found. Among them, 376 companies are RFID manufacturers, technology developers, or solution provides. Most companies of this group are tag or reader manufacturers. Some of them provide services to companies which want to adopt RFID. Others use

RFID technology to modify their current products or inventions and sell those products to other companies. In addition, 348 of the 1,045 are foreign companies. Their shares are not traded on American stock exchanges. They may also be foreign government agencies, research institutes, RFID tag or reader manufacturers, etc. Furthermore, 28 companies are American research or marketing companies.

Two hundred and ninety-three companies are identified as RFID end-users. Two hundred and fourteen are American private companies, governmental agencies, or non-profit organizations, and 79 are American public companies. The public companies' annual reports and websites are evaluated in this project.

Constraints on Selection of Sample Companies

1. Companies must be USA public companies who are required to file annual reports with the Securities and Exchange Commission. Due to the discrepancy of the culture, language, currency, and regulation requirements among countries, foreign companies are not included.

2. Companies' whose core business was determined to be RFID chip/system/software/hardware manufacturers or RFID solution provides/consultants/developers were removed from the sample. These RFID affiliated companies would bias the results by mentioning RFID on their websites or in their annual reports simply because RFID is one of their products or services. Hence, computer chip makers, such as Cisco Systems, General Electric (GE), International Business Machines Corporation (IBM), Motorola, Texas Instruments, etc., were not included in the sample of evaluated. As a result, the leadership of RFID technology end-users, not the technology product or service providers or developers, is compared.

DATA ANALYSIS

Annual reports for the period 2003-2006 were reviewed using the specific words/combination of words search function of Adobe Acrobat 8.0. The search function in each company's website was used as the search tool as well. Key words used in the search were as follows:

1. RFID
2. Radio frequency identification
3. RF solution
4. Contactless method

5,   Tagging

See Table 1 for a summary of research design and methodology, and see Appendix I for a list of sample companies.

Table 1: Summary of Research Design and Methodology	
Methodology	Description
Research method	Qualitative content analysis
Source of data collection	RFID Journal
Constraints on selecting sampling companies in the process of data collection	Sampling companies must be USA public companies; Their core business must not be a RFID technology developer or a RFID solution provider or consultant.
Data set	Working population - 293 companies; Sample (Identified companies meeting requirements) – 79 public companies;
Key words to be identified in data analysis process	RFID, Radio frequency identification, RF solution, Contactless method, and tagging

FINDINGS

Fifteen companies mentioned RFID, or related terms, only on their websites, while one company mentioned RFID, or related terms, only in its annual report. Forty-five of the 79 companies did not mention RFID in either their annual reports or on their websites. Eighteen companies mentioned RFID in both their annual reports and on their websites. See Table 2 for a summary of findings, and see Appendix II for detailed information.

Table 2: Summary of Findings				
	Public Companies using or implementing RFID – 2003-2006			
	In website only	In annual report only	In website and in annual report	Implement, but do not communicate publicly
Number=79	15	1	18	45
Percent of Companies that Communicate Information Regarding RFID	44%	3%	53%	0%

Table 3: Demonstration of Leadership		
	Public Companies using or implementing RFID – 2003-2006	
	Implement and communicate publicly in website or annual report OR both (34/79)	Implement, but do not communicate publicly (45/79)
Demonstrates Leadership		57%
Demonstrates "Special" Leadership	43%	

RESEARCH LIMITATIONS

Several limitations were determined in carrying out this research. First, some websites do not have searching engines, which made the key-word searching difficult and ineffective. Hence, the findings might not fully reflect the leadership image of the related companies. Second, leaders of certain companies may not want to reveal the implementation of RFID to the public due to it not being fully implemented or due to problems in the implementation. For example, Procter & Gamble (P&G) has been criticized by consumer privacy groups because of some pilot programs it engineered with RFID. In order not to receive further negative comments from the public, P&G was forced to play a low-key role in demonstrating its corporate leadership in the employment of RFID technology. It might be unfair to compare their leadership to companies with less visibility. Finally, news searching in the RFID journal is restricted to free news only. News available to subscribers cannot be accessed. As a result, the actual number of companies involved in RFID technology may be greater than the number found in this research.

DISCUSSION AND CONCLUSIONS

This research provides the following conclusions: 1. There is wide spread use of RFID technology across many product driven industries. 2. Less than half of public companies using RFID declare this use publicly. 3. Most use of RFID is in managing the supply chain at the bulk transfer level rather than at the individual product level. 4. At the retail level, privacy and security represent the greatest risks, but also the greatest opportunity for marketing research. 5. Cost, especially as it relates to transmitters in individual products, remains the greatest barrier to full adoption and ultimate replacement of bar coding. 6. Significant cost savings are available in the future, not only in supply chain management, but also in retail, where traditional checkout stations may be eliminated in favor of individual product transmitters and in-store receivers. 7. Company websites (often detailing press releases) and annual reports represent the primary vehicles for disseminating information about RFID implementation and outcomes. 8. Through the use of content-analysis of a company's information it is possible to determine the nature of a company's leadership. In the context of supply chain management, leadership is exhibited when company

leaders take the risk to implement a new technology such as RFID. We believe it takes "special" leadership to communicate this risk-taking action with the company's stakeholders in annual reports and on a company's website.

In summary, RFID is a relatively new technology, at least for commercial purposes. Examples of industries which have adopted this post-barcode technology include retailers, government agencies, such as the Department of Defense, pharmaceuticals, health care providers, and border controlling entities. The major functions of RFID application are varied. Some are for collecting sales data as a part of marketing research, others play a monitoring role in logistic businesses, while most are involved in company supply chain management.

Even though RFID technology is powerful, it is only a cost-saving tool, not a direct-profit-earning practice. Other changes inside the company or along the supply chain are also needed to fully implement the power of RFID. Moreover, adopting RFID technology is only part of the solution to improve a company's performance. In addition, some benefits, such as expanding the knowledge of consumer behaviors or marketing certain products to selected customers, are hard to measure by using financial data. As a result, it is not appropriate to measure the effectiveness of RFID by examining only the financial results of a company, such as the increase in profit or the reduction of expenses.

