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TABLE OF CONTENTS

LETTER FROM THE EDITORS

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THE ROLES OF TECHNOLOGY ACCEPTANCE MODEL ANTECEDENTS AND SWITCHING COST ON ACCOUNTING SOFTWARE USE

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ABSTRACT

The technology acceptance model (TAM) has proven to be one of the most powerful theories to explain users' technology adoption. Among many external variables incorporated into TAM, service quality (ServQ) and experience (PE) are considered as important factors that influence technology use. In this study TAM (Davis et al 1989) and information system success models (Delone and McLean 1992) are combined and then revised. The results show that service quality and alternative attractiveness had strong external influence on both perceived ease of use (PEOU) and perceived usefulness (PU) of accounting software programs, however product experience had not. Furthermore, instead of "attitude", mediating effect of switching cost is analyzed. Results show how the influence of PU gain more importance in creation of long-term loyalty compared to that of short-term use intentions. The indirect effect of service quality on intention to use via perceived usefulness is found ineffective while it stays significant to obtain a continuos loyaty. Switching cost support both intention to use and loyalty. The research data is collected from professional accountants working in accounting bureaus in Turkey. Briefly, the study helped to find-out the main affective decision-making criteria in use of accounting software programs.

Keywords: technology acceptance model, switching cost, customer loyalty, service quality, product experience, alternative attractiveness

INTRODUCTION

Accountants have generally increased their investment in accounting software in order to increase the efficiency of their business operations and to improve productivity. Thus, IT has become a strategic weapon to obtain competitive advantages in accounting based job accomplishments. The information system performance is found critical for software usage (Hernandez et al 2009, Hsu et al 2009). Delone and Mclean 1992 "information system success model" is represented mainly by three fundamental dimensions as information system quality, information quality and service quality (Delone and McLean 1992, Landrum et al 2008, Pitt et al

1995). Other system dimensions are system quality, frequency of use, customer satisfaction, personal and organizational effects (Delone and McLean 1992). One of them, service quality, is used in our extended TAM. In this study, it is aimed to find out the criterias that effect the use of a technological product and loyalty to that product based on the external effects of three variables; service quality, alternative attractiveness and product experience via "switching cost". Specifically, the objectives of this study are: (1) to evaluate how service quality, product experience, and alternative attractiveness effect perceived ease of use and perceived usefulness of accounting software programs , (2) to find-out the impact of perceived ease of use and perceived usefulness on switching cost, (3) to determine the impact of service quality and switching cost on behavior intention to use and behavior loyalty (4) At the end compare two combinations of the model, one with behavior intention to use and the other one with behavior loyalty.

A lot of empirical work has proved the positive relationships between service quality and behavioral consequences like customer loyalty in different fields of service industry such as banking and travel agencies (Jones et al 2002), information systems and internet (Hoxmier 2000, Good and Harris 2007). The most important unique value of this study is to find-out the effects of switching cost on accountants' software preferences using an extended technolgy acceptance model. Accountants are going to decide to keep or change the current accounting software program after making a comparative benefit-cost analysis of switching between alternatives, so the importance of switching cost effect is taken into consideration. The external influences of product experience (Lee and Kim 2009, Igbaria 1990) and service quality (Kim et al 2008, Robinson et al 2005, Ha and Stoel 2009) on both PEOU and PU have been looked for previously, however the one of alternative attractiveness has not been studied yet to our knowledge. Beside switching cost (Fornell 1992, Jones et al 2002), alternatives' deficiency(Ping 1993) in the market also is a good opportunity for a firm to keep clients on hand, which also analyzed in the study. Finally the model is comparatively tested one-side using a short-term use intentions and the other side long-term loyalty.

According to face-to-face interviews with professional accountants from accounting bureaus and some others from different firms' accounting departments in Turkey, the accountants prefer mostly multi-functional accounting software programs, especially the web-based ones. The security and privacy level like data protection during the program updates or upgrades and confidentiality of customers' accounts are important. The software's code quality, efficient technical service, additional benefits like free tutorials, extra technical service, or special discounts are other selective criterias mentioned by professional accountants in their purchasing decisions. Indeed, the study will be a guide for accounting software companies for how to create usage intention and then customer loyalty.

THEORY AND RESEARCH FRAMEWORK

TAM and external variables

Davis et al (1989) created a TAM where perceived ease of use (PEOU) and perceived usefulness (PU) enhance behavior intention to use (BI) and actual use (U) via individual's "attitude" (ATT) and perceived ease of use has a direct impact on perceived usefulness. In this study "attitude towards use" is removed and replaced by "switching cost" variable. Perceived ease of use refers to the degree to which an individual believes that using a particular system would be free of effort. Beside, perceived usefulness is defined as the degree to which an individual believes that a particular system would enhance his or her job performance within an organizational context (Davis et al 1989). Moreover, extended TAMs have focused on the external variables' effects like those of service quality and product experience (Lee and Kim 2009, Kim et al 2008, Robinson et al 2005, Ha and Stoel 2009). Service quality signify the overall quality of information system service (Delone and McLean 1992), while product experience depends on consumer's prior familiarities with other alternatives (Fornell 1992, Igbaria 1990). On the other hand, to our knowledge, alternative attractiveness, which refers to the good alternatives availability in the market (Ping 1993), has not been used as an external variable previously. Avlonitis and Panagopoulos(2005) used competition influence, organizational training, and computer experience as social, organizational and individual external variables in sequence. In this study, the external influence of accountant's previous software experiences (individual factors), the service support of the software firm (organizational factors), and alternatives' attractiveness (social/environmental factors) on software loyalty and usage intentions will be looked for.

PEOU and PU

Many empirical studies in information management have supported the positive siginificant efffect of PEOU on PU (Davis et al., 1989; Igbaria et al., 1997; Robinson et al 2005, Hsu et al 2009, Kim et al 2008, Luarn and Lin 2005, Wu and Wang 2005). On the other hand, Zhang and Gosain (2003) found that online retailers with greater usability of interface will reduce their potential customers' perceived learning costs. A user-friendly designed website can increase visitors' perceived learning cost of other web-sites encouraging the likelihood of return to the site (Agarwal & Venkatesh, 2002; Palmer, 2002). In addition to that, Amoako-Gyampah (2007) mentioned about the resistance of workers to change the familiar current information system with an unfamiliar complex ERP system. A user-friendly software program might also decrease intention to switch especially when the past interactions with the current one is ended up without significant drawbacks. PEOU is not found to have a significant relationship with

neither attitude toward social networks nor intention to use social network (Curran & Lennon, 2011).

Hypothesis 1a: *Perceived ease of use positively affects perceived usefulness.*
Hypothesis 1b: *Perceived ease of use positively affects switching cost*

Indeed, Sengupta et al (1997) proved that the greater the customer adaptation is undertaken by key account managers, the greater the switching cost will be faced for that customer account in revenue turn. Hsu et al (2009) mentioned the negative effect of statistical anxiety on perceived software usefulness for online MBA learners, vice-versa increase in PU might be expected to decrease uncertainty risk of being technically capable to use software programs. On the other hand, perceived usefulness has shown significantly positive effects on the use of different technologies like ERP systems (Amoako-Gyampah, 2007), mobile services and commerce (Luarn & Lin, 2005, Wu & Wang, 2005), electronic tax filing (Fu et al 2006). Its positive effect on software use also was supported in other studies (Hernandez et al 2009, Hsu et al 2009). In addition, Cyr et al (2006) showed the positive effect of PU on loyalty towards mobile services. Perceived usefulness is foud significantly and positively related to e-commerce adoptionfor internet users in South-Korea (Lee 2010).

Hypothesis 2a; *Perceived usefulness positively affects switching cost.*
Hypothesis 2b: *Perceived usefulness positively affects behavior intention to use*
Hypothesis 2c: *Perceived usefulness positively affects behavior loyalty*

Product Experience

Perceived usefulness of information systems has a remarkable positive effect on BI for experienced users, whereas the inexperienced ones are mostly affected by PEOU (Castaneda et al 2007, Venkatesh et al 2003). Zhou (2012) proved the positive effect of flow experience on mobile banking user adoption where technical skills and challenges compensate each other**.** The literature supports the controversial effect between perceived ease of use and experience. Heuristic-Systematic Model approach (Chen and Chaiken 1999) support that a customer with limited experience will evaluate the new product heuristically based on only the parts that are easy to use however the awareness to the more complex parts of the product increase by experience. Koufaris et al (2002) determined that individuals with low product involvement evaluate the use of a web store less challenging than what it currently is. In another research, Amoako-Gyampah (2007) found that long-term prior experience with currrent legacy systems has a negative effect on PEOU of new, more complex ERP systems.

On the other hand, opportunities gained by usage experience of computers improve users' beliefs about their usefulness (Kim et al 2007, Lee and Kim 2009, Igbaria 1990). Thompson et al

(1994) pointed out the positive influence of IT experience on IT utilization because the experienced users become more aware of long term benefits of PC use such as the accomplishment of more meaningful work. Indeed, as much as the accountant will be aware of the additional, special program tools with experience, PU of software use will also increase parallel to that.

Hypothesis 3a: *product experience has a negative relationship with perceived ease of use*

Hypothesis 3b: *product experience has a positive relationship with perceived usefulness*

Alternative Attractiveness

Alternative attractiveness is found positively associated with opportunistic behaviors and exiting the relationship at the end since customers will be encouraged to try other good alternatives (Ping 1993, Sharma and Patterson 2000, Zhang et al 2009). Zhang et al (2009) found that bloggers' intention to switch their blog services is strongly associated with attractive alternatives. The buying process brings different purchasing risks like financial, performance, psychological risks (Etzel et al, 1997) while good alternative opportunites might shorten the decision-making process reducing these risks. As a result, the more alternatives' opportunity, the more confident will be the accountants about the success and usefulness of software usage on job performance. Mostly, accountants are aware of the complexity of using acc programs that require good technical skills however high alternative attractiveness will increase the familiarity with those, and so PEOU.

Hypothesis 4a: *Alternative attractiveness has a positive effect on perceived ease of use*

Hypothesis 4b: *Alternative attractiveness has a positive effect on perceived usefulness*

Service Quality

Lots of TAM studies proved positive and significant effects of different service quality types on PEOU and PU like design aesthetics quality in mobile services (Cyr et al 2006) or technical support in intranet usage (Lee and Kim 2009), personal computing acceptance (Igbaria et al 1997), web-based learning (Sánchez and Hueros2010). Different combinations of TAM with Delone and McLean's information system success model (1992) studied the positive effects of service quality on both PEOU for hotel information systems (Kim et al 2008), CRM applications(Avlonitis and Panagopoulos 2005) and also on PU for library information systems

(Landrum et al 2008). Beside those, Lin et al (2011) found that the information quality of e-Government filing systems positively affects the PU of internet use. Indeed, a good service assistance that assure privacy and security of the customer accounts during software program set-ups or upgrading should increase expectations overall.

More recently, the direct positive effects of a favorable web-site appearance and design on behavioral usage intentions also have been proven (Good and Haris 2007). Moreover, Chang and Chen 2008 found that customer interface quality, including customization, interaction and convenience contributes to generate e-loyalty. Technical support is found as a crucial factor on acceptance of e-working by auditors (Bedard et al 2003), on intranet usage in major Korean companies (Lee and Kim 2009) and also on personal computing usage in small firms (Igbaria et al 1997). Hoxmier (2000) mentioned the important effect of reliable and error-free softwares on company reputation. Similar to those, a good technical service quality that guarantee error-free and reliable softwares will bring higher repurchase intentions and loyalty.

Hypothesis 5a: *Service quality positively affects perceived ease of use*
Hypothesis 5b: *Service quality positively affects perceived usefulness*

Hypothesis 6a: *Service quality has a positive effect on behavior intention to use*
Hypothesis 6b: *Service quality has a positive effect on behavior loyalty.*

Switching cost

Burnham et al (2003) classified switching costs under three categories; procedural, financial and relational. The procedural switching cost consists of economic risk cost (uncertainty cost), evaluation cost, learning cost and set-up cost. Economic risk cost involves the uncertainty of new service/product performance, evaluation cost reflects time and effort cost to evaluate other alternatives, set-up cost refers to the cost of a new relationship configuration, like implementation of a new software program and learning cost is the effort needed to learn the new service/product (Jones et al,2002, Burnham et al 2003, Guiltinan 1989). Financial cost involves both monetary loss and benefit loss costs. Monetary loss cost is the one time, incremental cost to start a new relationship (Guiltinan 1989, Burnham et al 2003), like deposit or licence fee for a software program. Benefit loss cost reflects special promotions, or unique benefits (Burnham et al 2003), like additional technical support, tutorial or upgrading to a new version.

Zhang et al (2009) found that bloggers' intention to switch their blog services is strongly associated with sunk costs. Switching costs are the sunk costs (Shy 2002) where the earned benefits cannot be transfered to another product. As a result, these costs stock consumers in relationships repurchasing the same brand even when the satisfaction level is low (Jones et al 2002) so they enhance customer loyalty (Fornell 1992, Liu et al 2011). Moreover, switching

costs have a negative effect on attitude towards switching to online banking (Lee et al 2011) and positively affect e-loyalty (Chang and Chen 2008). Jarvenpaa et al (2000) argued that low perceived risk of an Internet store is associated with increase in consumer's willingness to purchase from that store. Moreover, Aydın and Ozer (2005) mentioned the important role of switching cost on customer loyalty in their national customer satisfaction indices.

Hypothesis 7a: *Switching cost positively affects behavior intention to use*
Hypothesis 7b: *Switching cost positively affects behavioral loyalty*

METHODOLOGY

Sample and data collection

In this study, the sampling universe is the Professional accountants using accounting software programs in Turkey. These professional accountants are from accounting bureaus who have been authorized to choose the accounting softwares for their work. These accountants include accounting clerks, accounting managers, chartered accountants, public accountants and certified public accountants (CPA). In order to represent this population optimally, sampling was carried out from 20 biggest cities dispersed in different regions of Turkey. The distribution of the sample among these cities is consistent with their population and location. A total of 1020 questionnaires were collected by face-to-face interviews, however some were eliminated by examining the answers to control questions in the questionnaire form. As a result, to collect error-free data, the final data set contains 709 accountants. In order to test non-response bias X^2 difference test has been applied between the later and earlier respondents and no any significant difference is found at $p< 0.01$ level.

Measurement and Descriptive characteristics

In this study, all scales use a five-point rating scale anchored on "strongly disagree" and "strongly agree". In addition, the fitness of the measurement variables was validated through interviews with employees who were professional accountants using accounting software programs in Turkey. Moreover, face-to-face interviews with the chamber of Turkish accountants provided important benefits in preparation of the questionnaire form. Descriptive statistics of the respondents are summarized in Table 2. Among the 709 respondents 22.5% were females; 73.5% of the sample is accumulated between the middle-age group (30-50 yrs), the rest 26.5% forms the youngest (below 30) and oldest (above 50) sample population. Educational levels were generally high; 56.4% of the sample has university degree. In addition to those, 81% of the respondents have more than 7 yrs of experience. The sample characteristics are shown in table 1

Table 1: Respondents' profile		
Variables	Frequency	Percentages*%*
Gender	156	22.5
Female	538	77.5
Male		
Age		
Under 30	66	10.3
30-39	254	39.6
40-49	215	33.5
50 and above	107	16.7
Educational level		
High school	104	15.1
Collegue	143	20.7
University	389	56.4
Graduate school	54	7.8
Years of experience		
0-3	104	4.9
3-5	143	8.1
5-7	389	5.8
More than 7	54	81.1

Measurement of switching costs

At first, switching costs were conceptualised as a first-order factor model and treated as a uni-dimensional factor. To assess the reliability and validity of the measurement model, 24 switching cost items were analysed by exploratory factor analysis using varimax rotation and the missing values in the data set are substituted with a series of mean.

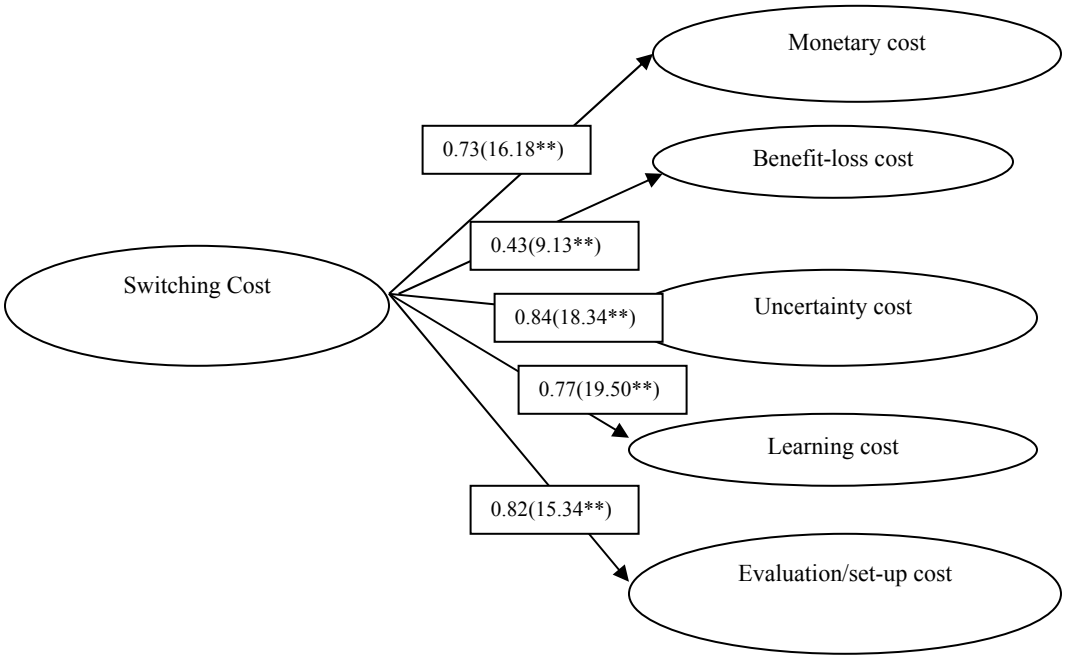
The initial analysis resulted in five factors with 23 items in total(monetary cost, benefit-loss cost, learning cost, evaluation/set-up cost, and uncertainty cost). One item from the evaluation cost scale was dropped which did not load meaningfully on the related construct. Moreover, evaluation and set-up costs are loaded under the same factor. As a result, five first-order factor loading is obtained. Factor loadings were between 0.805 and 0.597 for monetary cost, between 0.840 and 0.526 for benefit-loss cost, between 0.814 and 0.757 for learning cost, between 0.773 and 0.606 for evaluation/set-up cost, and between 0.818 and 0.560 for uncertainty cost.

Confirmatory Factor Analysis for Switching Cost

As exploratory factor analysis is defined as a precursor for confirmatory factor analysis (Gerbing and Hamilton 1996), five first-order factors (monetary, benefit-loss, uncertainty, evaluation/set-up, learning costs) with 23 items are directed to obtain a second-order switching cost variable. A maximum likelihood method of estimation by LISREL 8.51 is used for confirmatory factor analysis. First of all, the items used to measure each of the five components of switching cost were averaged to arrive at a single score for each component. Then, one single

switching cost factor is defined by five single averaged score items representing monetary, benefit loss, learning, evaluation/set-up and uncertainty costs. The results of confirmatory factor analysis are shown in figure 1.

Figure1: Second-order measurement model of switching cost



The model was found to be statistically significant ($X^2_{(223)}$= 3.78, p<0.01). In general, model fit is assured if CFI, NFI, IFI and GFI are larger than 0.9, AGFI is larger than 0.8 and RMSEA is smaller than 0.08. The ratio of chi-square to degrees-of-freedom with a suggested value of 5 or below is acceptable (Bagozzi & Yi, 1988; Hair et al., 1998; Jöreskog & Sörbom, 1993). The fit indices suggested a good model fit (RMSEA=0.063, CFI=0.98, IFI=0.98, NFI=0.97, RFI=0.96, SRMR=0.058, GFI=0.91, AGFI=0.88). (Bagozzi and Yi, 1988;Hair et al., 1998; Jöreskog and Sörbom, 1993).

To assure discriminant validity, two models were compared using X^2 difference tests for each pair of constructs : one where the correlation between pair is a free parameter and the other where it is fixed at one (Mak and Sockel, 2001). The chi-square of the first model where the correlation is a free parameter should be much smaller than the other model where it's fixed at one and be significant at $p < 0.01$ (Bagozzi & Yi, 1988, Mak and Sockel, 2001). Ten different models were first tested by chi-square for the first-order factors and discriminant validity is achieved with minimum $X^2_{(1)}$= 140.75, p<0.01. The difference of chi-square between two constructs must be 3.84 or greater to justify that two models are different at a 95% confidence

interval. Secondly, variance extracted test is assessed. In this test, the variance extracted estimate is compared to the squares of the correlations (shared variances) between two factors. Both variance extracted estimates should be greater than square correlations in order to obtain discriminant validity. Table 2 shows intercorrelations and share variances among constructs. The cells on the bottom left corner are intercorrelations while the cells on the upper right corner (in bold) are shared variances. The explained variance (i.e., AVE) of constructs exceeds all combinations of shared variances of corresponding constructs (Straub, 1989).

Table 2: Descriptive statistics and correlation matrix

Constructs	1	2	3	4	5	6	7	8	Mean	SD
1.Perceived usefulness	1	**0.45**	**0.26**	**0.02**	**0.21**	**0.35**	**0.36**	**0.19**	4.1881	0.82748
2.Perceived ease of use	0.674(**)	1	**0.16**	**0.01**	**0.11**	**0.18**	**0.19**	**0.09**	4.3025	0.86502
3.Service quality	0.510(**)	0.395(**)	1	**0.04**	**0.08**	**0.27**	**0.28**	**0.16**	3.8530	0.95984
4.Product experience	0.157(**)	0.088(*)	0.211(**)	1	**0.01**	**0.02**	**0.02**	**0.03**	3.1387	1.19417
5.Switching cost	0.461(**)	0.331(**)	0.289(**)	0.121(**)	1	**0.15**	**0.13**	**0.16**	3.7454	0.75748
6.Behavior loyalty	0.593(**)	0.422(**)	0.519(**)	0.144(**)	0.384(**)	1	-	**0.26**	3.8953	1.06292
7.Behavior intention to use	0.601(**)	0.435(**)	0.528(**)	0.148(**)	0.363(**)	-	1	**0.22**	4.1187	1.04922
8. Alternative attractiveness	0.436(**)	0.295(**)	0.402(**)	0.168(**)	0.401(**)	0.507(**)	0.474(**)	1	3.3591	1.11653

All correlations are significant at the 0.05 level 2-tailed. Intercorrelations are included in the lower triangle of the matrix. Shared variances in % are included in the upper triangle of the matrix. The construct reliability estimates are underlined and positioned on the diagonal

To assure convergent validity, all factor loadings of items should be significant (their t-values should exceed 1.96) (Anderson and Gerbing, 1988) and represent their underlying construct factor. Moreover, the value of average variance extracted (AVE) should exceed .50 (Fornell & Larcker, 1981). AVE shows directly the amount of variance accumulated in a construct due to its indicators. As shown in table 3, the values for all factors are either close to or greater than 0.50, supporting the standard of Fornell and Larcker 1981. Moreover, each of the factor loadings (λ_{ij} for items, β_{ij} for first-order factors, γ_{ij} for second-order factors) is significant at the 0.01 level supporting convergent validity for all constructs in the study. In addition to those, CCR for each construct is calculated using Fornell and Larcker (1981) formula by the calculation of total coefficients of determination to see whether the measurement variable is representative of the related construct. All composite reliability coefficients are acceptable, being larger than 0.60 (Siguaw and Diamantopoulos 2000). Moreover, the Cronbach's alpha values for all factors are greater than 0.70, confirming the criteria of Nunnally (1978).

Table 3: Switching cost items sub-constructs			
Constructs and scales	Items	Stand loadings	T values
Monetary Cost(α=0.85 CRC=0.86 pv=0.50**)**			
Burnham et al 2003	MC1	0.62	16.05
Guiltinan 1989	MC2	0.70	18.20
	MC3	0.71	18.51
	MC4	0.80	20.88
	MC5	0.76	-
	MC6	0.66	17.06
Benefit loss Cost(α=0.72 CRC=0.75 pv=0.52**)**			
Burnham et al 2003	BLC1	0.40	9.67
Guiltinan 1989	BLC2	0.80	-
	BLC3	0.87	14.46
Uncertainty Cost(α=0.89 CRC=0.88 pv=0.60**)**			
Burnham et al 2003	UC1	0.72	29.94
Jones et al 2002	UC2	0.75	-
Guiltinan 1989	UC3	0.81	21.55
	UC4	0.86	22.86
	UC5	0.73	19.18
Learning Cost(α=0.91 CRC=0.91 pv=0.71**)**			
Burnham et al 2003	LC1	0.83	28.02
Jones et al 2002	LC2	0.87	-
Guiltinan 1989	LC3	0.84	28.52
	LC4	0.83	28.14
Evaluation/Set-up Cost(α=0.84 CRC=0.83 pv=0.49**)**			
Burnham et al 2003	ESC1	0.60	13.63
Jones et al 2002	ESC2	0.79	16.76
	ESC3	0.78	16.64
	ESC4	0.65	-
	ESC5	0.66	23.96
Switching Cost *second order*			
Monetary Cost	MC	0.73	16.18
Benefit Loss Cost	BLC	0.43	9.13
Uncertainty Cost	UC	0.84	18.34
Learning Cost	LC	0.77	19.50
Evaluation-setup Cost	ESC	0.82	15.34

Dimensionality, convergent and discriminant validity of "structural model"

Service quality, product experience, alternative attractiveness, perceived ease of use, perceived usefulness, switching cost, behavior intention to use and behavioral loyalty, all are loaded on a single factor supporting the uni-dimensionality principle for each scale. As a result, the scale validity of 7 factors with 34 items for BI (behavioral intention to use)model and then 36 items for BL(behavioral loyalty) model are tested by confirmatory factor analysis, including switching cost variable. Both models show good fit indices; BI model ($X^2_{(501)}$ = 2.66; RMSEA:0.048, CFI:0.99, IFI:0.99, NFI:0.98, RFI:0.97, SRMR:0.041, GFI:0.90, AGFI:0.88)

and BL model ($X^2_{(569)}$ = 2.79; RMSEA:0.050, CFI:0.98, IFI:0.98, NFI:0.97, RFI:0.97, SRMR:0.043, GFI:0.89, AGFI:0.87). (Bagozzi and Yi, 1988; Jöreskog and Sörbom, 1993).

Each of the factor loadings is significant at the 0.01 level based on the significance of parameter estimation (Anderson and Gerbing, 1988). Therefore convergent validity was achieved for all the constructs in the study. To assess discriminant validity, a chi-square difference test was used following the standards set by Mak and Sockel(2001). As a result, 20 different chi-square values were obtained for 20 different models for both BL and BI models. Discriminant validity had been achieved for both BI and BL models with (minimum $X^2_{(1)}$=752.84, p<0.01). Moreover, Cronbach's alpha values for all factors were greater than 0.70, meeting the criterion set by Nunnally (1978). In addition to that, composite reliability(CRC) values were above the acceptable limits (Siguaw & Diamantopoulos,2000) . In addition to that, average variance extracted (pv) was either close or above the acceptable limit (table 4). Thus, all reliability analyses indicated that the structural model is statistically reliable.

Table 4: Structural measurement model assessment results

Constructs and scales	Items	Stand loadings BL/BI	t values BL/BI	AVE BL/BI	CCR BL/BI
Service Quality (α=0.90)					
Brown and Swartz 1989	ServQ1	0.77	29.04/21.77	0.63	0.90
Delone and McLean 2003	ServQ2	0.79/0.80	22.79/22.80		
	ServQ3	0.80	-/-		
	ServQ4	0.84	23.97/24.56		
	ServQ5	0.77	21.67/22.05		
Product Experience(α=0.83**)**					
Burnham et al 2003	PE1	0.76	19.37/19.31	0.63	0.83
Thompson et al 1994	PE2	0.88/0.89	-/-		
	PE3	0.72	18.67/18.62		
Alternative Attractiveness (α=0.80)					
Ping 1993	AAT1	0.80/0.64	13.18/12.51	0.51/0.41	0.80/ 0.73
Burnham et al 2003	AAT2	0.86/0.72	13.41/13.47		
	AAT3	0.63/0.57	11.67/18.11		
	AAT4	0.51/0.57	-/-		
Perceived Ease of Use(α=0.91)					
Davis et al 1989	PEOU1	0.81	27.21/27.24	0.72	0.91
Venkatesh and Davis 2000	PEOU2	0.87	-/-		
Igbaria 1990	PEOU3	0.82	27.45		
	PEOU4	0.88	31.13		
Perceived Usefulness(α=0.94**)**					
Davis et al 1989	PU1	0.76	25.45	0.64	0.94
Venkatesh and Davis 2000	PU2	0.83	29.45		
Igbaria 1990	PU3	0.71	22.92		
	PU4	0.65	20.10		
	PU5	0.87	32.50/32.54		
	PU6	0.88	41.12		
	PU7	0.88	-/-		
	PU8	0.83	29.62/29.66		

Table 4: Structural measurement model assessment results					
Constructs and scales	Items	Stand loadings BL/BI	t values BL/BI	AVE BL/BI	CCR BL/BI
	PU9	0.75	25.06		
Behavior Intention to Use(α=0.888)					
Davis et al 1989	BI1	0.73	23.42	0.69	0.90
	BI2	0.85	30.43		
	BI3	0.89	-		
	BI4	0.85	30.08		
Behavioral Loyalty(α=0.89)					
Narayandas 1996	BL1	0.73	22.53	0.59	0.90
	BL2	0.85	-		
	BL3	0.88	30.43		
	BL4	0.84	28.18		
	BL5	0.59	16.92		
	BL6	0.67	19.92		
Switching Cost *second order* α=0.80					
Monetary Cost	MC	0.67	16.79/16.73	0.46	0.81
Benefit Loss Cost	BLC	0.46	11.40/11.29		
Uncertainty Cost	UC	0.77	-/-		
Learning Cost	LC	0.72	17.85/17.84		
Evaluation-setup Cost	ESC	0.73/0.74	18.18/18.23		
Note single values show that there are no differences between st loadings validity and reliability values of both models on the other hand .../... shows the results for BL/BI models. BL=model with behavior loyalty BI= model with behavior intention to use.					

Structural equation model analysis and hypothesis testing results

The both proposed structural models were found statistically significant with good model fit indices. The overall fit of the BI model was sound with ($X^2_{(507)}$: 2.96, $p < 0.01$, RMSEA: 0.053, CFI:0.98, IFI:0.98, NFI:0.97, RFI:0.97, SRMR:0.051, GFI:0.89, AGFI:0.87). BL model also was found statistically significant with ($X^2_{(575)}$: 2.87, $p < 0.01$), also other fit indices suggested a good model fit (RMSEA:0.051, CFI:0.98, IFI:0.98, NFI:0.97, RFI:0.97, SRMR:0.050, GFI:0.89, AGFI:0.87) indicating that the proposed model achieved a strong predictive validity except slightly difference of GFI value with 0.89 (Bagozzi and Yi, 1988; Jöreskog and Sörbom, 1993).

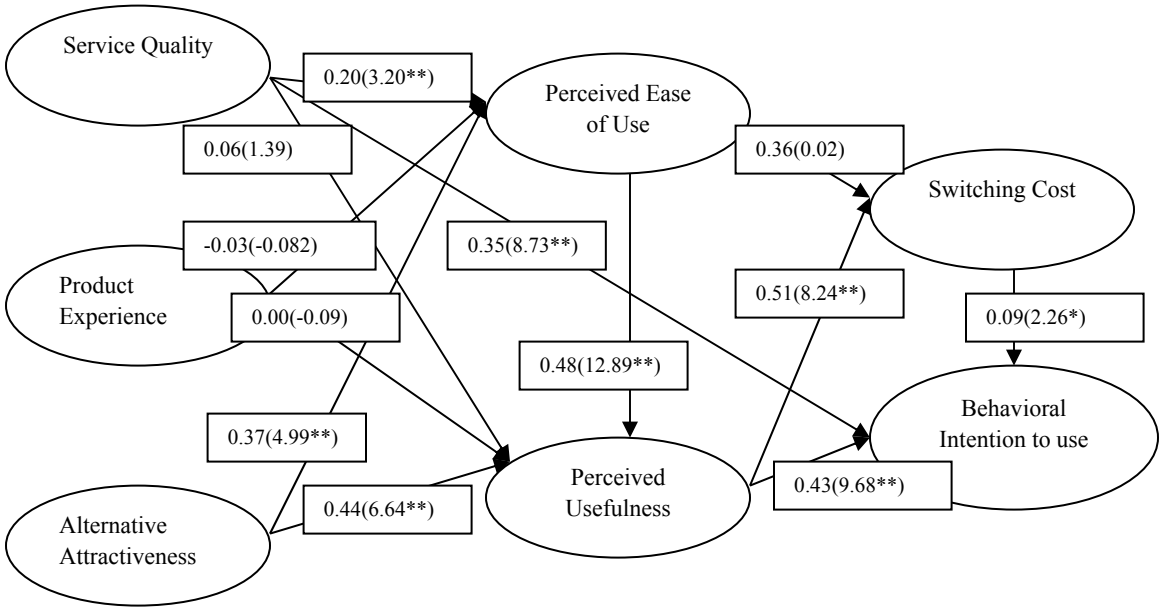
Hypothesized structural relationships can explain 54% of BI and 53% of behavioral loyalty in sequence based on their SMC values. Other SMC values for both BI, BL models in sequence are like 0.28,0.28 for switching cost, 0.27,0.22 for PEOU and 0.70,0.63 for PU. High SMC values for perceived usefulness, behavioral intention to use and behavioral loyalty variables, show that the exploratory power of both models is also high (Siguaw and Diamantopoulos 2000).

Table 5: Structural equation model analysis and hypothesis testing results						
Hypothesized paths Mbehavioral Loyalty/ MBehavioral Intention to use		Direct effects BL/BI		Indirect effects BL/BI	Total effects BL/BI	Remarks BL/BI
		Path coefficients	t-values			
H1a	PEOU→ PU	0.56/0.48	16.06**/12.89**	-	-	Supported/Supported
H1b	PEOU→ SC	0.03/0.02	0.43/0.36	-	-	Not Supported/ Not Supported
H2a	PU → SC	0.51/0.51	8.17**/8.24**	-	-	Supported/Supported
H2b	PU→ BI	0.43	9.68**	-	-	Supported
H2c	PU→ BL	0.42	9.39**	-	-	Supported
H3a	PE→ PEOU	-0.02/-0.03	-0.61/-0.82	-	-0.02/-0.03	Not Supported/ Not Supported
H3b	PE→ PU	0.01/-0.00	0.32/-0.09	-0.01/-0.02	0.00/-0.02	Not Supported/ Not Supported
H4a	AAT → PEOU	0.20//0.37	4.07**/4.99**	-	0.20/0.37	Supported/Supported
H4b	AAT → PU	0.22/0.44	5.86**/6.64**	0.11/0.18	0.33/0.62	Supported/Supported
H5a	ServQ → PEOU	0.34/0.20	7.20**/3.20**	-	0.34/0.20	Supported/Supported
H5b	ServQ → PU	0.20/0.06	5.71**/1.39	0.19/0.10	0.40/0.16	Supported/Not Supported
H6a	ServQ→ BI	0.35	8.73**	0.08	0.42	Supported
H6b	ServQ→ BL	0.34	8.52**	0.19	0.53	Supported
H7a	SC→ BI	0.09	2.26*	-	-	Supported
H7b	SC→ BL	0.11	2.73**	-	-	Supported
	SQ→ SC			0.21/0.09	0.21/0.09	
	PE→ SC			0.00/-0.01	0.00/-0.01	
	AAT→ SC			0.17/0.32	0.17/0.32	
	PE→ BL			0.00	0.00	
	PE→ BI			-0.01	-0.01	
	AAT→ BL			0.16	0.16	
	AAT→ BI			0.29	0.29	
	R^2 *PEOU*	0.22/0.27				
	R^2 *PU*	0.63/0.70				
	R^2 *SC*	0.28/0.28				
	R^2 *BL/BI*	0.53/0.54				
Note PEOU; perceived ease of use, PU; perceived usefulness, ServQ; service quality, PE; product experience, AAT; alternative attractiveness, SC; switching cost, BI; behavior intention to use, BL; behavior loyalty. *Significant at p<0.05, **Significant at p<0.01						

Significant and positive relationships were found between PEOU and PU for both BI (β_{1a}:0.48 p<0.01) and BL models (β_{1a}:0.56 p<0.01).Therefore, Hypothesis H_{1a} is supported. As proposed in $H_{2a,}$ PU positively and equally effect switching cost for both BI and BL (β_{2a} :0.51, p < 0.01) models however no relationship could be found between PEOU and switching cost for both BI and BL models as shown by the path coefficients, so H_{1b} is not supported. As proposed in $H_{2b,c}$ PU positively and significantly effect BI(β_{2b} :0.43; p < 0.01) and BL(β_{2c} :0.42; p < 0.01). The signs of all significantly correlated structural paths were also consistent with the hypothesized relationships. However, as shown in Fig. 2,3 and Table 5, the correlations related to product experience were found non-significant. Thus, $H_{3a,b}$ are not supported for both BI($\beta_{3a:}$-0.03, β_{3b}:0.00 $_p$>0.05) and BL($\beta_{3a:}$-0.02, β_{3b}:0.01 $_p$>0.05) models as shown by the path coefficients. As expected alternative attractiveness is found positively correlated with both PEOU and PU for both BI(β_{4a}:0.37, β_{4b}:0.44; p < 0.01) and BL(β_{4a}:0.20, β_{4b}:0.22; p < 0.01) models. The correlations between service quality and PEOU were positive and significant at 0.20 and 0.34 respectively for both BI and BL models, thus, Hypotheses H_{5a} is supported. However,

the correlation between service quality and PU was positive and significant at 0.20 for only BL model, but not significant at 0.06 for BI model. Therefore H_{5b} is partly supported. As proposed in $H_{7a,b}$ perceived quality has positive and significant relationship both with BI(β_{6a}:0.35 $p < 0.01$) and BL(β_{6b} :0.34 $p < 0.01$). Switching cost positively and significantly effect BI(β_{7a}:0.09; $p < 0.01$) and BL(β_{7b}:0.11; $p < 0.01$), so $H_{7a,b}$ is supported (figure 2,3-table 5).