FUTURE RESEARCH

Future studies might examine the relationships between the adoption of RFID and Six Sigma, Best Practice-ISO 9000 recognition, and Baldridge Award recipients. Another avenue for future research might involve searching annual reports for RFID-related pictures to determine if the management theory of "symbolic action" plays a role in the implementation of RFID technology.

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Appendix I: Sample Companies			
	American Public Company		American Public Company
1	Abercrombie & Fitch Co.	41	Kimberly-Clark Corp.
2	Aermisourcebergen Corp.	42	Koninklijke Ahold N. V.
3	Alberto-Culver Co.	43	Kroger Co.
4	Albertsons Inc.	44	Lexmark International Inc.
5	Altria Group Inc.	45	Lockheed Martin Corp.
6	American Airlines Inc.	46	MasterCard Inc.
7	American Express Co.	47	Mattel Inc.
8	AT&T Inc.	48	McDonald's Corp.
9	Bank of America Corp.	49	McKesson Corp.
10	BB&T Corp.	50	Michelin
11	Benetton Group Spa.	51	Molson Coors Brewing Co.
12	Best Buy Co. Inc.	52	Occidental Petroleum Corp.
13	Biomet Inc.	53	Owens-Illinois Inc.
14	Blyth Inc.	54	Pfizer Inc.
15	Boeing Co.	55	Pliant Systems Inc.
16	BP Plc.	56	Pricer Inc.
17	Cardinal Health Inc.	57	Procter & Gamble Co.
18	Caterpillar Inc.	58	Raytheon Co.
19	Cephalon Inc.	59	Ryerson Inc.
20	Chevron Corp.	60	Safeway Inc.
21	Chiquita Brands International Inc.	61	Schiff Nutrition International Inc.
22	Coca-Cola Co.	62	Sears Holdings Corp.
23	Colgate-Palmolive Co.	63	Sempra Energy
24	Corning Inc.	64	Six Flags, Inc.
25	CVS Caremark Corp.	65	Smurfit-Stone Container Corp.
26	Dow Chemical Co.	66	Staples Inc.
27	Eastman Kodak Co.	67	Starbucks Corp.
28	EMC Corp. (RSA Security)	68	SunTrust Banks Inc.
29	Energizer Holdings Inc.	69	Symmetry Medical, Inc.
30	Exxon Mobil Corp.	70	Target Corp.
31	Fedex Corp.	71	Tyco International Ltd.
32	Gap Inc.	72	Tyson Foods Inc.

Appendix I: Sample Companies			
	American Public Company		American Public Company
33	General Dynamics Corp.	73	VF Corp.
34	General Mills Inc.	74	Walgreen Co.
35	GlaxoSmithKline Plc	75	Wal-Mart Stores Inc.
36	Goodyear Tire & Rubber Co. (North America)	76	West Pharmaceutical Services Inc.
37	Handleman Co.		
77	Weyerhaeuser Co.		
38	Horizon lines, Inc.	78	YRC Worldwide Inc.
39	International Paper Co.	79	Yum! Brands, Inc.- Taco Bell
40	Johnson & Johnson		

Appendix II: Companies' Level of Communication Related to RFID							
		Level of Communications					
	Company	Ann. Rept. Only	Web-site only	Ann. Rept. & Web-site	Neither	Fortune 1000 ranking	Industry
1	Abercrombie & Fitch Co.				0	604	Apparel Stores
2	Aermisourcebergen Corp.			1		0	Drugs Wholesale
3	Alberto-Culver Co.				0	550	Personal Products
4	Albertsons Inc.				0	0	Grocery Stores
5	Altria Group Inc.				0	23	Cigarettes
6	American Airlines Inc.				0	0	Major Airlines
7	American Express Co.			1		79	Credit Services
8	AT&T Inc.			1		27	Telecom Services - Domestic
9	Bank of America Corp.				0	9	Money Center Banks
10	BB&T Corp.				0	265	Regional - Mid-Atlantic Banks
11	Benetton Group Spa.		1			0	Textile - Apparel Clothing
12	Best Buy Co. Inc.				0	72	Electronics Stores
13	Biomet Inc.				0	852	Medical Appliances & Equipment
14	Blyth Inc.				0	0	Personal Products
15	Boeing Co.		1			28	Aerospace/Defense - Major Diversified
16	BP Plc.		1			0	Major Integrated Oil & Gas
17	Cardinal Health Inc.		1			19	Drugs Wholesale
18	Caterpillar Inc.				0	55	Farm & Construction Machinery

	Appendix II: Companies' Level of Communication Related to RFID					
		Level of Communications				
	Company	Ann. Rept. Only	Web-site only	Ann. Rept. & Web-site	Neither	Fortune 1000 ranking	Industry
19	Cephalon Inc.				0	930	Drug Manufacturers - Other
20	Chevron Corp.				0	4	Major Integrated Oil & Gas
21	Chiquita Brands International Inc.				0	488	Farm Products
22	Coca-Cola Co.				0	94	Beverages - Soft Drinks
23	Colgate-Palmolive Co.				0	200	Personal Products
24	Corning Inc.				0	439	Communication Equipment
25	CVS Caremark Corp.				0	51	Drug Stores
26	Dow Chemical Co.				0	40	Chemicals - Major Diversified
27	Eastman Kodak Co.		1			0	Photographic Equipment & Supplies
28	EMC Corp. (RSA Security)		1			224	Data Storage Devices
29	Energizer Holdings Inc.				0	636	Industrial Electrical Equipment
30	Exxon Mobil Corp.				0	2	Major Integrated Oil & Gas
31	Fedex Corp.		1			68	Air Delivery & Freight Services
32	Gap Inc.				0	144	Apparel Stores
33	General Dynamics Corp.				0	92	Aerospace/Defense Products & Services
34	General Mills Inc.				0	213	Processed & Packaged Goods
35	GlaxoSmithKline Plc		1			0	Drug Manufacturers - Major
36	Goodyear Tire & Rubber Co. (North America)		1			114	Rubber & Plastics
37	Handleman Co.				0	0	Wholesale, Other
38	Horizon lines, Inc.			1		0	Shipping
39	International Paper Co.			1		93	Paper & Paper Products
40	Johnson & Johnson				0	36	Drug Stores - Major
41	Kimberly-Clark Corp.			1		137	Personal Products
42	Koninklijke Ahold N. V.		1			0	Grocery Stores
43	Kroger Co.				0	26	Grocery Stores
44	Lexmark International Inc.				0	442	Computer Peripherals
45	Lockheed Martin Corp.			1		57	Aerospace/Defense Products & Services
46	MasterCard Inc.			1		601	Business Services
47	Mattel Inc.		1			406	Toys and Games
48	McDonald's Corp.				0	108	Restaurants
49	McKesson Corp.			1		18	Drugs Wholesale
50	Michelin		1			0	Rubber & Plastics
51	Molson Coors Brewing Co.	1				386	Beverages - Brewers
52	Occidental Petroleum Corp.				0	0	Independent Oil & Gas

		Level of Communications					
	Company	Ann. Rept. Only	Web-site only	Ann. Rept. & Web-site	Neither	Fortune 1000 ranking	Industry
53	Owens-Illinois Inc.				0	318	Packaging & Containers
54	Pfizer Inc.			1		39	Drug Manufacturers - Major
55	Pliant Systems Inc.		1			0	Packaging - film
56	Pricer Inc.			1		0	Labeling - electronic
57	Procter & Gamble Co.		1			25	Personal Products
58	Raytheon Co.			1		96	Aerospace/Defense - Major Diversified
59	Ryerson Inc.				0	385	Metal Fabrication
60	Safeway Inc.				0	56	Grocery Stores
61	Schiff Nutrition International Inc.		1			0	Drug Related Products
62	Sears Holdings Corp.				0	38	Department Stores
63	Sempra Energy				0	210	Gas Utilities
64	Six Flags, Inc.				0	0	General Entertainment
65	Smurfit-Stone Container Corp.			1		303	Paper & Paper Products
66	Staples Inc.				0	126	Specialty Retail, Other
67	Starbucks Corp.				0	310	Specialty Eateries
68	SunTrust Banks Inc.				0	183	Money Center Banks
69	Symmetry Medical, Inc.				0	0	Medical Appliances & Equipment
70	Target Corp.			1		33	Discount, Variety Stores
71	Tyco International Ltd.			1		0	Diversified Electronics
72	Tyson Foods Inc.				0	86	Meat Products
73	VF Corp.				0	332	Textile - Apparel Clothing
74	Walgreen Co.				0	44	Drug Stores
75	Wal-Mart Stores Inc.			1		1	Discount, Variety Stores
76	West Pharmaceutical Services Inc.			1		0	Medical Instruments & Supplies
77	Weyerhaeuser Co.			1		105	Lumber, Wood Production
78	YRC Worldwide Inc.				0	249	Trucking
79	Yum! Brands, Inc.- Taco Bell				0	262	Restaurants

Appendix II: Companies' Level of Communication Related to RFID

THE SIGNIFICANCE OF CAREER COMMITMENT IN GENERATING COMMITMENT TO ORGANIZATIONAL CHANGE AMONG INFORMATION TECHNOLOGY PERSONNEL

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ABSTRACT

The commitment of individuals is critical for the success of an organizational change initiative. In this quantitative survey-based study conducted at a large global bank, we analyze the perceptions of 575 information technology (IT) software professionals in India and Malaysia regarding an enterprise-wide change in order to understand the impact of career commitment vs. organizational commitment and how they impact change messages (beliefs) to generate commitments towards the change. Our finding is that the role of career commitment among IT personnel is more important than organizational commitment in generating commitment to change. Also, we show that it is career commitment, rather than organizational commitment, that is critical for change messages to be effective.

INTRODUCTION

Modern organizations need their employees to adapt to constant changes with a minimal amount of disruption. However, dysfunctional reactions to change, in terms of poor commitment to new processes, appear to be far more prevalent than the authentic embracing of new changes (Fedor et al., 2006). In order to secure the desired form of commitment, managers spend a great deal of time, effort, and capital implementing elaborate change management and communication strategies, often with little success (Sumner and Yager, 2004; Sumner et al., 2005). While the importance of an individual's commitment to the success of a change has been well established in the literature (Meyer & Allen, 1996; Meyer & Herscovitch, 2001), there has been little research on the impact of change messages on individual commitment to change.

It has been discussed that people who are committed to the organization are more likely to embrace organizational changes (Herscovitch and Meyer, 2002). Also, Armenakis et al. (1999) extensively covers the role of communication in helping employees to make sense of organizational changes. We argue that, compared to organizational commitment, it is actually the commitment of

professionals to their career that amplifies the effect of change message on individual's attitude towards organizational change. Even though organizational commitment is desirable during organizational change, it is more effective when employees are committed to their careers rather than just to the organization.

Through a survey of IT professionals in two large centers of a global bank, we collected 575 responses to test our model. Findings followed by discussions and practical implications are also presented.

THEORETICAL FRAMEWORK AND HYPOTHESES

The concept of organizational commitment has evolved over the last three decades, starting with Porter et al. (1974) which conceptualized commitment with the following factors: "(a) strong belief in and acceptance of the organization's goals and values, (b) a willingness to exert considerable effort on behalf of the organization, and (c) a definite desire to maintain organizational membership". More current research defines affective commitment as "the desire to remain", continuance commitment as "the perceived cost of leaving", and normative commitment as "the perceived obligation to remain"(Meyer, et al., 1990; Meyer and Allen, 1991). These factors enable the differentiation among commitment forms that are characterized by different mindsets, while individuals may simultaneously experience different combinations of all three mindsets. These three components altogether become an employee's commitment profile.