Figure 2: Structural equation model analysis and hypothesis testing results for BI model

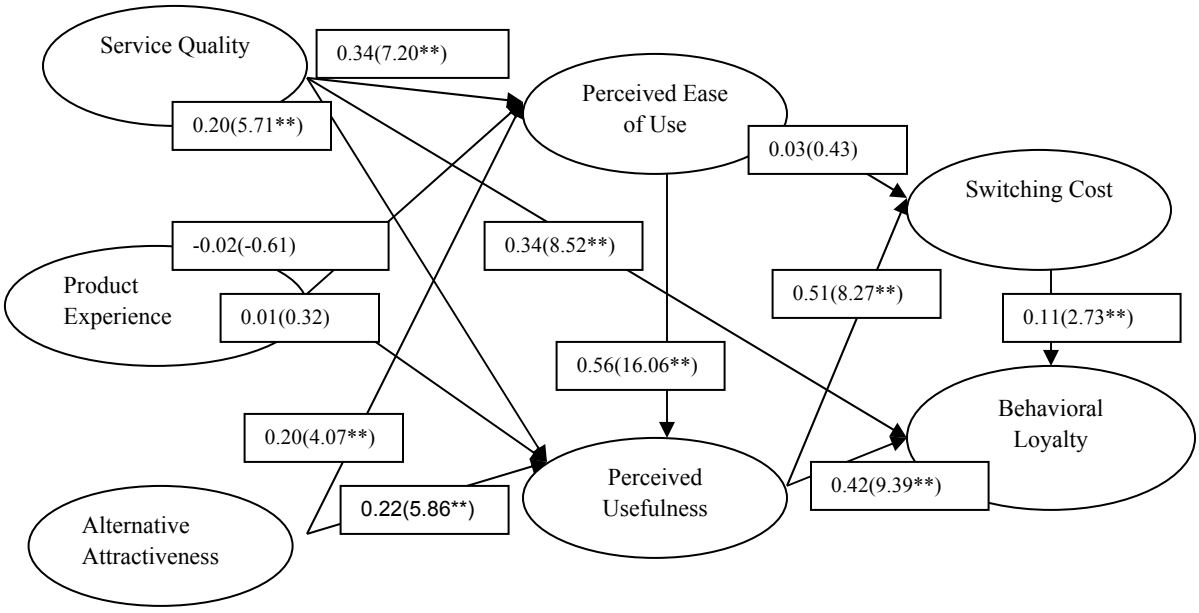


DISCUSSION

The positive correlation of PEOU with PU means that the easier the use of software programs is perceived, the more the accountants will perceive their usefulness since more work could be accomplished at the end. While PU has an important role on technology usage, PEOU effects BI and BL via PU**.** Although PEOU is one of the foundamental constructs of the TAM from a theoretical perspective, it did not show a significant relationship with switching cost and its relationships with dependent variables have not even been searched. Indeed many researchers proved the stronger direct effects of PU than that of PEOU (Fu et al 2006, Amoako-Gyampah 2007, Ha and Stoel 2009, Burton-Jones and Hubona 2006). In fact, among all the variables examined, perceived usefulness has the highest explonatory power on behavior intention to use and behavioral loyalty with SMC values, 0.63 and 0.70 in sequence. On the other hand, when the PU increases, the risk of switching to another software is going to increase too because of the other alternatives' uncertain privacy, security and performance levels beside the beginning

monetary, evaluation and set-up costs. Ease of use becomes with habit already so the fear of loosing useful tools like on-line application facilities or automatic data storage during upgrades or set-ups makes perceived usefullness the main predictor in switching decisions. For this reason web-based accounting software programs are mostly prefered compared to those without online applications.

Figure 3: Structural equation model analysis and hypothesis testing results for BL model



Service quality has an indirect positive effect on BL(0.19) via PU. However, the same indirect effect on BI is found not significant (0.08) while service quality keeps only its direct effect. Loyalty is a continous usage behavior that is obtained in the long-term, however usage intention that comes before "actual usage" in TAMs appears in the short term. Polancˇicˇ, et al 2010, found that one of the main factors for a successful software framework use is a continuous framework use intentions. Loyalty, is the result of accumulated positive attitude and commitments, in other words the ending point after a bunch of "intention to use behaviors". It can be mentioned that in the short-term, a positive service quality alone will be enough to initiate a usage behavior, however, the positive effect of "perceived usefulness" gain importance and becomes necessary in the long-term, in order to obtain a customer loyalty.

Among the antecedents of perceived usefulness (i.e., PE, AAT, ServQ), service quality had the greatest effect. To facilitate an efficient accounting software usage, it is essential to understand what practitioners need and then assure the required technical skills. On the other hand, as expected alternative attractiveness increased overall "usefulness" and "ease of use"

perceptions since good alternatives' availability motivated the trial of other software programs. However, no relationship was found among experience, PEOU and PU, probably because long-term experience diminished the overall importance given to both perceived ease of use and usefulness. The majority (81%) of our sample population had more than 7 yrs of software experience which may automatically disregard any prospective evaluation processes between other alternatives **(table 1)**. Other non-significant relationships were found among PEOU, PU, field sales people's lenght of service (Robinson et al 2005) and also their experience in word processing applications (Burton-Jones and Hubona 2006). Another reason for this insignificancy might be age factor where approximately 50% of our sample population was quite old, above their 40s. Literature suggests that habits can become stronger with age, because routines become difficult to change (Harrison and Rainer 1992, Morris and Venkatesh 2000**).** . The longer that someone has used a system, the more likely it will become a routine tool and users will not need to assess its PU or PEOU each time they use it.

CONCLUSION, LIMITATION AND FUTURE WORK

First of all, managers should assure a good service quality in order to increase switching cost and to obtain loyal customers at the end. Secondly, perceived ease of use cannot be an issue to create any switching cost and loyalty. Managerial attempts should focus on enhancing the perceived usefulness especially since the software use intention and loyalty mostly depends on how useful the accountants perceive the system than how easy it will be to use it.

Indeed, our analysis was restricted to one service context and needs to be tested over numerous contexts in order to be certain of its applicability to other domains. The target market is limited by only accounting bureaus. In the future the sample population might include also international auditing firms and accountants in other professional firms which will increase the validity of the research.

However, irrespective of the limitations, this study highlights a number of potentially interesting future research projects. For instance, the effects of personal characteristics like being market-maven(Stern and Stephen 1988, Goldsmith et al 1996), or innovativeness (Cestre and Darmon 1998) on usage intention and loyalty can be explored. The possible moderator effects of switching cost antecedents like product characteristics, investment and relationship lenght (Burnham et al 2003, Zhang and Gosain 2003, Sengupta et al 1997) on the relationship between the switching cost, behavioral intention to use and loyalty can be looked for. Beside, the role of brand trust (Zhang and Gosain 2003, Lee at al 2011, Goode and Harris 2007) can be searched in this circle under both high and low alternatives' availability conditions in the market. For example Sharma and Patterson (2000) found that trust has a stronger effect on commitment under low alternative attractiveness, however satisfaction becomes the main criteria under high alternative attractiveness. Moreover, the research model can comparatively be tested separating respondents from different regions and cities of Turkey, to follow whether the hypothesis results

are changing or not. On the other hand, the effects of demographic variables like education level or gender might be included in the model.

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Future Research

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Appendix A. Switching Cost Measurement Items	
Monetary Cost	
MC1	Buying a new software program causes monetary cost
MC2	Switching to a new software program might lead to monetary problems.
MC3	The implementation cost and one-time licence fee will be high
MC4	Time and effort cost of moving to a new software program is high
MC5	Buying a new program causes extra cost.
MC6	Cost of buying a new program will be high.
Benefit Loss Cost	
BLC1	Switching to a new software program would mean losing extra discounts, promotions, gifts, etc. that I have already gained
BLC2	Switching to a new software program would mean losing free software upgrades, additional technical support, etc. that I have already gained
BLC3	These extra services and discounts that I have gained with my current software company are important for me.
Uncertainty Cost	
	If I switched to a new software program;
UC1	The new service offered might not be as good as expected
UC2	Service support might be non-satisfactory after a while
UC3	Its performance might not be as good as expected
UC4	Unpredicted costs can appear (new licence fee, set-up and tutorial costs…)
UC5	Quality, speed and efficiency on the job processing might decrease.
Learning Cost	
	If I switched to a new software program,
LC1	I cannot figure out to use some tools until I learn the software program deeply
LC2	It takes time to learn the new tools
LC3	Time required to learn new tools shouldn't be so long
LC4	I will not feel comfortable with the new way of use for a certain period of time.
Evaluation/Set-up Cost	
	If I switched to a new software program,
ESC1	The evaluation and decision process takes a lot of energy, time and effort
ESC2	Although I could have enough information, comparing software programs requires lots of time and effort
ESC3	I do not have time to collect information for software evaluation.
ESC4	The installation process will require extra effort and time
ESC5	I should deal with a lot of procedures during the installation process.

Appendix B. Structural Model Measurement Items	
Service Quality (α=0.90)	
ServQ1	How do you perceive the quality of your accounting software company's technical service? (proficiency, technical problem solving, etc…)
ServQ2	How do you perceive your accounting software company's customer services? (responsiveness, accessibility and punctuality of the sales team)
ServQ3	How do you perceive the quality of your accounting software company's adding services, (additional technical support, education, discounts, gifts, etc…)?
ServQ4	How do you perceive the quality of your accounting software company's campaigns (special promotions, version upgrades, etc…)?
ServQ5	How would you rate the satisfaction level from your expectations met by the accounting software program?
Product Experience	
PE1	I consider my-self an experienced accounting software user
PE2	I have tried to use other accounting softwares on occasion
PE3	I am familiar with other acc software programs' modules and usage instructions
Alternative Attractiveness	
AAT1	It is not easy to find another acc software program with a good price
AAT2	I would not be happy with using another software program
AAT3	If I need to change my acc software program, it would be difficult to find other good alternatives.
AAT4	Compared to this acc software program, there are other software programs with which I could be equally or more satisfied.
Perceived Ease of Use	
PEOU1	My interaction with the accounting software program is clear and understandable
PEOU2	I find it easy to navigate the software to do what I want to do
PEOU3	I find an accounting software program easy to use.
PEOU4	Interacting with accounting sofware programs does not require a lot of mental effort.
Perceived Usefulness	
PU1	Using an accounting software program would enable me to accomplish my job more quickly and reach required information
PU2	Using an accounting software program can facilitate to do my job
PU3	The program that I use avoid data loss and also provides security and privacy for clients' information
PU4	The program that I use shows flexibility and easy sectoral adaptation
PU5	Using an accounting software program can increase productivity in job
PU6	Using an accounting software program can improve my job performance
PU7	Using an accounting software program can increase my efficiency and control on job.
PU8	Using an accounting software program can help me to accomplish more complex duties in a shorter time

Appendix B. Structural Model Measurement Items	
PU9	Using an accounting software program can provide support in in critic times
Behavior Intention to Use	
BI1	I intend to use this software program for my accounting needs
BI2	Using the software program for handling my accounting transactions is something I would do
BI3	I would see my self using this software program to accomplish my accounting duties
BI4	I intend to use this software program frequently nowadays
Behavioral Loyalty	
BL1	I will go on using this software program, since I feel a strong sense of attachment to it
BL2	If I bought a new accounting software program, I would prefer this brand again.
BL3	I will recommend this program to other people/my collegues because I really like it
BL4	I will encourage my collegues who plan buying this program
BL5	Although other software programs might be adventageous somehow, I would continue to use this program
BL6	Even if the other programs are cheaper, I would go on using this product.

THREE-GROUP CLASSIFICATION WITH UNEQUAL MISCLASSIFICATION COSTS USING GOAL PROGRAMMING

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ABSTRACT

In this paper, we present a goal programming modification to a mixed-integer programming model for the minimization of misclassification costs in the three-group classification problem. The proposed secondary goal, which is incorporated into the model to enhance group separation, maximizes the sum of the minimum deviations of the discriminant scores of the correctly classified observations of each group from the endpoints of the interval assigned to that group.

INTRODUCTION

Fisher's (1936) linear discriminant function and Smith's (1947) quadratic discriminant function, as incorporated in commonly used statistical packages, do not incorporate the provision for the assignment of distinct misclassification costs c(h|g) for the erroneous classification of an observation to different groups in the multiple-group classification problem. Loucopoulos (2001) presented a mixed integer programming model for the minimization of misclassification costs in the three-group problem, with distinct costs being assigned to the misclassification of an observation from one group to either of the other two groups.

Mathematical programming approaches to the statistical classification problem have generated considerable research interest since the early 80's. Such interest has continued in recent years with a focus in the area of the multiple-group classification problem. New mathematical programming models or modifications of previously published models for the multiple-group classification problem have been recently proposed by Brooks & Lee (2010), Sun (2010), Sun (2011), Bal & Orkcu (2011), Youssef, Jbir & Rebai (2011), Loucopoulos (2011) as well as Pai, Lawrence, Klimberg & Lawrence (2012). Previously proposed mathematical programming models for the multiple-group classification problem include those by Choo & Wedley (1985), Gehrlein (1986), Lam & Moy (1996), Wilson (1996), Gochet, Stam, Srinivasan & Chen (1997), and Loucopoulos & Pavur (1997). Using real and simulated data, the above studies have demonstrated that mathematical programming approaches to the multiple-group classification problem can outperform Fisher's linear discriminant function (LDF) and Smith's quadratic discriminant function (QDF) for a variety of data configurations.

Mathematical programming approaches to the multiple-group classification problem with unequal misclassification costs have attracted very limited research interest. Loucopoulos (2001) proposed a mixed integer programming model for the minimization of misclassification costs in the three-group classification problem that allows the assignment of distinct misclassification costs in the case of the misclassification of observations to different groups. In contrast, commonly used statistical packages do not incorporate the provision of distinct misclassification costs, when the number of groups is three or more. However, this model may yield alternate optimal solutions in the training sample. The choice of the alternate solution used for generating the discriminant function can have a significant effect on the classificatory performance of the model on the holdout sample. In order to enhance group separation and thus improve the classificatory performance of the model on the holdout sample, we propose the following goal programming modification to the model.

THE PROPOSED MODEL

The proposed model incorporates the secondary goal of maximizing the sum of the minimum deviations of the discriminant scores of the correctly classified observations of each group from the endpoints of the interval assigned to that group. As shown in Loucopoulos (2011), this secondary goal improves the classificatory performance of the model in the holdout sample, when the primary goal is the minimization of the number of misclassified observations in the training sample. In contrast, the primary goal in this proposed model, which is assigned preemptive priority, is the minimization of the sum of the misclassification costs.

NOTATION:

$c(h|g)$ is the cost of misclassifying an observation $i \int G_g$ to group G_h $(g,h = 1, 2, 3 \ \ g \neq h)$

$I_i^{(h|g)} = \begin{cases} 1 & \text{if observation } i \in G_g \text{ is misclassified to group } G_h \\ 0 & \text{otherwise} \end{cases}$

a_k is the weight assigned to attribute variable X_k

$X_k^{(i)}$ is the value of attribute variable k for observation i

a_0 is a locational adjustment to the discriminant function

M_1 is the maximum deviation of the discriminant score of a misclassified observation from the closest endpoint of the interval assigned to its group

é is the width of the middle interval

M_2 is the maximum deviation of the discriminant score of a correctly classified observation, that belongs to either the leftmost or the rightmost group, from 0 or é, respectively

n_g is the number of observations in group G_g $(g = 1, 2, 3)$

$$K_2 = \begin{cases} 1 & \text{if group } G_2 \text{ is assigned to the interval on the left} \\ 0 & \text{if group } G_2 \text{ is assigned to the interval in the middle} \end{cases}$$

$$K_3 = \begin{cases} 1 & \text{if group } G_3 \text{ is assigned to the interval on the right} \\ 0 & \text{if group } G_3 \text{ is assigned to the interval in the middle} \end{cases}$$

$\zeta_{h\ell}$ is the minimum deviation of the discriminant scores of correctly classified observations that belong to group G_h (h=1,2,3) from the lower endpoint of the interval assigned to its group.

ζ_{hu} is the minimum deviation of the discriminant scores of correctly classified observations that belong to group G_h (h=1,2,3) from the upper endpoint of the interval assigned to its group.

FORMULATION:

$$\min P_1 \sum_h \sum_g \sum_{i \in G_g} c(h \mid g)\, I_i^{(h|g)} - P_2 \sum_h (\zeta_{hu} + \zeta_{h\ell})$$

s.t.

$$\left.\begin{aligned}
& a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} - M_1 I_i^{(2|1)} - M_1 I_i^{(3|1)} + \zeta_{1u} \le e' K_2 + M_2(1-K_3) \\
& a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} + M_1 I_i^{(2|1)} + M_1 I_i^{(3|1)} - \zeta_{1\ell} \ge e'(1-K_3) - M_2(1-K_2) \\
& a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} + M_1 I_i^{(2|1)} \le e'(1-K_2) + M_1 \\
& a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} - M_1 I_i^{(2|1)} \ge -M_1 - M_2 K_2
\end{aligned}\right\} \quad \forall i \in G_1$$

$$\left.\begin{array}{l} a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} - M_1 I_i^{(1|2)} - M_1 I_i^{(3|2)} + \zeta_{2u} \le e'(1 - K_2) \\ a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} + M_1 I_i^{(1|2)} + M_1 I_i^{(3|2)} - \zeta_{2\ell} \ge - M_2 K_2 \\ a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} + M_1 I_i^{(1|2)} \le e' K_2 + M_1 + M_2 (1 - K_3) \\ a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} - M_1 I_i^{(1|2)} \ge e'(1 - K_3) - M_1 - M_2 (1 - K_2) \end{array}\right\} \forall i \in G_2$$

$$\left.\begin{array}{l} a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} - M_1 I_i^{(1|3)} - M_1 I_i^{(2|3)} + \zeta_{3u} \le e' + M_2 K_3 \\ a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} + M_1 I_i^{(1|3)} + M_1 I_i^{(2|3)} - \zeta_{3\ell} \ge e' K_3 \\ a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} + M_1 I_i^{(1|3)} \le e' K_2 + M_1 + M_2 (1 - K_3) \\ a_0 + \sum_{k=1}^{p} a_k X_k^{(i)} - M_1 I_i^{(1|3)} \ge e'(1 - K_3) - M_1 - M_2 (1 - K_2) \end{array}\right\} \forall i \in G_3$$

$$\zeta_{1\ell} + \zeta_{3u} \le (1 + K_2 - K_3)(M_2 + e')$$

$$\zeta_{2\ell} + \zeta_{1u} \le (1 - K_2 + K_3)(M_2 + e')$$

$$\zeta_{2\ell} + \zeta_{3u} \le (2 - K_2 - K_3)(M_2 + e')$$

$$K_2 + K_3 \ge 1$$

$$\sum_{i \in G_g} I_i^{(h|g)} \leq n_g - 1 \quad (g,h = 1, 2, 3\ g \neq h),$$

and weights P_1 and P_2 in the objective function are appropriately chosen so that $P_1 > \frac{(2M_2 + e)}{\min\limits_{g,h} c(h|g)} P_2$

The values of the parameters M_1, M_2 and é are chosen so that $M_1 \geq$ é, $M_1 \geq M_2$ and M_2, é > 0. Furthermore, the condition on the weights P_1 and P_2 guarantees that the goal of minimizing the misclassification cost is assigned preemptive priority over the goal of maximizing the sum of the minimum deviations of the discriminant scores of the correctly classified observations from the endpoints of the interval assigned to that group. The model assigns weights a_k to each attribute variable X_k and thus, a discriminant score is generated for each observation i, where a_0 is a locational adjustment to the discriminant function. Such score is projected onto a line, which is divided into three intervals, one for each group. An observation is correctly classified and thus it does not create a misclassification cost if its discriminant score falls in the interval assigned to its group, otherwise there is a cost c(h|g) of misclassifying an observation i∫G_g to group G_h (g,h = 1, 2, 3 g≠h). The model requires four constraints for each observation. The first two constraints determine if an observation is correctly classified, as well as the minimum deviations of the discriminate scores of the correctly classified observations that belong to group Gg (g = 1, 2, 3) from the lower endpoint and the upper endpoint of the interval assigned to that group. The last two constraints determine the group classification of a misclassified observation, and thus are redundant if an observation is correctly classified. For example, the last two constraints for i∫G_1 determine if the observation has been misclassified to G_2. Obviously, if an observation i∫G_1 is misclassified, but not to group G_2, then it is misclassified to group G_3. The constraint that the maximum number of misclassified observations from each group does not to exceed the number of observations of that group minus 1, eliminates the possibility of an unacceptable solution with $a_1 = a_2 = ... = a_p = 0$. The ordering of the three groups is determined by the values of K_2 and K_3. In the above model, the following three group orderings are considered: (G_1, G_2, G_3), (G_2, G_1, G_3) and (G_2, G_3, G_1), as the remaining three possible orderings are the mirror images of the above orderings, and thus they can be generated by the multiplication of the discriminant scores by -1. In these group orderings, G_1 is the only group that can be assigned to any one of the three intervals, but such choice was arbitrary, and has no effect on the classification results.

USING THE MODEL IN THE MBA ADMISSION PROCESS

The potential usefulness of the proposed model is illustrated using the MBA admissions data provided in Johnson & Wichern (1992). The same data have been previously used by Sun

(2011), Loucopoulos (2011) and Loucopoulos (2001) for the assessment of the classificatory performance of other mathematical programming models for the three-group classification problem. Eighty-five applicants to an MBA program are classified as admissible, borderline or non-admissible, based on their undergraduate GPA and GMAT scores. Out of the 85 applicants, 31 were admissible (group G_1), 26 were borderline (group G_2) and 28 were non-admissible (group G_3). Thus, additional criteria, including letters of reference, relevant work experience, record of community service and extracurricular activities during undergraduate studies, and the applicant's statement of professional aspirations may be used to assess the admissibility of the 26 borderline applicants.

The following cost structure was considered:

		Classified		
		Admissible	Borderline	Non-Admissible
Actual	Admissible	-	.05	.6
	Borderline	.55	-	.5
	Non-Admissible	1	.3	-

The classificatory performance of the proposed model was assessed using Lachenbruch's (1967) leave-one-out cross validation procedure. An observation is left out and the remaining n-1 observations are used to construct classification functions and thus, the left out observation is classified into one of the three groups, with the process being repeated n times. Therefore, in the data set of the 85 MBA applicants, 84 applicants were used as the training sample, and the left out applicant was used as a validation sample of size 1, with the process being repeated 85 times (i.e., number of applicants).

The proposed goal programming model yielded 9 misclassified applicants (hit rate of 89.4%) with a total misclassification cost of 1.65. The mixed integer programming model without the secondary goal yielded 10 misclassified applicants (hit rate of 88.2%) with a total cost of 1.70.

CONCLUSIONS

In this paper a goal programming approach to the three-group classification problem with unequal misclassification costs is presented. It is shown that the secondary goal can improve the classificatory performance of the model. Further research should examine the classificatory performance of the proposed goal programming model under different misclassification cost structures, as well as different data configurations.

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A MODEL FOR MANAGING RENTAL FLEETS IN THE NEW COMPETITIVE LANDSCAPE – MAINTENANCE, PRODUCTIVITY, CORPORATE BRANDING AND LEGAL IMPLICATIONS

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ABSTRACT

Rental companies across the United States are paying close attention to profitability. The current economic landscape has changed, and unfortunately it forces those companies to move away from the outdated model of utilizing rental cars between four and six months, after which they are disposed of on the used car market for high profits. An improved model is needed to address the dynamic changes in the new competitive landscape, which may significantly impact profitability and other business operational factors. The authors of this paper propose a model, examining maintenance costs, productivity, branding and legal implications for more effective management of rental companies.

INTRODUCTION

Those who lease or rent vehicles for personal or business use often do so with the assumption that maintenance, defects or recall issues have all been addressed. From a consumer advocacy point of view rental car companies must practice due diligence, which simply means that they are responsible for a car's overall maintenance while it is in their fleet. Sadly enough, this may not be the case. A jury awarded $15 million in the wrongful death of two sisters, ages 20 and 24, who had rented a vehicle from Enterprise Rental Car Company. The company failed to repair a leaking power steering fluid, which was cited under a recall. It was determined that leaking power steering fluid was ultimately the cause for the fatal accident. This type of occurrence has damaging effects on corporate branding, which significantly impacts revenue, customer satisfaction, reputation, trust, corporate image and social responsibility.

A designed structured approach is required to closely monitor and take corrective action to resolve problems like recalls. Units in the fleet can be fixed systematically without the risk of grounding the operation. A fleet manager can assess the severity of its recalls by working closely with the manufacturer to resolve problems in a timely fashion. In addition to recall issues, it is imperative for fleet managers to proactively respond to basic wear and tear issues such as those related to tires, brakes, hoses, oil changes and belts, as well as any repairs outside of those covered by the manufacturer's warrantee.

As the number of new car acquisitions continues to decline, fleet operators are faced with tremendous challenges in managing a diverse mix of new and old units. The Big Three (GM, Ford and Chrysler) have significantly reduced both program cars and deep discounts (Sawyers, 2011). This essentially means that older units can potentially accumulate as much as 50,000 miles (Sawyers, 2010), which leads to significant increases in maintenance cost. With a reduction of program cars, fleet managers must absorb added expenses to prepare a rental unit for its disposal on the used car auction market place.

The authors of this paper propose the Fleet Maintenance Planning (FMP) model, which will yield significant benefits to rental car fleet operators in both small and large markets. The output from this model will assist operators to better manage and improve maintenance costs, increase productivity, enhance corporate branding and limit business liability.

LITERATURE REVIEW

Several authors discuss fleet maintenance as a secondary topic. No one has directly identified a model to address maintenance needs. Erns, Horn, Kilby and Krishnamoorthy (2010) discuss rental fleet scheduling problems which arises when a rental unit is rented from one location and returned to another. They link this problem to revenue management issues but do not discuss fleet maintenance directly. Lieberman and warren (2007) are concerned more with pricing and revenue management capabilities rather than exploiting customer needs for safer and well maintained rental units. These two criteria alone would significantly influence revenue. If a customer's perception is that rental units are deemed unsafe, then certainly pricing policy becomes a moot point as no one wants to rent an unsafe car. Cho (2005) addresses determinants for used rental car resale values such as branding; however, he does not mention that overall maintenance, which is even a bigger factor. Antich (2011) specifically focuses on fleet car maintenance and identifies key factors such as oil changes, tires, increases to repair shop labor rates, which are likely to adversely impact maintenance and productivity.

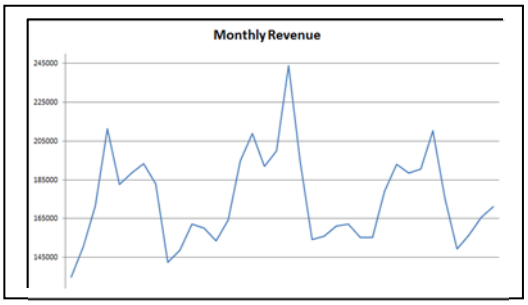
Unfortunately after an exhaustive search, the literature search did not produce any articles, which specifically identified rental operators and any specific fleet maintenance programs. The authors targeted trade many popular trade journals such as "Automotive Fleet," which openly discusses the need for maintenance programs as a fleet begins to age. However, they do not identify maintenance programs with rental car operators. Several on-line media outlets such as Auto Rental News repeatedly (Brown, 2012) discuss fluctuating earnings, RPD (revenue per day) pricing schemes, while keeping expenses low (i.e. fleet costs). One could argue that keeping expenses low could have widespread implications on other cost issues such as those related to timely repairs and or preventative maintenance.

MANAGING FLEET OPERATIONS

Depressed economic conditions, contracting fleet sizes, fewer program cars, elimination of deep discounts from the Big Three (Ford, Chrysler and GM) manufacturers, aging units, and reduced fleet allocation by manufacturers (i.e. aimed at protecting residuals) are an indication that changes in the rental car industry are here to stay (Thompson, 2009 and Brown, 2011). Fleet

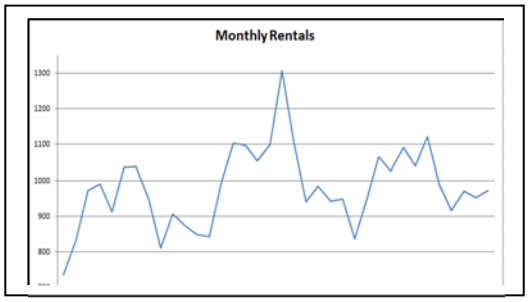
operators in both small and large markets are adversely affected by these changes. Unfortunately, those operating in small markets are finding it increasingly difficult to manage their operations, and yet maintain an acceptable level of profitability. Data collected from a local small market fleet operator (who wishes to remain anonymous) between 2009-2011 reveals much of the same problems listed above. Figure 1 clearly shows an overall pattern of declining monthly revenues, while Figure 2 confirms the positive correlation between monthly rentals and revenues.

Figure 1. Monthly Revenues 2009-2011



Source: local rental car fleet operator

Figure 2. Monthly Rentals 2009-2011



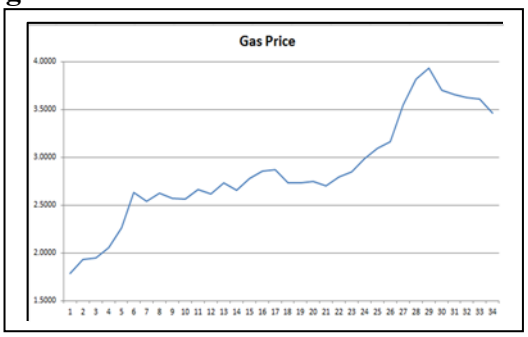
Source: local rental car fleet operator

Both revenues and the number of rentals declined steadily in 2009 as the recession had a firm grip on the economy; however, there were signs of recovery during the first half of 2010 as the number of rentals increased giving a sharp boost to revenue. Unfortunately, rentals and revenues declined sharply in the latter half of 2010 and showed only marginal gains in 2011. An overall pattern of declining revenue together with the number of rentals can be attributed to several factors: higher fuel prices resulting in fewer planned trips, businesses cutting back on travel, and increased carpooling.

Figure 3 illustrates sharp increases in the price of regular fuel during the same period from 2009-2011, which essentially confirms the patterns in revenue and the number of rentals shown in Figures 1 and 2, respectively. The modest gains in revenue displayed during the first half of 2010 is explained largely by the steady price of regular fuel, which hovered between $2.63 to $2.75 per gallon as shown in Figure 3. There are many factors which influence the price of fuel, some of which include: political unrest in the Middle East (i.e. Egypt, Iran, Syria, Iraq influences world supply and demand), world priced of crude oil, a weakened U.S. dollar, China's surging demand for crude and oil futures trading by commodity brokers. Though rental car operators are not directly involved in influencing changes to fuel prices, unfortunately they are adversely affected as are many other businesses that rely on its use such as the airline industry.

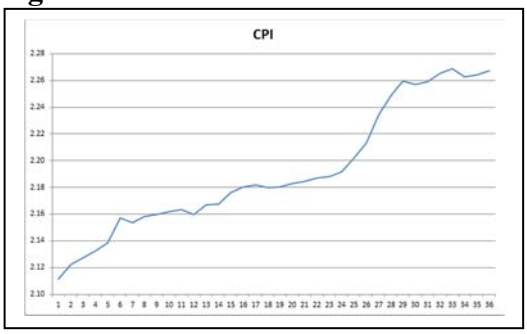
Figure 4 simply bolsters and confirms the adverse impact felt by rental car operators during the same period. An upward CPI trend is indicative of a weakened economy as consumers are faced with challenges of managing increases to household expenditures. Certainly such a trend cannot be welcoming news to rental car operators, or any other businesses for that matter.

Figure 3. Price of Fuel from 2009-2011



Source: http://www.eia.gov/

Figure 4. CPI from 2009-2011



Source: http://www.bls.gov/

MAINTENANCE AND PRODUCTIVITY

4.0.1 Current Maintenance Practice

In this section an overview of current practice and discussion of key attributes associated with fleet maintenance are presented. An important consideration is the current practice of managing fleet maintenance particularly with a mix involving both current and aging units. The authors contacted several local managers at rental car agencies to inquire about their fleet maintenance practices. Unfortunately, many were very apprehensive and reluctant to share information. For the purpose of our research, the manager of a large chain decided to share insights about current maintenance practices on the condition that company information remained anonymous. When asked about a specific fleet maintenance program, the manager stated that there was no formal program in place nor was any suggested by corporate office. Maintenance was handled on an as-needed basis and hence data collection is reported for cost associated with any untimely repairs. Emphasis was placed on basic preventative maintenance such as oil changes. That is, whenever the car reached a certain mileage, its internal computer would alert the operator that it was time to change the engine's oil. The engines found in most new cars allow for oil changes every 7,000 to 10,000 miles resulting from a switch to higher motor oil (Antich, 2011) standards. Unfortunately, new oil standard grade denoted by GF-5 already in use in new Chrysler and Ford models can expect an increase in oil service cost about 15% or an added $2 to $3 per quart. On the subject of tires, which can add about $85.45 per vehicle (Antich, 2009); the manager indicated that tires are only serviced if there was an obvious problem such as a puncture, which would normally be the responsibility of the driver and not covered under the rental agreement. Tire rotation is not even a planned service. At the next oil change interval depending on the service provider, a multi-point inspection may be conducted. I pointed out that a typical car loses about 2 psi in each tire per month. Hence waiting for the next oil change, a car could be potentially losing anywhere from 2-8 psi per tire depending on service date. Drop in tire pressure can lead to tremendous under-steering and ultimately loss of control, which is further compounded if the vehicle is carrying a significant load.

In summary, it was revealed that no formal preventative maintenance existed at any of their rental locations. It was common practice to perform a quick visual inspection, while preparing the car for the next rental customer. The inspection is not mechanical but rather cosmetic such as

detecting unusual scratches and body abrasions. Their maintenance practice corroborates the findings in the literature search, which suggested that maintaining profits is the goal at the expense of keeping costs low. When pressed about recalls, the manager indicated that they are certainly important; however, there was no published protocol at the local level to handle such issues. Repairs of any kind are only triggered by customer complaints. Otherwise the rental units are returned to service as quickly as possible. The manager suggested that their methods of dealing with maintenance are not unique to them, but rather it is similarly practiced by their competitors for whom he had previously worked.

The shortcomings of using an adhoc process for addressing maintenance issues present many problems, particularly as rental units age. Failure to inspect for basic wear in components such as belts, brakes, tires, hoses or checking fluid levels can all lead to higher repair costs, when operators do not subscribe to formal preventative maintenance program. Failure to address recall issues in a timely manner can lead to unsafe operation thereby placing a customer at risk, which was the case with the Enterprise who failed to fix the leak in a power steering hose as described in a recall bulletin by Chrysler. The result was a fiery crash and the loss of two innocent lives.

As an example, most cars today use a single belt called a serpentine belt to drive major engine components such as the alternator, water pump, power steering and air conditioning. These belts are subjected to extreme working conditions and can fail without notice due to hairline cracks, which can be overlooked by an untrained individual. A skilled technician will often remove the belt for careful inspection. A failed serpentine renders a vehicle in operable leaving a rental customer stranded until the vehicle is towed to a repair facility.

Again we can site brake inspection as another example, which can lead to increased maintenance cost. Braking systems are more advanced and designed to last longer. However, rental units are never driven by the same individual hence the rate at which wear takes place will vary thereby affecting stopping distance. For instance, this can create problems for travelers who have to make emergency stops with a loaded vehicle. Trained technicians would remove each tire and measure the thickness of the rotor and drum followed by an inspection of both shoes and pads. These measurements would be recorded and monitored by the operators for each rental unit. The short list of examples presented offer insights of what can go wrong when a preventative maintenance program is not present. Not only are repair costs likely to increase, but also impending liability risks of operating a poorly maintained vehicle. The FMP model proposed in this paper forces fleet operator to maintain a preventative maintenance program, document all occurrences and to act on needed repairs before component failure, thereby limiting both operating cost and reducing personal risk. In this way, a customer will be much safer when driving a rental vehicle.

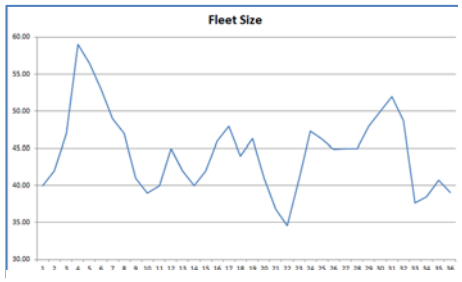
4.0.2 Attributes of Fleet Maintenance

An effective fleet maintenance plan is critical to the survival of operators because they are forced to adopt a new model. This new model involves smaller fleet sizes with rental units held for longer periods perhaps accumulating as much as 50,000 miles before disposal at the used car auction. Figure 5 shows a steady decline in fleet size for the local rental fleet operator from 2008-2009. Ironically, in 2008 GM asked the federal government for bailout assistance to avoid filing chapter 11 bankruptcy. A strong resale market in 2010 allowed the small operator to

replace his fleet and hence reduce maintenance costs. Most rental car companies like Enterprise Rent-a-Car and Budget strive to keep their cars from one to two years, where mileage can accumulate between 18,000 to 30,000 miles before moving those units onto their used car lot. Of course, this is their goal which may or may not be applicable to all of their rental units.

The Big Three have since cut their production, which means fewer fleet allocations to rental car operators with even smaller discounts. Fleet operators found it to be very difficult to dispose of their used rental units because the used car market was already saturated, which translates into much smaller profits. In some instances disposal may result in significant losses at which point the decision to sell becomes moot. As a result, fleet operators are challenged to maintain their existing rental units with an understanding that the composition of their fleet will include both new and aging (greater than six months) units. Maintenance by definition is moving beyond simple oil changes. Instead, operators must address and anticipate critical repairs particularly for those units that begin to accumulate significant mileage.

Figure 5: Fleet Size from 2009-2011



Source: Local fleet rental operator

GE Capital Solutions Fleet Services is a fleet management company located in Eden Prairie, Minnesota. In the last 17 years, they have been regularly conducting surveys of fleet operators to track and compile maintenance data of their passenger cars. Their results reveal significant findings, which are very relevant and applicable to all fleet car rental operators as it is invaluable in helping them to better understand and plan their maintenance program. In their most recent study of 13,318 passenger cars from January 1 to December 31, 2011, they found a slight decrease in overall fleet maintenance costs as compared to the calendar year 2010. Fleet operators were able to capitalize on a strong 2010 resale market, which allowed them to keep their overall maintenance costs "flat". The concept of keeping costs flat is achieved as fleet operators replace older units in a timely manner to avoid preventative and costly repairs commonly associated with aging units. Table 1 displays maintenance cost associated with fleet maintenance from 2009 to 2011.

Table 1: Fleet Maintenance Cost from 2009-2011

	Total Maintenance		Oil Change Services Cost		Replacement Tire Cost		Average Repair Cost per Unit	
Calendar Year	Cost per Unit per Month	Cost per Mile	Cost per Unit	Cost per Mile	Cost per Unit per Month	Cost per Mile	Cost per Unit per Month	Cost per Mile
2009	$56.11	$0.0292	$8.72	$0.0045	$18.75	$0.0098	$26.92	$0.0140
2010	$55.89	$0.0292	$9.01	$0.0047	$16.05	$0.0084	$28.51	$0.0150
2011	$53.49	$0.0276	$9.01	$0.0046	$15.78	$0.0081	$26.01	$0.0134

Source: GE Capital Fleet Services (2011)

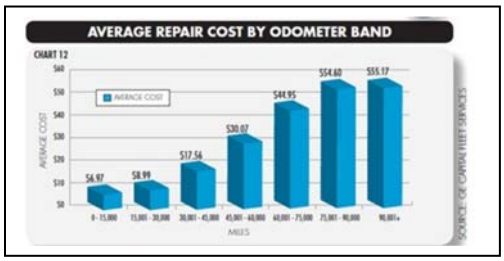
Total maintenance costs include tires, maintenance repairs (which include unscheduled services such as brakes, suspension, engine, transmission, electrical, and other), along with other preventative maintenance for passenger cars. As shown in Table 1, a strong resale market, increased interval between oil changes according to OEM specification, and an overall improvement in the quality of cars helped to keep maintenance costs flat. Price of oil change services increased by six percent from last year (Strom, 2011), which is reflected in part by increases in crude oil. Manufacturers are switching to new motor oil for "improved efficiency and engine protection" as noted by Strom. GM's new cars and trucks are designed to use Dexos, while Ford is moving toward the new GF-5 oil standard for its vehicles. Some fleet operators are beginning to rely on the unit's on-board oil service indicator for determining when to change oil. Of course, this strategy is acceptable as long as driving conditions and environment are kept constant. Unfortunately, this is an unrealistic expectation as fleet managers must keep a detailed log from each unit to provide effective maintenance.

Fleet managers were able to negotiate fleet pricing for tire replacement as reflected by the lower rate shown in Table 1. However, tire pricing levels are expected to rise this year as increases are expected in raw materials, crude oil, and an overall high global demand for rubber. Figure 6 indicates an upward trend in average repair costs as rental units remain longer in service. Average repair costs appear to almost triple after a rental unit's first year in service increasing from $8.76 in year 1 to $24.18 in year 2. Figure 7 shows a similar upward trend in repair cost as mileage increases. Most new vehicle warrantee is three years or 36 months, whichever comes first. Average repair costs unrelated to warrantee increased from $6.97 to $17.56, when a rental unit reaches up to 45,000 miles. Beyond 45,000 miles, rental units average repair costs increase significantly as major repair components begin to fail.

Figure 6. Average Repair Cost by Months in Service

Source: GE Capital Fleet Services

Figure 7. Average Repair Cost per Odometer Band



Source: GE Capital Fleet Services

Productivity is expected to decline as maintenance repair costs continue to climb with aging rental units. To ensure the highest level of productivity, fleet managers must adopt a progressive preventative maintenance program. It is best that they have a dedicated licensed and insured reputable repair shop with an agreed pricing contract for basic operations such as oil changes and a routine 21 point inspection. Any deviation from a dedicated maintenance program will result in unsafe vehicles and expose the company to financial losses, litigation and may adversely impact branding.

CORPORATE BRANDING

The issue of branding for car rental companies must include image. Branding is considered a name assigned to individual products, services or a group of complementary products. Some rental car companies use their corporate image to deliver many complimentary products to the marketplace.

Corporate image reflects the feelings consumers and businesses have about the overall organization and its individual brands (Low and Baak, 2012). The image may be divided into two distinct categories which are the consumer perspective and the corporate perspective.

Rental car companies spend millions of dollars to create, change or rejuvenate their existing image. For example Avis selected the marketing and design firm of Siegel and Gale tocreate a new identity in readiness for its flotation on the US market and to help it compete in the increasingly competitive car rental market. Its task will be to create a new corporate image for the car rental giant in readiness for its initial public offering which was filed for this month (Design Week, 2012).

In the case of Avis the consumer perspective will be of utmost importance due to several factors including confidence in purchasing decisions, product assurance and social acceptance of the product. From the corporate perspective a good image allows rental car companies to charge more for goods and services, attract better employees and create greater channel power not to mention the more favorable image on Wall Street.

Avis employs the family brand for many related products used to enhance their rental car services. For example, Avis markets Avis where2® GPS Navigation, Avis Blast - Portable XM Radio and Avis Access (Disability Products) The addition of disability products elevates Avis by offering the following services:

- Scooter Rentals: Avis provides mobility scooter rentals
- **Transfer Board**: Enables easier transfer from a wheelchair into and out of the vehicle.
- **Panoramic Mirror**: Provides a much larger field of view for any driver.
- **Swivel Seat**: Allows the driver or passenger to turn his or her body in the car seat with limited effort.
- **Hand Controls**: Enables drivers to accelerate or brake using a hand-controlled device.
- **Spinner Knob**: Enables the driver to turn the steering wheel with a full turning radius using only one hand.
- **Easy Access Bus**: Offers an electrically-operated ramp, two ADA compliant wheelchair positions, wider doors, spacious aisles and low luggage racks.

Enterprise Rental Car Company brands their rental service as local establishments that deliver rental cars directly to their customers either at home or at work. The consumer perspective of Enterprise is greatly enhanced through this image primarily as social acceptance.

Enterprise Rent-A-Car is the latest organization to enroll as an NABC(National Auto Body Council) diamond level member, the highest level of NABC corporate membership. Like several other corporate members, Enterprise's support of the NABC will include participation in Recycled Rides, the NABC-sponsored nationwide awareness project whereby NABC members repair and donate recycled vehicles to families and service organizations in need in their communities. This move by Enterprise should motivate consumers by assurance of product reliability.

Hertz Rental Car utilizes their corporate logo and image to further market their many brands. Hertz corporate vision states the following: "Hertz will be the corporate leader in mobility and equipment solutions" The term mobility solutions may be a substitute for rental cars and if we look carefully at Hertz complimentary and flanker brands we will see why.

Hertz utilizes the corporate image (logo) to market several products and services as extensions to the flagship brand of rental cars. For example:

• Hertz Rent a Car: Providing Quality Car Service for over 90 years.
• Hertz Local Edition®: In Your Neighborhood, providing local and insurance replacement rentals.
• Hertz Equipment Rental: A leading provider of heavy construction equipment and tool rental and sales
• Hertz Car Sales®: Selling one-year old vehicles from the Hertz fleet at low prices.
• Hertz Truck & Van Rental: Whether you are moving across town or making large deliveries, we are here to help.
•Hertz Entertainment Services offers everything you need for your next big film or television production or live event.

Hertz employs family brands(different logo) for several other products such as, Hertz On Demand™ a pay-as-you go car membership club, Donlen Corporation which is a global provider of innovative fleet leasing and management solutions for corporate fleets across the U.S. and Advantage Rental Car which offers a value rental rate in key vacation destinations.

In summary, we are seeing the core business of the rental car industries diversifying through complimentary and family brands of products in order to increase revenue and grow the business.

LEGAL ISSUES

6.0.1 Previous Law and Background

Under prior law, some states held car rental companies "vicariously liable." Under this doctrine, an accident victim injured due to the negligent operation of a rental car could hold the car rental company responsible for injuries regardless of whether or not the car rental company was negligent, or in any way at fault. Liability was imputed to the car rental company through mere ownership of the vehicle. In 2005, Congress passed the Transportation Equity Act, a provision of which eliminated vicarious liability, as it applies to rental companies. Referred to as the Graves Amendment, the law provides that a rental car company will not be held liable for the tortuous actions of the driver of a car that the company owns, rents, or leases to an individual so

long as the rental car company is not negligent or guilty of criminal wrongdoing. 49 U.S.C. Sec. 30106(a)(2005)

6.0.2 Current Law

Although the Graves Amendment has served to remove car rental companies from vicarious liability, they can still be liable under other theories of tort law in negligence such as negligent maintenance and negligent entrustment (Coverage Counsel, 2009).

6.0.3 Negligent Maintenance and Strict Product Liability

As car rental companies are now keeping the cars in their fleets for a longer period of time, negligence in failing to maintain the vehicles in a safe condition becomes of increasing concern. In addition, the car rental companies can be a party-defendant to a strict product liability lawsuit. Although the manufacturers will likely ultimately bear the liability in the lawsuit, the rental car company will be called upon to defend itself to the claim and incur steep legal costs in such a lawsuit (Scott, C. and Kissane, P.A., 2011)

In some instances, the vehicle may be subject to a safety recall mandated by the National Highway Traffic Safety Administration. Under current law, car dealerships cannot sell recalled vehicles to consumers; however, no law bans car rental companies from renting such vehicles to consumers. Although car rental companies are not subject to supervision of the NHTSA, this does not absolve them of liability. Under tort law, they have a duty to fix these vehicles, as evidenced by a California case. In 2011, a jury awarded $15 million in damages to the family of Raechel and Jacqueline Houck. The twin sisters were killed in a fiery crash involving a recalled PT Cruiser, rented to them from Enterprise Rent-a-Car. In the lawsuit, it was brought out that the vehicle had a safety recall issue with a power steering hose that could leak and cause a fire. Enterprise had not made the necessary repairs on the vehicle. Although Enterprise was not subject to the NHTSA recall notice, the company was held to be negligent by not repairing the vehicle. Of note, a bill has been introduced to the Senate (named for the Houck twins) that will prohibit the rental of defective cars and trucks, and bring the rental car companies under the control of the NHTSA.

6.0.4 Negligent Entrustment

Under the theory of negligent entrustment, a rental car company can be liable in tort for negligent "entrusting" the operation of a vehicle to another. If a car rental company should know that a potential rental operator of a vehicle will pose an unreasonable risk to others and does entrust that vehicle to that person, the rental company is liable if this renter injures another through negligent operation of the vehicle. However, the threat and magnitude of such lawsuits is not affected by the aging fleets of the car rental companies.

MODEL DEVELOPMENT

The Fleet Maintenance Planning (FMP) model is built on the principal of continuous improvement. It uses the Plan-Do-Act-Check (PDCA) management method whose application was highlighted extensively by W. Edward Deming (Kanji, 1996; Smart, Henderson, et.al., 1993). Deming used this and other quality control tools and highlighted their application in assisting companies to better manage and improve their business processes. The concept of PDCA, which has four stages, is built on a scientific basis with its roots derived from the work of Francis Bacon, a pioneer, advocate and practitioner of using scientific methods. This methodical approach permits management to create a structure around which fleet operators can effectively manage their operations and use a feedback mechanism to check and make corrections when bottlenecks or constrictions are identified within their processes (Marquis, 2009).

Figure 8: PDCA Model
(Source: Moen and Norman, 2006)

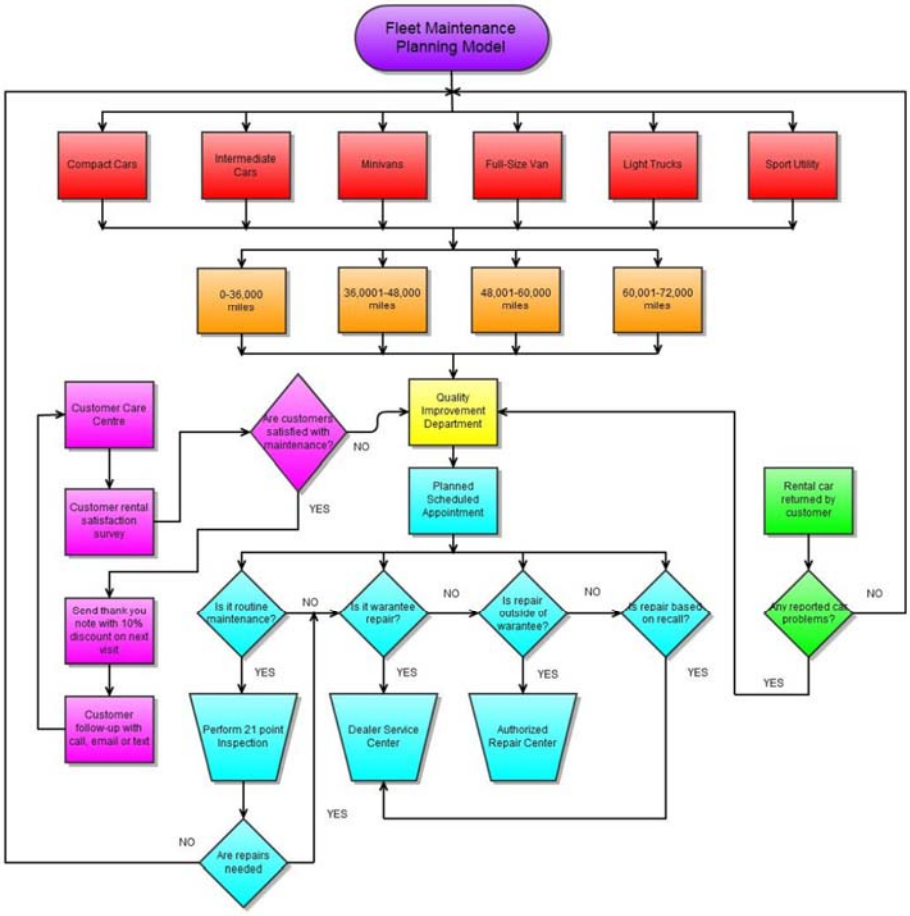
The PDCA method showed in figure 8 forms the basis in the development of the FMP. The output from the model presented in the this paper will greatly assist fleet operators in collecting data, planning and controlling operating cost, minimize downtime, improve productivity, act on recalls, and listen to customer maintenance concerns. The four typical stages to the PDCA method are given below:

PLAN: companies set goals and identify methods needed to reach those goals, which can be accomplished by designing a new or revising an existent business process

- **DO**: This is a prototype stage where companies can implement the plan and establish metrics to measure its performance
- **CHECK**: Review results from prototype test in DO stage and compare against goals established in PLAN stage. Provide feedback to management.
- **ACT**: Implement refined and improved solution by deciding on changes needed to meet company goals.

The FMM as shown in Figure 9 illustrates all four stages of the PDCA method (Stevenson, 2009). As noted, the PLAN stage is perhaps the most important step because it specifically outlines company goals and objectives in its long-term strategic plan.

Figure 9. Fleet Maintenance Planning Model



In the "**PLAN**" stage, a fleet is presented using six categories as noted by the "red" symbols in Figure 9: compact, intermediate, mini vans, full size vans, light trucks and sport utility vehicles, which is consistent among operators (i.e. Hertz, Avis, Economy etc…). Each class of vehicle is further classified into four mileage groupings shown in by the "orange symbols": 0-36,000 miles, 36,001-48,000, 48,001-60,000 and 60,001-72,000. This mileage grouping is based on the criteria presented in Automotive Fleet, which was used to capture maintenance data by tracking repairs over a 12-month period across several categories as shown in Table 2.

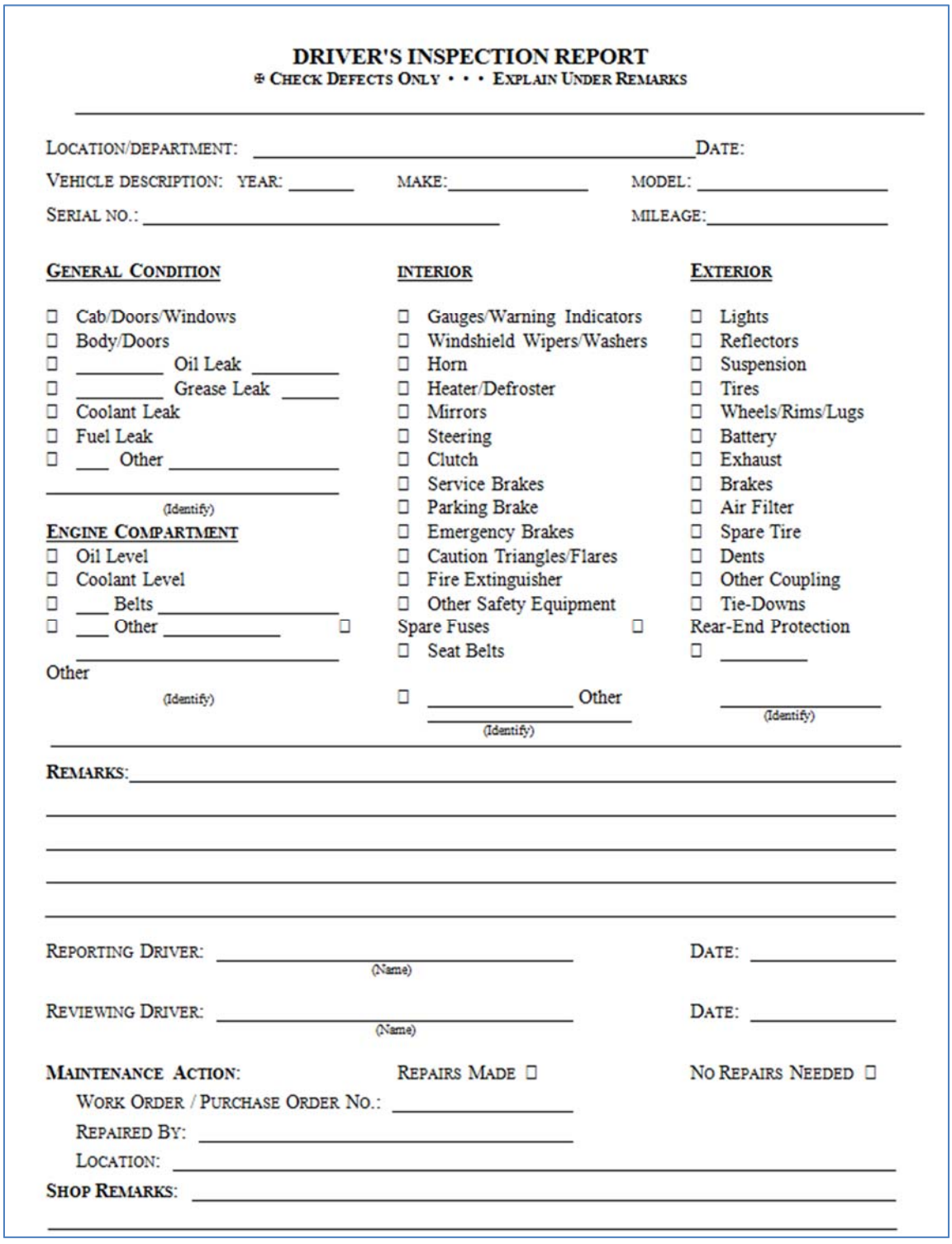
A "Quality Improvement (QI)" department oversees all aspects associated with organizing and planning maintenance needs within a fleet (Stevenson, 2009; Jacobs and Chase, 2011). Fleet managers would work closely with their QI coordinator to ensure that both throughput and workload are not adversely impacting fleet utilization levels, which is particularly important for operators during high-peak periods such as Thanksgiving. In others words, the QI coordinator along with the fleet manager would systematically devise a plan where

maintenance for high volume rentals are prioritized at the highest level, while maintenance for less frequently rented units are worked on later.

Table 2. Repair Categories Associated with Annual Fleet Maintenance			
Item No.	**Category**	**Item No.**	**Category**
1	Tires	8	HVAC
2	Brakes	9	Suspension
3	Engine	10	Exhaust
4	Steering	11	Starting System
5	Fuel System	12	Ignition
6	Cooling	13	Electrical
7	Charging System	14	Transmission

The blue symbols highlight the "**DO**" stage where operators pilot their process before full scale implementation. In this way, mistakes can be identified and potentially resolved without significant financial and operational disruption. The QI coordinator works at executing the maintenance schedule once it is reviewed and approved by the fleet manager. Appointments are scheduled based on the type of maintenance needs, which can be simply routine as in a basic or detailed multi-point inspection (i.e. similar to the ones indicated below in Figures 10 and 11), warrantee repair, non-warrantee repair or recall related.

Figure 10: Basic Multi Point Inspection



DRIVER'S INSPECTION REPORT

✠ CHECK DEFECTS ONLY • • • EXPLAIN UNDER REMARKS

LOCATION/DEPARTMENT: _____ DATE:

VEHICLE DESCRIPTION: YEAR: _____ MAKE: _____ MODEL: _____

SERIAL NO.: _____ MILEAGE: _____

GENERAL CONDITION

- ☐ Cab/Doors/Windows
- ☐ Body/Doors
- ☐ _____ Oil Leak _____
- ☐ _____ Grease Leak _____
- ☐ Coolant Leak
- ☐ Fuel Leak
- ☐ ___ Other _____

_____
(Identify)

ENGINE COMPARTMENT

- ☐ Oil Level
- ☐ Coolant Level
- ☐ ___ Belts _____
- ☐ ___ Other _____

_____
Other
(Identify)

INTERIOR

- ☐ Gauges/Warning Indicators
- ☐ Windshield Wipers/Washers
- ☐ Horn
- ☐ Heater/Defroster
- ☐ Mirrors
- ☐ Steering
- ☐ Clutch
- ☐ Service Brakes
- ☐ Parking Brake
- ☐ Emergency Brakes
- ☐ Caution Triangles/Flares
- ☐ Fire Extinguisher
- ☐ Other Safety Equipment
- ☐ Spare Fuses
- ☐ Seat Belts
- ☐ _____ Other

_____
(Identify)

EXTERIOR

- ☐ Lights
- ☐ Reflectors
- ☐ Suspension
- ☐ Tires
- ☐ Wheels/Rims/Lugs
- ☐ Battery
- ☐ Exhaust
- ☐ Brakes
- ☐ Air Filter
- ☐ Spare Tire
- ☐ Dents
- ☐ Other Coupling
- ☐ Tie-Downs
- ☐ Rear-End Protection
- ☐ _____

_____
(Identify)

REMARKS: _____

_____

_____

_____

_____

REPORTING DRIVER: _____ DATE: _____
(Name)

REVIEWING DRIVER: _____ DATE: _____
(Name)

MAINTENANCE ACTION: REPAIRS MADE ☐ NO REPAIRS NEEDED ☐

WORK ORDER / PURCHASE ORDER NO.: _____

REPAIRED BY: _____

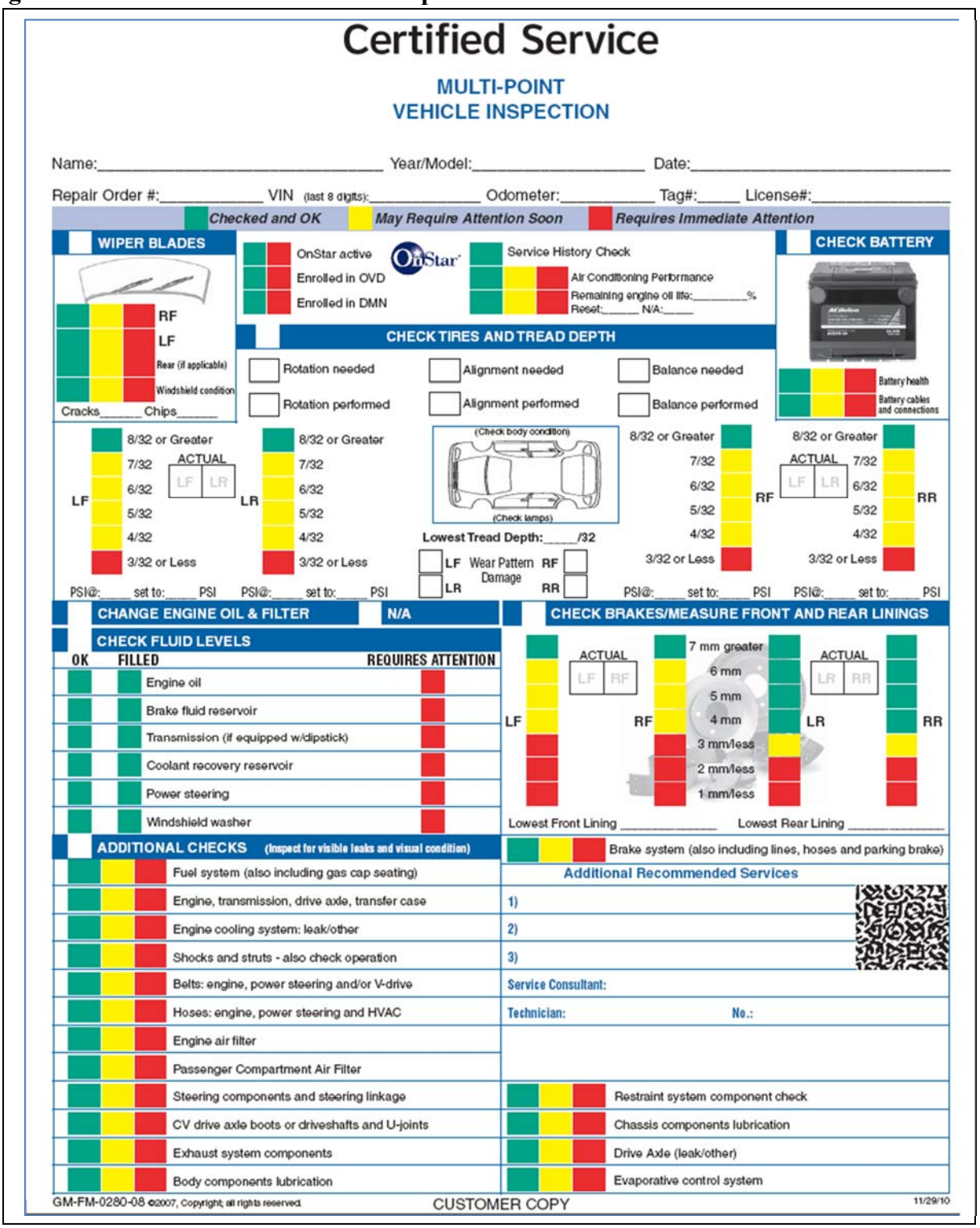
LOCATION: _____

SHOP REMARKS: _____

_____

Source: www.harrp.com/.../Vehiclemaintenanceformanddriversinspectionrep.

Figure 11: Detailed GM Multi Point Inspection



Source: http://www.mycertifiedservice.com

At the "**CHECK**" stage data is gathered twofold: 1) customer returns rental unit indicated by the "green" symbols and 2) post customer comments from "customer" satisfaction survey shown by the "pink" symbols. The importance of this stage is to compare the goals and objectives, which were established in the "**PLAN**" stage using the gathered data. Any deviation or departure from stated goals must be addressed and corrected before full implementation is pursued in the "**ACT**" stage. Attendants checking in each rental unit can administer a quick survey, while speaking with the customer and logging their responses into their PDA. The "Customer Care Center" shown by the "pink" symbol would send a customer satisfaction survey out to those who might have used the drop box when returning their rental unit. All customers would receive a follow-up visit via telephone call, text, or by e-mail. As a courtesy, fleet managers could offer a 10% discount on their next rental as a token of customer appreciation.

The final stage of the PDCA method is to "**ACT**". At this stage management are able to perform a final review, verify and validate inner workings of the FMP model by closely examining the collected data. Fleet operators can make any change(s) deemed necessary before moving towards full implementation of the FMP model. All participants, both internal and external to the process, can share any input before standardization is adopted. As fleet managers move forward towards adoption, they must understand that the PDCA method seeks continuous improvement. Hence, fleet operators can rest assured that the FMP model will continue to evolve as more opportunities for improvement are presented along the process.

MODEL IMPLICATIONS AND FUTURE WORK

The FMP model developed in this paper successfully incorporates the PDCA method in a rental car fleet maintenance program. The incorporated PDCA method promotes continuous improvement and makes use of a dynamic feedback process to monitor performance against stated company goals and objectives.

The FMP model specifically addresses the cores issues discussed in this paper, fleet maintenance, productivity, branding and legal implications. Fleet maintenance is central to the development of the FMP model. The QI department plays a significant role in this process as it's responsible for overseeing the process of continuous improvement by keeping channels of communication open between the fleet managers, fleet owners and customers. Its responsibility is to ensure that every unit is properly maintained particularly for those units which are aging relative to others in the fleet. QI will ensure that every vehicle is maintained for safe and reliable operations by working closely with its authorized repair centers. It is important for fleet operators to forge long-term relationships with their repair centers, much like Wal-Mart does with its suppliers. It builds trust, mutual respect and ensures quality of service.

There are two feedback loops in this model as both are designed to collect data, which can then be used to make changes deemed necessary to ensure 100% customer satisfaction. Customers can report any maintenance problems as they drop their rental off. The advisor

checking in their rental will log their concern, which will be addressed by the QI department. Advisors can offer a 10% discretionary discount as a "goodwill" gesture.

Sometimes customers simply drop off their rentals without ever seeing an advisor. In this case, a survey would be sent to those individuals. If they are happy, a 10% discount is offered on their next visit. Otherwise, the QI department is given the task to deal with any negative maintenance experiences. In both cases, there will be a follow-up by the either the customer care center or the QI department with every event logged for quality control. The advantage to this strategy is to ensure that customers do not seek alternate on-line blogs to vent their concerns as this serves only to adversely affect the company branding. Too often companies ignore customer complaints until it begins to affect business. In a business climate affected by an economic downturn, it is prudent for rental car fleet operators to act quickly on customer maintenance related complaints.

Recalls are no longer ignored but rather they are systematically addressed on a prioritized basis by the QI department. It is not necessary for fleet operators to ground their fleet at the sight of a recall. Instead, the QI department would work closely with the dealer service center to identify the severity of the recall problem and schedule it for repair. In this way, fleet operators will avert any legal issues and hopefully not rent a car if the recall is deemed detrimental to its safe operation.

This research has established a solid framework and foundation, which enhances the way rental car companies approach fleet maintenance. The structure of the FMP model can be adapted in whole or parts to any fleet car maintenance program. The next step is find a company, who is willing to use this model as a pilot study from which data can be collected to monitor its effectiveness. This could form the basis of a follow-up research paper.

CONCLUSION

Rental car fleet operators have adopted a new model, one that includes fewer fleet allocation, no more program cars, and declining discounts from manufacturers. Fleets must manage a mix of both new and aging rental units. The FMP model, which is driven by the PDCA method establishes maintenance accountability and uses feedback for achieving continuous improvement. It allows rental car fleet operators to address and manage issues such as productivity, branding and legality as they are all linked to fleet maintenance. In an environment where change is constant, fleet owners must embrace this new competitive landscape and work relentlessly to exceed maintenance needs in their fleet. In the end, they will have a safer fleet and much happier customers.

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STOCK MARKET PREDICTIVE MODEL BASED ON INTEGRATION OF SIGNAL PROCESSING AND ARTIFICIAL NEURAL NETWORK

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ABSTRACT

Stock market prediction is highly volatile and extremely difficult to model the trends using traditional statistical techniques. Therefore, an intelligent technique is required for stock market prediction. In this study, we integrate signal processing technique with Artificial Neural Network to propose a stock index predictive model. An archived data of Dow 30 and Nasdaq 100 indices were used for training and testing the proposed model. The results strongly supported the effectiveness of the proposed model with an overall average prediction accuracy of 96.7%. Therefore, we believe that the proposed model would be a viable alternative for the stock market forecasting.

Keywords: *Artificial Neural Network, Signal Processing, Stock Market Forecasting.*

INTRODUCTION

Stock market prediction involves the interaction of many variables, making forecast very difficult and complex using traditional statistical techniques. These models have limitations due to noise and nonlinearity in stock price movements. On the other hand, Artificial Neural Networks (ANN) have demonstrated its capability of addressing problems with a great deal of complexity. An ANN specifically designed to take a pattern of stock price data and generalize from it, enhances an investor's forecasting ability (Trippi & Turban, 1996; Sharma & Alade, 1999).

Over the past two decades, several studies have shown that an ANN is more appropriate than the other forecasting methods (Trippi and Turban, 1993; Sharda and Patil, 1990; Tang, 1991; Atsalakis and Valavanis, 2009). An ANN can provide excellent forecasting for irregular time series and can be trained to approximate the underlying mapping of the series. However, the accuracy of approximation depends on a number of factors such as ANN architecture, learning methods, and training procedures (Sharma & Alade, 1999). Also, an ANN has excellent learning ability and can produce robust performance on a large amount of data, but often exhibits variation in performance for noisy data (Kim, 2006). Hence, there is a need to integrate a signal processing based filtering technique to overcome the limitations of noisy data.

According to Nair et al. (2010), adaptive filters are commonly used in general signal processing, but rarely used for financial signals. Based on the work of Nair et al. (2010) and the literature review, we observed that in the area of "financial signals predictive models", signal processing theory has been rarely exploited and explored. Therefore, we believe that there is a truly good opportunity to investigate the effectiveness of signal processing-based techniques in addressing predictive models for financial signals, namely, stock market indexes. Furthermore, we utilize the robustness of ANN and combine it with signal processing techniques to propose a predictive model for financial signal, especially stock market indices. The proposed approach models the input feature vectors to the Multi-Layer Perceptron (MLP) network as k-element vector of stock index close day entries. The classes of vectors are modeled as the last entry in each vector, after mapping them to a suitable representation that meets MLP input output layer requirements. Dow 30 and Nasdaq 100 indices for more than twelve years were used for training and testing the proposed model. The results strongly supported the effectiveness of the proposed model with an overall average prediction accuracy of 96.7%.

The remainder of the paper is organized as follows: first, a review of literature related to the subject is presented; second, the theory and technical approach for this study is described; third, experimental work and result analysis of the study are reported; and finally, the paper ends with conclusions.

REVIEW OF LITERATURE

Over the years, Artificial Neural Networks (ANN) have become a popular tool to solve a broad range of real world problems in business and economics. Literature is replete with studies using ANN for stock forecasting problems. In one of the earliest studies, White (1988) investigated an ANN to perform time series analysis on the IBM common stock daily returns. Trippi and DeSieno (1992) applied technical analysis to investigate the effectiveness of a specific neural network trading system for S&P 500 index futures contracts. Lin and Lin (1993) presented ANN to forecast Dow Jones Industrial Average (DJIA). Kryzanowski et al. (1993) implemented the Boltzmann machine for ANN training to classify stock returns as negative, positive, or neutral. Refenes et al. (1993) applied a feed forward network with four layers (two hidden ones). Refenes et al. (1994) compared regression models with a back-propagation network for stock forecasting. Dropsy (1996) applied ANN as a nonlinear forecasting tool to predict international equity risk premia. Wang and Leu (1996) presented an autoregressive integrated moving average (ARIMA) based ANN for forecasting price movement of the Taiwan stock market. Motiwalla and Wahab (2000) used a back propagation neural network. Lam (2004) investigated ANNs' ability to incorporate fundamental and technical analysis for financial performance prediction. Qing et al. (2005) applied ANN to predict stock price movement for firms traded on the Shanghai stock exchange. Constantinou et al. (2006) used a MLP Network with two inputs. Zhu et al. (2008) used ANN in forecasting with the data of stock returns and

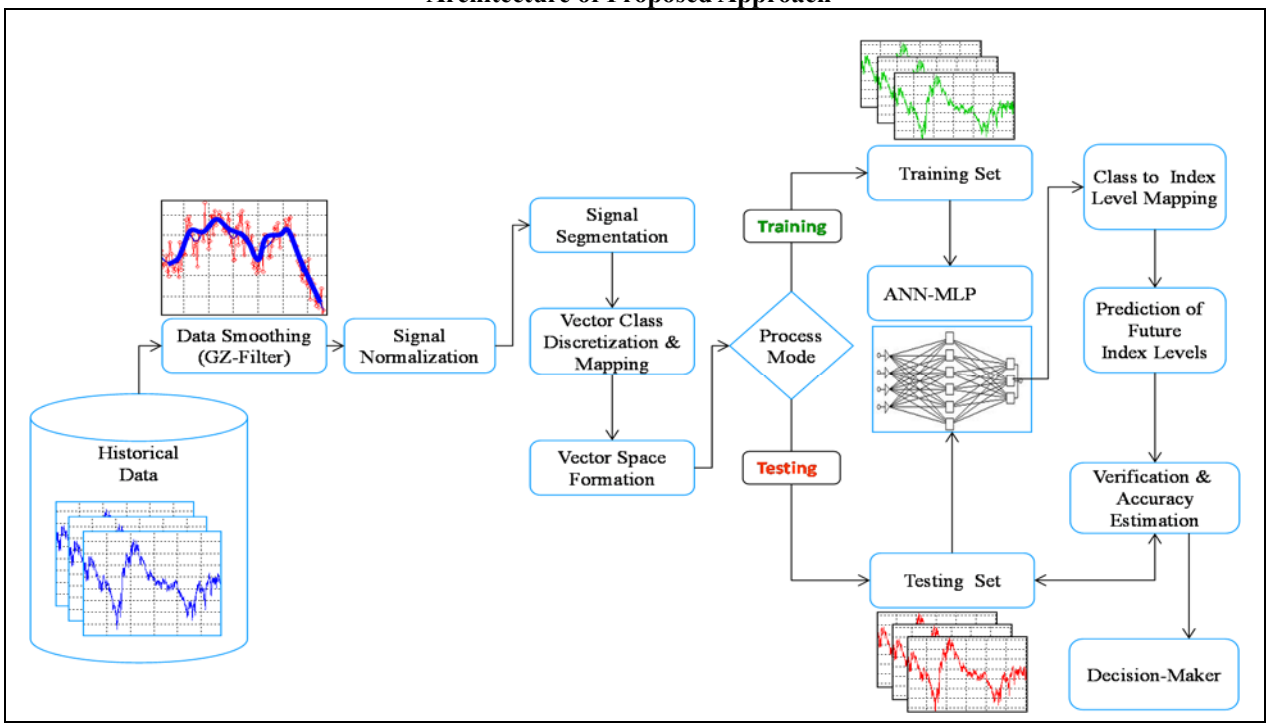
volumes from various indices. Atsalakis and Valavanis (2009) presented an intensive literature review on the stock market forecasting. Recently, Manjula et al. (2011) applied ANN models to predict the daily returns of the Bombay Stock Exchange Sensex. Multilayer perceptron network was used to build the daily return's model, and the network was trained using multiple linear regressions to provide a better alternative for weight initialization. Qing et al. (2011) studied the predictive ability of several forecasting models such as a single-factor capital asset pricing model (CAPM), Fama and French's three-factor model and compared the forecasting ability of each of these models with ANN.

THEORY AND TECHNICAL APPROACH

This section will present the theoretical concepts and the mathematical modeling of the proposed approach. The process of the proposed approach is depicted in Figure 1. The process illustrated in the block diagram of Figure 1 is discussed as follows:

Historical Data: the historical record of any stock index that is needed to be processed by this approach. We used an online source (http://finance.yahoo.com/) to acquire data for more than twelve years.

Figure 1
Architecture of Proposed Approach



Signal Processing: as stated earlier, one of the main objectives of this study is to investigate the effectiveness of signal processing techniques in stock market index prediction. Signal processing (Quinquis, 2008) is concerned with processing one and multi-dimensional time series via a spectrum of techniques, filters and algorithms. Depending on the sought objective, input signal can be processed with low-level, intermediate, and high-level processing methods. Low-level methods are concerned with mainly noise reduction (filtering), signal analysis, decomposition, etc; examples include: linear/non-linear filters, convolution, segmentation, etc. Intermediate-level methods are concerned with signal modeling, feature extraction and dimensionality reduction; examples include: Fast Fourier Transforms (FFT), wavelet decomposition, probabilistic/statistical-based, principal component analysis (PCA), etc. The high-level methods are concerned with clustering, classification and recognition problems; examples include: KMeans, soft-computing, AI methods, etc. The relevant level we are investigating in this study is the low-level methods. Specifically, we are interested in an effective filter, the Gaussian Zero-Phase Filter.

Data Smoothing: Gaussian Zero-Phase Shift filter (GZ-filter) is a very effective digital signal filter. Rababaah (2009) used the GZ-filter to smooth the output of the surveillance situation tracking signal which may be prone to human and random errors. Therefore, we propose the GZ-filter to be used as the smoothing model of the stock market index signal as the first step before we apply further processing such as segmentation, feature vector modeling, training and classification, etc. The concept of GZ-filter is to estimate the signal level at each time instance by computing a kernel of Gaussian-weighted neighborhood of the surrounding data points. As can be seen in Figure 2, a kernel size of three was demonstrated and the Gaussian probability distribution function (PDF) is used to modulate the original signal as a linear combination of the kernel Gaussian weights by the neighboring data points. According to the formula (1) below:

$$GZ(S(t),\Delta t)=\sum_{t-\Delta t}^{t+\Delta t} G_{pdf}(t)S(t) \tag{1}$$

where, $S(t)$: the input noisy signal, t: time, Δt: time interval considered to compute the de-noised signal, G_{pdf}: Gaussian probability distribution function. The uniqueness of the GZ-filter is that unlike conventional signal filters such as moving average or median filter, it retains the phase of the original signal. This means the peaks of the original signal are guaranteed to align with the filtered signal which could be critical if one is interested to identify the exact instances where the signal have abrupt changes. Figure 3 demonstrates this fact by illustrating the process diagram of the GZ-filter.