Commitment to change is particularly important now, given the speed and complexity of change in a distributed, global business environment. The command and control model of shaping employees' behaviors and attitudes at work is giving way to a model of "developing committed employees who can be trusted to use their discretion to carry out job tasks in ways that are consistent with changing organizational goals" (Arthur, 1994). Having a committed workforce is becoming a competitive advantage in the industry and various studies (Arthur, 1994; Huselid, 1995; Macduffie, 1995) have shown that commitment strategies are associated with low turnover and high productivity and corporate financial success. Commitment has also been shown to be positively associated with improved organizational functioning (Meyer & Allen, 1997) and even minor changes in employees' work always have significant influences on the bottom line (Cascio, 1982). Many studies have examined antecedents, correlates, and dimensions of organizational commitment and consequences (Mathieu and Zajac, 1990; Meyer and Allen, 1997; Ketchand and Strawser, 2001), but only a few have addressed the distinction between career commitment and organizational commitment (Darden et al., 1989; McAulay et al., 2006). As the successful implementation of organizational change often needs employees' acceptance and support from various aspects (Fedor et al., 2006), we propose the following theoretical framework of three levels of commitment. In particular, we address the impact of organizational commitment and career commitment on embracing change through change message effectiveness.

**Figure 1 Conceptual Model of the Impact of Organizational Commitment and
Career Commitment on Commitment to Change through Change Message Effectiveness**
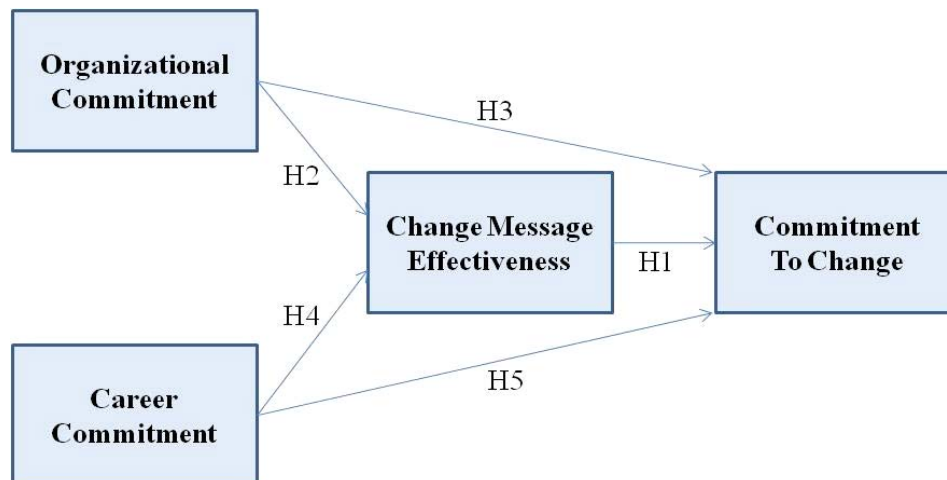
Change Message Effectiveness

Communication literature has often talked about the quantity and channels of organizational commitment, but deeper insight occurs through the interpretation of specific change messages (Armenakis et al., 2007). This makes it important to understand the role that different change messages play in generating the acceptance of organizational change by employees.

In any organization, those individuals who are subjected to change try to make sense of the organization transformation based on what they hear, see, and experience; and they formulate their beliefs that become part of their process of deciding whether to support or resist the change. Armenakis et al. (2007) define a belief as "an opinion or conviction about the truth of something that may not be readily obvious or subject to systematic verification" and identify "discrepancy, appropriateness, efficacy, principal support, and personal valence" as the most significant factors to affect an organizational change. Change messages (beliefs) are typically exchanged through social interaction between various levels of the organization (top leaders, change agents, supervisors, and peers). These messages are typically transmitted through various influence strategies depending on the need or life-cycle stage of the change initiative.

Since a positive belief in change increases the chance of employees making a commitment to support the change (Armenakis et al., 2007), change messages through various communication venues from the management help employees understand the change and develop a positive attitude towards the change. This belief in turn leads to enhanced commitment towards the change. Therefore, we hypothesize:

> *H1:   Change message effectiveness is positively associated with commitment to change.*

Organizational Commitment

Organizational commitment has been defined and interpreted in a variety of ways (Mathews and shepherd, 2002). According to Arnold et al. (1998), organizational commitment refers to the attachment of a person to his or her organization. Taking a multidimensional view, Meyer (1990) distinguish affective commitment, continuance commitment, and normative commitment in employees' organizational commitment profile, and argue that employees can experience these three components simultaneously. Mathews and Shepherd (2002) define organizational commitment as "a strong belief in and acceptance of the organization's goals and values, a willingness to exert considerable effort on behalf of the organization, and a strong desire to maintain membership with the organization". In addition, organizational commitment is found to be a psychological bond that tied the employees to the organization. The nature of this bond is formulated as "compliance, identification and internalization" (O'reily and Chatmen, 1986), and "identification, involvement and loyalty" (Cook and Wall, 1980).

Many studies find that organizational commitment improved job performance and work attitude (Meyer, et al., 1989; Carson et al., 1999; Somers and Birnbaum, 2000; Rayton, 2006), and reduced turnover intention and behavior (Blau & Boal, 1987; Huselid and Day, 1991; Somers, 1995; Trimble, 2006). Furthermore, organizational change research shows that organizational commitment enhanced perceived readiness to organizational change (Madsen et al., 2005), change communication (Elving and Bennebroek Gravenhorst, 2009) and employee acceptance of organizational change (Iverson, 1996). According to Meyer and Allen (1997), employees that are committed to an organization typically believe change communication from their management with regard the changes that management wishes to implement in the organization. They also argue that employees who are committed to the organization will also commit to any organizational changes that are required. Therefore we hypothesize:

> *H2:   Organizational commitment is positively associated with change message effectiveness*

> *H3:   Organizational commitment is positively associated with commitment to change.*

The combination of H1 and H2 shows the mediating role of change message effectiveness in creating a positive effect towards organizational commitment on commitment to change. H3 posits the direct effect of organizational commitment on commitment to change. According to the clarification of conditions and decision points for mediational type inferences provided by Mathieu

and Taylor (2006), we present H1, H2 and H3 to clearly emphasize mediating relationship without the confusion of indirect effects.