Figure 2
The GZ-Filter kernel (left) and Index Data Smoothing Results with GZ-Filter (right)

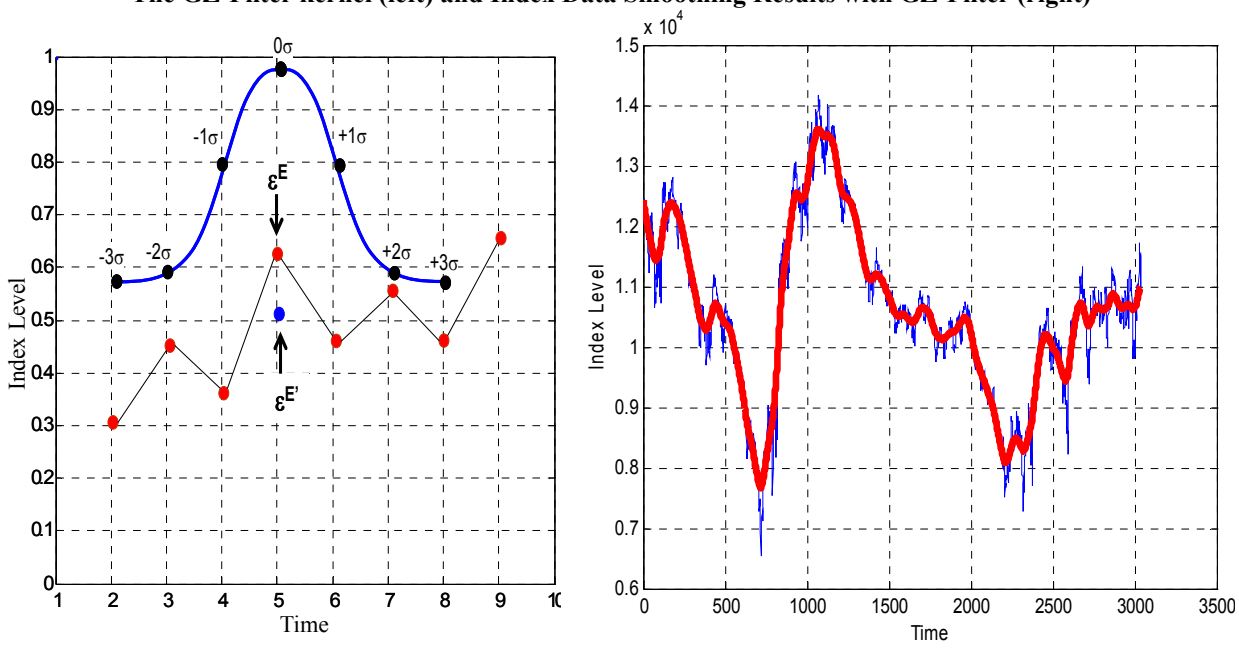
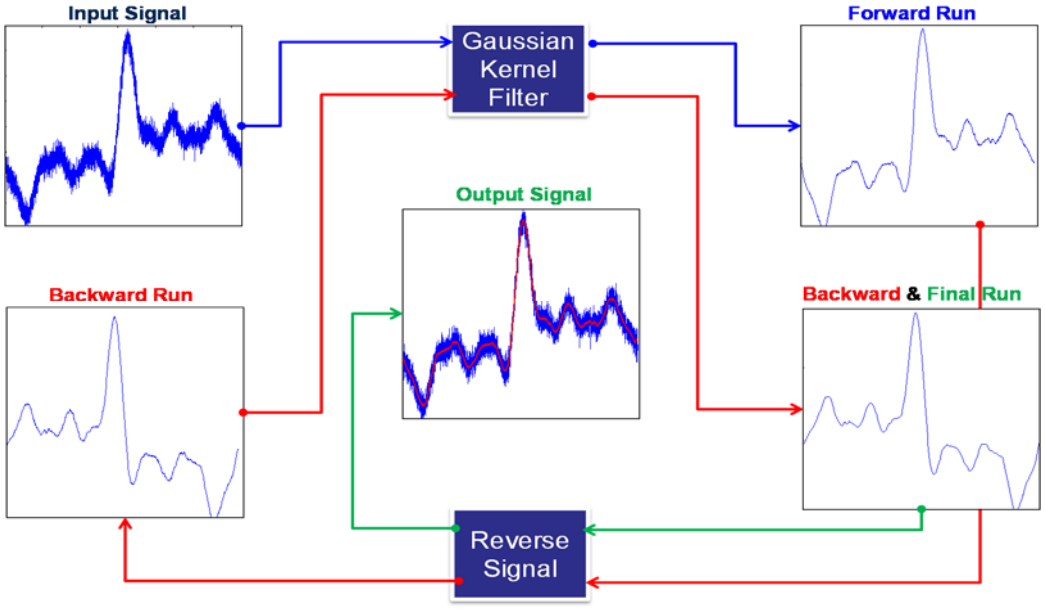


Figure 3
The Process Diagram of the GZ-Filter

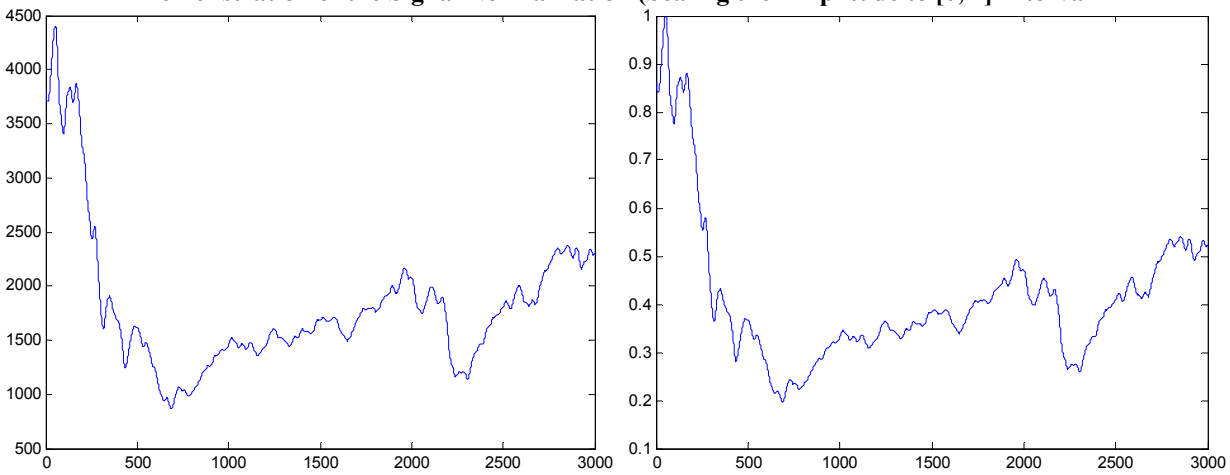


Signal Normalization: in this step, the data is normalized (as shown in Figure 4) to the range [0, 1]. This is important since the Artificial Neural Network – Multi-Layered Perceptron (ANN-MLP) model requires normalized input vectors. Mathematically, the normalization is expressed as:

$$S(i) = \frac{S(i)}{\max(S)} \tag{2}$$

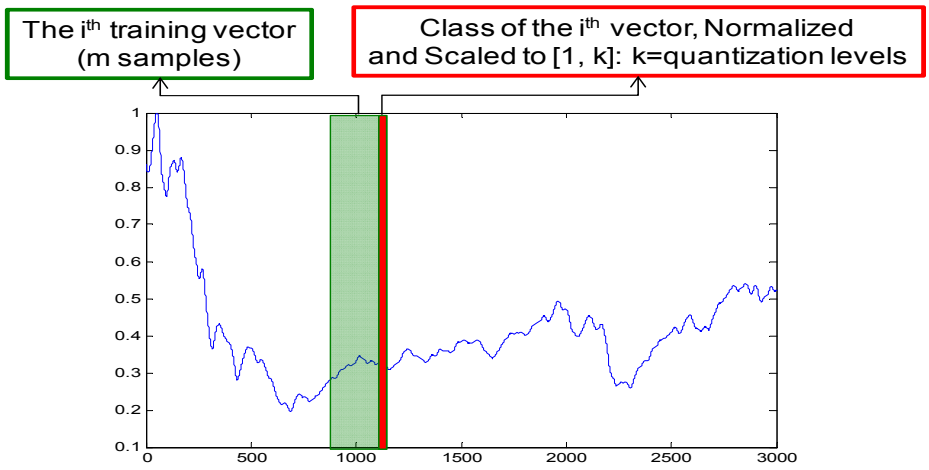
Where, *S(i)* is the signal level at index *i* and *S* is the entire signal and *max* is the maximum level of the signal.

Figure 4
Demonstration of the Signal Normalization (Scaling the Amplitude to [0, 1] Interval



Signal Segmentation: the signal is then segmented into m-sized (shown in Figure 5) vectors that represent the feature vectors used to train and test the ANN-MLP model. *Vector Space Formation*: in this step, the first m-1 elements in the segmented vectors are used as input feature vectors and the m^{th} element is used as the vector class in supervised training.

Figure 5
Illustration of the Signal Segmentation Stage to Generate the Training/Testing Sets for the ANN Model

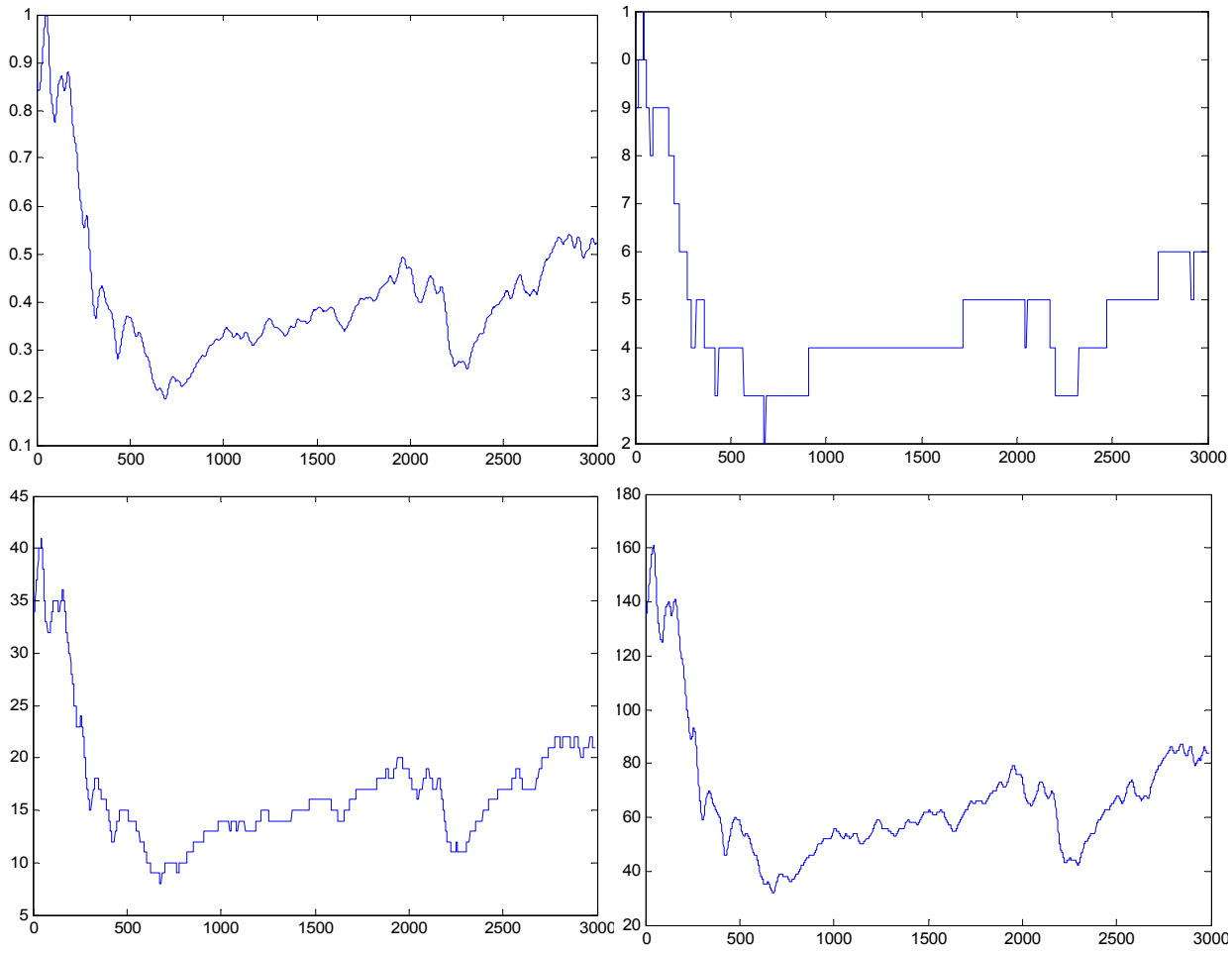


Vector Class Discretization: After normalizing the signal level to the range [0, 1] and segmenting it into vectors, we need to assign each vector a class label. The range [0, 1] is continuous, therefore, depending on the desired resolution, a set of k-classes can be established. In this work, we assumed 20 classes as follows: [0, .05) → class 1, [0.5, 0.1) → class 2, …, [0.95, 1] → class 20. The formula to map the index level into a discrete training class is given as:

$$S_{\min} = \min(S),\ S_{\max} = \max(S),\ D_{index} = \frac{S_{\max} - S_{\min}}{k},\quad C(i) = \left\lfloor \frac{S(i) - S_{\min}}{D_{index}} \right\rfloor \tag{3}$$

Where, D_{index} is the uniform increment in index levels, k is the number of levels/classes, $C(i)$ the mapped ith class from the ith index level $S(i)$. Figure 6 illustrates samples of signal discretization with different k-levels.

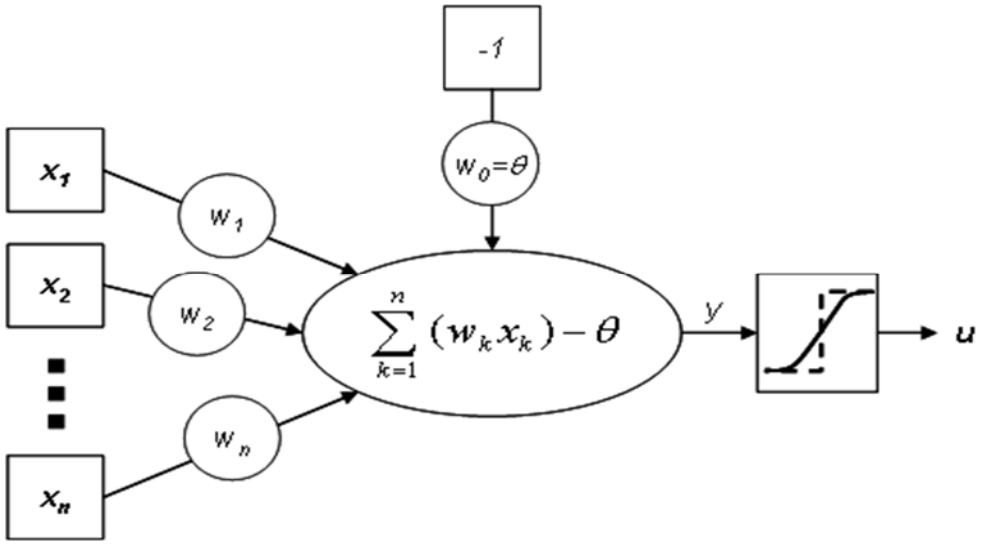
Figure 6
Samples of Signal Discretization using Four Different k-levels of: 10, 40, 80 and 160



MLP Training: At this point, the data is conditioned to be fed into the training stage where typically 80-90% of the data is utilized for training the MLP and 10-20% of the data is used for testing.

Multi-Layer Perceptron (MLP): The basic functional unit in the network architecture of MLP is the perceptron (Figure 7), which computes weighted sum of the components of the input vector and subtracts a threshold value (θ) from it. The result is then passed to an activation function, which can be Hard-limiting, or Sigmoid as shown in Figure 8. The sigmoid function is very essential in the learning process as it has the property of being differentiable which is a must requirement for the derivative-based optimization techniques such as the gradient descent (Hush & Horne, 1993).

Figure 7
The Perceptron, the functional unit in ANN



The basic functionality of a perceptron involves being as a discriminant function in a pattern recognition problem, where it performs a nonlinear transformation from the input space into the output space. Also, it is used as a binary logic unit that is capable of implementing many logic functions including AND, OR, and NOT. The capabilities of a single perceptron are limited to problems that are linearly separable, i.e., the boundaries of different classes can be separated by a linear function as depicted in Figure 9.

Figure 8
Two types of Activation Functions in MLP Neural Networks

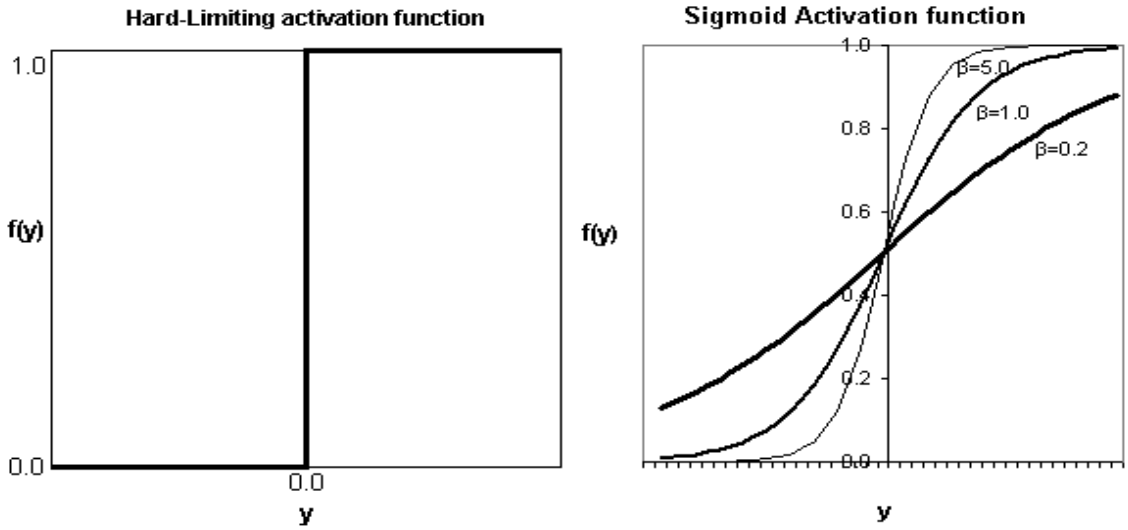
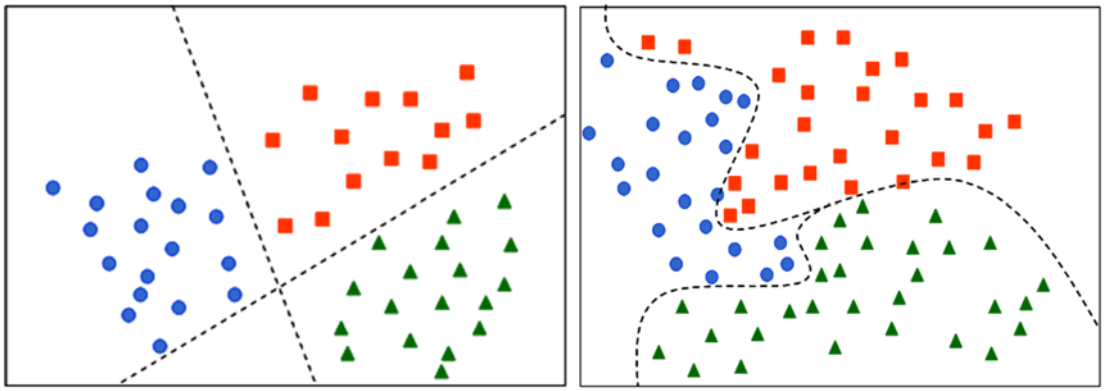
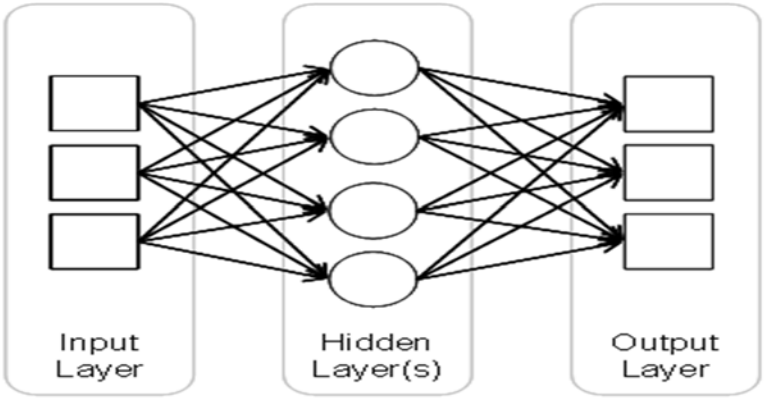


Figure 9
Input feature spaces that demonstrate linearly separable (left) and linearly inseparable vector space (right)



The power and capabilities of the perceptron is greatly extended by the multi-layered architecture with the back propagation learning algorithm. This architecture is illustrated in Figure 10.

Figure 10
Multi-layer Perceptron Typical Architecture

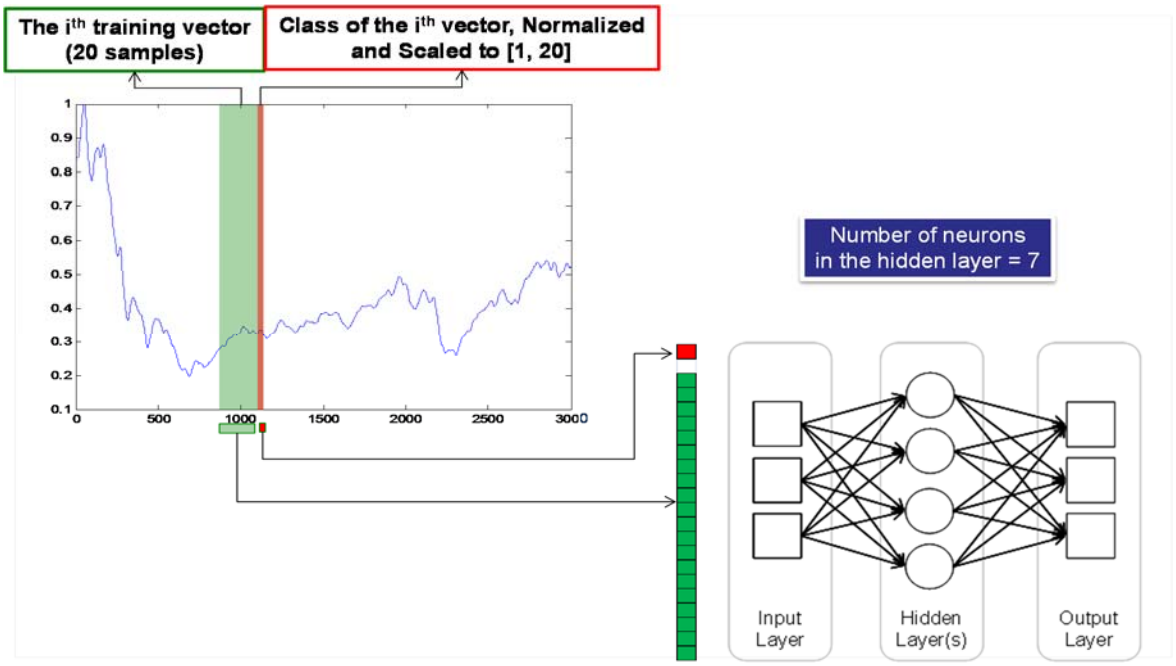


The structure of the MLP (Figure 10) consists of three parts: Input layer, the first layer of perceptrons that receives the input vector. Hidden layer(s), located between the input and the output layer; the output of the input layer is fed into the first hidden layer; the output of the first layer is fed into the next hidden layer and so on. The number of hidden layers needed varies based on the complexity of the application. Often the nodes (perceptrons) of the adjacent layers are fully connected. Output layer, the multiple nodes in the output layer typically correspond to multiple classes for multi-class pattern recognition problem. The most common approach in the learning process is the gradient descent algorithm, in which a gradient search technique is used to find the network weights that minimize a criterion function. The criterion function to be minimized is the Sum-of-Square-Error. The convergence of the algorithm depends on a threshold error. The MLP outputs one class [1-20] corresponding to a particular index level [0, 1], which is the *Class to Index Level Mapping*. In the *Verification and Accuracy Estimation* step, the output of the MLP and the true index levels are compared to estimate the classification accuracy, hence the prediction accuracy of the proposed model. The prediction accuracy is expressed as:

$$Accuracy = 1 - \frac{\sqrt{\sum_{i=1}^{n} [\, C_T(i) - C_P(i) \,]^2}}{n} \tag{5}$$

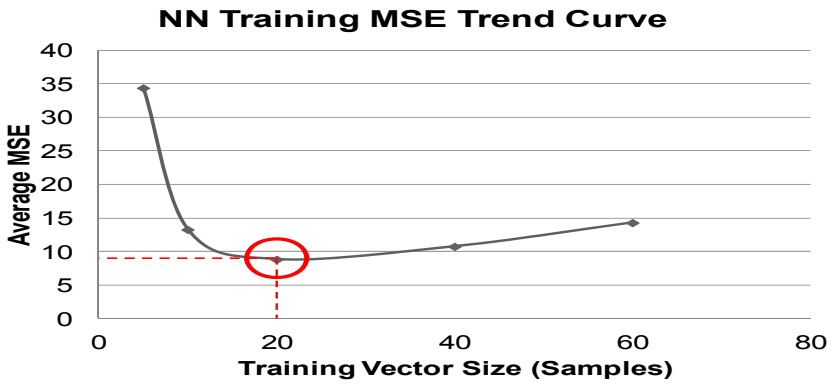
where, C_T is the true class of the i^{th} vector, C_P is the predicted class of the i^{th} vector and n is the number of sample vectors in the testing set. The training/testing data set generation and ANN training are depicted in Figure 11.

Figure 11
Training/Testing Vector Data Sets Generation and ANN Training



In the ANN training stage (Haykin, 1994), it is important to find an optimal vector size so that the Mean Squared Error (MSE) is minimum. We conducted several experiments to try to reveal the pattern at which the MSE changes as a function of the input vector size. The results of these experimenters are plotted in Figure 12. As it can be observed, the optimal vector size was found to be 20.

Figure 12
Finding the Optimal Input Size Vector for Training and Testing Sets of the Neural Network Model



The pseudo code of the proposed approach is given in Table 1.

Table 1
Pseudo Code of the Proposed Approach

```
S[]:    the time sequence of the index of interest
VSize:  the size of the feature vector (number of days)
TSize:  the size of the testing set
NClass: the number of discrete classes for the index levels
VSpace: feature vector space, for MLP network
VLabel: feature vector labels, for MLP network
PLabel: the predicted labels of the testing set

ALGORITHM STOCK_INDEX_PREDICTION( S[], VSize, TSize, NClass )
BEGIN
  S0 = Normalize(S)
  S1 = SegmentSignal(S0, VSize)
  Smin = min(S0)
  Smax = max(S0)
  DS = (Smax - Smin) / NClass

  VSpace = S1[1:VSize-1, :]          // Matrix operation
  VLabel = S1[VSize, :]              // Matrix operation
  VLabel = round( (VLabel - Smin) / DS ) // Matrix operation

  MLP_Net = NNTRain( VSpace, VLabel )   // ANN Matlab Library
  PLabel  = NNTEst( MLP_Net, VSpace )   // ANN Matlab Library
  Accuracy = 100*sqrt{sum((VLabel-PLabel^2))}/TSize
END
```

Pseudo Code of MLP

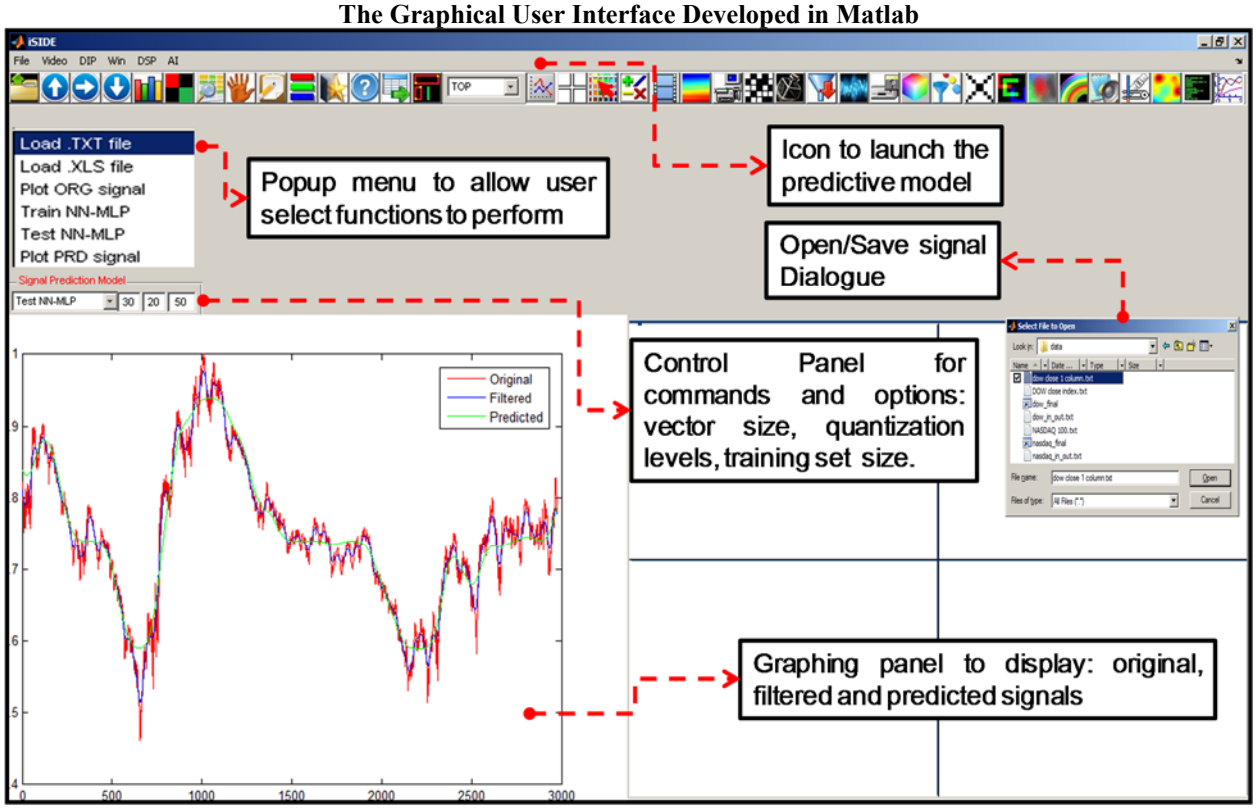
```
backProbagation()
{
 initializeWeights();
 while( training vectors not finished ) {
  getNextVector();
  feedForward();
  computeGradient();
  updateWeights();
  testTerminationCondition();
 }
}

feedForward()
{
 // L = number of layers in the network
 for( layer = 1 to L, ++layer ){

  // N = number of nodes per each layer
  for( node = 1 to N, ++node )
   computeNodeOutput();
 }
}
computeNodeOutput()
{
```

```
  // N = number of nodes of preceding layer
  for( node = 1 to N, ++node ){
    findWeightedSum();
    computeSigmoid( weightedSum );
  }
}

computeGradient()
{
  for( layer = L to 1, --layer){
    for( node = to N, ++node ){
      if( layer == L )
        err[node] = output[node] – desired[node];
      else
        err[node] =
        sumof{ err[node,layer+1]*output[node,layer+1]*
        (1-output[node,layer+1])*weight[node,layer+!]};
    }

  for( node = 1 to N, ++node )
    gradient[node] = err[node] * output[node]
    (1-output[node]) * output[node, layer+1];
  }
}
updateWeights()
{
  for( layer = 1 to L, ++layer )
    for( node = 1 to N, ++node )
      weight[layer,node] = weight[layer,node] -
      (learningRate * gradient[layer,node];
}
```

EXPERIMENTAL WORK AND RESULT ANALYSIS

To test and verify our proposed model, we implemented it in Matlab. Figure 13 shows the Graphical User Interface (GUI) which facilitates the interaction between the user and the model. As it can be seen in Figure 13, the GUI consists of the following components: *Popup menu* – it list available options that are linked to functions including load a signal from a text file, load a signal from a spread sheet, plot signal, build vector space, train the ANN model, test the model, etc. *Control panel*: it enables the experimentation with different parameters such as vector size, quantization levels, training set size, etc. *Graphing panel*: provides the means to plot the original and predicted signals. *Open/Save Dialogue*: allows the user to select a path/file to read/save the signal to. To develop this GUI and the underlying functions, Matlab GUIDE for GUI development was used. The main libraries used to implement different functions and algorithms are: Signal Processing toolbox, Neural Network toolbox and Plotting interface.

Figure 13
The Graphical User Interface Developed in Matlab



We used archived data of the Dow 30 and Nasdaq 100 indices for about twelve years (1/3/2000 - 1/13/2012) (http://finance.yahoo.com/). The data set has 3,000 data points of close date index. The data sets are segmented into ten consecutive data points each for different time intervals, 1,000 segments at a time. Seventy-five percent of each 1,000 data points segment was used for training while the other 25% was used in the testing stage.

The initial training results are depicted in Figures 14 & 15. Four sample training results for each index are shown in Figures 14 & 15, where the proposed model demonstrated (Summary in Figure 16) an average accuracy of 96.7%. The final testing of both Dow and Nasdaq with the entire signals was proven to have a much higher prediction accuracy of 98.7% (Figures 17 & 18).

Figure 14
Sample Results of the MLP Predictive Model for the DOW Index

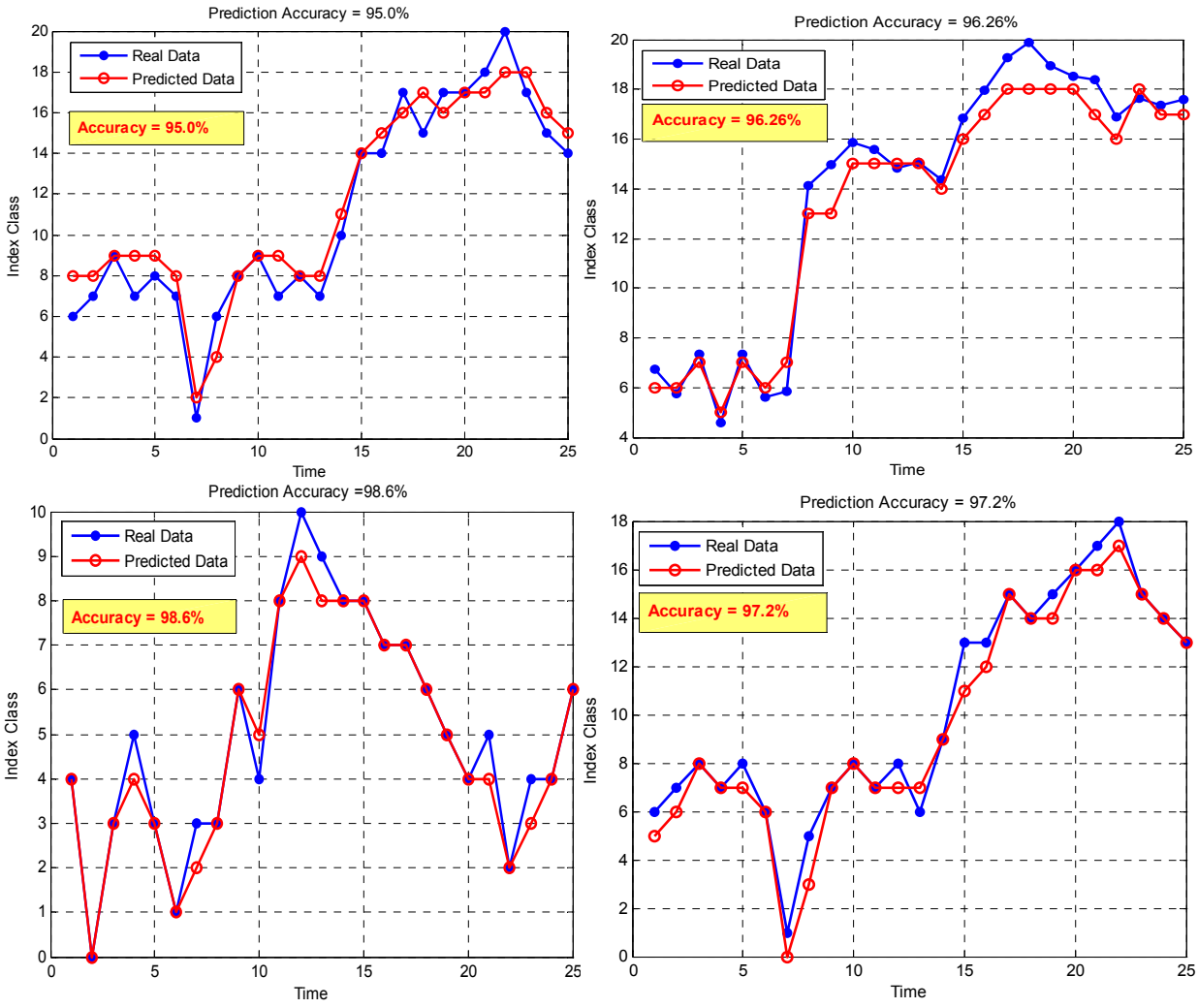


Figure 15
Sample Results of the MLP Predictive Model for the NASDAQ Index

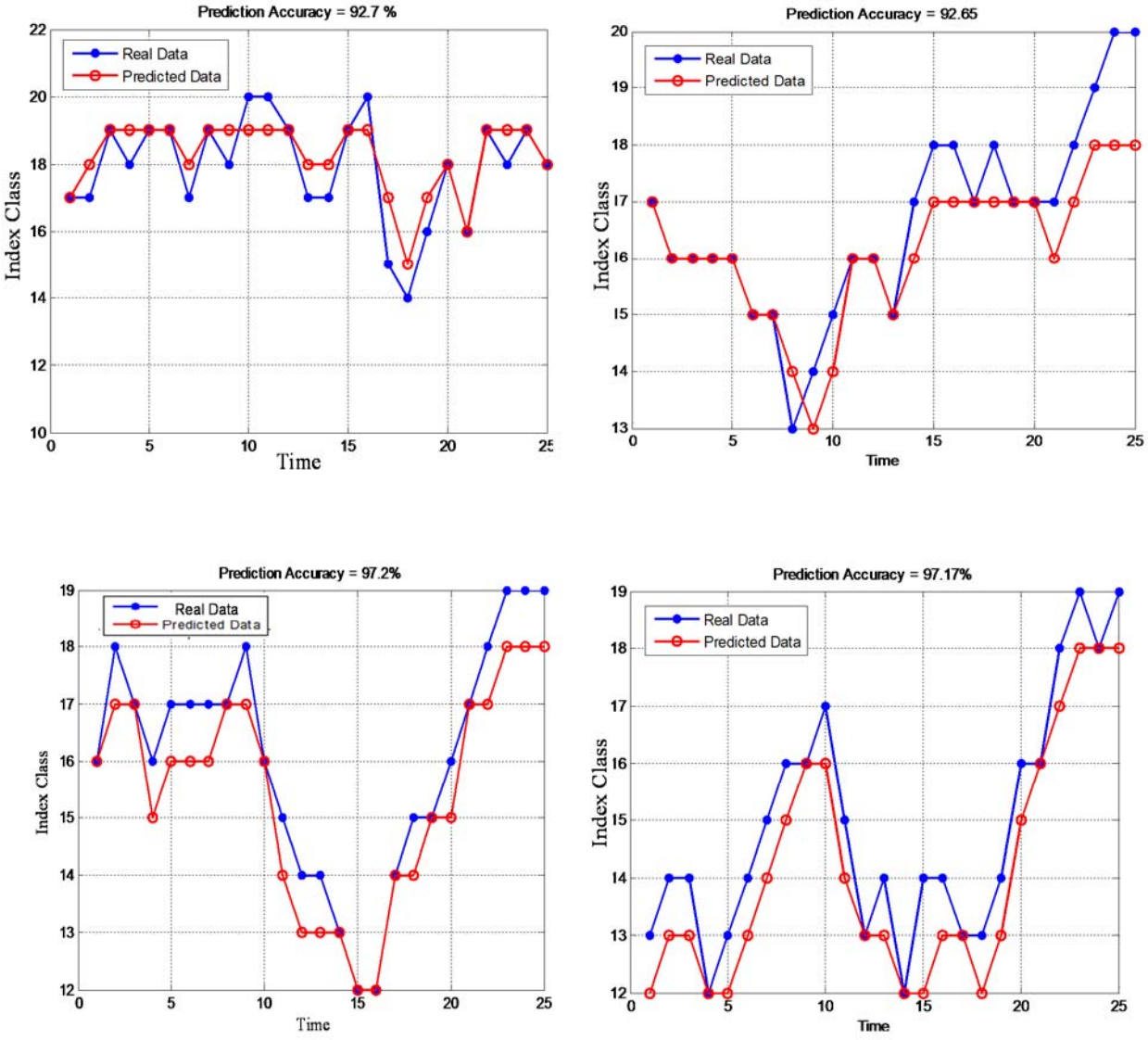


Figure 16
Summary Results of the Prediction Accuracy of the Two Indices: DOW (Blue Bars) and NASDAQ (Red Bars)

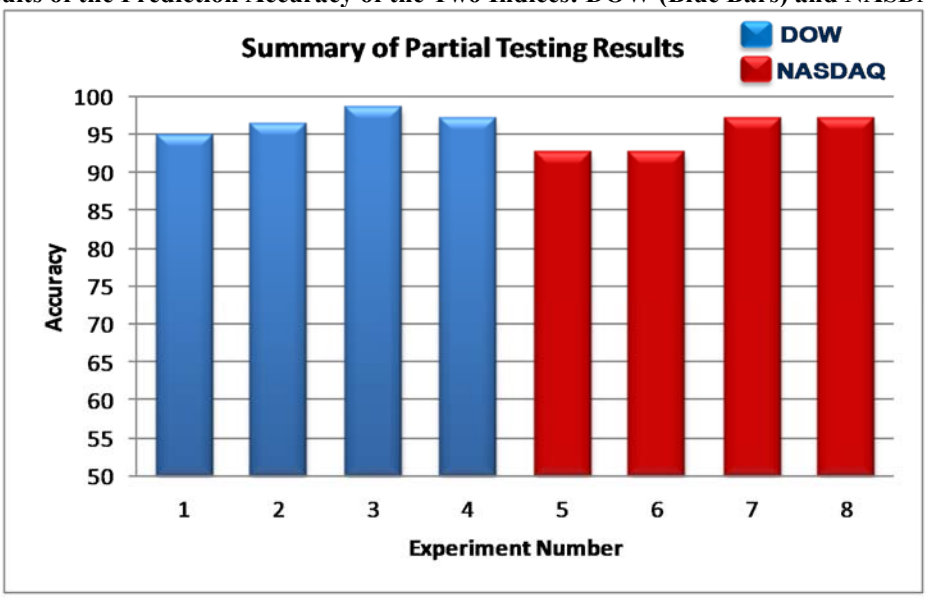
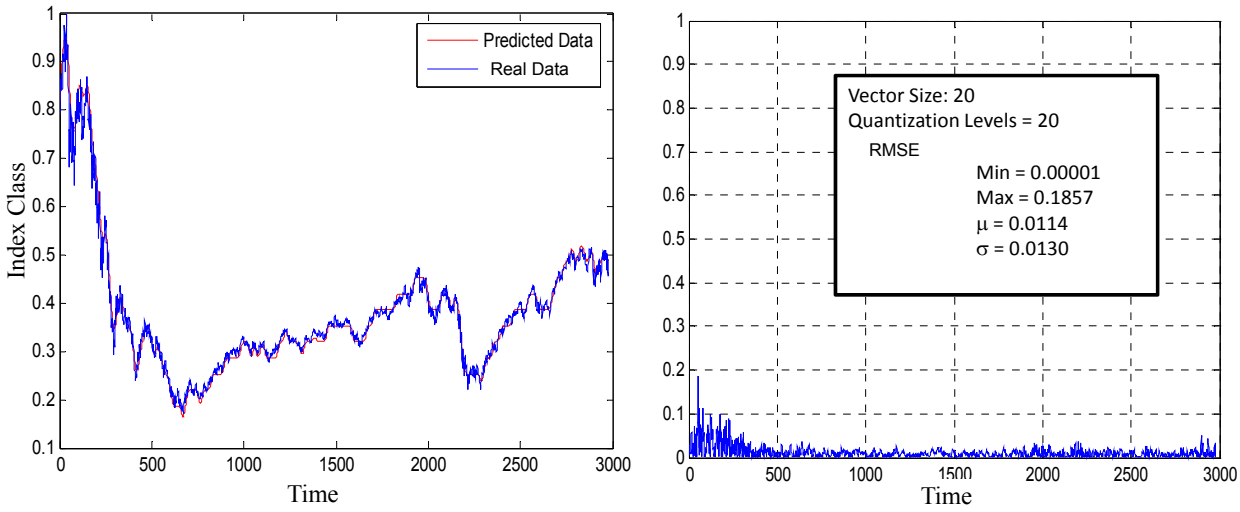


Figure 17
Top: Real vs. Predicted Signals and the RMSE Analysis of the NASDAQ index data. Bottom: Real vs. Predicted Signals and the RMSE Analysis of the DOW index data



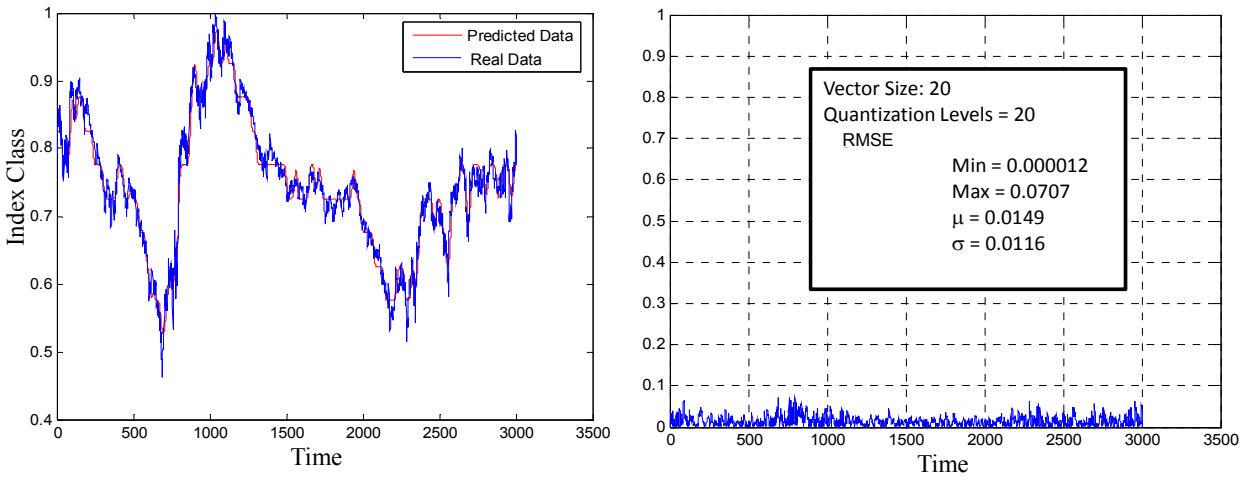
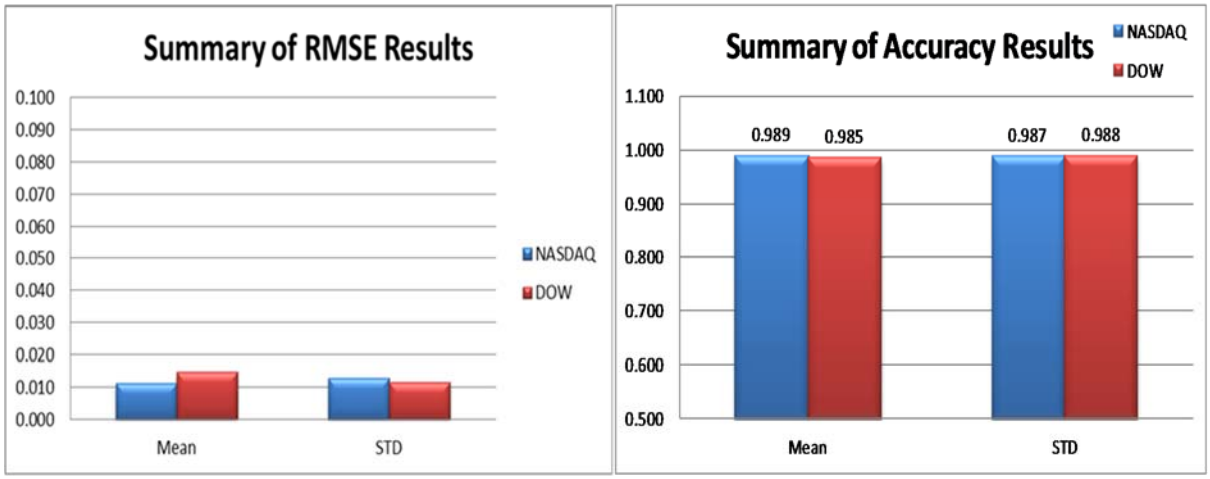


Figure 18
Summary of the Final Results of DOW and NASDAQ Indices



CONCLUSIONS

We have presented a stock index predictive model based on Signal Processing/Gaussian Zero-Phase Filter (GZ-Filter) and Artificial Neural Networks/Multi-Layered Perceptron (ANN-MLP). The proposed approach models the input feature vectors to the MLP network as k-element vector of stock index close day entries. The classes of vectors are modeled as the last entry in each vector after mapping them to a suitable representation that meets MLP input output layer requirements, which is an integer class labels. The GZ-Filter was very effective not only de-noising the input signal, but also in retaining its phase. An archived data of Dow 30 and Nasdaq 100 indices for more than twelve years were used for training and testing the proposed

model and the results strongly supported the effectiveness of the proposed model with an overall average prediction accuracy of 98.7%.

We believe that due to our finding in the literature review, the signal processing techniques are rarely explored as a potential solution for predictive models. This study presents a unique investigation via exploring the potential of signal processing techniques and their effectiveness in developing predictive models for stock market indices.

Our recommendations forward include applying this approach to a variety of potential business applications such as stock buy-sell decision making, and expanding the elements of the input vector such as: open, close, low, and high prices. Since our study focused on the closing price of the stock market index, it would be of interest, to test the model on low, high, and open prices as well.

Acknowledgement

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A HOLISTIC STUDY OF PRIVACY IN SOCIAL NETWORKING SITES

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ABSTRACT

Research related to social networking is abundant. Studies have examined such areas as attitudes toward social networking, security flaws, privacy policies, and user behavior. However, the major areas relating to the privacy options available to users, the different types of information that can be shared as well as the ease of use and degree of control a user has over privacy options on a social networking site have not been captured. This study researches and reports in these areas. Overall, information categories were of four types, namely profile, personal, social, and professional. Varying privacy options were available for each type of information. Privacy options were basically easy to find, but application was a herculean task because of the large learning curve involved. Users are called to pay more attention to the details about different types of privacy options and to bear more responsibility for their privacy settings on social networking sites. The findings of this study add to the social networking body of research and are helpful to both the social networking sites and social networking users.

INTRODUCTION

In this digital era, social networking has become a global phenomenon (Boyd et al. 2008). People of all ages use online social networking sites (SNS) as a primary communication media to get or stay connected with their friends and family (Livingstone 2008). Individuals voluntarily share a lot and different types of information on the SNS. For instance, users share personal information, such as personal interests, special hobbies, and several other facets of their lives in an effort to develop intimate and personal connections with other users (Vasalou et al. 2010). Moreover, a lot of personally identifiable information is collected during the sign-up process (Bonneau et al. 2009b). One of the major challenges surrounding SNS is to ensure that user information is protected.

Recent trends note that SNS have been subject to legal scrutiny due to their privacy violations (Pilkington 2007). The information available on SNS has been misused by several different agencies including educational institutions (Fogel et al. 2009) and prospective/current employers (Finder 2006). Prior studies depict the ease of extracting information from SNS; for example, attackers could take photographs extracted from a friend's social networking pages and use them as personal signatures to create an authentic phishing message (Jagatic et al. 2007). In

some cases the consequences for SNS and their users have been socially damaging and humiliating (Rosenblum 2007). The industry trends indicate that SNS are increasingly releasing privacy options to protect various facets of user information; however it does not seem to alleviate the privacy concerns (Barbara 2011). Some possible explanations include – (a) the privacy options are skewed towards protecting certain user information (Eldon 2011), (b) users are not aware of the privacy options available to protect their content (Barbara 2011), (c) users may not have sufficient know-how to locate and apply the privacy options (Huber et al. 2011). This study attempts to address these issues using a three step approach. First, it examines the different types of information users can share on SNS. Second, it captures the privacy options provided by SNS to protect the different types of information. Third, it examines the users' ease of use and degree of control for each privacy option. Ease of use refers to the degree of effort required to use the privacy options, and degree of control is the leverage users have to manipulate the privacy options. The rationale for the third objective is drawn from technology acceptance research which contends that individuals intend to use a technology when it requires less effort and is perceived to be beneficial (Venkatesh et al. 2003; Venkatesh et al. 2012).

The findings provide implications for both users and social networking sites. From a user standpoint, this study provides suggestions on the different types of information that can be shared safely on social networking sites. In addition, this research informs users regarding the effort required to enable and handle various privacy options to protect their online information. From a social networking provider perspective, this study provides awareness about what is being expected with respect to privacy options and how to meet those expectations. In addition, the findings shed insight on how to enrich various privacy options in order to cater to user requirements and thereby to facilitate their sharing of different types of information. This is particularly important because success of a social networking site depends on the magnitude of users utilizing it to share information.

LITERATURE REVIEW

Research related to social networking is continually emerging. Prior research has explored several issues related to social networking. Some studies have examined the factors that motivate individuals to participate in social networking (Boyd et al. 2008; Tufekci 2008). Others have analyzed user attitudes towards social networks with an emphasis on information sharing and disclosure (Constant et al. 1994; Livingstone 2008). Another stream has focused on the relationship between cultural affiliation and social networking (Fogg et al. 2008; Vasalou et al. 2010).

Research on user privacy and security has been an active area, but the focus has been on privacy policies (Bonneau et al. 2009b) and the potential threats and risks of using social networking (Dwyer et al. 2007; Frankowski et al. 2006). Some researchers have taken a technical approach to examine the security flaws (Bonneau et al. 2009a) and/or the network

architectures (Anderson et al. 2009) with an emphasis on proposing new privacy preserving front ends for existing social networks. Some of the interesting findings include - (a) users genuinely do express concern about their privacy, and it is one primary factor considered while selecting the SNS (Acquisti et al. 2006; Bonneau et al. 2009b; Gaurav Bansal et al. 2008), (b) information shared on social networking sites is subject to various attacks that include spam, phishing and identity theft (Gross et al. 2005; Huber et al. 2011; Jones et al. 2005), and (c) the burden to protect online content is skewed towards the user rather than the social networking site (Dwyer et al. 2007). Consequently, the users have to take responsibility to identify and enable privacy options.

While informative, most of the studies have focused on user behavior, specifically how privacy policies affect or influence user behavior. The focus has been largely on personal information. On the contrary, recent trends indicate that individuals share more than just personal information on SNS (Strater et al. 2007). Similarly, in some instances users were not aware of the availability of the privacy options (Dwyer et al. 2007). To illustrate, an app installed by a user's friend could have access to the user's information even if the user does not install the app himself or herself (Barbara 2011). Even though it is possible for the user to opt out of sharing information with his or her friends' apps, many users "do not know to do this because they are not aware that the sharing is happening in the first place" (Barbara 2011). More interestingly, users did not intentionally enable the privacy options because of the complexity surrounding them (Jagatic et al. 2007). Accordingly, it is not only important to explore the privacy options available to protect other types of information but also to understand the factors that will trigger the user's intention to accept and use the privacy options. The rationale for this emanates from the technology acceptance and use literature which contends that an individual's intention to accept and use a technology is influenced by four key factors: effort expectancy, performance expectancy, social influence and facilitating conditions (Venkatesh et al. 2003; Venkatesh et al. 2012). Performance expectancy is defined as the degree to which using a technology will provide benefits to individuals in performing certain activities. Effort expectancy is the degree of ease associated with individuals' use of technology. Social influence is the extent to which individuals perceive that important others (e. g., family and friends) believe they should use a particular technology; and facilitating conditions refer to individuals' perceptions of the resources and support available to perform a behavior (Brown et al. 2005; Venkatesh et al. 2003; Venkatesh et al. 2012). This study extends these two constructs to social networking privacy and contends that an individual's intention to use a privacy option will depend upon the extent to which it is easy to deploy and the extent to which he or she can leverage it to maximize the benefits. From a broader perspective, a privacy option is beneficial only if the user can customize it to meet his or her requirements to protect his or her online content.

METHOD

An exhaustive survey of the major, general-purpose social networking sites was conducted in order to explore the various privacy options available for users to protect their information. In addition, this research captured the different types of information that can be shared on SNS and their associated privacy options. Finally, degree of control and ease of use was recorded.

SELECTION OF SITES

The top 100 social networking sites were selected based on Alexa ranking, a web information company which ranks sites based on their popularity (number of users). To be included in the analysis the sites had to meet five criteria – (1) the main purpose of the site should be general purpose social networking i.e., the primary use of the site is interacting with others through profile pages on the web (2) the site should be available in English (3) the site must be active and fully functional; (4) the accessibility should be free and require no fee or special invitations, (5) the site must have at least 50 million users because this is commonly used as a general indicator of the amount of traffic a site is receiving and as an indirect scoring for a site's popularity (Bonneau & Preibusch, 2009). These criteria were necessary to ensure fair comparison between sites and to avoid general content sharing websites such as YouTube, Flickr among others. The constraints enforced in this study are consistent with prior research (e.g., Bonneau et al. 2009b) examining user privacy in social networking sites. After a thorough analysis this study narrowed down to 10 SNS that satisfied the above mentioned five criteria. Table 1 shows the SNS that were considered in this study.

Table 1
List of Social Networking Sites included in the Analysis

Social Networking Site	Users (Million)	Country
1. Facebook	500	USA
2. Bebo	117	USA
3. MySpace	100	USA
4. Tagged	100	USA
5. Okrut	100	USA
6. Friendster	90	USA
7. LinkedIn	80	USA
8. Hi5	80	USA
9. MyLife	51	USA
10. Classmates	50	USA

Source: *http://www. alexa. com/topsites*

The analysis of selected SNS was done in a systematic manner. First, a generic user account was created to gain access into the SNS and examine different types of user information shared by the users. Second, the privacy options available to protect different types of information were recorded. Third, the ease of use and degree of control were examined for each privacy option and coded using a seven point Likert scale. The scale for ease of use was (1 -- Extremely easy, 2 – Very easy, 3 – Easy, 4 – Somewhat easy, 5 – Difficult, 6 – Very difficult, 7 – Extremely difficult). Factors such as effort required to locate the option and appearance (icon, text) were taken into consideration while determining the ease of use. Similarly, the scale for degree of control was (1 – Extremely customizable, 2 – Very customizable, 3 – Customizable, 4 – Somewhat customizable, 5 – Little customizability, 6 – Very limited customizability, 7 – Extremely limited customizability). Factors such as number of options, for example public, private, by invitation only, among others were taken into account to determine the degree of control. This was done for every privacy option identified.

RESULTS AND DISCUSSION

The exploratory analysis was done in a sequential manner. First, the SNS were searched to identify the different types of information users can share. Second, the privacy options for each information piece within each information type were recorded and a frequency analysis was done. Third, the ease of use and degree of control for each privacy option was evaluated on a 7 point Likert scale as aforementioned.

Overall, the SNS have broadened their scope allowing users to share more than just profile and personal information. In particular, it was observed that users also shared social and professional information. Social information refers to data that helps the individual to socialize with similar people. Examples include group affiliations, network interests and tags on preferred videos. Professional information relates to the posting data about one's expertise, credentials, and experience. This includes information such as degrees, educational levels, certificates, and place of employment.

The privacy options available to protect the different types of information were significant which indicates that SNS are increasingly addressing users' privacy concerns. However, the distribution of privacy options related to profile, personal, social and professional information was not balanced as shown in Table 2. There were significantly more privacy options available to protect profile and personal information compared to social and professional information. This is consistent with the current market trends and with research which has primarily emphasized the need for protecting profile and personal information (Bonneau et al. 2009b). For SNS users this finding implies that it is important to pay close attention on what pieces of social and professional information they share on their SNS webpage. This is imperative given the fact that potential recruiters/employers consider the information shared on their SNS page while making critical decisions. The SNS sponsors must render more effort

towards protecting all types of information rather than focusing on just personal and profile information. From a broader perspective, SNS sponsors should realize that their users are using SNS as an interface for exploring more comprehensive opportunities than just sharing personal information.

Table 2
Summary of Information Types and Associated Privacy Options

Type of Information	Number of Privacy Options
Profile	11
Personal	20
Social	7
Professional	6

PROFILE INFORMATION

Profile information refers to the amount of information required to register an account and all the publicly viewable sections of the webpage that are presented to non-members who visit the site. At this junction it is important to emphasize that this study only recorded the information that was publicly available i.e., access to information without any special request or adding to friends list. In general most SNS allowed users to share a lot of information while registering the account. Some of the information was required to create an account. A total of 11 different privacy options were identified. The results are displayed in Table 3.

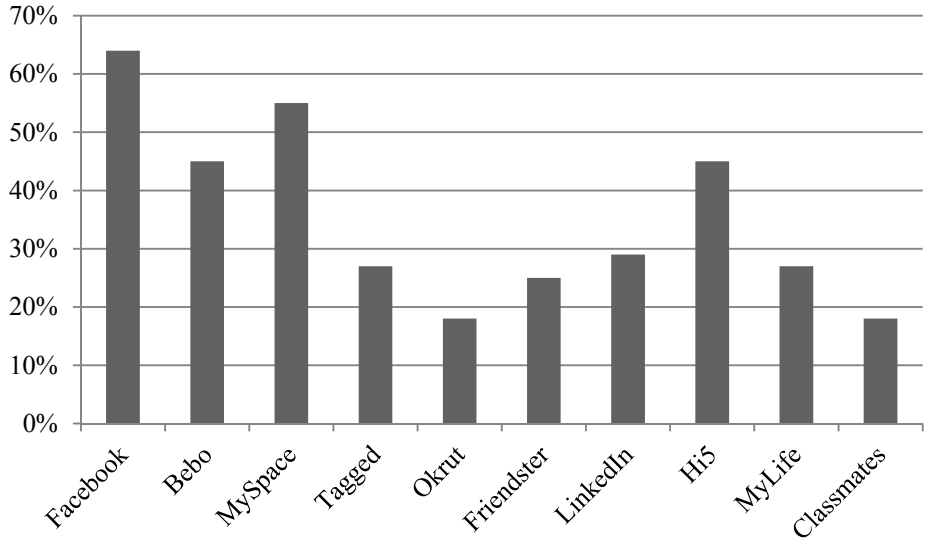
Table 3
Profile Information and Privacy Options

1. Option to block photos shared by others
2. Option to enable/disable messages
3. Option to enable/disable friend requests
4. Option to block posts by others on your profile
5. Option to disable " place I check in to" features
6. Option to block users
7. Option to control visibility on Search (not show the user name)
8. Option to control visibility on Public Search *(show the user name only to selected ones)*
9. Option to share when you update your profile
10. Option to block unwanted application invites from certain users
11. Option to choose whose profile pictures to view

The availability percentages for privacy options are presented in Figure 1. Interestingly, there was a considerable variation of availability among the SNS. Some SNS provided more privacy options compared to others, but the overall trend indicates that service providers are

attempting to respond to their users' demands. Moreover, the percent availability of privacy options for profile information was relative higher compared to the other information categories. This is consistent with past and current trends which reveal that user's first interaction with SNS is through creating their profile which can have a large impact on their decision to join the SNS (Tufekzi, 2008). From a SNS user standpoint, this indicates the responsibility one has to bear while selecting a SNS. This is especially true for teenagers who think that their information is private as along as it not read by their parents (Barnes 2006). Another, interesting fact is that most SNS users create an attractive profile in order to lure others which is dangerous if the other entity accessing their information does not have good intentions (Huffaker et al. 2005). Overall it is vital that SNS sponsors continue to provide more tools to protect their users profile information to avoid dire consequences such as identity theft and/or cyber bullying/stalking. The SNS users should understand and bear the responsibility of what they disclose in the profile to elude pervasive intrusions.

Figure 1
Privacy Options - Profile Information



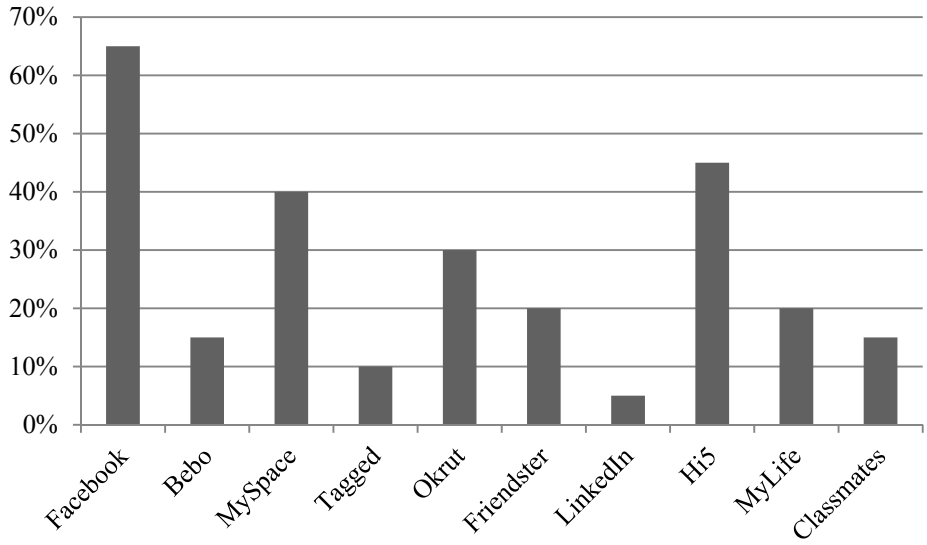
PERSONAL INFORMATION

Personal information refers to information individuals share to create an identity on SNS. Not surprisingly, most SNS allowed their users to share a lot of personal information. This is consistent with the history of social networking which reveals that social networking was created in order to allow individuals to share personal information (Boyd et al. 2008). Also, this finding reiterates past research which emphasized the need and importance for protecting personal information (Joinson 2008). A total of twenty privacy options were identified as seen in Table 4.

Table 4 Personal Information and Privacy Options
1. Option to share birthday
2. Option to share your age
3. Option to share posts by me
4. Option to share gender
5. Option to share real name
6. Option to share IM screen name
7. Option to share display name
8. Option to share profile picture
9. Option to share relationships/marital status
10. Option to share biography/favorite quotes
11. Option to share e-mail address
12. Option to share family members
13. Option to share home address
14. Option to share current city/hometown
15. Option to share other phone number
16. Option to share religious/political views
17. Option to share photo albums and videos
18. Option to share when you add new photos, videos, or blogs
19. Option to share when you add new friends
20. Option to show online status

Figure 2 below shows that the availability of privacy options for protecting personal information varies considerably across the selected SNS. Some of the prominent SNS like MySpace are still in developing phase while other newcomers like Orkut and Hi5 are increasingly offering more privacy options for protecting their users' personal information. But overall this finding is consistent with recent trends which indicate that there is advancement across SNS to protect their users' online identity from factors such as cyber bullying; cyber stalking, identity theft and information abuse (Ahn et al. 2011). From a SNS user standpoint, they have to realize that increasingly many employers, universities and other institutions are framing their judgments based on what they see on SNS. This is especially true for teenagers and young adults who share a vast amount of personal information on SNS (Grant 2005). Thus, it is important to pay close attention to what type of information one posts on a social networking site, failing which can lead to dire consequences.

Figure 2
Privacy Options - Personal Information



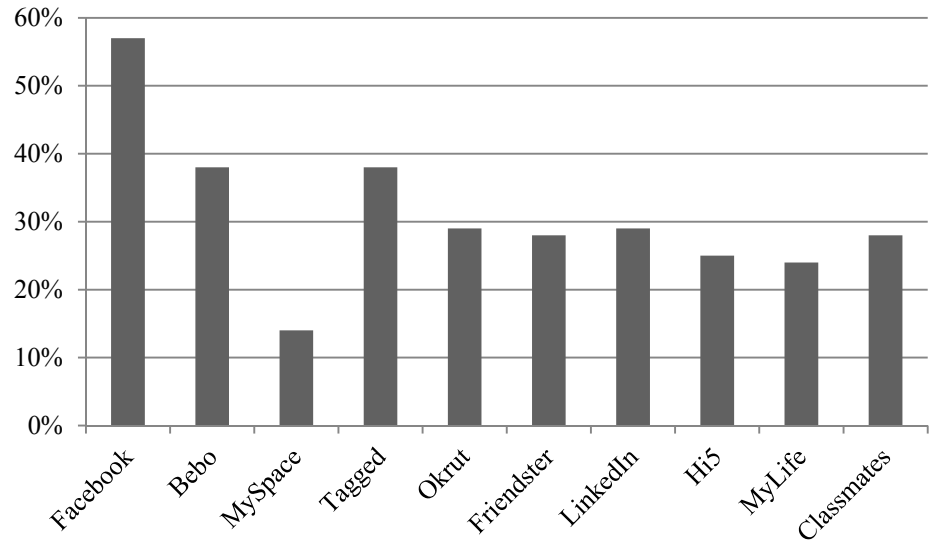
SOCIAL INFORMATION

Social information refers to data that helps the individual to socialize with similar people. Examples include group affiliations, network interests and tags on preferred videos. Compared to profile and personal information, this information category is still in its infancy. A total of seven privacy options were identified and are listed in Table 5. It is important for SNS users to exercise some judgment to determine which SNS are safe for their information and also to determine the possibility of privacy breach on the site. For instance, prior studies note that SNS have become an attractive target for consumer profiling and social phishing by both legal and illegal bodies (Boyd et al. 2011; Eldon 2011).

Table 5 **Social Information and Privacy Options**
1. Option to share interests/other information
2. Option to share friends list/connections
3. Option to share information about application activity
4. Option to share what types of contact you are interested in
5. Option to share when you post events
6. Option to share when you are tagged in a photo, video, or blog
7. Option to share e-mail and IM addresses to help friends find you

Overall the percentages of privacy options for social information are improving as shown in Figure 3. There was less variation among the SNS on this dimension as compared to profile and personal information. This finding indicates that SNS, new and established ones, are constantly responding to the emerging trends in the industry. Recent research indicates that individuals and businesses are using SNS to promote brand affiliations or to create special groups in order to encourage brand loyalty and/or attract customers (Waters et al. 2009). For instance, Harley Davidson encourages its customers to meet on Facebook to organize and share trip details. In conclusion, SNS sponsors should consider providing more options to share and protect social information. This will also help SNS sponsors intensely increase their user base.

Figure 3
Privacy Options - Social Information



PROFESSIONAL INFORMATION

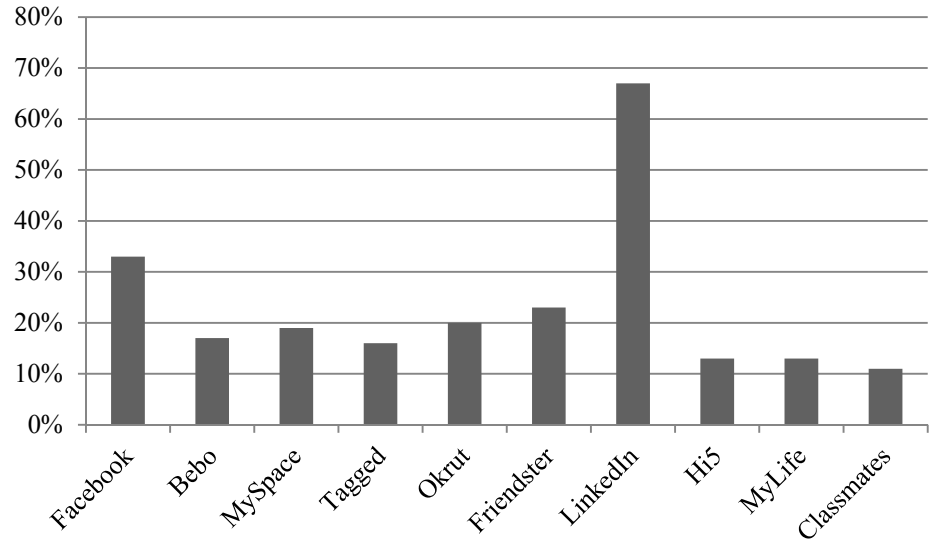
Table 6 Professional Information and Privacy Options	
1.	Option to share education/work experience
2.	Option to share your blogs
3.	Option to share honors and awards
4.	Option to share when you are attending events
5.	Option to share comments posted on another profile
6.	Option to share your news feed

Professional information relates to posting data about one's expertise, credentials, and experience. The objective for sharing professional information is to enhance one's creditability and job marketability. Recent studies have shown that organizations use SNS to attract and to

research about potential job candidates (Finder 2006). However, in general most SNS are still at the developing phase while specialized sites like LinkedIn have become the leaders. This study identified six privacy options related to professional information as displayed in Table 6.

Overall as revealed in Figure 4, the privacy options for protecting professional information were lower than the other information categories. However, it is important to note that the SNS sponsors are catering to the emerging demands of their users; however this area is still in the developing mode. From a SNS user standpoint, it is important to understand how/what professional information can be shared on SNS. For instance, SNS users can list a lot of professional information under the personal information category without recognizing that it can mislead recruiters (Barnes 2006; Benevenuto et al. 2009). In general SNS users must consider the consequences of sharing professional information on their SNS web page.

Figure 4: Privacy Options - Professional Information



EASE OF USE AND DEGREE OF CONTROL

The final objective of this study was to analyze the ease of use and the degree of control for each privacy option. In general most of the privacy options were fairly accessible; the ease of use average scores are listed in Table 7. Another interesting observation was the availability of fine-grained privacy options. Inasmuch, users had more options to manipulate their visibility rather than simply opt-in or opt-out. However, this can be a double edge sword, that is, in some situations enabling the privacy options can become very stressful and confusing for novice users.

Table 7 Privacy Options Ease of Use		
Information Category	**Average Scores**	**Standard deviation**
Profile	1.72	0.43
Personal	1.93	0.45
Social	2.00	0.26
Professional	1.58	0.57

(1 -- Extremely easy, 2 – Very easy, 3 – Easy, 4 – Somewhat easy, 5 – Difficult, 6 – Very difficult, 7 – Extremely difficult)

Most of the privacy options were easy to locate and activate. However, some privacy options were difficult to locate. For instance, privacy options related to professional information were apparent and could be easily activated. This is consistent with the existing trends which reveal that individuals increasingly use SNS to share professional information such as photos and blogs (Bonneau et al. 2009b). On the other hand, privacy options for social information were a little harder to locate. These trends were common across most of SNS with little or no variation.

Table 8. Privacy Options Degree of Control		
Information Category	**Average Scores**	**Standard deviation**
Profile	4.33	1.48
Personal	4.24	1. 96
Social	4.66	2. 23
Professional	4.12	2. 31

(1 – Extremely customizable, 2 – Very customizable, 3 – Customizable, 4 – Somewhat customizable, 5 – Little customizability, 6 – Very limited customizability, 7 – Extremely limited customizability)

The average scores for degree of control listed in Table 8 indicate rather low customization of privacy options. In general, most privacy options provided little or no leverage for users to customize them to meet their needs. Most common option was "private" or "public". Some of the major SNS like Facebook provided more options allowing users to specify who is able and not able to view the shared content. However, the option to customize was available for a narrow range of privacy options. Surprisingly, privacy options related to social information had the lowest level of customization. In general, the profile name and photo were always shown with no option to hide the visibility. This availability reiterates the point about the increasing growth in social phishing i.e., using photos on SNS to create authentic phishing messages (Jagatic et al. 2007). Moreover, in some SNS the users were required to be well versed with the technical terminology to determine the best way to protect their online content. Additionally, organizations are using Facebook as a potential database for retrieving photos and

information which in turn are used for consumer profiling. The surprising part is that no login is required to collect this information (Chunka 2011).

While the privacy options were easy to locate, applying them in the right manner was a herculean task. There is a large learning curve for employing privacy options; this is especially true for novice users (Vaknin 2011). In conclusion, while major SNS players like Facebook are making changes to their design and features to provide users more control over their information, most SNS are still in trial and error mode.

LIMITATIONS AND FUTURE RESEARCH

As with all research, this study is subject to limitations which must be considered when evaluating its implications. Specifically, this study used secondary data to explore the different types of information shared by SNS users and the privacy options available to protect that information. Future research can extend the findings of this study by using the comprehensive list to develop a questionnaire to survey SNS users. Another limitation was this research included a narrow range of SNS based on predefined criteria. It may be interesting to extend the findings to a larger base of SNS. This can help better understand the privacy issues surrounding SNS. Finally, it would be worthwhile to explore how the number of privacy options affects the quality of information shared on SNS. For instance, this study observed that SNS are reactive to their users' demands. As social networking continues to grow as a global phenomenon, it may require SNS to take a proactive approach to privacy in order to attract a larger user base.

CONCLUSION

Online social networking is a promising and growing phenomenon. Individuals are finding various ways to use social networking sites. This study found that social networking sponsors are encouraging SNS users to share different types of information by providing a variety of privacy options to protect that information. However, proportions of privacy options were not balanced. In other words, there were more privacy options for protecting profile and personal information than social and professional information. SNS users no longer have to worry just about what Facebook, Google+, LinkedIn and other SNS sponsors do with their database information; they have to worry about what SNS sponsors can enable others to do with it also. As a SNS user, it is important to pay close attention to the details about different types of privacy options. The SNS users must educate themselves about the privacy settings before uploading their information. SNS sponsors like Facebook are developing rich knowledge bases to educate users about privacy settings (Eldon 2011). The privacy paradox plaguing both SNS sponsors and users is waning; it is time that both entities bore some responsibility for their actions.