Career Commitment

According to Darden, Hampton and Howell (1989) and Lee, Carswell and Allen (2000), career commitment refers to employee's psychological bond to his or her career, which is distinguishable from organizational commitment. That is, an employee may be committed to his or her career only or committed to his or her organization only or committed to both or committed to neither. They also suggest that "some jobs with a high level of transference of skills from one organization to another may engender higher levels of career commitment". It has been observed that knowledge workers, such as IT professionals, have a distinctive nature in their occupational orientations, reward preference, and value systems, and thus career commitment is an important contributing factor. Since employees feel that they have lower job security and feel more uncertainty towards the future given the globalization of business, career commitment gains more interest from researchers (Blau, 1989; Blau, 2003), and some research even suggest that commitment may shift from organization to career (Johnson, 1996; Meyer & Allen, 1997).

Career commitment has a strong influence on an individual's behavior (Chang, 1999). Employees with a high career commitment spend more time improving their skills and had less intentions of changing careers (Aryee and Tan, 1992). Darden, Hampton and Howell (1989) further suggest that employees with high transferrable work skills, such as IT professionals in our study, are more likely to achieve higher levels of career commitment, and thus hold more positive attitude towards their jobs which certainly include effective communications during organizational change. So employees who are very career minded may be interested in putting extra energy into the change communication that deals with the overall organizational change and making extra commitment to support organizational change effort (Arthur and Rousseau, 2001). Therefore we hypothesize:

H4: *Career commitment is positively associated with change message effectiveness.*

H5: *Career commitment is positively associated with commitment to change.*

The combination of H1 and H4 shows the mediating role of change message effectiveness in the negative effect of career commitment on commitment to change. H5 posits the direct effect of career commitment on commitment to change.

METHOD

Research Setting, Data Sources, And Sampling

Two software development centers of a large global bank were surveyed online. One of the centers is in Malaysia, and the other one is in India. The Malaysia center has about 800 employees out of which 244 completed the survey. The India center has about 1,300 employees out of which 333 completed the survey. Overall, we obtained complete responses from 577 employees in two sites, for a response rate of 30%. A comparison of the responses from two sites revealed no significant mean differences for study variables. The demographic information of the respondents is summarized in Table 1. After checking the data consistency and homogeneity, we retained 568 individual responses for further analysis.

Table 1 Demographic Information of Survey Participants								
Gender			**Background**			**Job Status**		
	Site 1	Site 2		Site 1	Site 2		Site 1	Site 2
Male	65.0	85.4	Native	70.0	99.7	Full-time	79.2	98.5
Female	35.0	14.6	Foreigner	30.0	0.3	Contractor	20.8	1.5
Age			**Level of Education**					
	Site 1	Site 2		Site 1	Site 2			
<25	12.9	14.6	High school	0.8	0.0			
25-30	44.6	36.6	Diploma	6.7	1.8			
31-35	22.9	31.1	College degree	75.4	42.1			
36-40	12.5	9.8	Master or above	17.1	56.1			
41-50	6.7	7.0						
>50	4.0	0.9						
Note: All numbers are in percentages.								

Measurement And Operationalization

Commitment to change.

Herscovitch and Meyer (2002) define commitment to change as "a force (mind-set) that binds an individual to a course of action deemed necessary for the successful implementation of a change initiative." This mind-set can be reflected to varying degree in three dimensions: "(a) a desire to provide support for the change based on a belief in its inherent benefits (affective commitment

to change), (b) a recognition that there are costs associated with failure to provide support for the change (continuance commitment to change), and (c) a sense of obligation to provide support for the change (normative commitment to change)" (Herscovitch and Meyer, 2002). That is, employees can feel liable to support a change because they are willing to or forced to. Therefore, the three component scales have 18 items, six for each for affective, continuance and normative commitment to change with alphas of .92, .71 and .78 respectively.

Change message effectiveness

In a set of articles, Armenakis et al. (1993) and Armenakis et al. (1999) outline frameworks specifying the five domains for effective change efforts: discrepancy, efficacy, appropriateness, principal support, and personal valence. These five change messages are measured through a 26-item scale that is developed in Armenakis et al. (2007) and produce an alpha ranging from .70 to .92 for discrepancy, from .89 to .95 for appropriateness, from .76 to .86 for efficacy, from .69 to .87 for principal support, and from .78 to .90 for personal valence. Also, the overall composite reliability of change message scale ranges from .90 to .94; however, in our study we are using the individual subscales.

Discrepancy focuses on the issue of whether change is necessary and is normally assessed by the difference between an organization's current performance and those benchmarks (Katz & Kahn, 1978). To motivate individuals to change, an organization must convince individuals that there is something wrong and change is needed. Out of the four items in the original scale for discrepancy, we use three items; and during the EFA/CFA, we drop one item due to cross loading, resulting in a composite reliability of .751.

Appropriateness of the change is distinct from discrepancy because individuals may only agree the changes to some extent, that is, they do not agree with all the changes being proposed. This reticence is carefully intentioned and possibly helpful as individuals make their decisions based on the appropriateness of some particular change. From both the EFA analysis and the literature review of this scale (Armenakis et al., 2007), appropriateness scale items turn out to be very close to affective commitment to change items, one of the dependent variables in the study. Therefore, we decide to drop this scale from the study.

Efficacy addresses the issues of individual's confidence in his or her ability to succeed (Bandura, 1986). According to the expectancy theory of motivation (Vroom, 1964), individuals are willing to attempt a change only if they are likely to succeed. We find efficacy items to be very close to the affective commitment to change in the EFA, so we decide to drop the scale from the study. Principal support is important because any organizational change needs resources and commitment across the institutional hierarchy (Armenakis et al., 2007). Many changes fail because of poor support, so employees hesitate to become actively involved in a change until a strong commitment to support is given. Out of the six items in the original scale for principal support, we use five items;

and during the EFA/CFA, we dropped three of them due to cross loading, resulting in a composite reliability of .874.

Personal valence is important because members of the change target ask, "what's in it for me?" Cobb et al. (1995) indicate that an individual will evaluate both positive and negative outcomes of an organizational change, whether the change is fair, and how they are treated in and after the change. So if his/her self-interest is not well protected, a proposed change will likely not be supported (Clarke et al., 1996). We use all five items in the original scale for personal valence and kept three items after the EFA/CFA analysis, resulting in a composite reliability of .819. In excluding the appropriateness and efficacy measures from our analysis, we are consistent with Armenakis et al. (2007) which find discriminant validity issues between these constructs and the other dimensions they identify for messages in certain contexts.

Career commitment.

It is defined as "one's motivation to work in a chosen vocation" (Carson, et al, 1999). Factor analysis yields two dimensions: career planning and career identity, which is consistent with Carson and Bedeian (1994). Career identity builds a tight emotional link with one's career, career planning figures out one's developmental needs and career goals, and career resilience means the resistance of career disruption while facing adversity. Cronbach alphas ranged from .79 to .85 as field tested with 476 respondents in various work settings. For our sample, EFA and CFA analyses lead us to trim two items from Career Identify, two items from Career Planning with resulting composite reliabilities of .827 and .671, respectively.

Organizational commitment.

Fields (2002) summarize eleven well-known measures of organization commitment. One of them by Gregersen (1992) with the specific focus of commitment to parent organization (CPO) and commitment to local firm (CLF) fits global organizational environment in this research setting. This measure separates commitment to a parent company from commitment to a local operation. We use the scale developed by Gregersen (1992) but extend it from five-point Likert scales to seven-point for consistency with rest of the survey. The first factor (Alpha = .84) is composed of four items focusing on commitment to a parent organization. The second factor, also of four items, reflects commitment to local firm (Alpha = .72).

Besides the key constructs presented above, we also include four factors as control variables. Their measurement is summarized as follows.

Competence.

It (work-related self-efficacy) is defined as an individual's belief in his or her capability to perform activities with skill and was analogous to personal mastery (Spreitzer, 1995). It is measured via a 3-item scale on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree) and has a alpha of .85 and .83 in samples collected during two separate time periods in the Spreitzer (1995) study.

Job involvement.

This scale is part of a broader organizational culture scale developed by Glasser, Zamanou and Hacker (1987) in the scale development efforts as part of the Organizational Culture Survey (OCS). Two items are dropped due to cross loading after the EFA/CFA analysis on our sample data with the resulting composite reliability of .84.

Growth opportunity.

This scale assesses employee control problems in the area of limited growth opportunities. It is adapted from the original four construct scale consisting of 17 items in Remondet and Hansson, 1991. The scale asks respondents to rate both frequency of event occurrence and degree to which the event results in loss of control over employee's job and has the composite alpha of .87 for the overall measure of work-related control problems (Abraham, 1996). We uses all four items of the limited growth opportunities sub-scale but without asking for frequency of event. Two items are dropped due to cross loading after the EFA/CFA analysis on our sample data with the resulting composite reliability of .909.

Fairness of reward.

Moore (2000) create a two item scale for Fairness of Rewards by taking the subset of the scale for distributive justice developed by Niehoff (1993). Fairness of Reward has an alpha of .81 with a sample of 268 IT professionals. Our EFA/CFA confirms the two item scale with the composite reliability of .917.

Method Of Analysis

The analytical approach involves measurement assessment of the key constructs and testing the hypothesized model. Table 1 summarizes the key descriptive statistics for the studies constructs. For the subjective measures, a combination of exploratory factor analysis (EFA) and confirmatory

factor analysis (CFA) procedures are used to assess the psychometric properties. We explicitly focused on the evidence for the convergent and discriminant validity of the study constructs.

Table 2 Descriptive Statistics and Intercorrelations for the Study Constructs[a]						
	1	2	3	4	Mean	s. d.
1. Commitment to Change	1				5.26	0.94
2. Change Messages Effectiveness	.52**	1			4.6	0.94
3. Organizational Commitment	.26**	.31**	1		5.69	1.03
4. Career Commitment	.32**	.42**	.45**	1	5.7	0.84
[a] All constructs are measured by seven-point likert scale.						
* p < .05						

FINDINGS

Measurement Analysis

We estimate a fully disaggregated measurement model with the key observed indicator to ensure that the measures correspond only to their hypothesized constructs and evidenced acceptable reliability and validity. A confirmatory factor analysis of the study constructs using AMOS software yielded the following fit statistics: $\chi2 = 1202.26$, d.f. = 564, $p < 0.01$; NFI = 0.91; NNFI (TLI) = 0.94; CFI = 0.95; RMR = 0.05; RMSEA = 0.045 (90% confidence interval = .04 - .05). On statistical, absolute, and relative fit, as well as substantive grounds, the posited measurement model provides a good fit to the data. Table 3 provides further support for the convergent and discriminant validity of the constructs. The estimated loadings for the relationship between individual indicants and their underlying construct are, without exception, large and significant (t-value > 9.0, $p < .01$). In addition, the reliability estimates are large and significant, ranging from .84 to .92, with an average reliability index of .88, which exceeds the conventional .70 criterion. In terms of discriminant validity, the variance extracted not only exceeds the average variance shared but also exceeds .50, the threshold value that Fornell and Larcker (1981) recommend. The preceding evidence provides robust support for the convergent and discriminant validity of study constructs.