Overall privacy in social networking is still at its infancy which urges the need for more research in identifying new issues and providing options or solutions that can be implemented by novice users. It is critical for SNS sponsors to offer more sophisticated privacy options to develop a niche in the industry. This research hopes that the ideas presented here, along with the published dataset, will be an important starting point.

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KEY ACTORS IN THE MOBILE PHONE INDUSTRY: THE SMART PHONE WARS

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ABSTRACT

We use Actor Network Theory (ANT) as a lens to study the 'wars' among broad based smart phone companies such as Samsung, and high end specialists such as Apple. In addition to historical data, the study draws on recent coverage of the patent disputes among these companies. The key actors in the network are mobile phone, operating system companies, and telecom carriers. As operating system companies, Google, Apple, and Microsoft comprise a key 'vertex' of the network that affects the actions of smart phone companies. The study extends the scope of ANT, and introduces new concepts into this well known theory. Theoretical implications, limitations, and conclusions are also discussed in the paper.

Keywords: Smart phones, Alliances, Strategy, Patent wars, Actor Network Theory.

INTRODUCTION

The key players in the mobile phone industry are mobile phone manufacturers, operating system companies, and carriers. The manufacturers are referred to as mobile phone companies in the paper. We focus on smart phone companies, which use an operating system not unlike a computer. Pioneered in the Personal Digital Assistant (PDA) era, these phones have been nearly eclipsed by smart phones. A number of technologies are needed for a smart phone to provide value to users. In addition to the operating system, these technologies include discrete applications or 'apps' downloaded from app stores. The competitive nature of the industry, and requirements of high technology, have given rise to patent wars (Levine, Gupta, & Reuters, 2012).

The patent wars are analyzed on 2 levels in this paper. First, these appear as litigation among the mobile phone companies, the most visible of which are Samsung and Apple. On a different level, these are wars between and among the operating system companies- Apple iOS, Google Android, and Microsoft Windows Phone. These three companies have accumulated large troves of patents over the years. Google's acquisition of Motorola, in particular, was seen as acquisition of a rich portfolio of patents held by the latter, a pioneer of mobile phone industry.
Given the extant emphasis on firm level analyses such as the resource based view (Das & Teng, 2000) in literature, there is a need for an assessment of the role of patents. Extant research on this industry has covered the antecedents of use of mobile phones (Fillion & Ekionea, 2010) and adoption of mobile TV (Shin & White, 2012).

In this paper, we study the role of actors in the mobile phone industry through the lens of ANT. The paper addresses the research question: What are the key actors or actants in the smart

phone industry, and how would the smart phone wars, inclusive of patent litigation, affect the industry as regards actor networks in the industry? We analyze historical data on leading mobile phone companies and selected actors in related industries. The article is organized as follows. We start with a background on the industry and actor network theory. This section is followed by analyses of companies and selected vendors. The article concludes with discussion, contributions, limitations and suggestions for future research.

INDUSTRY BACKGROUND

The largest mobile phone companies by volume are Nokia, Samsung, LG, and Motorola. In the feature phone era, 1994 to 2004, Ericsson and Siemens were among the leaders. The change in pecking order represents the rise of smart phones, with new players such as Apple and HTC entering the market. Share of smart phones has increased through the years, increasing from 5% of global sales in 2007 to 36% in the second quarter of current year (Source: Gartner). Nokia, Ericsson, and Siemens have large interests in telecom networks, which leverages their relationships with telecom carriers, also referred to as service providers. Service providers are important in that they serve as a direct channel to customers, particularly in the US market where mobile phones are bundled with phone service. AT&T and Verizon have gained in the US, while Sprint and T-Mobile have been weaker as regards subscribers. Finally, the operating system for smart phones is comprised of 'exclusive' iOS used by Apple, and licensed software such as Android and Windows Phone for other companies. These are provided by Google and Microsoft, respectively, and researched in literature (Barnes, 2002). Microsoft extended its well known Windows operating system to Windows Mobile. It has reached a share of around 5-10% in recent years. The latest version, Windows Phone 8, redesigned to be in step with the desktop Windows 8 software, has attracted interest from Nokia and Samsung. Historically, Symbian was a leading standard promoted by Nokia, until it became an independent consortium. Samsung promoted a new standard, Bada, in a similar strategy.

FIRMS AND MARKET SHARES

Smart phone sales have shown higher growth as compared to feature phones in the current year. In the second quarter of 2012, their share reached 36.7% of total mobile phone sales (Source: Gartner). Samsung, Apple, and Nokia are leaders, with HTC having a small though visible share.

In order to gain an understanding of smart phone industry, operating systems (OS) are important. The leading operating systems are Google's Android and Apple iOS. These OS had 60% and 20% share of smart phone market, respectively, in the 12 months to June 2012 (Source: Strategy Analytics). The balance share is held by Microsoft Windows Phone, and RIM. In many ways, iPhone is at the center of patent wars. Since the first iPhone was introduced in 2007, it has been a highly popular product, with the latest avatar, iPhone 5, being launched in September 2012. In contrast to a multiple handset and multi-tier strategy of Samsung, Apple has focused on a single model. However, older versions of iPhones continue on sale, with price reductions to attract a less 'current' user. Drawing on iPod and iTunes, Apple has a large store of applications

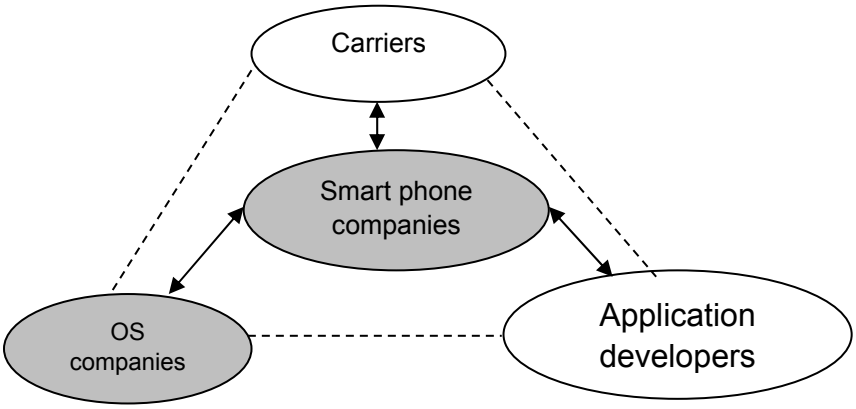
or 'apps' that are difficult to match in the store's scale and variety. This has attracted high quality developers to the Apple app store.

THEORY, FRAMEWORK AND LITERATURE

Actor Network Theory (ANT) is a lens to study social and technological worlds at the same time (Callon, 1986; Latour, 1996). A number of characteristics of ANT are relevant to this context. The networks are heterogeneous elements (Hanseth, Aanestad, & Berg, 2004) comprised of artifacts, organizations, or institutions. In this sense, technologies would be considered an element of the network, or an actant. These actants are considered 'equal' by the researcher, who treats all of them uniformly. In ANT related literature, social and technical elements are treated as a seamless web. In ANT, the researcher remains impartial "between actors engaged in controversy" (Callon, 1986). The artifacts are not passive, when analyzed under the lens of ANT. A number of reviews of ANT are available in literature, and cover more ground on theory and its application. Actor network theory has been introduced (Hanseth, et al., 2004), and used to study telecom products such as Personal Digital Assistants (PDA) (Allen, 2004) and new telecom standards in China (Gao, 2005).

This wide ranging theoretical lens covers (for example) phone companies, and their invented technologies or standards to be considered in the context of similar players in OS and carrier industry. The ANT elements are called actants, and include the traditional actors, as well as what are usually considered as passive artifacts in literature. The actants have some interests, or simply display some behaviors that are relevant to the network. Well researched actants in the telecom industry are devices (Allen, 2004) and standards (Gao, 2005).

Figure 1. ANT Framework



The framework is shown in Figure 1, with key actors shown in the ovals. Smart phone companies are at the center, with other actors or actants as the vertices. These are carriers, OS companies, and application developers. There are a number of relationships possible in the

network, which guide the application of ANT. Given the importance of OS in smart phone industry or 'ecosystem' this would be an important vertex. Application (or 'app' developers) and telecom carriers comprise the additional vertices in the model. Overall, the left vertex of the triangle is worthy of greater interest. With respect to Apple and RIM, which have their own operating system, the internal ecosystem of the company extends to include this vertex.

In the next section, we discuss the smart phone and OS companies.

KEY COMPANIES

Here we focus on the largest firms, as regards smart phones and OS. In the second quarter of the year, their shares were Samsung 21.6%, Nokia 19.9%, and Apple 6.9% in the overall mobile phone market of 419 million units (Grundberg, 2012). Smart phones continued to grow, while the overall market contracted slightly.

Nokia, characterized as the old leader, had overtaken Motorola, to reach pole position in the mobile phone market in 1998. Symbian was an operating system pioneered by Nokia, until Nokia started using Android, and then Windows. The weak financial performance of Nokia, which concurrent losses, has seen a shift to Microsoft, with the latest 'Lumia' range of phones based on Windows. Recent launches of Lumia phones were not received well, at least among shareholders (Rooney, Grundberg, & Jones, 2012). Nokia was overtaken by Samsung in the broader mobile phone market in early 2012.

Samsung is the leader in smart phones, and extended its lead over Apple as it sold twice the number in second quarter of 2012 (Zeman, 2012). While this was before the introduction of iPhone 5, Samsung Galaxy S III sold above expectations. This was also before the patent case in the US, which was won by Apple (Winkler, 2012). Samsung won a patent case in Japan (Bradshaw, Jung-a, & Soble, 2012). Apple is well known for its focus on the iPhone, the latest version of which was introduced in September 2012. Low sales for Apple in the lead up to iPhone 5 introduction have been blamed on the wait for a new model.

Google and Microsoft are the key operating system companies that underpin smart phone performance. Android from Google has a wide lead in OS market, and a decent sized app store has arisen over the years. Microsoft has a low share of market that is expected to improve when Nokia phones are introduced, equipped with Windows Phone 8.

DISCUSSION AND CONCLUSIONS

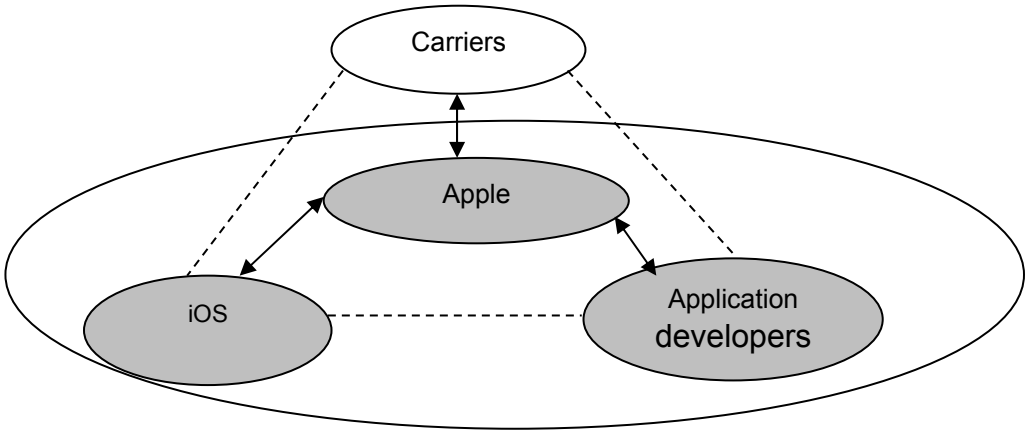
We discuss the links between smart phone and OS companies in this paper. The analyses suggest that Android, the current leader, and iOS, Apple's proprietary OS, are engaged in a proxy war. In spite of its win in the US, patent wars are likely to be drawn out, and across the world. It might involve smaller players such as HTC, and ultimately could involve Google. In preparation for such litigation, smart phone companies have developed or acquired war chests of

patents. These include patents of Motorola, which was acquired as a hedge against future patent action over Android (Winkler, 2011).

Apple controls its own actor network tightly, through iOS and the app store. We label this a 'focused' network, with tight control on hardware and software. iOS is important to this network, as well as Apple's early start with selling content online, such as iTunes. This combination of technology and content is nearly impossible to replicate, making the Apple network fairly unique. With reference to Figure 1, this leaves only carriers, as the 'open' element of network. In this respect, carriers are limited in their actions and responses to Apple. They have also become more open to Windows. As an example, Verizon intends to feature Windows Phone 8 in this holiday season later in the year (Feibus, 2012).

In this respect, patent wars reflect a move by Apple to clarify the weakness of rival networks represented by Android. As the leader among Android OS companies, Samsung represents a proxy and is believed to be a target for litigation by Apple (Karlgaard, 2012). It is notable that such patent related weaknesses are known to some extent, and have been subject to pre emptive action. For example, Samsung paid royalties on Android devices to Microsoft (Winkler, 2011). Google acquired Motorola at least in part for its patents. However, recent analyses show that Apple is ahead of many mobile phone companies in its acquisition of patent intellectual property, and has used it in litigation (Reuters, 2012). Analyzing the patent applications for last ten years, this report notes that in addition to smart phone, user interface, and camera, there are a number of 'less related' areas such as fuel cell system for a smart phone. The pace of patent application has accelerated since 2007, when Apple introduced the first iPhone.

Figure 2. Apple's Actor Network



In contrast, Samsung appears to depend more on alliances and scale. Its multiple alliance strategy is wide, and includes Android, Windows, and Bada. Figure 1 represents this wide

network, a type that has been well researched across different sectors. In this network, speed and range of alliances is important. Its speed is an advantage in setting up and executing these alliances. For example, Samsung launched Windows phones after the US patent case, even earlier than Nokia. In contrast, Nokia was unable to provide a release date and price at the time of launch of its latest Windows phones (Rooney, et al., 2012). Samsung has also promoted an operating system, Bada. In some ways, this strategy appears to be similar to Nokia's early efforts with Symbian. Its scale supports low cost for non smart phones made by Samsung. Samsung also appears to maintain relationships with a wide range of carriers. In emerging economies, it has leveraged its consumer electronics range to set up wide distribution. This 'wide'actor network calls for a different set of capabilities, again difficult to replicate in the short term.

CONTRIBUTIONS, LIMITATIONS, AND FUTURE RESEARCH

The study of different actor networks of Samsung and Apple, which we label as wide and focused respectively, are a contribution to research. Looking at reviews of ANT, the extant literature has not researched these differences in actor networks (Hanseth, et al., 2004). In our paper, we compare these networks within the same industry. This controls for inter industry variations. This study of 'types' of networks is a contribution to research and theory. Secondly, the study covers a new aspect of mobile phone industry that has not been studied in recent research (Fillion & Ekionea, 2010; Shin & White, 2012). Finally, these results suggest that actor network theory is a useful and interesting lens in the study of alliances. In addition to academic researchers, it can help practitioners to understand the structure of an industry.

There are several limitations, theoretical as well as empirical. *Our sources are limited to secondary data. In this respect, the actions of players are gleaned solely through secondary data, which is a key limitation. Given that a number of competitive actions reported in secondary data are strategic 'signals' and do not represent full fledged actions actually carried out, this would tend to distort our analyses.* We do not collect additional primary data. Path dependence (David, 1994) is an alternative lens to study this data. We focus on selected actors, as shown in the shaded area in Figure 1. This leaves out a key actant, service providers, such as Verizon. The recent influential roles of Google and Microsoft, which have also introduced their own hardware devices, is of concern to smart phone companies as convergence gains ground. The empirical limitations relate to data availability. The paper is based on secondary data, which is subject to bias and other errors in the coverage and reporting on the mobile phone industry.

These wide and focused networks are worthy of additional study. Additional research questions relate to why and how of such networks arising in different types of industries.

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DO WEB PRIVACY POLICIES STILL MATTER?

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ABSTRACT

Many studies have indicated that people are concerned with their privacy when conducting online transactions. Websites attempt to address these concerns via privacy policies. The original intent of this research was to compare strong versus weak privacy policies on an actual Website. However, we found that almost nobody actually clicks on the privacy policy link - even in cases where very sensitive personal data is requested. We conclude that the current approach to online privacy protection is inadequate and suggest future research directions for determining new methods.

INTRODUCTION

Dozens of studies dating back to 1990's (see for example Culnan, 1999) indicate that consumers are concerned about the privacy of their personal information online. Some of these studies show that a large percentage of consumers are so concerned about privacy that they are reluctant to shop online (Kolsaker & Payne, 2002; Suh & Han, 2003).

Over the last decade numerous researchers have examined the role of privacy policies on trust in the context of electronic commerce. However, a recent meta analysis by Belangar and Crossler (2011) reveals that this research has relied heavily on the use of student surveys.

The goal of this research was to use a real Website and actual potential customers to gauge the effectiveness of strong and weak privacy policies on Web site conversion rates. However, based on the data gathered the goal changed to understanding why Web site visitors almost never even click on privacy policies.

BACKGROUND

Privacy has long been identified as an antecedent to consumer trust in electronic commerce (Flavia and Guinaly, 2006; Park and Kim, 2003). The concept of privacy is multifaceted and includes such notions as Brandeis' famous "right to be let alone". In the context of online transactions privacy involves two major components. The first is the right to be informed about the collection of personal data. The second is a determination over who controls the data and its dissemination (Foxman and Kilcoyne, 1993; Culnan, 1995; Caudill and Murphy, 2000).

One simple method that many Websites use to increase trust is inclusion of a written privacy policy statement. These statements typically deal with the two privacy components by explicitly stating that certain personal data is being gathered (the collection component) and how that data will be controlled and used. Peterson, et. al. (2007) categorized privacy policy statements into "highly restrictive" and "less restrictive" categories. A "highly restrictive" statement would indicate that any personal data provided would be used only by the company collecting it and only for specific purposes. A "less restrictive" statement might indicate that the company intends to share personal data with other entities (e.g., business partners, other units within the company, etc.). Peterson, et. al. (2007) also identify a third category which they define as "no protection". In other words the Website merely indicates that it is gathering the data, but places no restrictions on dissemination.

Therefore we developed an initial hypothesis as follows.

H1 *Consumers are more likely to provide personal data on a Website with a "highly restrictive" privacy policy statement than one with "no protection".*

THE STUDY

The auto insurance industry was chosen to test the impact of privacy policies. This industry was selected since personal information is required in order to apply for auto insurance. The personal information includes the customer's basic contact information, social security number, place of employment, salary, and bankruptcy history. This is exactly the type of personal information that most people are wary about providing on a Web site.

We created a real Website, EZCarLoan4U.com (no longer active), and contracted with a company (Detroit Trading) that would pay for each auto insurance lead we provided. The site was a simple one-page form. Once a visitor completes the form, the data is transmitted to Detroit Trading (DT) and entered into their lead system. Auto insurance agents bid on the leads based on geographic location and credit background. Some leads are not sold. Those that are sold typically fetch from $1 - $15.

The site was setup with the typical privacy policy link at the bottom of the page. In addition, the following text appeared above the submit button, "By Clicking the submit button below I agree to the following terms: I have read and agree to the privacy policy and I authorize you to forward my application to a participating lender/auto dealer and I authorize you to check my credit report." Finally, a small privacy graphic, with a link to the privacy policy, appears to the left of the submit button. Thus, visitors had three opportunities to click on the privacy policy link. In addition, by clicking on the submit button they were affirming that that had actually read the policy.

Two different privacy policies were used. The first policy, which we designated as the "highly restrictive" one, was recommended by DT. It is a fairly standard policy and is used by dozens of other sites that also sell leads to DT. The heart of the policy reads as follows:

> *"Access to the information we obtain about you resulting from credit application submission is restricted to only those service providers who need to know that information for the purpose of purchasing an automobile, obtaining insurance or warranties, or obtaining credit.*
> *Other than as set forth above, we do not share personally identifiable information with other companies, apart from those acting as our agents in providing our product(s)/service(s), and which agree to use it only for that purpose and to keep the information secure and confidential."*

The other policy was written by us and was designated as the "no protection" one. The heart of that policy reads:

> *"We reserve the right to share personal information obtained about you with other companies or individuals. These other companies include, not only auto insurance providers, but other companies with whom we have a current or future business relationship. These other companies may access your Social Security Number, credit and employment history and may contact you directly.*
> *Due to our technology infrastructure, your personal information (including, but not limited to your social security number) may not be stored in a secure manner."*

The site was set to rotate between the strong and weak privacy policies each time a user clicked on the privacy link.

RESULTS

We used Google pay-per-click (PPC) ads, banner ads, and pop-under ads to drive traffic to the site. Google Analytics was installed on the site in order to track visitors and their onsite behavior.

In total 2,313 unique visitors accessed the site. Out of those visitors 269 completed the form and clicked on the submit button. According to our contact at DT, this conversion rate, 11.62%, is about average for this type of lead generation site.

Based on these statistics we would anticipate that a high number of visitors clicked on the privacy policy. After all, 269 visitors clicked on the submit button, which in theory means they should have read the privacy policy. In addition, we would expect that some visitors read the privacy policy without completing the form.

We were surprised to find that only 7 visitors clicked on the privacy policy links. Thus approximately 0.3% of visitors actually clicked on the privacy policy. It is clear that there is a major disconnect between the number of people who submitted their information and the number who clicked on the privacy policy. In fact, only one of the visitors who clicked on the privacy policy went on to complete and submit the form. That visitor saw the "highly restrictive" policy.

In order to determine if the above results were unique to the site or industry chosen, we analyzed data from an online retail site. The site sells women's intimate apparel. It requires customers to enter their name, address, phone number, and credit card data in order to make a purchase. During the time analyzed (a 6 month period) the site received a total of 178,207 unique visitors. Only 173 of those visitors clicked on the privacy policy link which appears on the bottom on every page on the site. Thus the click through rate for the privacy policy was less than 0.1%, which is in line with the previous case.

LIMITATIONS

Clearly, a major limitation of this study is that it used only two Web sites. However, the first site requires visitors to enter extremely personal information, such as Social Security Number, employment history, and annual salary. The second site requires customers to enter credit card information.

CONCLUSIONS AND FUTURE DIRECTIONS

This research shows that Web privacy policies are not clicked on - even in situations where highly private information is gathered. There are a number of possible reasons for this phenomenon. First, a number of studies have suggested that the typical privacy policy is written for a very high (college or above) reading level (Graber, et. al., 2002). Second, Acquisti and Grossklags (2005) suggest that not reading might be a rational behavior given the time required to read and understand the typical privacy policy. While the privacy policies used in this study were deliberately written to a sixth grade reading level and kept fairly short, Web users have come to expect obtuse privacy policies written in complex legalese and therefore do not even bother to click the link.

This study did not examine the reasons why users did not click on the privacy link., . Do visitors assume that the privacy policy exists and is reasonable? How might site visitors react to a site that contains no privacy policy at all? Would visitors even notice this omission? These questions require further investigation.

Clearly the disconnect between users' stated privacy concerns and their willingness to read privacy policies requires a new approach to informing users about the privacy practices of the Websites they visit.

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REVISITING SOFTWARE PIRACY USING GLOBE CULTURAL PRACTICES

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ABSTRACT

Software piracy is a pervasive phenomenon that began to be noticed in the 80s. Statistics from the Business Software alliance (BSA) indicate that the software piracy rate is approximately 42% worldwide and represents potential losses in sales revenue of up to US$60 billion. Earlier studies addressed software piracy utilizing economic wealth and culture factors to understand the phenomena. In terms of culture, previous research have used Hofstede's operationalization of cultural values. This study differentiates by using the GLOBE's project operationalization of cultural practices to revisit the software piracy issue. As a result we gathered secondary data on cultural practices, income per capita, and software piracy rate to analyze the software piracy phenomenon. The outcomes of this this research contribute to the literature by confirming previous findings about the positive relationship of collectivism with software piracy and the negative relationship with income, as measured by GDP per capita. Moreover, this research finds that performance orientation practices, as operationalized by GLOBE, have a negative relationship with software piracy rate. Such finding has not been mentioned in the extant literature of software piracy, to the best of our knowledge.

Key words: *Software Piracy, Cultural Practices (GLOBE), Performance Orientation Practices, Intellectual Property, Multiple Regression Analysis*

INTRODUCTION

Software piracy is a pervasive phenomenon that began to receive attention in the 80s (Cook, 1984; Cooper, 1984; Graham, 1984; Morgan & Ruskell, 1987). A basic definition of piracy portrays it as "the unauthorized use of another's production, invention, or conception especially in infringement of a copyright "(Merriam Webster, 2012). In the information systems (IS) literature software piracy has been defined as "any illegal software copying activity" (Peace, Galletta, & Thong, 2003), or the unauthorized duplication, distribution (Moores & Dhillon, 2000), and downloading of computer software and applications (Nill & Shultz, 2009).

Recent statistics underscore the importance of the software industry as an important sector of the United States economy. It is estimated that in 2011, the software industry added more than US$ 150 billion in revenue to the US economy (First Research, 2014). Moreover, the

US software industry controls about 43% of the global sales (Marketline, 2012). Nevertheless, despite the suggested positive context, Business Software Alliance (BSA) exposes that not all is good news. For instance, this organization claims that for the year of 2011 software piracy increased by 7.8% (BSA, 2012). In addition, the same report presents that the global piracy rate is 42% and estimates that loses for software developers extend to US$60 billion, worldwide, for the year of 2011 (BSA, 2012). Hence, given the suggested level of piracy rate we think it is important to continue studying this phenomenon.

In the early 2000s, researchers began to empirically uncover the role that culture has in understanding the phenomena of software piracy at the national level (Husted, 2000; Marron & Steel, 2000). Both studies relied on Hofstede's (1983) cultural value measures to analyze software piracy. Hofstede's cultural dimensions were obtained from data collected at different subsidiaries of US-corporation IBM across the globe during the late 60s (Javidan, House, Dorfman, Hanges, & De Luque, 2006). Hofstede's effort became a highly utilized way to understand and measure culture (House, Hanges, Javidan, Dorfman, & Gupta, 2004). However, it has been criticized (Javidan, House, et al., 2006; McSweeney, 2002; Schwartz, 1994). Some say that the instrument used was biased on the needs of IBM and developed with no theoretical support (Javidan, House, et al., 2006). Others suggest that because only one organization from a hi-tech sector was used, it is plausible to think that respondents' education level was biased, especially in the context of developing countries (Schwartz, 1994). In addition, some researchers indicate that Hofstede's dimensions confuse cultural values (what ought to be) and behavior (actual practices) (Terlutter, Diehl, & Mueller, 2006).

The culture literature has different instruments proposed to measure culture. One of these instruments came through the Global Leadership and Organizational Behavior Effectiveness (GLOBE) program (House et al., 2004). This project resulted from the collaboration of more than 160 researchers from different parts of the world (Javidan, House, et al., 2006). The effort focused on developing an instrument elaborated with theory while using modern statistical techniques with the aim of having a valid and reliable instrument (House et al., 2004). Also, the instrument divided the measure of culture into practices and values since the researchers aimed to test if values indeed drive cultural practices and because it is argued that it is practices that actually drive social phenomena (Javidan, House, et al., 2006).

Hence, given the alleged weaknesses of Hofstede's instrument and the claim that cultural practices are better measured with GLOBE, we address a gap in the literature since we know of no other study that uses GLOBE measurements to assess the impact of culture practices on software piracy. As a result, we replicate previous studies (Husted, 2000) that addressed software piracy at the national level using GLOBE (House et al., 2004) cultural practices instead of Hofstede's cultural values. For this reason we address the following research questions:

1. Are cultural practices, as measured by GLOBE, correlated with software piracy rates at the national level?

2. What of the dimensions of GLOBE cultural values affect software piracy rates at the national level?
3. Controlling for GLOBE cultural practices, does GDP per capita correlates with software piracy rate at the national level?

We contribute to the literature by reviewing how cultural practices, as measured by GLOBE, are related to the phenomenon of software piracy. Also, we explore other dimensions of GLOBE cultural practices that may be associated to software piracy.

LITERATURE REVIEW

Software piracy has been a subject study at the individual, organizational, and national level. At the national level, researchers have used different aspects such as socio-economic, institutional factors, and cultural factors to address the problem (Husted, 2000; Moores, 2003; Moores & Dhillon, 2000; Peace et al., 2003). Nations that are host to software developers emphasize the detrimental impact that software piracy has on innovation (Husted, 2000). On the other hand there are nations that do not seem to adopt effective practices to control software piracy which may be part of an attitude to allow its society to have access to technology (Marquez Escobar, 2005; Marron & Steel, 2000). Thus, the problem of software piracy may be more about a societal's valorization of intellectual property rights (Yang & Sonmez, 2007). Yet, software developers need national governments to protect their software creation to pay for the development, marketing, and distribution of the software goods (Husted, 2000; Yang & Sonmez, 2007).

Previous studies, have suggested that economic and national cultural factors may have an important effects in the software piracy rate (SPR) (Hamister & Braunscheidel, 2013; Husted, 2000; Marron & Steel, 2000; Moores, 2008; Moores & Dhillon, 2000). Some researchers underscore the pattern showing high income countries having lower software piracy rates while low income countries showing the contrary (Husted, 2000; Marron & Steel, 2000). In both cases they point out the role that economic development plays in the availability of strong institutions that enforce intellectual property rights (Husted, 2000; Marron & Steel, 2000). On the other hand some researchers have explored the role of culture using the operationalization developed by Hofstede (Hamister & Braunscheidel, 2013; Husted, 2000; Lovett, Simmons, & Raja, 1999; Moores, 2003, 2008; Shin, Gopal, Sanders, & Whinston, 2004).

Hofstede's seminal work opened the door for a deeper understanding of national cultures (House et al., 2004). It can be said that this work has been the most used framework use when studying national culture. However, as presented in the introduction of this paper there are concerns about the reliability and validity of Hofstede cultural dimensions (House et al., 2004). For this reason, the researchers of the GLOBE program developed an instrument to address some of the weaknesses of Hofstede's model. GLOBE researchers argue that because their study is

based in theory, designed to be culturally decentered, with sound validation methodology, and with a sample that included a variety of organization, GLOBE should be a more robust framework to analyze culture (Javidan, House, et al., 2006).

The GLOBE project adopts a definition for culture that portrays it as the "shared motives, values, beliefs, identities, and interpretations of meanings of significant events that result from common experiences of members of collectives that are transmitted across generations" (House & Javidan, 2004, p. 15). GLOBE researchers indicate that culture is manifested in common agreements and common reported practices among members of a society (House & Javidan, 2004). In GLOBE's operationalization of the culture construct common values and common practices are measured at the societal level. The rationale is that culture may manifest not only through values but also in beliefs, norms, and behavioral patterns (Javidan, House, et al., 2006; Leung, Bhagat, Buchan, Erez, & Gibson, 2005). Thus, instead of assuming that by knowing the values of the culture you may anticipate the practices, the GLOBE project decided not follow such assumption and divided the measurement of culture in values and practices (Javidan, House, et al., 2006). The GLOBE project "studies culture in terms of their cultural practices (the ways things are) and their cultural values (the way things should be (Javidan, Dorfman, De Luque, & House, 2006, p. 69). Also, it is argued that cultural practices as reported by surveyed subjects "are predictive of social phenomena" (Javidan, House, et al., 2006, p. 903) whereas "cultural values and not practices are associated with reported attributes of outstanding leadership across GLOBE countries" (Javidan, House, et al., 2006).

The GLOBE project measurement includes nine cultural dimensions covering 62 societies across the globe (House et al., 2004). These dimensions are uncertainty avoidance, power distance, institutional collectivism, in-group collectivism, gender egalitarianism, assertiveness, future orientation, performance orientation and humane orientation (House & Javidan, 2004). The GLOBE team indicates that the first six dimensions were derived, in part, from Hofstede's work (House, Javidan, Hanges, & Dorfman, 2002). In addition, Hofstede points out the similarity of GLOBE's future orientation dimension with the long term orientation of his culture framework (Hofstede, 2006).

The work of the GLOBE program is not immune to criticism. Some researchers question this cultural measure on the basis of the complexity of its items (questions), use of isomorphic scales, excessive number of cultural dimensions, and failing to load into suggested number of factors (Hofstede, 2006). However, GLOBE researchers argue that their methodology to measure culture incorporated greater scholarly rigor. They note that the GLOBE project included 62 societal cultures, used theory to develop its formulation of survey items, performed the surveys in different types of organizations, and included more than 160 researchers in the project (House et al., 2004). Hence, we see an opportunity to extend the literature of software piracy and culture by testing the cultural practices measures provided by the GLOBE measurement in the context of software piracy at the national level.

HYPOTHESIS DEVELOPMENT

Researchers have examined the *economic wealth* of countries as a factor researched to understand the phenomena of software piracy. Usually when making comparisons of wealth across countries, a measure that accounts for wealth per capita or per household is required (FED, 2000). Gross domestic product (GDP) measures the monetary worth of the final goods and services produced in a country in given period of time (Callen, 2012). Researchers of the software piracy phenomena have noted the influence that personal wealth has over the disposition to buy or pirate software (Moores, 2003; Shin et al., 2004). Previous research underscores how in high income countries software piracy tends to be lower and in low income countries, higher (Husted, 2000; Moores, 2008; Shin et al., 2004). Yet, regardless of the national income, software companies usually charge the same price across countries (Moores, 2008). Hence, what can be affordable for a person living at a country with high income will not necessarily be affordable for a person living at a nation with a low income (Moores, 2008). Moreover, researchers have highlighted that the institutional protection of intellectual property rights tends to be weaker in low income economies when compared with high income countries (Marron & Steel, 2000). Thus, given that GDP per capita gives us an approximate idea of the wealth of citizens of a nation we hypothesize:

H1 *Countries that reflect a larger degree of economic wealth, as measured by the GDP per capita, will tend to have a lower degree of software piracy*

Uncertainty avoidance "refers to the extent to which members of collectives seek orderliness, consistency, structure, formalized procedures, and laws to cover situations in their daily lives" (De Luque & Javidan, 2004, p. 603). Likewise, Hofstede (1997) indicates that uncertainty avoidance measures the degree that an individual perceives to be threatened by uncertainty or unknown circumstances. Hence, given our research scope of testing societal practices we consider De Luque and Javidan's (2004) definition to be more in line to reflect what uncertainty avoidance practices are rather than what is valued in society.

Researchers indicate that uncertainty may be avoided by developing a dependence on mechanisms such as social norms, rites, religion, bureaucracy, law, and technology (Hofstede, 2001; House & Javidan, 2004). Further, societies that practice high uncertainty avoidance tend to be successful in the domain of sciences (De Luque & Javidan, 2004) and have governments that establish policies that protect the development of science. Consequently, in such environment it is plausible that stronger intellectual property rights of software are enforced. Hence we hypothesize:

H2 *Countries with high uncertainty avoidance practices, in the GLOBE score, will tend to have lower piracy rates*

Power distance is the tolerance that society members have to accept that power can be condensed on the hands of higher hierarchy members of the organization or the government (House & Javidan, 2004). Empirically, the GLOBE study found that societies with high score in power distance practice have members who have a preference for distributed power whereas societies with low scores presented a preference for less equally distributed power (Carl, Gupta, & Javidan, 2004). Also, the GLOBE study finds that societies that practice high power distance have low success in the development of science and lower government support to facilitate the success of business organizations (Carl et al., 2004). Under such environment powerful members of society actively engage towards retaining their level of influence regardless of how they can affect the societal institutions (Vebelen as cited in Carl et al., 2004). Researchers have suggested that countries that have strong institutions facilitate the protection of intellectual property and tend to have lower rates of software piracy (Marron & Steel, 2000). However, as implied, it may be plausible that in high power distance societies there will be high powered individuals that will undermine the support of the government if it means giving away its influence. That may translate into weaker institutions that will not enforce the protection against piracy. For this reason we hypothesize

H3 *Countries that practice high power distance will tend to have a higher incidence of software piracy rate*

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Collectivism focuses in the nature of the relationship between individuals and groups at the societal or organizational level (Gelfand, Bhawuk, Nishii, & Bechtold, 2004). In the GLOBE study the dimension of collectivism and its opposite of individualism were divided into two components: institutional collectivism and in-group collectivism because researchers see it as a multidimensional construct (Gelfand et al., 2004).

Institutional collectivism measures the degree to which society and organizations promote and reward (in practice and values) collective distribution of resources and collective engagement (House & Javidan, 2004). In the GLOBE study it was found that high scoring cultures of institutional collective practice focus on the future and on performing using the collective effort as the mean to achieve their objectives while exerting low power distance and assertiveness (Gelfand et al., 2004). Hence, the globe project found an empirical correlation between practices of institutional collectivism and institutions that are supportive of the business environment and sciences (Gelfand et al., 2004). It is plausible to think that as countries score higher in this dimension they will have better affinity to protect intellectual property rights and consequently less software piracy will take place. For this reason we hypothesize:

H4 *The more that countries practice institutional collectivism the less that software piracy will take place*

In-group collectivism measures the degree of association between individuals and small groups such as the family and organizations in the form of pride, loyalty, or interrelation (House & Javidan, 2004). Societies with high score of in-group collectivism practice emphasize close ties with family members and other persons from the collective and respect for hierarchy. Yet these societies develop an environment with fewer rules and procedures (Gelfand et al., 2004) and have no problem to ignore them if that means helping a member of the in-group (Seleim & Bontis, 2009). Empirical findings from the GLOBE project indicate that countries that score high in in-group collectivism show a lower government support for business practices and lower support for the development of science (Gelfand et al., 2004). For this reason it is plausible to think that the emphasis of in-group collectivistic cultures on supporting its in-group members may turn into lower support for the protection of intellectual property rights such as the one that protect software piracy because the in-group collectivism is the priority. For this reason we hypothesize:

H5 *The greater the practice of in-group collectivism in a society the more that software piracy will take place.*

Assertiveness is the level of bold self-confidence, toughness, confrontation, aggressiveness, and competitiveness that will be found in society members (in practice and values) in their relationships with others (House & Javidan, 2004; Javidan & House, 2001). This particular dimension was derived from Hofstede's masculinity dimension that was deemed to have two components, namely, assertiveness and gender egalitarianism (House & Javidan, 2004). Societies that value assertiveness are sympathetic to competitive and strong members (Javidan & House, 2001). De Hartog (2004) suggests that societies with higher assertiveness scores will value dominant behavior, control over nature, and will act opportunistically over others. In such situations the opportunistic behavior may have bigger rewards that the cost incurred (De Hartog, 2004). Hence, given the previous rational we hypothesize:

H6 *The greater the practice assertiveness in a society the more that software piracy will take place.*

Future orientation measures the degree that a society focus in the future through planning, investing in the future, and the delaying of immediate gratification (House & Javidan, 2004). Societies that practice high future orientation practices tend to focus on developing a strong institutional environment that protects and enforces intellectual property rights (North, 1990). Such environment may influence society members to execute future oriented investments (North, 1990). Empirically, the GLOBE program found that societies scoring high on future orientation focus highly in avoiding uncertainty. Such avoidance is associated with governments that actively promote and protect technology as a form of science (De Luque & Javidan, 2004). Hence we hypothesize:

H7 *The greater the practice future orientation in a society the less that software piracy will take place.*

Performance orientation is the tendency that societies have to promote and reward society members for devising performance improvement and striving for excellence (House & Javidan, 2004). Performance oriented cultures foster the development of an environment that encourages achievement of goals and tasks (Javidan, 2004). Empirically, the GLOBE project found that societies with more performance oriented practices are associated with more government support for prosperity of business (Javidan, 2004). Such finding has been linked to better protection of intellectual property rights (North, 1990) which in turn are suggested to be associated with the growth and diffusion of technological markets (Khan & Sokoloff, 2001). Consequently we hypothesize:

H8 *Performance oriented societies will tend to have lower levels of software piracy rate.*

Humane Orientation is related to societies that promote and reward fairness, altruism, friendliness, kindness, generosity, and caring for others (House & Javidan, 2004). This culture measure shares similarities with Hofstede's feminine side of its *masculinity versus femininity* (MAS) dimension (Kabasakal & Bodur, 2004; Parboteeah, Bronson, & Cullen, 2005). Members of cultures that score low in Hofstede masculinity index are considered to be high in humane orientation (Kabasakal & Bodur, 2004). Hence, societies with high humane orientation emphasize that their members should be supportive of family, friends, and strangers. Thus, it is plausible that in these cultures the emphasis to care for others can be more important than the specific interest of guarding the intellectual property associated to software, for this reason we hypothesize:

H9 *Humane oriented societies will tend to have higher levels of software piracy.*

Although the GLOBE study has nine cultural practices defined, we did not proposed one for gender egalitarianism. *Gender egalitarianism* was derived from previous work of Hofstede cultural dimensions and it is defined as the extent to which societies focus on diminishing gender inequality (House & Javidan, 2004). Empirical findings of the GLOBE program do not show a significant impact of egalitarian practices supporting the business environment or sciences (Emrich, Denmark, & Den Hartog, 2004). Hence, we did not see the connection between this dimension and the environment in terms of promoting business success or innovation. Consequently, we infer that this dimension does not have an impact over the protection of software as a form of intellectual property. For this reason, we did not proposed a hypothesis for this dimension.

METHODS AND ANALYSIS OF DATA

For testing the effects of cultural practices on software piracy (dependent variable) as measured by GLOBE, we will use ordinary least squares. In addition, we will utilize cross-sectional data originating in different sources for the estimation of our model. Software piracy rate will be obtained from BSA 2012 report which is based on numbers reported for the year of 2011 (BSA, 2012). The rate is calculated by dividing the number of unlicensed software units over the total software units installed in personal computers. BSA uses research firms IDC and IPSOS Public Affairs to gather data and collaborate in the publication of this calculation (BSA, 2012)

For cultural practices and the nine dimensions used in this study we used the report of culture practices presented by the GLOBE study (House et al., 2004). The report represents culture measures collected from 17,000 managers from 951 organization from 62 societies representing 58 nations across the world (House, 2004). Such large project was conceived in 1991, initially funded in 1993, conducted by 160 social scientists, and went through the data collection phase of GLOBE from 1995 through 1997(Gupta, Sully De Luque, & House, 2004; House & Javidan, 2004). The GLOBE instrument was composed by more than 700 questionnaire items, developed after a survey of the literature in culture research and went through two refining pilot stages and the final collection of the data.

We matched the GLOBE culture results and the software piracy rates. Overall, we found an intersecting set of 42 countries, which is now our sample size (n=42). Table A.1 in appendix A contains the details. Additionally, we are also testing the effect of national wealth in terms of gross domestic product per capita (GDP/capita) which we obtained from data downloaded from the International Monetary Fund database (IMF, 2013). Hence, we used GDP per capita statistics for the year of 2011 to be consistent with the collection year of data of the BSA report utilized for this study. We were able to match each of the countries and completed the data set for this study. Consequently, our sample size remained at 42 observations (table A.1).

Table 1: Descriptive statistics

stats	N	mean	skewness	kurtosis	se(mean)	max	min	sd
SPR	42.00	57.88	-0.34	2.13	3.14	92.00	19.00	20.35
Astv_P	42.00	4.10	0.02	2.00	0.05	4.72	3.47	0.33
InsC_P	42.00	4.25	0.71	3.29	0.06	5.23	3.63	0.38
InGC_P	42.00	5.37	-1.28	4.80	0.09	6.37	3.58	0.56
FOrt_P	42.00	3.73	0.63	3.49	0.06	4.88	3.06	0.39
HOrt_P	42.00	4.18	0.06	2.49	0.06	5.12	3.29	0.42
POrt_P	42.00	4.07	0.26	2.47	0.06	4.86	3.41	0.36
PDis_P	42.00	5.17	0.19	3.20	0.05	6.14	4.44	0.35
UAvo_P	42.00	3.96	0.61	3.36	0.07	5.16	3.09	0.44
GDP_C	42.00	20,151.00	1.94	7.69	3,053.07	100,375.00	523.97	19,786.13
Log_GDP_C	42.00	9.45	-0.55	3.54	0.16	11.52	6.26	1.06

We proceeded to analyze the data. First we conducted descriptive statistics (table 1). Our results indicate that software piracy rate at the national level has a mean of 57.88, small skewness, moderate kurtosis, and standard deviation of 20.35 for the sample. Also, the average GDP per capita is of US$ 20,151, positively skewed, and with a rather large value for kurtosis. The cultural practice scores present small skewness with the exception of in-group collectivism (InGC_P) which is also the cultural practice with the largest peak. After this initial analysis of the descriptive statistics we conducted a Shapiro-Wilks procedure to test the normality assumption of each of the variables (Field, 2009). Table A.2, in appendix A, contains the results. Shapiro-Wilks testing indicates that in-group collectivism and GDP per capita fail to meet the normality assumption. With the identification of two variables that do not meet the normality test, we proceeded to perform transformation procedures.

GDP per capita was transformed using the natural log and after that it met the normality assumption as can be demonstrated on table A.3 (appendix A). However, for the in-group collectivism neither natural log, inverse, square nor square root could bring this variable under normality. A box plot analysis of this variable indicates that we have four outliers in this variable (figure A.1, appendix A). Three of the outliers belong to Anglo cultures having low in-group collectivism scores (New Zealand, Canada, and the USA). The other outlier is Morocco which scored high in in-group collectivism. However, given that we are exploring GLOBE cultural practices in the context of national software piracy and that collectivism has been suggested in previous studies to have an effect over our dependent variable (Husted, 2000), we decided to keep it for further analysis.

The next step was to calculate the correlations among variables. We found that five of the eight hypothesized cultural practices have a significant correlation with SPR and in the expected direction as hypothesized. However, two of the cultural dimensions, assertiveness (Astv_P) and power distance (PDist_P) practices did not show significant relations with SPR. On the other hand, GDP per capita, as expected, has a significant and strong negative correlation with software piracy rate.

Table 2: Correlations

Variable	SPR	Astv_P	InsC_P	InGC_P	FOrt_P	HOrt_P	POrt_P	PDis_P	UAvo_P	Log_GDP_C
SPR	1.00									
Astv_P	-0.09	1.00								
InsC_P	*-0.43	-0.26	1.00							
InGC_P	*0.66	0.00	-0.24	1.00						
FOrt_P	*-0.46	0.13	*0.43	-0.33	1.00					
HOrt_P	0.27	*-0.38	0.21	0.01	0.02	1.00				
POrt_P	*-0.49	-0.05	*0.52	-0.34	*0.57	0.07	1.00			
PDist_P	0.21	0.18	-0.17	*0.40	-0.36	-0.08	-0.31	1.00		
UAvo_P	*-0.39	-0.11	*0.47	*-0.40	*0.65	0.18	*0.74	*-0.41	1.00	
Log_GDP_C	*-0.73	0.08	0.35	*-0.46	0.25	-0.29	0.20	-0.23	0.25	1.00

* significant at least at $p < .05$

We also checked for correlations greater than 0.90 that may suggest that we have very high collinearity between or among variables of our sample. The largest correlation in our sample is r=0.74 and it occurs between uncertainty avoidance (UAvo_P) practices and performance orientation (Port_P). Such value does not suggest that we have a collinearity issue among or between the variables. However, we will revisit collinearity again after we perform the OLS estimation.

Table 3: OLS estimations

Variable	Est. 1	Est. 2	Est. 3	Est. 4	Est. 5	Est. 6	Est. 7
Astv P	2.31						
InsC P	-3.06	-3.76					
InGC P	***14.25	***14.20	***14.00	***13.75	**12.39	**12.71	**11.73
FOrt P	-10.52	-9.73	-10.35	-10.94	-9.96		
HOrt P	6.62	6.19	5.19				
POrt P	*-17.91	*-17.74	**-19.23	**-19.91	**-20.22	**-22.26	**-15.24
PDist P	-8.31	-7.77	-8.15	-8.52			
UAvo P	9.37	9.08	9.05	10.9	*12.61	8.46	
Log GDP C	***-9.05	***-8.98	***-9.49	***-10.27	***-10.19	***-10.45	***-10.28
cons	**160.70	***169.27	**173.86	***203.77	***157.18	***145.42	***154.01
r2 a	0.74	0.75	0.75	0.75	0.74	0.72	0.72
rmse	10.3	10.17	10.08	10.16	10.39	10.69	10.84
df	32	33	34	35	36	37	38
F-stat	14.24	16.42	19	21.57	24.24	27.92	35.51
B.-Pagan p > chi	0.18	0.21	0.24	0.23	0.18	0.23	0.34

* p<0.05; ** p<0.01; *** p<0.001

We continued by running our 42 observations and 9 regressors into an OLS estimation using Stata I/C 13.1. We ran estimation #1 with all the hypothesized regressors. For the first estimation our results indicate that two cultural practices in-group collectivism and performance orientation (InGC_P, POrt_P) have a significant effect. After the first OLS estimation, we proceeded to run six additional estimations. Each time, we dropped a non-significant regressor which additionally had to be the one with the least significance (see Appendix B). We stopped at estimation 7 when we ended up with the same regressors that were significant in in estimation 1 (InGC_p, POrt_p). At each step, we tested for heteroskedasticty with the Breusch-Pagan test (Wooldridge, 2009). We did not find heteroskedasticty to be a problem for any of the estimations. For estimation # 7, we conducted both the Breusch-Pagan test and a histogram of the residual frequencies (Field, 2009; Wooldridge, 2009). Both tests suggest that the residuals are normally distributed and there should not be concerns that heteroskedasticty affects the t-statistics that will be used to test the regressors. Additionally, the F statistic was run to test if the combined effect of the regressors was significant. For all estimates the F-statistic was significant.

Consequently, estimation # 7 is significant with $F(4,37)=27.92$ and $p<.001$. It accounts for 72% of the variance according to the adjusted R^2. For the culture practice variables, this estimation portrays a positive and significant relationship ($p<.01$) between the *performance orientation* and *SPR* and a negative and significant relationship ($p<.01$) between *in-group*

collectivism and *SPR*. Both of these relations resulted significant and with the direction previously hypothesized. Additionally, the logarithm of GDP per capita was significant ($p<.001$) as hypothesized, as well. We tested for collinearity running a variance inflation factors test and no VIF was larger than 1.38 (see table B.9 in appendix B). Hence, as per estimation # 7 the estimate for software piracy rate in our sample data is:

$$SPR = 154.01 + 11.73InGC\_P - 15.24POrt\_P - 10.28Log(GDP\_C)$$

(Details about the OLS estimation are available in appendix B).

DISCUSSION

The results from our study indicate that two cultural practices, namely in-group collectivism and performance orientation, have an impact over the rate of software piracy in our sample of 42 nations. This indicates that cultural practices do have an impact with software piracy. The finding implies that there is an effect of cultural practices in software piracy rate. Such effect goes in line with the suggestion that culture practice is an important factor that impacts social phenomena (House et al., 2004). It also confirms previous software piracy studies that found culture to be a factor to consider when studying software piracy at the national level (Husted, 2000; Moores, 2003, 2008).

Table 4: Summary of findings

#	Hypothesis	Relation	Finding	Comment
1	Log(GDP_C) --> SPR	positive	significant	supported
2	UAvo_P --> SPR	negative	not significant	not supported
3	PDist_P --> SPR	positive	not significant	not supported
4	InsC_P --> SPR	negative	not significant	not supported
5	InGC_P --> SPR	positive	significant	supported
6	Astv_P --> SPR	positive	not significant	not supported
7	FOrt_P --> SPR	negative	not significant	not supported
8	POrt --> SPR	negative	significant	supported
9	HOrt --> SPR	positive	not significant	not supported

Our second research question addressed specific dimensions of culture practices. Our findings indicated that culture practices, as conceived in GLOBE, have an effect over software piracy. *In-group* collectivism and *performance orientation* were the two cultural practices that emerged as significant in our researched sample.

It is interesting to encounter that not all forms of collectivism have an impact on software piracy. Particularly for this study *institutional collectivism* as defined by GLOBE focuses in collective actions of the society aimed to reduce uncertainty or avoid it. The coefficient for institutional collectivism resulted with the sign we anticipated but it was never close to being significant.

A possible explanation for this finding is that since this type of collectivism measures collective actions of institutions within a nation, that citizens do not see the acquisition of software as something that plays a role on reducing uncertainty and as such that it does not require the collective actions of national institutions.

On the other hand, the GLOBE instrument confirms that in-group collectivistic measures, that focus more at the perceptions of the individual and its family or close circle, were found to have a significant impact in software piracy rate. This finding supports previous research of software piracy using Hofstede's *individualism versus collectivism* (IDV) scale. Further, our results are not necessarily improving the findings of software piracy research using Hofstede's IDV. For instance, in Husted (2000) GDP per capita, GINI index and IDV were found to be significant and accounting for 83% of the variance in a sample of 39 countries.

However, our finding that *performance orientation* has a negative relationship with software piracy contributes an aspect that, to the best of our knowledge has not been mentioned in the extant literature. In cultures with high performance orientation, societies look to reward citizens for the high performance and search of excellence (Javidan, 2004). In these societies, governments establish policies to support businesses and to protect intellectual rights (North, 1990). It is plausible that although there might be opportunity to acquire software without proper licensing, the citizens of these high performance societies do not see this as something acceptable because it goes against the practice of rewarding the innovator. Also, it may be the result of more enforcement of intellectual property rights. Nevertheless, we did not test individual level perceptions of punitive actions or the strength of law enforcement because that is beyond the scope of this study. Yet, finding this significant relationship should open additional debate about the dimensions of culture that influence software piracy activities.

Our last research question addressed the effect of GDP per capita in software piracy rate. As previous research has found, GDP per capita does have an effect. The more income the less software piracy. The less income, the more software piracy. Indeed, with our sample data, GDP per capita alone explained 54% of the variance of the dependent variable with a significance $F(1,40) = 47.61$ (table B.8, appendix B). This would suggest income to be the most important factor accounting for the SPR. Previous research has hinted to the burden that having a single pricing policy for software may have across all countries (Moores, 2008) or cost being an important factor to decide whether or not to commit software piracy (Peace et al., 2003; Shin et al., 2004).

Finally, this model explained about 73% of the variance. Previously, similar studies using cultural dimensions explained 63% (Shin et al., 2004) and 83% (Husted, 2000) of the variance, Nevertheless, the variance explained by our study is in the range of similar studies, suggesting the plausibility of the overall estimation and providing further support for previous findings.

LIMITATIONS AND IMPLICATIONS

Our research certainly has limitations. For instance, we have used arguments about the importance of institutional support to facilitate an environment that promotes technology and businesses through the protection of intellectual property rights. In our proposed model we have not controlled for the strength of national policies or strength of institutions. Consequently, some of the effects that we have found could be affected with the proposed additional controls.

Moreover, the statistics that we use from the BSA have been criticized because the methodology could overestimate the rate of software piracy (Cukier & Roberts, 2012). However, it is also possible that such statistics underestimate the rate of software piracy as well (MacDonald & Fougere, 2002).

The study of software piracy research is a topic that will get renewed attention in the years to come. With the emergence of cloud computing some argue that piracy will be better controlled and dampen to an insignificant figure (Barret, 2011) others think that the phenomena will evolve (Holleyman, 2012). Hence, understanding the factors that exacerbate or improve SPR are important for software developers and national governments alike.

In summary, this study has contributed to the literature by confirming through the use of GLOBE cultural practices and national GDP per capita that culture and income appear to be important factors when researching software piracy. Findings about culture from previous research and the this study could move software producers to think of alternative modes of distributing software that consider the collective licensing of software to families for instance; at an improved cost that is sensitive to the purchasing power of the economy where it is being offered or needed. Otherwise if practices of the same strategies of intellectual property rights continue, there may not be changes ahead on regards to the software piracy rate phenomena.

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Appendix A

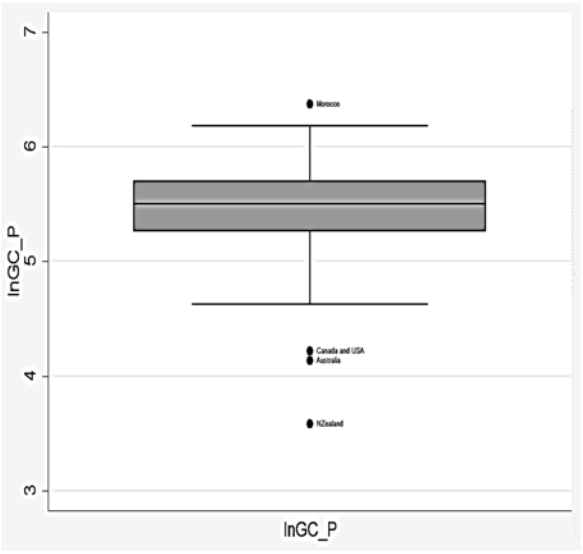
Table A.1
Source Data

#	Countries	SPR	Asstv_P	Ins_Collc_P	Grp_Collc_P	FOR_P	HOr_P	POr_P	PDist_P	UAVO_P	GDP_CAP_PPP	Log(GDP_C)
1	Albania	0.75	4.57	4.28	5.51	3.69	4.40	4.57	4.44	4.45	7,774.20	8.96
2	Argentina	0.69	4.18	3.66	5.51	3.10	3.94	3.63	5.56	3.63	17,476.60	9.77
3	Australia	0.23	4.29	4.31	4.14	4.09	4.32	4.37	4.81	4.40	40,470.04	10.61
4	Bolivia	0.79	3.78	3.96	5.44	3.55	3.99	3.57	4.46	3.32	4,800.37	8.48
5	Brazil	0.53	4.25	3.94	5.16	3.90	3.76	4.11	5.24	3.74	11,545.07	9.35
6	Canada	0.27	4.09	4.36	4.22	4.40	4.51	4.46	4.85	4.54	41,351.06	10.63
7	China	0.77	3.77	4.67	5.86	3.68	4.29	4.37	5.02	4.81	8,304.53	9.02
8	Colombia	0.53	4.16	3.84	5.59	3.35	3.72	3.93	5.37	3.62	10,207.90	9.23
9	Costa Rica	0.58	3.83	3.95	5.26	3.64	4.38	4.10	4.70	3.84	11,861.36	9.38
10	Ecuador	0.68	3.98	3.82	5.55	3.66	4.45	4.06	5.29	3.63	9,693.15	9.18
11	Egypt	0.86	3.91	4.36	5.49	3.80	4.60	4.15	4.76	3.97	6,387.91	8.76
12	El Salvador	0.80	4.49	3.74	5.22	3.73	3.69	3.72	5.56	3.69	7,099.29	8.87
13	Georgia	0.64	4.15	4.03	6.18	3.45	4.17	3.85	5.15	3.54	5,445.26	8.60
14	Guatemala	0.79	3.96	3.78	5.54	3.35	3.91	3.85	5.47	3.44	5,042.16	8.53
15	Hong Kong	0.43	4.53	4.03	5.33	3.88	3.72	4.69	4.94	4.17	49,775.23	10.82
16	Hungary	0.41	4.71	3.63	5.31	3.31	3.39	3.50	5.57	3.26	19,393.64	9.87
17	India	0.63	3.70	4.25	5.81	4.04	4.45	4.11	5.29	4.02	3,707.15	8.22
18	Indonesia	0.86	3.70	4.27	5.50	3.61	4.47	4.14	4.93	3.92	4,620.25	8.44
19	Israel	0.31	4.19	4.40	4.63	3.82	4.07	4.03	4.71	3.97	32,925.00	10.40
20	Japan	0.21	3.69	5.23	4.72	4.29	4.34	4.22	5.23	4.07	34,486.24	10.45
21	Kazakhstan	0.76	4.51	4.38	5.50	3.72	4.44	3.72	5.40	3.76	12,829.75	9.46
22	South Korea	0.40	4.36	5.20	5.71	3.90	3.73	4.53	5.69	3.52	30,911.16	10.34
23	Kuwait	0.59	3.56	4.32	5.70	3.18	4.44	3.79	4.97	4.02	37,934.70	10.54
24	Malaysia	0.55	3.77	4.45	5.47	4.39	4.76	4.16	5.09	4.59	15,889.65	9.67
25	Mexico	0.57	4.31	3.95	5.62	3.75	3.84	3.97	5.07	4.06	14,747.60	9.60
26	Morocco	0.66	4.72	4.18	6.37	3.50	4.52	4.31	6.14	3.95	5,022.04	8.52
27	New Zealand	0.22	3.47	4.96	3.58	3.46	4.43	4.86	5.12	4.86	28,407.82	10.25
28	Nigeria	0.61	4.53	4.00	5.34	3.95	3.96	3.79	5.32	4.14	2,555.41	7.85
29	Philippines	0.70	3.85	4.37	6.14	3.92	4.88	4.21	5.15	3.69	4,098.27	8.32
30	Poland	0.53	4.11	4.51	5.55	3.23	3.67	3.96	5.09	3.71	19,843.23	9.90
31	Qatar	0.50	4.39	4.78	5.07	4.08	4.79	3.76	5.05	4.26	100,374.96	11.52
32	Russia	0.63	3.86	4.57	5.83	3.06	4.04	3.53	5.61	3.09	16,594.04	9.72
33	Singapore	0.33	4.06	4.77	5.66	4.88	3.29	4.81	4.92	5.16	60,441.25	11.01
34	Slovenia	0.63	4.01	4.09	5.49	3.56	3.75	3.62	5.32	3.76	28,145.49	10.25
35	South Africa	0.35	4.46	4.51	4.80	4.37	3.96	4.40	4.71	4.35	10,942.37	9.30
36	Taiwan	0.37	3.70	4.30	5.45	3.65	3.82	4.27	5.00	4.04	37,351.27	10.53
37	Thailand	0.72	3.58	3.88	5.72	3.27	4.87	3.84	5.62	3.79	8,810.49	9.08
38	Turkey	0.62	4.42	4.02	5.79	3.74	3.92	3.82	5.43	3.67	14,428.15	9.58
39	United States	0.19	4.50	4.21	4.22	4.13	4.18	4.45	4.92	4.15	49,796.95	10.82
40	Venezuela	0.88	4.25	3.96	5.41	3.43	4.19	3.41	5.22	3.55	12,734.70	9.45
41	Zambia	0.82	4.00	4.41	5.72	3.55	5.12	4.01	5.23	3.92	1,592.30	7.37
42	Zimbawe	0.92	4.04	4.08	5.53	3.76	4.38	4.20	5.54	4.12	523.97	6.26

Table A.2: Shapiro Wilks test / pre-transformation					
Variable	Obs	W	V	z	Prob > z
SPR	42	0.96	1.72	1.15	0.13
Astv_P	42	0.97	1.14	0.27	0.39
InsC_P	42	0.95	1.93	1.39	0.08
InGC_P*	42	0.87	5.16	3.46	0.00
FOrt_P	42	0.97	1.23	0.44	0.33
HOrt_P	42	0.98	0.83	-0.40	0.65
POrt_P	42	0.98	0.67	-0.86	0.80
PDis_P	42	0.99	0.59	-1.13	0.87
UAvo_P	42	0.97	1.17	0.32	0.37
GDP_C*	42	0.80	8.25	4.45	0.00
* These variables are significant and not normally distributed.					

Table A.3: Shapiro Wilks test / post-transformation					
Variable	Obs	W	V	z	Prob>z
SPR	42	0.96	1.72	1.15	0.13
Astv_P	42	0.97	1.14	0.27	0.39
InsC_P	42	0.95	1.93	1.39	0.08
InGC_P*	42	0.87	5.16	3.46	0.00
FOrt_P	42	0.97	1.23	0.44	0.33
HOrt_P	42	0.98	0.83	-0.40	0.65
POrt_P	42	0.98	0.67	-0.86	0.80
PDis_P	42	0.99	0.59	-1.13	0.87
UAvo_P	42	0.97	1.17	0.32	0.37
Log_GDP_C	42	0.97	1.07	0.14	0.44
* This variable is significant and not normally distributed. However, we will keep for further analysis.					

Figure A.1
Box plot analysis for in-group collectivism



APPENDIX B

Table B.1
ESTIMATION #1

Source	SS	df	MS	Number of obs	=	42.000
				F(9, 32)	=	14.240
Model	13591.587	9	1510.176	Prob > F	=	0.000
Residual	3392.818	32	106.026	R-squared	=	0.800
				Adj R-squared	=	0.744
Total	16984.405	41	414.254	Root MSE	=	10.297
SPR	Coef.	Std. Err.	t	P>t		Beta
Asstv_P	2.307	5.731	0.400	0.690		0.038
Ins_Collc_P	-3.061	5.858	-0.520	0.605		-0.057
Grp_Collc_P	14.251	3.571	3.990	0.000		0.391
FOR_P	-10.520	6.047	-1.740	0.092		-0.200
HOr_P	6.619	4.631	1.430	0.163		0.135
POr_P	-17.911	7.186	-2.490	0.018		-0.314
PDist_P	-8.308	5.506	-1.510	0.141		-0.143
UAvo_P	9.374	6.413	1.460	0.154		0.201
Log_GDP_C	-9.053	1.994	-4.540	0.000		-0.471
_cons	160.702	58.411	2.750	0.010		.
. regress SPR Asstv_P Ins_Collc_P Grp_Collc_P FOR_P HOr_P POr_P PDist_P UAvo_P Log_GDP_C, beta						

Table B.2
ESTIMATION #2

Source	SS	df	MS	Number of obs	=	42
				F(8, 33)	=	16.42
Model	13574.409	8	1696.801	Prob > F	=	0
Residual	3409.996	33	103.333	R-squared	=	0.7992
				Adj R-squared	=	0.7506
Total	16984.405	41	414.254	Root MSE	=	10.165
SPR	Coef.	Std. Err.	t	P>t		Beta
Ins_Collc_P	-3.759	5.524	-0.680	0.501		-0.070
Grp_Collc_P	14.201	3.523	4.030	0.000		0.390
FOR_P	-9.727	5.645	-1.720	0.094		-0.185
HOr_P	6.186	4.447	1.390	0.174		0.126
POr_P	-17.740	7.082	-2.510	0.017		-0.311
PDist_P	-7.769	5.273	-1.470	0.150		-0.133
UAvo_P	9.084	6.290	1.440	0.158		0.195
Log_GDP_C	-8.984	1.962	-4.580	0.000		-0.467
_cons	169.270	53.699	3.150	0.003		.
. regress SPR Ins_Collc_P Grp_Collc_P FOR_P HOr_P POr_P PDist_P UAvo_P Log_GDP_C, beta						

Table B.3
ESTIMATION 3

Source	SS	df	MS	Number of obs	=	42
				F(7, 34)	=	19
Model	13526.558	7	1932.365	Prob > F	=	0.000
Residual	3457.847	34	101.701	R-squared	=	0.796
				Adj R-squared	=	0.755
Total	16984.405	41	414.254	Root MSE	=	10.085
SPR	Coef.	Std. Err.	t	P>t		Beta
Grp_Collc_P	14.00	3.48	4.02	0.00		0.38
FOR_P	-10.35	5.53	-1.87	0.07		-0.20

Table B.3 **ESTIMATION 3**						
Source	SS	df	MS	Number of obs	=	42
HOr_P	5.19	4.16	1.25	0.22		0.11
POr_P	-19.23	6.68	-2.88	0.01		-0.34
PDist_P	-8.15	5.20	-1.57	0.13		-0.14
UAvo_P	9.05	6.24	1.45	0.16		0.19
Log_GDP_C	-9.49	1.80	-5.27	0.00		-0.49
_cons	173.86	52.85	3.29	0.00		.
. regress SPR Grp_Collc_P FOR_P HOr_P POr_P PDist_P UAvo_P Log_GDP_C, beta						

Table B.4 **ESTIMATION #4**						
Source	SS	df	MS	Number of obs	=	42
				F(6, 35)	=	21.57
Model	13368.825	6	2228.1	Prob > F	=	0
Residual	3615.580	35	103.3	R-squared	=	0.787
				Adj R-squared	=	0.751
Total	16984.405	41	414.25	Root MSE	=	10.164
SPR	Coef.	Std. Err.	t	P>t		Beta
Grp_Collc_P	13.748	3.504	3.920	0.000		0.378
FOR_P	-10.936	5.549	-1.970	0.057		-0.208
POr_P	-19.907	6.712	-2.970	0.005		-0.349
PDist_P	-8.522	5.233	-1.630	0.112		-0.146
UAvo_P	10.897	6.109	1.780	0.083		0.234
Log_GDP_C	-10.269	1.701	-6.040	0.000		-0.534
_cons	203.771	47.449	4.290	0.000		.
. regress SPR Grp_Collc_P FOR_P POr_P PDist_P UAvo_P Log_GDP_C, beta						

Table B.5 **ESTIMATION #5**						
Source	SS	df	MS	Number of obs	=	42
				F(5, 36)	=	24.240
Model	13094.856	5	2618.971	Prob > F	=	0.000
Residual	3889.549	36	108.043	R-squared	=	0.771
				Adj R-squared	=	0.739
Total	16984.405	41	414.254	Root MSE	=	10.394
SPR	Coef.	Std. Err.	t	P>t		Beta
Grp_Collc_P	12.391	3.481	3.56	0.001		0.340
FOR_P	-9.960	5.642	-1.77	0.086		-0.189
POr_P	-20.217	6.861	-2.95	0.006		-0.355
UAvo_P	12.606	6.155	2.05	0.048		0.271
Log_GDP_C	-10.193	1.739	-5.86	0.000		-0.530
_cons	157.181	38.713	4.06	0.000		.
. regress SPR Grp_Collc_P FOR_P POr_P UAvo_P Log_GDP_C, beta						

Table B.6 **ESTIMATION #6**						
Source	SS	df	MS	Number of obs	=	42.000
				F(4, 37)	=	27.920
Model	12758.181	4	3189.545	Prob > F	=	0.000
Residual	4226.224	37	114.222	R-squared	=	0.751
				Adj R-squared	=	0.724
Total	16984.405	41	414.254	Root MSE	=	10.687

Table B.6 **ESTIMATION #6**						
Source	SS	df	MS	Number of obs	=	42.000
SPR	Coef.	Std. Err.	t	P>t		Beta
InGC_P	12.707	3.574	3.560	0.001		0.349
POrt_P	-22.260	6.954	-3.200	0.003		-0.391
UAvo_P	8.460	5.850	1.450	0.157		0.182
Log_GDP_C	-10.449	1.782	-5.860	0.000		-0.543
_cons	145.422	39.211	3.710	0.001		.
. regress SPR InGC_P POrt_P UAvo_P Log_GDP_C, beta						

Table B.7 **ESTIMATION #7**						
Source	SS	df	MS	Number of obs	=	42.000
				F(3, 38)	=	35.510
Model	12519.29	3	4173.096	Prob > F	=	0.000
Residual	4465.118	38	117.5031	R-squared	=	0.737
				Adj R-squared	=	0.716
Total	16984.4	41	414.2538	Root MSE	=	10.840
SPR	Coef.	Std. Err.	t	P>t		Beta
InGC_P	11.732	3.560	3.300	0.002		0.322
POrt_P	-15.244	5.053	-3.020	0.005		-0.268
Log_GDP_C	-10.281	1.804	-5.700	0.000		-0.535
_cons	154.014	39.311	3.920	0.000		.
. regress SPR InGC_P POrt_P Log_GDP_C, beta						

Table B.8 **ESTIMATION #8**						
Source	SS	df	MS	Number of obs	=	42
				F(1, 40)	=	47.610
Model	9230.287	1	9230.287	Prob > F	=	0.000
Residual	7754.118	40	193.853	R-squared	=	0.544
				Adj R-squared	=	0.532
Total	16984.405	41	414.254	Root MSE	=	13.923
SPR	Coef.	Std. Err.	t	P>t		Beta
Log_GDP_C	-14.178	2.055	-6.900	0.000		-0.737
_cons	191.858	19.534	9.820	0.000		.
. regress SPR Log_GDP_C, beta						

Table B.9: Variance Inflation Factor (VIF)		
Variable	VIF	1/VIF
InGC_P	1.38	0.72
Log_GDP_C	1.27	0.79
POrt_P	1.14	0.88
Mean VIF	1.26	

A COMPARISON OF THE INFLUENCING FACTORS OF USING A MOBILE PHONE: ATLANTIC CANADA VS. CAMEROON AFRICA

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ABSTRACT

Individual adoption of technology has been studied extensively in the workplace (Brown & Venkatesh, 2005). But far less attention has been paid to adoption of technology in the household (Brown & Venkatesh, 2005). Obviously, mobile phone is now integrated into our daily life. Indeed, according to the latest research from Strategy Analytics, global mobile phone shipments grew from about 1% annually to reach 362 million units in the second quarter of 2012 (Business Wire, 2012), that is, more than 1.5 billion units were sold in 2012. The International Telecommunication Union (ITU) inventoried 4.6 billion subscriptions in 2010, from which 57% come from the developing countries. In addition, according to Cisco, one of the greatest global networking companies, there will be 5.2 billion mobile phone users in the world by 2017 while the population will be reaching 7.6 billion people (Ferland, 2013). So the purpose of this paper is then to pursue the investigation on what make such people around the world are so using the mobile phone. In fact, on the basis of two recent studies already conducted on the influencing factors of using a mobile phone, a first study made in Atlantic Canada involving 327 respondents (Fillion & Booto Ekionea, 2010) and a second study performed in Cameroon Africa involving 505 respondents (Fillion et al., in press), this paper establishes a comparison of the different factors influencing mobile phone usage in these two countries located at about 10 000 miles of distance. In the two studies, the same moderator-type research model developed by Brown and Venkatesh (2005) to verify the determining factors in intention to adopt a computer in household by American people has been used to identify the determining factors in the use of mobile phone by people in household. And the data analysis was performed using the structural equation modeling software Partial Least Squares (PLS).

INTRODUCTION

Since numerous years, mobile phone is used for different professional purposes, particularly by senior managers in the workplace. And this technology is more and more used in the workplace since mobile applications have been integrated to actual enterprise business strategies. Individual adoption of technology has been studied extensively in the workplace

(Brown & Venkatesh, 2005). But far less attention has been paid to adoption of technology in the household (Brown & Venkatesh, 2005). Obviously, mobile phone is now integrated into our daily life. Indeed, according to the latest research from Strategy Analytics, global mobile phone shipments grew from about 1% annually to reach 362 million units in the second quarter of 2012 (Business Wire, 2012), that is, more than 1.5 billion units were sold in 2012. The International Telecommunication Union (ITU) inventoried 4.6 billion subscriptions in 2010, from which 57% come from the developing countries. In addition, according to Cisco, one of the greatest global networking companies, there will be 5.2 billion mobile phone users in the world by 2017 while the population will be reaching 7.6 billion people (Ferland, 2013). So the purpose of this paper is then to pursue the investigation on what make such people around the world are so using the mobile phone. In fact, on the basis of two recent studies already conducted on the influencing factors of using a mobile phone, a first study made in Atlantic Canada involving 327 respondents (Fillion & Booto Ekionea, 2010) and a second study performed in Cameroon Africa involving 505 respondents (Fillion et al., in press), this paper establishes a comparison of the different factors influencing mobile phone usage in these two countries located at about 10 000 miles of distance one from the other.

Few studies have been conducted until now which investigate the intention to adopt a mobile phone by people in household (in the case of those who do not yet own a mobile phone) or the use of mobile phone in the everyday life of people in household (in the case of those who own a mobile phone). Yet we can easily see that the mobile phone is actually completely transforming the ways of communication of people around the world. It is therefore crucial to more deeply examine the determining factors in the use of mobile phone by people in household as well as the differences in the determining factors between different countries in the world. So this is the aim of the present paper. The related literature on the actual research area of mobile phone is summarized in Table 1.

In addition to the summary of literature on the actual research area of mobile phone presented in Table 1, other researchers have identified some factors which may increase the use of mobile phone by people in household. For example, in a large study conducted in 43 countries of the world, Kauffman and Techatassanasoontorn (2005) noted a faster increase in the use of mobile phone in countries having a more developed telecommunications infrastructure, being more competitive on the wireless market, and having lower wireless network access costs and less standards regarding the wireless technology. Another study involving 208 users by Wei (2007) showed that different motivations predict diverse uses of mobile phone. According to the Wei's findings, mobile phone establishes a bridge between interpersonal communication and mass communication. And a large study conducted by Abu and Tsuji (2010) in 51 countries classified by the *Banque Mondiale* revealed that, in general, income is a very important factor to adopt a mobile phone in the countries having a fix telephone infrastructure.

Table 1
Related Literature Survey
(adapted from Isiklar and Büyüközhan, 2007, p. 267; and updated)

Research Areas	*References*
Mobile phone diffusion and its impacts on people's daily life.	LaRose (1989) Kwon & Chidambaram (2000) Botelho & Costa Pinto (2004) Funk (2005) Andonova (2006) Centrone et al. (2007) Ehlen & Ehlen (2007) Fillion & Berthelot (2007) Fillion & Le Dinh (2008) Kurniawan (2008) Abu & Tsuji (2010) Sripalawat et al. (2011) Abdul-Karim et al. (2010) Fillion & Booto Ekionea (2010) Glajchen (2011) Kwun et al. (2013)
Mobile phone ownership and usage.	LaRose (1989) Kwon & Chidambaram (2000) Palen et al. (2000) Aoki & Downes (2003) Selwyn (2003) Davie et al. (2004) Mazzoni et al. (2007) Peters et al. (2007) Tucker et al. (2007) Sohn & Kim (2008) Wessels & Drennan (2010) Chong et al. (2010) Fillion & Booto Ekionea (2010) Gebauer et al. (2010) Kwun et al. (2013)
Mobile phone ownership and usage from a behavioral and psychological perspective.	Karjaluoto et al. (2003) Wilska (2003) Davie et al. (2004) Liljander et al. (2007) White et al. (2007) Butt & Phillips (2008) Abu & Tsuji (2010) Kimiloglu et al. (2010) Lane & Manner (2011)
Effects on human health and daily activities.	Repacholi (2001) Salvucci & Macuga (2002) Weinberger & Richter (2002) Sullman & Baas (2004) Treffner & Barrett (2004) Westerman & Hocking (2004) Balik et al. (2005) Balikci et al. (2005) Eby et al. (2006) Rosenbloom (2006) Törnros & Bolling (2006) Cocosila & Archer (2010)

Evaluation and design of mobile phone features for user interface and user satisfaction.	Chuang et al. (2001) Chen et al. (2003) Han & Wong (2003) Chae & Kim (2004) Han et al. (2004) Lee et al. (2006) Kimiloglu et al. (2010) Haverila (2011)
Analytical evaluations of mobile phone-related observations.	Tam & Tummala (2001) Campbell & Russo (2003) Han & Wong (2003) Wang & Sung (2003) Lai et al. (2006) Haque et al. (2010) Liu (2010)
Comparative analysis on the use of mobile phone according to the cultures.	Zhang & Maruping (2008) Lee & Lee (2010)
New mobile phone generation on the form of mobile computer and virtual life.	Brown (2008) Hurlburt et al. (2011) Murugesan (2011) Kwun et al. (2013)

As we can see in the summary of literature related to mobile phone presented above, few studies until now examined the determining factors in the use of mobile phone by people in household. And, at our knowledge, no study until now tried to establish a comparison of the determining factors of using a mobile phone between people of different countries around the world. Thus, the present paper brings an important contribution to fill this gap as it allows a better understanding of the impacts of mobile phone usage into people's daily life as well as the different usage of the mobile phone by people of different cultures and nationalities. It focuses on the following research question: What are the differences in the determining factors in the use of mobile phone by people in household in different countries around the world?