Table 3 Factor Loadings and Measurement Properties of Various Study Constructs							
	1st Order Loading	2nd Order Loading	t-Value	Composite Reliability	Variance Extracted	Highest Variance Shared	Average Variance Shared
Commitment to Change				0.85	0.5	0.47	0.16
CCA3	0.88		-				
CCA6	0.84		23.75				
CCN3	0.51		12.33				
CCN6	0.4		9.29				
CCC2	0.61		15.55				
CCC5	0.6		14.93				
Change Message Effectiveness				0.92	0.59	0.47	0.19
CMD2	0.53		12.97				
CMA2	0.86		24.11				
CMA4	0.88		25.19				
CMV1	0.84		23.17				
CMV3	0.8		21.64				
CMS1	0.6		15.02				
CME2	0.78		20.98				
CME4	0.81		-				
Organizational Commitment				0.85	0.6	0.34	0.17
CPO1	0.81		-				
CPO3	0.76		19.2				
CLF1	0.67		15.91				
CLF4	0.83		20.61				
Career Commitment				0.85	0.49	0.4	0.24
Career Identity		0.83	-				
CARI1	0.84		18.5				
CARI2	0.91		19.33				
CARI4	0.71		-				
Career Planning		0.67	11.08				
CARP1	0.44		10.31				
CARP2	0.88		22.65				
CARP3	0.92		-				
Growth Opportunities				0.88	0.71	0.18	0.05
GOPP2	0.7		-				
GOPP3	0.92		19.66				

Table 3 Factor Loadings and Measurement Properties of Various Study Constructs							
	1st Order Loading	2nd Order Loading	t-Value	Composite Reliability	Variance Extracted	Highest Variance Shared	Average Variance Shared
GOPP4	0.9		19.2				
Fairness of Rewards				0.92	0.85	0.13	0.05
FOR1	0.91		15.38				
FOR2	0.94		-				
Job Involvement				0.84	0.57	0.4	0.13
JI1	0.62		-				
JI2	0.78		14.21				
JI3	0.81		14.23				
JI6	0.71		13.27				
Competency				0.89	0.74	0.34	0.14
COMP1	0.92		18.99				
COMP2	0.97		19.64				
COMP3	0.66		-				
Notes: Loading = standardized coefficient estimate based on the maximum likelihood estimation method using AMOS software. t-values greater than 1.96 indicate significant effects at p = .05 for a two-tailed test. Composite reliability and variance extracted are based on Fornell and Larcker's (1981) formula. Average of the variance shared between the corresponding latent construct and all other constructs;it is computed as the mean of squared correlations.							

Hypothesized Model Analysis

According to our empirical results summarized in Table 2, H1, H3 and H4 are supported among five hypotheses that we proposed. Career commitment is positively related to change message effectiveness (β = 1.01, p < .01), which is positively related to commitment to change (β = .72, p < .01). Thus, H1 and H4 are supported. In addition, career commitment has no direct effect on commitment to change (β = -.14, p > .10) after controlling for the effect of change message effectiveness, so H5 is not supported. Based on Shrout and Bolger (2002), the mediation hypothesis is supported if both the antecedent -> intervening and the intervening -> outcome coefficients are significant. Therefore, the results show that change messages fully mediate the relationship between career commitment and commitment to change. On the other path, organizational commitment has no significant effect (β = -.07, p > .10) on change message effectiveness, but directly relates to commitment to change (β = .10, p < .05). So H2 is not supported. Furthermore, this direct effect is positive, which supports H3 indicating that an increasing emphasis on organizational commitment enhances commitment to change.

Table 4 Estimated Coefficients for the Hypothesized Model		
	Dependent Variables	
	Change Message Effectiveness	Commitment to Change
Independent Variables		
Organizational Commitment	-.07 (.05)	.10 (.05)
Career Commitment	1.01 (.07)	-.14 (.10)
Change Message Effectiveness	-	.72 (.04)
Control Variables		
Growth Opportunities	-	-.16 (.04)
Fairness of Rewards	-	.09 (.03)
Job Involvement	-	-.22 (.06)
Competency	-	.30 (.05)
Note: The results reported are unstandardized coefficients following by standard error in parentheses. Coefficients significant at p = .05 are in bold.		

DISCUSSIONS

As our findings show, career commitment operates very differently than organizational commitment in terms of its impact of change message effectiveness as well and on commitment to change. Most of the change communication literature emphasizes the need to develop organizational commitment so that belief in change can be enhanced. Our findings show no significant relationship between organizational commitment and change messages effectiveness. On the other hand, the role of career commitment is far more important when it comes to the change message effectiveness. In other words, employees who are committed to their careers are more ready to absorb and interpret the change message communication.

However, the end goal of change communication is not just to influence the belief towards the change but go a step further by enhancing the commitment towards the change. In this area, our findings show how organizational commitment and career commitment operate differently. When it comes to the direct effect, organizational commitment does lead to a commitment towards change while career commitment has no direct effect on commitment to change (only indirectly through change message effectiveness).

We want to highlight that in term of effect size, change message effectiveness has the greatest impact on commitment to change, which makes the role of career commitment far more important than organizational commitment in enhancing commitment to change. The direct effect of organizational commitment on commitment to change is much smaller compared to the impact that career commitment has on commitment to change through change message effectiveness. If organizations want to enhance commitment to change, they should help employees become more

career focused rather than just try to enhance their commitment to the organization. This is especially true for the loosely-coupled global organizational networks in which employees are increasing finding themselves in which any single organizational commitment may not be that relevant for the overall change success across the organizational network.

PRACTICAL IMPLICATIONS

The practical implications for our research is that rather than investing time and other resources towards improving the organizational commitment, it is more effective for organizations to invest in helping their employees develop career commitments. During change communication, management can show the link between the organizational change and the career aspirations of the employees to maximize their commitment towards the organizational change effort. If employees see that connection between the organizational change and the advancement of their respective careers, they will indeed be more willing to embrace the change.

Limitations

Even though we collected the data from two different IT centers in two different cultural settings, the data is still is part of one global bank and so any generalization of findings may not be relevant. In addition, two of the constructs, change message effectiveness and commitment to change have high correlation. However, this is largely due the nature of these two constructs, since both of them are designed to study the change process. We believe that they are distinct from one another as the shared variance is still less than 0.30 and other published works acknowledge and work around this limitation as well. For example, Holt et al (2007) explain that the five change messages are more about readiness for change, which is a precursor to resistance and adoption behavior. In our view there is a natural overlap between the constructs but change message effectiveness and commitment to change are still distinct enough in the context of the overall change management process.

Future Research

Our findings on the importance of career commitment in the context of organizational change open a window into the retention research as well, a topic that is very important in the knowledge intensive IT industry. It would be interesting to study which antecedents of career commitment are more critical in the context of organizational change and change communication both for advancing research and for developing practical insights for human resource executives to design their HR strategies in the IT industry in the constantly changing business environment that most IT firms find themselves in.

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APPENDIX
OPERATIONAL ITEMS USED TO MEASURE VARIOUS STUDY CONSTRUCTS

Unless otherwise noted, we measured the following items on a seven-point Likert scale where 1 = "strongly disagree" and 7 = "strongly agree." The items marked with (R) were reversed to keep the consistency with other measures.

Commitment to Change (Herscovitch and Meyer, 2002)

Affective (cca1-6)

CCA1: I believe in the value of this change to the [pool model]. [q105]
CCA2: This change to the [pool model] is a good strategy for this organization. [q108]
CCA3: I think the management is making a mistake introducing this change. [q111] (R)
CCA4: Change to the [pool model] will serve an important purpose. [q114]
CCA5: Things would be better without this change to the [pool model]. [q117] (R)
CCA6: This change to the [pool model] is not necessary. [q120] (R)

Continuance (ccc1-6)

CCC1: I have no choice but to go along with this change. [q107]
CCC2: I feel pressure to go along with this change. [q110]
CCC3: I have too much at stake to resist this change. [q113]
CCC4: It would be too costly for me to resist this change. [q116]
CCC5: It would be too risky to speak out against this change. [q119]
CCC6: Resisting this change is not a viable option for me. [q122]

Normative (ccn1-6)

CCN1. I feel a sense of duty to work toward this change. [q106]
CCN 2. I do not think it would be right of me to oppose this change. [q109]
CCN 3. I would not feel badly about opposing this change. (R) [q112]
CCN 4. It would be irresponsible of me to resist this change. [q115]
CCN 5. I would feel guilty about opposing this change. [q118]
CCN 6. I do not feel any obligation to support this change. (R) [q121]

Change Messages (Armenakis, Bernerth, Pitts, & Walker, 2007)

Discrepancy (cmd1-4)

CMD1: We needed to change the way we did some things in this organization. [q39]
CMD2: We needed to improve the way we operate in this organization. [q45]
CMD3: We needed to improve our effectiveness by changing our operations. [q51]
CMD4: A change was needed to improve our operations. [q57]

Principal Support (cms1-5)

CMS1: Most of my respected peers will most likely embrace this change. [q42]
CMS2: Top leaders support the change from [team model] to [pool model]. [q48]
CMS3: The majority of my respected peers are dedicated to making this change successful. [q54] [O]
CMS4: My immediate manager encourages me to support this change. [q60]
CMS5: My immediate manager is in favor of the change from [team model] to [pool model]. [q56]

Valence (cmv1-5)

CMV1: This change from [team model] to [pool model] will benefit me. [q43]
CMV2: With this change in my job, I will experience more self-fulfillment. [q49]
CMV3: The change in my job assignments will increase my feelings of accomplishment. [q55] [O]
CMV4: Not embracing this change will have a negative effect on my future career. [q61]
CMV5: I will have the potential to earn higher pay from my job after this change. [q62]

Appropriateness (cma1-5)

CMA1: I believe the change from team model to pool model will have a favorable effect on our operations. [q40]
CMA2: This change will improve the performance of our organization. [q44]
CMA3: The change that we are implementing is correct for our situation. [q46]
CMA4: When I think about the change from team model to pool model, I realize it is appropriate for our organization. [q52]
CMA5: This change from team model to pool model will prove to be best for our situation. [q58]

Efficacy (cme1-5)

CME1: I have the capability to help implement the change from team model to pool model. [q41]
CME2: I can implement this change in my job. [q47]
CME3: I am capable of successfully performing my job duties after this change is implemented. [q50]
CME4: I believe we can successfully implement this change. [q53]
CME5: We have the capability to successfully implement this change. [q59]

Career Commitment (Carson & Bedeian, 1994)

Career Identity (cari1-4)

CARI1. My career is an important part of who I am. [q76]
CARI 2. This career has a great deal of personal meaning to me. [q77]
CARI 3. I do not feel passionate about my career. [q78] (R)
CARI 4. I strongly identify with my chosen career. [q79]

Career Planning (cp1-4)

CARP1. I do not have a strategy for achieving my goals in my career. [q80] (R)
CARP 2. I have created a plan for my career development. [q81]
CARP 3. I have identified specific goals for my development. [q82]
CARP 4. I do not often think about my personal career development. [q83] (R)

Organizational Commitment (Gergersen and Black, 1992)

Commitment to Parent Organization (cpo1-4) (from measures at work).

CPO1. The reason I prefer this parent company to others is because of its values, or what it stands for. [q8]
CPO 2. I really care about the fate of this parent company. [q9]
CPO 3. I talk up this parent company to my friends as a great place to work. [q10]
CPO 4. What this parent company stands for is important to me. [q11]

Commitment to Local Firm (clf1-4) (from measures at work)

CLF1. What my local firm stands for is important to me. [q12]
CLF2. I really care about the fate of my local firm. [q13]
CLF3. I talk up my local firm to my friends as a great group to work with. [q14]
CLF4. The reason I prefer this local company to others is because of its values, or what it stands for. [q15]

AUTHORS' NOTE

Both authors contributed equally.

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