The paper builds on a framework suggested by Fillion (2004) in the conduct of hypothetico-deductive scientific research in organizational sciences, and it is structured as follows: first, the theoretical approach which guided the two studies is presented; second, the methodologies followed to conduct the two studies are described; finally, the results got from the comparison of the two studies are reported and discussed.

THEORETICAL APPROACH

The two studies compared in this paper were based on the theoretical foundations developed by Venkatesh and Brown (2001) to investigate the factors driving personal computer adoption in American homes as well as those developed by Brown and Venkatesh (2005) to verify the determining factors in intention to adopt a personal computer in household by American people. In fact, Brown and Venkatesh (2005) performed the first quantitative test of the recently developed model of adoption of technology in households (MATH) and they

proposed and tested a theoretical extension of MATH integrating some demographic characteristics varying across different life cycle stages as moderating variables. With the exception of behavioral intention (we included user satisfaction instead given people investigated in these studies own a mobile phone), all the variables proposed and tested by Brown and Venkatesh (2005) were used in these studies. And we added two new variables in order to verify whether people were using mobile phone for security and mobility. The resulting theoretical research model is depicted in Figure 1.

Figure 1
Theoretical Research Model

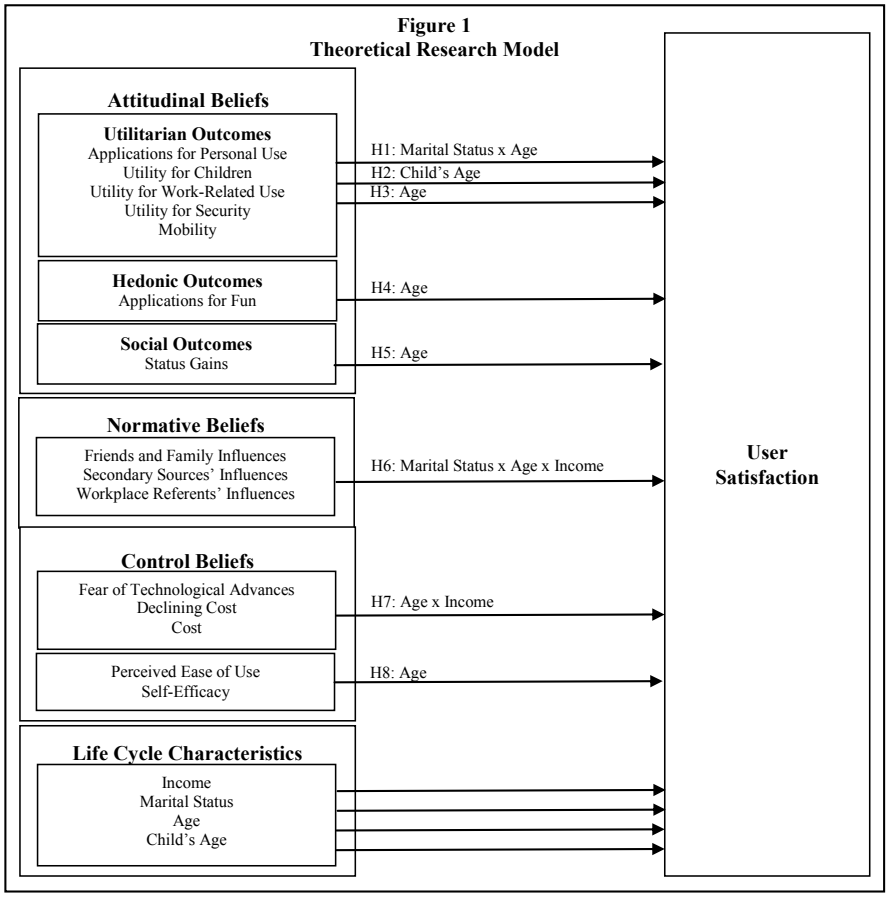


Figure 1 shows that Brown and Venkatesh (2005) integrated MATH and Household Life Cycle in the following way. MATH presents five attitudinal beliefs grouped into three sets of outcomes: *utilitarian*, *hedonic*, and *social*. Utilitarian beliefs are most consistent with those found in the workplace and can be divided into beliefs related to *personal use*, *children*, and *work* (we added beliefs related to *security* and *mobility*). The extension of MATH suggested and tested by Brown and Venkatesh (2005) presents three normative beliefs: *influence of friends and family*, *secondary sources*, and *workplace referents*. As for control beliefs, they are represented in MATH by five factors: *fear of technological advances*, *declining cost*, *cost*, *perceived ease of use*, and *self-efficacy*. And, according to Brown and Venkatesh (2005), integrating MATH with a

life cycle characteristics (LCC), including *income*, *age*, *child's age*, and *marital status*, allows to provide a richer explanation of household personal computer adoption (household mobile phone usage in these studies) than those provided by MATH alone. Finally, as shown in Figure 1, the dependant variable of the theoretical research model developed is related to *user satisfaction* (satisfaction in the use of mobile phone by people in household). All the variables integrated into the theoretical research model depicted in Figure 1 are defined in Table 2.

Table 2
Variables and Definitions

Beliefs/LCC	***Variables***	***Definitions***
Attitudinal Beliefs (independent variables)	Applications for Personal Use	The extent to which using a mobile phone enhances the effectiveness of household activities (adapted from Venkatesh & Brown, 2001).
	Utility for Children	The extent to which using a mobile phone enhances the children's effectiveness in their activities (adapted from Venkatesh & Brown, 2001).
	Utility for Work-Related Use	The extent to which using a mobile phone enhances the effectiveness of performing work-related activities (adapted from Venkatesh & Brown, 2001).
	Utility for Security	The extent to which using a mobile phone increases the security of its user and his/her family (Fillion & Berthelot, 2007).
	Mobility	The extent to which a mobile phone allows to use only this telephone to perform all personal and professional activities (Fillion & Berthelot, 2007).
	Applications for Fun	The pleasure derived from mobile phone use (adapted from Venkatesh & Brown, 2001). These are specific to mobile phone usage, rather than general traits (adapted from Brown & Venkatesh, 2005; see Webster & Martocchio, 1992, 1993).
	Status Gains	The increase in prestige that coincides with the purchase of a mobile phone for home use (adapted from Venkatesh & Brown, 2001).
Normative Beliefs (independent variables)	Friends and Family Influences	"The extent to which the members of a social network influence one another's behavior" (Venkatesh & Brown, 2001, p. 82). In this case, the members are friends and family (Brown & Venkatesh, 2005).
	Secondary Sources' Influences	The extent to which information from TV, newspaper, and other secondary sources influences behavior (Venkatesh & Brown, 2001).
	Workplace Referents' Influences	The extent to which coworkers influence behavior (Brown & Venkatesh, 2005; see Taylor & Todd, 1995).
Control Beliefs (independent variables)	Fear of Technological Advances	The extent to which rapidly changing technology is associated with fear of obsolescence or apprehension regarding a mobile phone purchase (adapted from Venkatesh & Brown, 2001).
	Declining Cost	The extent to which the cost of a mobile phone is decreasing in such a way that it inhibits adoption (adapted from Venkatesh & Brown, 2001).
	Cost	The extent to which the current cost of a mobile phone is too high (adapted from Venkatesh & Brown, 2001).
	Perceived Ease of Use	The degree to which using the mobile phone is free from effort (Davis, 1989; also adapted from Venkatesh & Brown, 2001).
	Self-Efficacy (or Requisite Knowledge)	The individual's belief that he/she has the knowledge necessary to use a mobile phone. This is closely tied to computer self-efficacy (Compeau & Higgins, 1995a, 1995b; see also Venkatesh & Brown, 2001).
Life Cycle Characteristics (moderator variables)	Income	The individual's year gross income (see Wagner & Hanna, 1983).
	Marital Status	The individual's family status (married, single, divorced, widowed, etc.) (see Danko & Schaninger, 1990).
	Age	The individual's age (see Danko & Schaninger, 1990). In this case, age is calculated from the individual's birth date.
	Child's Age	The age of the individual's youngest child (see Danko & Schaninger, 1990). In this case, age is represented by a numeral.

We can see in Table 2 that the definitions of MATH variables integrated into the theoretical research model proposed in Figure 1 are, in the whole, adapted from the theoretical foundations developed by Venkatesh and Brown (2001) to investigate the factors driving personal computer adoption in American homes. As for the definitions of the variables related to the household life cycle, they were taken from Danko and Schaninger (1990) as well as Wagner and Hanna (1983), respectively. And the definitions of the two new independent variables that we added to the model are from Fillion and Berthelot (2007). In fact, we defined these two variables in accordance with which we wanted to measure concerning utility for security and mobility before to develop and validate items measuring them on the basis of the definitions we formulated.

In the reminder of the section, we present the eight research hypotheses (H1-H8) tested in the two studies compared in this paper and derived from the theoretical research model presented in Figure 1.

H1: Marital status and age will moderate the relationship between applications for personal use and satisfaction of using a mobile phone at home.

H2: Child's age will moderate the relationship between utility for children and satisfaction of using a mobile phone at home.

H3: Age will moderate the relationship between utility for work-related use and satisfaction of using a mobile phone at home.

H4: Age will moderate the relationship between applications for fun and satisfaction of using a mobile phone at home.

H5: Age will moderate the relationship between status gains and satisfaction of using a mobile phone at home.

H6: Age, marital status, and income will moderate the relationship between the normative beliefs ((a) friends and family influences; (b) secondary sources' influences; and (c) workplace referents' influences) and satisfaction of using a mobile phone at home.

H7: Age and income will moderate the relationship between the external control beliefs ((a) fear of technological advances; (b) declining cost; and (c) cost) and satisfaction of using a mobile phone at home.

H8: Age will moderate the relationship between the internal control beliefs ((a) perceived ease of use; and (b) self-efficacy) and satisfaction of using a mobile phone at home.

In the next section, we describe the different methodologies followed to conduct the two studies compared in this paper.

METHODOLOGY

The two studies compared in this paper were designed to gather information on mobile phone adoption decisions in Atlantic Canada and Cameroon Africa households. Indeed, the focus of the two studies was on individuals who own a mobile phone. In the first study, that is, those in Atlantic Canada, we conducted a telephone survey research with individuals from Moncton, Riverview, Shediac, Magnetic Hill, St-John and Halifax. In the second study, that is, those in Cameroon Africa, we conducted an in-person survey research with individuals from the two more important cities in Cameroon, Yaounde and Douala. In this section, we describe the instrument development and validation, the sample and data collection, as well as the data analysis process.

INSTRUMENT DEVELOPMENT AND VALIDATION

To conduct the two studies, we used the survey instrument developed and validated by Brown and Venkatesh (2005) to which we added three new scales, the first two measuring other dimensions in satisfaction in the use of mobile phone by people in household, that is, utility for security and mobility, and the last one measuring user satisfaction as such. The survey instrument was then translated in French (a large part of the population in Atlantic and Cameroon are speaking French) and both the French and English versions were evaluated by peers. This review assessed face and content validity (see Straub, 1989). As a result, changes were made to reword items and, in some cases, to drop items that were possibly ambiguous, consistent with Moore and Benbasat's (1991) and DeVellis's (2003) recommendations for scale development. Subsequent to this, we distributed the survey instrument to a group of 25 MBA students for evaluation. Once again, minor wording changes were made. Finally, we performed some adjustments to the format and appearance of the instrument, as suggested by both peers and MBA students. As the instrument was already validated by Brown and Venkatesh (2005) and showed to be of a great reliability, that we used the scale developed by Hobbs and Osburn (1989) and validated in their study as well as in several other studies to measure user satisfaction, and that we added only few items to measure the new variables utility for security and mobility, then we have not performed a pilot-test with a small sample. The evaluations by both peers and MBA students were giving us some confidence that we could proceed with a large-scale data collection.

SAMPLE AND DATA COLLECTION

Atlantic Canada's Study

First, in this study, we chose to survey people in household over 18 years taken from a large area in Atlantic Canada who own a mobile phone. To do this, undergraduate and graduate

students studying at our faculty were hired to collect data using the telephone. A telephone was then installed in an office of the faculty, and students, one at a time over a 3 to 4-hour period, were asking people over the telephone to answer our survey. And in order to get a diversified sample (e.g., students, retired people, people not working, people working at home, and people working in enterprises), data were collected from 9 a.m. to 9 p.m. Monday through Friday over a 5-week period. Using the telephone directory of the large area in Atlantic Canada chosen for the study, students were randomly selecting people and asking them over the telephone to answer our survey. The sample in this study is therefore a randomized sample, which is largely valued in the scientific world given the high level of generalization of the results got from such a sample. Once an individual had the necessary characteristics to answer the survey and was accepting to answer it, the student was there to guide him/her to rate each item of the survey on a seven points Likert-type scale (1: strongly disagree … 7: strongly agree). In addition, the respondent was asked to answer some demographic questions. Finally, to further increase the response rate of the study, each respondent completing the survey had the possibility to win one of the 30 Tim Hortons $10 gift certificates which were drawn at the end of the data collection. To that end, the phone number of each respondent was put in a box for the drawing. Following this data collection process, 327 people in household answered our survey over a 5-week period.

Cameroon Africa's Study

First, in this study, we chose surveying people in household over 18 years taken from the two more important cities in Cameroon Africa (Yaounde and Douala) who own a mobile phone. To do this, a graduate student studying at the Faculty of administration of the University of Moncton, one of our colleagues from the University of Yaounde I, and a friend of our colleague in Yaounde were collecting data in-person. One at a time over a 3- to 4-hour period, the three responsible to collect data were soliciting people in-person to answer our survey. And, in order to get a diversified sample (e.g., students, retired people, people not working, people working at home, people working in enterprises, and so on), data were collected from 9 a.m. to 9 p.m. Monday through Friday over a 6-week period. People answering our survey were randomly selected in the streets, in the stores, and in the houses of the two Cameroonian cities chosen for the study by the three responsible to collect data. The sample in this study is then a randomized sample, which is largely valued in the scientific world given the high level of generalization of the results got from such a sample. Once an individual had the necessary characteristics to answer the survey and was agreeing to answer it, a responsible was there to guide him/her to rate each item of the survey on a seven points Likert-type scale (1: strongly disagree … 7: strongly agree). In addition, the respondent was asked to answer some demographic questions. Finally, it is important to mention here that no incentive has been used in order to try increasing the response rate of the study. So, following this data collection process, 505 people in household answered our survey over a 6-week period.

DATA ANALYSIS PROCESS

The data analysis of the two studies was performed using a structural equation modeling software, that is, Partial Least Squares (PLS-Graph 3.0). Using PLS, data have no need to follow a normal distribution and it can easily deal with small samples if the sample is at least 10 times greater than the number of items measuring the variable having the greatest weight in terms of items into the model (Barclay et al., 1995; Fornell & Bookstein, 1982). Recently, some authors (see Goodhue et al., 2012) tried to refute this evidence but, in our view, they did not succeed well. In addition, PLS is appropriate when the objective is a causal predictive test instead of the test of a whole theory (Barclay et al., 1995; Chin, 1998) as it is the case in these studies. And, to ensure the stability of the model developed to test the research hypotheses of the two studies, we used the PLS bootstrap resampling procedure (the interested reader is referred to a more detailed exposition of bootstrapping (see Chin, 1998; Chin et al., 2003; Efron & Tibshirani, 1993)) with an iteration of 100 sub-sample extracted from the initial samples (327 Atlantic people and 505 Cameroonian people). Some analyses were also performed using the Statistical Package for the Social Sciences software (SPSS 13.5). The results follow.

RESULTS

In this section of the paper, the results of the two studies are reported. We begin to present some characteristics of the participants. Then we validate the PLS model developed to test the research hypotheses. Finally, we describe the results got from PLS analyses to test the research hypotheses.

PARTICIPANTS

Atlantic Canada's Study

The participants in this study were either relatively aged or relatively young, with a mean of 39.8 years and a large standard deviation of 14.5 years. These statistics on the age of the participants are, in fact, consistent with the growing old population phenomenon. Near from two third of the participants were female (62%). Near from 80% of the participants were married (50.9%) or single (28.4%). The gross yearly income of the respondents in the study was in the range of $0 to $50,000. Indeed, 72.4% of the respondents were winning between $0 and $50,000, and, from this percentage, 35.5% were winning between $30,000 and $50,000. And 5.5% of the respondents were winning $100,000 or over. Concerning the level of education, 25.5% of the participants in the study got a high-school diploma, 26.4% got a college degree, and 39.6% completed a baccalaureate. Only 2.1% of the participants got a doctorate, which is relatively

consistent with the whole population in general. Finally, the respondents in this study were mainly full-time employees (52.5%), retired people (12%), students (11.7%), self-employed (9%), part-time employees (7.4%), and unemployed (4.6%). These statistics on the respondents' occupation help to explain the large standard deviation on their age reported above. Indeed, 11.7% of the respondents were young students, while 12% were retired people. So the difference in age between these two groups is very large.

Cameroon Africa's Study

As for the participants in the Cameroon Africa's study, they were not relatively aged, with a mean of 30 years and a standard deviation of 11 years. More than half of the participants were male (54.2%). More than 80% of the participants were single (57.9%) or married (28.5%). The gross yearly income of the respondents in the study was in the range of $0 to $5 445 (0 to 2 750 000 CFA francs). Indeed, 78.9% of the respondents were winning between $0 and $1 979 (0 and 1 000 000 CFA francs), and, from this percentage, 67.6% were winning between $0 and $989 (0 and 500 000 CFA francs). And only 3% of the respondents in the study were winning between $4 950 and $5 445 (2 500 000 and 2 750 000 CFA francs). Concerning the level of education, 15.4% of the participants in the study got a high-school diploma, 11.1% had a college degree, 36.6% completed a baccalaureate, 23.6% got a master, and 5.7% got a doctorate. The percentage of participants having a doctorate is very surprising here since it is three times higher than the Atlantic Canada's study (see Fillion & Booto Ekionea, 2010) compared in this paper. Finally, the respondents were mainly students (36.4%), full-time employees (19.7%), self-employed (13.1%), unemployed (12.9%), part-time employees (10.5%), and volunteers (3%).

VALIDATION OF THE PLS MODEL TO TEST HYPOTHESES

First, to ensure the reliability of a construct or a variable using PLS, one must verify the three following properties: individual item reliability, internal consistency, as well as discriminant validity (Yoo & Alavi, 2001; see the paper for more details).

To verify individual item reliability, for each study, a confirmatory factor analysis (CFA) was performed on independent and dependent variables of the theoretical research model. A single iteration of the CFA was necessary in the two studies given all loadings of the variables were superior to 0.50 and then none item was withdrawn nor transferred in another variable in which the loading would have been higher. Indeed, in the whole, items had high loadings, which suppose a high level of internal consistency of their corresponding variables. In addition, loadings of each variable were superior to cross-loadings with other variables of the model. Hence the first criterion of discriminant validity was satisfied.

And to get composite reliability indexes and average variance extracted (AVE) in order to satisfy the second criterion of discriminant validity and to verify internal consistency of the variables, we used PLS bootstrap resampling procedure with an iteration of 100 sub-sample

extracted from the initial samples (327 Atlantic people and 505 Cameroonian people). The results of the two studies are presented in Table 3 and Table 4.

Table 3 (Atlantic Canada's Study)
Means, Standard Deviations, Composite Reliability Indexes, Correlations, and Average Variance Extracted of Variables

Variable	*M*	*SD*	*Relia-bility Index*	*Correlations and Average Variance Extracted*[d]																		
				1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*
1. Applications for Personal Use	3.84	1.92	**0.82**	**0.77**																		
2. Utility for Children	2.07	2.52	**0.96**	.27	**0.94**																	
3. Utility for Work-Related Use	3.17	2.46	**0.91**	.39	.10	**0.88**																
4. Utility for Security	5.62	1.68	**0.89**	.21	.16	-.04	**0.85**															
5. Mobility	3.55	2.03	**0.88**	.30	.05	.23	.09	**0.84**														
6. Applications for Fun	2.88	1.96	**0.89**	.35	.05	.23	.13	.25	**0.82**													
7. Status Gains	2.45	1.72	**0.93**	.18	.15	.19	.13	.31	.37	**0.90**												
8. Friends and Family Influences	3.66	2.27	**0.93**	.26	.05	.16	.13	.19	.43	.40	**0.88**											
9. Secondary Sources' Influences	3.24	2.25	**0.90**	.17	.09	.08	.10	.09	.25	.23	.36	**0.87**										
10. Workplace Referents' Influences	3.12	2.41	**0.98**	.26	-.03	.37	.04	.19	.31	.29	.53	.33	**0.98**									
11. Fear of Technological Advances	3.21	1.97	**0.83**	-.06	.10	.04	.10	-.09	.04	.15	.13	.15	.16	**0.79**								
12. Declining Cost	4.14	1.88	**0.89**	.17	.13	.08	.12	.12	.06	.05	.04	.13	.08	-.04	**0.85**							
13. Cost	4.38	1.83	**0.96**	.07	.01	.04	.16	.13	.04	.22	.16	.07	.10	.24	-.09	**0.96**						
14. Perceived Ease of Use	5.69	1.45	**0.88**	.19	-.05	.09	.15	.27	.24	.18	.17	-.02	.20	-.11	.15	.00	**0.80**					
15. Self-Efficacy	6.39	1.02	**0.93**	.18	-.14	.04	.12	.18	.12	.03	.11	-.08	.12	-.12	.15	-.00	.66	**0.91**				
16. Income[a]	NA	NA	**NA**	.04	.11	.09	-.12	-.11	-.32	-.23	-.24	-.05	-.04	-.07	.02	-.11	-.05	-.00	**NA**			
17. Marital Status[a]	NA	NA	**NA**	-.04	-.03	-.22	.27	-.02	.09	-.06	.06	.00	-.04	.04	-.11	.03	-.03	-.02	-.22	**NA**		
18. Age[b]	39.80	14.50	**NA**	.12	-.24	.20	.04	.21	.46	.22	.31	.16	.37	-.05	-.03	.10	.31	.18	-.41	.16	**NA**	
19. Child's Age[c]	16.29	9.09	**NA**	.11	.09	-.03	-.06	.02	.33	.12	.24	.13	-.09	-.06	-.07	.09	.16	.14	-.21	.07	-.08	**NA**
20. User Satisfaction	5.46	1.41	**0.86**	.18	.04	-.09	.31	.20	.21	.11	.16	.06	.03	-.10	.21	-.06	.40	.27	-.13	.10	.06	.07	**0.71**

[a]This variable was coded as a nominal variable. It was measured in terms of non quantified distinct categories.
[b]This variable was coded as a continuous variable. It was measured using the respondents' birth date.
[c]This variable was coded using the age of the respondents' youngest child.
[d]Boldfaced elements on the diagonal of the correlation matrix represent the square root of the average variance extracted (AVE).
For an adequate discriminant validity, the elements in each row and column should be smaller than the boldfaced element in that row or column.

As shown in Table 3 (Atlantic Canada's study), PLS analysis indicates that all square roots of AVE (boldfaced elements on the diagonal of the correlation matrix) are higher than the correlations with other variables of the model. In other words, each variable shares more variance with its measures than it shares with other variables of the model. Consequently, discriminant validity is verified. Finally, as supposed previously, we can see in Table 3 that PLS analysis showed high composite reliability indexes for all variables of the theoretical research model. The

variables have therefore a high internal consistency, with composite reliability indexes ranging from 0.82 to 0.98.

Table 4 (Cameroon Africa's Study)
Means, Standard Deviations, Composite Reliability Indexes, Correlations, and Average Variance Extracted of Variables

Variables	*M*	*SD*	*Reliability Indexes*	*Correlations and Average Variance Extracted*[d]																			
				1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*
1. Applications for Personal Use	4.17	2.17	**0.85**	**0.81**																			
2. Utility for Children	4.21	2.10	**0.95**	.32	**0.93**																		
3. Utility for Work-Related Use	4.07	2.19	**0.86**	.45	.46	**0.82**																	
4. Utility for Security	4.71	2.03	**0.89**	.25	.23	.32	**0.86**																
5. Mobility	3.68	2.18	**0.93**	.36	.25	.29	.24	**0.90**															
6. Applications for Fun	4.75	2.03	**0.89**	.19	.08	.15	.23	.09	**0.82**														
7. Status Gains	2.87	2.07	**0.92**	.22	.25	.31	.35	.39	.20	**0.89**													
8. Friends and Family Influences	4.49	2.05	**0.93**	.25	,21	.25	.29	.28	.20	.33	**0.87**												
9. Secondary Sources' Influences	4.26	2.00	**0.93**	.26	.30	.30	.38	.33	.17	.31	.54	**0.90**											
10. Workplace Referents' Influences	4.65	2.06	**0.97**	.31	.33	.38	.23	.26	.10	.26	.53	.44	**0.97**										
11. Fear of Technological Advances	4.50	2.25	**0.89**	.19	.13	.22	.26	.24	.17	.28	.30	.30	.27	**0.89**									
12. Declining Cost	5.54	1.72	**0.86**	.18	.04	.09	.20	.16	.26	.05	.16	.12	.12	.18	**0.82**								
13. Cost	4.64	1.93	**0.66**	.18	.17	.20	.29	.24	.26	.16	.26	.34	.21	.24	.13	**0.66**							
14. Perceived Ease of Use	5.56	1.63	**0.88**	.16	.12	.19	.21	.16	.22	.03	.23	.13	.15	.13	.37	.20	**0.81**						
15. Self-Efficacy	5.82	1.61	**0.87**	.24	.15	.23	.25	.18	.21	.03	.29	.18	.20	.14	.35	.16	.64	**0.83**					
16. Income[a]	NA	NA	**NA**	.01	.22	.02	.05	.06	-.08	-.03	.07	.03	.11	.10	.03	.04	.10	.14	**NA**				
17. Marital Status[a]	NA	NA	**NA**	-.02	-.21	-.02	.04	.01	.17	-.04	-.07	-.05	-.15	-.01	.02	-.02	.04	-.01	-.02	**NA**			
18. Age[b]	30.13	10.63	**NA**	.06	-.01	.07	.05	.11	.14	.07	.17	.08	.06	.09	.05	.09	.06	.08	.04	-.02	**NA**		
19. Child's Age[c]	8.31	6.87	**NA**	0.0	.21	.03	.03	.03	-.11	.00	.13	.09	.10	.09	.00	.09	-.02	-.02	-.02	-.37	-.02	**NA**	
20. User Satisfaction	4.92	1.87	**0.88**	.29	.28	.31	.31	.40	.33	.29	.39	.39	.38	.28	.30	.30	.47	.46	.08	-.02	.08	.08	**0.73**

[a]This variable was coded as a nominal variable. It was measured in terms of non quantified distinct categories.
[b]This variable was coded as a continuous variable. It was measured using the respondents' birth date.
[c]This variable was coded using the age of the respondents' youngest child.
[d]Boldfaced elements on the diagonal of the correlation matrix represent the square root of the average variance extracted (AVE).
For an adequate discriminant validity, the elements in each row and column should be smaller than the boldfaced element in that row or column.

And as shown in Table 4 (Cameroon Africa's study), PLS analysis shows that all square roots of AVE (boldfaced elements on the diagonal of the correlation matrix) are higher than the correlations with other variables of the model. In other words, each variable shares more variance with its measures than it shares with other variables of the model. As a result, discriminant

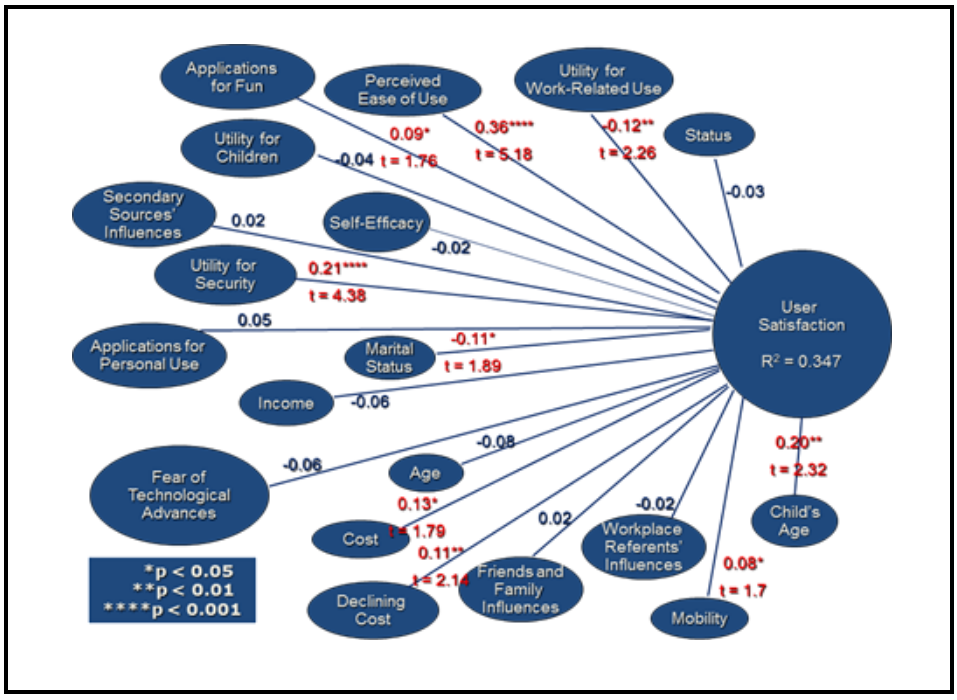
validity is verified. Finally, as supposed previously, we can see in Table 4 that PLS analysis showed high composite reliability indexes for all variables of the theoretical research model. The variables have therefore a high internal consistency, with composite reliability indexes ranging from 0.66 to 0.97.

HYPOTHESIS TESTING

First, to get the significant variables in these studies as well as the percentage of variance explained (R^2 coefficient) by all the variables of the research model, we developed PLS models similar to those of Fillion (2005), Fillion and Booto Ekionea (2010), Fillion et al. (2010), Limayem and DeSanctis (2000), and Yoo and Alavi (2001). And to ensure the stability of the model, we used the PLS bootstrap resampling procedure with an iteration of 100 sub-sample extracted from the initial samples (327 Atlantic people and 505 Cameroonian people). The PLS models are depicted in Figure 2 and Figure 3.

Atlantic Canada's Study

Figure 2 (Atlantic Canada's Study) PLS Model to Get Significant Variables and Percentage of Variance Explained (one-tailed test)



As shown in Figure 2, all the variables of the theoretical research model, used as independent variables, are explaining 34.7% of the variance around the dependant variable user

satisfaction. And half of these variables are significant, that is, they are determining factors in satisfaction of using a mobile phone by people in household. More specifically, the two more significant variables are perceived ease of use ($t = 5.18$, beta = 0.36, $p < 0.001$) and utility for security ($t = 4.38$, beta = 0.21, $p < 0.001$). Three other variables are a few less significant than these first two, but they are also very significant. These variables are child's age ($t = 2.32$, beta = 0.20, $p < 0.01$), utility for work-related use ($t = 2.26$, beta = -0.12, $p < 0.01$), as well as declining cost ($t = 2.14$, beta = 0.11, $p < 0.01$). And four other variables are significant at the level of significance requested in this study, that is, $p \leq 0.05$. These variables are marital status ($t = 1.89$, beta = -0.11, $p < 0.05$), cost ($t = 1.79$, beta = 0.13, $p < 0.05$), applications for fun ($t = 1.76$, beta = 0.09, $p < 0.05$), and mobility ($t = 1.70$, beta = 0.08, $p < 0.05$).

And to measure interaction effect of moderator variables (the life cycle stage characteristics: income (I), marital status (MS), age (A), and child's age (CA)) in order to verify hypotheses 1 to 8, we used the PLS procedure proposed by Chin et al. (2003) (see the paper for more details). On the other hand, in a review of 26 papers assessing interaction effect of moderator variables published between 1991 and 2000 into information systems (IS) journals, Carte and Russell (2003) found nine errors frequently committed by researchers while estimating such an effect, and provided solutions (see the paper for more details). So we tried to avoid these nine errors in applying their solutions to test hypotheses 1 to 8. Indeed, among others, in the verification of hypotheses 1 to 8 that follows, interaction effect of a moderator variable is significant if, and only if, the path between the latent variable (the multiplication of items of independent and moderator variables forming interaction effect) and the dependent variable is significant, as well as if the change in R^2 coefficient (the difference between the R^2 calculated before the addition of interaction effect and those calculated after the addition of interaction effect, that is, ΔR^2 (pronounced delta R^2)) is greater than 0.

For a matter of space, given that the test of hypotheses 1 to 8 required the development of several PLS structural equation models (two models per hypothesis, that is, 16 models), we summarize PLS analyses to test each hypothesis. And, as for the PLS model developed to get the significant variables in the study and the percentage of variance explained by all the variables of the theoretical research model previously (see Figure 2), for each PLS model developed, we used the PLS bootstrap resampling procedure with an iteration of 100 sub-sample extracted from the initial sample (327 Atlantic Canadian people) to ensure the stability of the model.

Concerning hypothesis 1 related to the independent variable applications for personal use (APU), the path from the latent variable APU*MS*A to the dependent variable user satisfaction is significant ($t = 1.698$, beta = -0.154, $p < 0.05$) and there is a change in R^2 ($\Delta R^2 = 0.011$). Thus, as we expected, the moderator variables marital status and age have an influence on the relationship between applications for personal use and satisfaction of using a mobile phone by people in household. Also hypothesis 1 is supported. The scenario is different for hypothesis 2 related to the independent variable utility for children (UC). The path from the latent variable UC*CA to the dependent variable user satisfaction is not significant ($t = 0.188$, beta = 0.034) and there is no change in R^2 ($\Delta R^2 = 0.000$). So, contrary to our expectations, the moderator variable child's age has not an influence on the relationship between utility for children and satisfaction of using a mobile phone by people in household. As a result, hypothesis 2 is not supported. For hypothesis 3 related to the independent variable utility for work-related use (UWRU), the path

from the latent variable UWRU*A to the dependent variable user satisfaction is significant (t = 1.743, beta = -0.267, $p < 0.05$) and there is a change in R^2 ($\hat{}R^2 = 0.005$). Thus, as we expected, the moderator variable age has an influence on the relationship between utility for work-related use and satisfaction of using a mobile phone by people in household. Hypothesis 3 is therefore supported. Regarding hypothesis 4 related to the independent variable applications for fun (AF), the path from the latent variable AF*A to the dependent variable user satisfaction is not significant (t = 0.450, beta = -0.068) and there is no change in R^2 ($\hat{}R^2 = 0.000$). Contrary to our expectations, the moderator variable age has not an influence on the relationship between applications for fun and satisfaction of using a mobile phone by people in household. As a result, hypothesis 4 is not supported. And the scenario is similar for hypothesis 5 related to the independent variable status gains (SG), the path from the latent variable SG*A to the dependent variable user satisfaction is not significant (t = 0.466, beta = 0.093), but there is a small change in R^2 ($\hat{}R^2 = 0.002$). So, contrary to our expectations, the moderator variable age has not an influence on the relationship between status gains and satisfaction of using a mobile phone by people in household. Consequently, hypothesis 5 is not supported.

In the case of hypothesis 6-a related to the independent variable friends and family influences (FFI), the path from the latent variable FFI*MS*A*I to the dependent variable user satisfaction is not significant (t = 0.477, beta = -0.068), but there is a substantial change in R^2 ($\hat{}R^2 = 0.006$). So, contrary to our expectations, the moderator variables marital status, age, and income have not an influence on the relationship between friends and family influences and satisfaction of using a mobile phone by people in household. As a result, hypothesis 6-a is not supported. Concerning hypothesis 6-b related to the independent variable secondary sources' influences (SSI), the path from the latent variable SSI*MS*A*I to the dependent variable user satisfaction is significant (t = 1.666, beta = -0.169, $p < 0.05$) and there is a change in R^2 ($\hat{}R^2 = 0.002$). Thus, as we expected, the moderator variables marital status, age, and income have an influence on the relationship between secondary sources' influences and satisfaction of using a mobile phone by people in household. And hypothesis 6-b is supported. The scenario is similar for hypothesis 6-c related to the independent variable workplace referents' influences (WRI), the path from the latent variable WRI*MS*A*I to the dependent variable user satisfaction is significant (t = 1.778, beta = -0.195, $p < 0.05$) and there is a change in R^2 ($\hat{}R^2 = 0.001$). Thus, as we expected, the moderator variables marital status, age, and income have an influence on the relationship between workplace referents' influences and satisfaction of using a mobile phone by people in household. Consequently, hypothesis 6-c is supported.

Regarding hypothesis 7-a related to the independent variable fear of technological advances (FTA), the path from the latent variable FTA*A*I to the dependent variable user satisfaction is not significant (t = 0.493, beta = 0.092), but there is a small change in R^2 ($\hat{}R^2 = 0.001$). Thus, contrary to our expectations, the moderator variables age and income have not an influence on the relationship between fear of technological advances and satisfaction of using a mobile phone by people in household. Hypothesis 7-a is then not supported. The scenario is similar for hypothesis 7-b related to the independent variable declining cost (DC), the path from the latent variable DC*A*I to the dependent variable user satisfaction is not significant (t = 0.653, beta = -0.139), but there is a change in R^2 ($\hat{}R^2 = 0.003$). So, contrary to our expectations, the moderator variables age and income have not an influence on the relationship between

declining cost and satisfaction of using a mobile phone by people in household. Consequently, hypothesis 7-b is not supported. And the scenario is also similar for hypothesis 7-c related to the independent variable cost (C), the path from the latent variable C*A*I to the dependent variable user satisfaction is not significant (t = 0.498, beta = -0.081), but there is a change in R^2 ($\hat{}R^2$ = 0.004). Thus, contrary to our expectations, the moderator variables age and income have not an influence on the relationship between cost and satisfaction of using a mobile phone by people in household. As a result, hypothesis 7-c is not supported.

Finally, concerning hypothesis 8-a related to the independent variable perceived ease of use (PEU), the path from the latent variable PEU*A to the dependent variable user satisfaction is not significant (t = 0.816, beta = -0.334), but there is a substantial change in R^2 ($\hat{}R^2$ = 0.005). Thus, contrary to our expectations, the moderator variable age has not an influence on the relationship between perceived ease of use and satisfaction of using a mobile phone by people in household. As a result, hypothesis 8-a is not supported. The scenario is different regarding hypothesis 8-b related to the independent variable self-efficacy (SE), the path from the latent variable SE*A to the dependent variable user satisfaction is significant (t = 1.726, beta = -0.512, $p < 0.05$) and there is a substantial change in R^2 ($\hat{}R^2$ = 0.006). So, as we expected, the moderator variable age has an influence on the relationship between self-efficacy and satisfaction of using a mobile phone by people in household. Consequently, hypothesis 8-b is supported.

Cameroon Africa's Study

Figure 3 (Cameroon Africa's Study)
PLS Model to Get Significant Variables and Percentage of Variance Explained (one-tailed test)

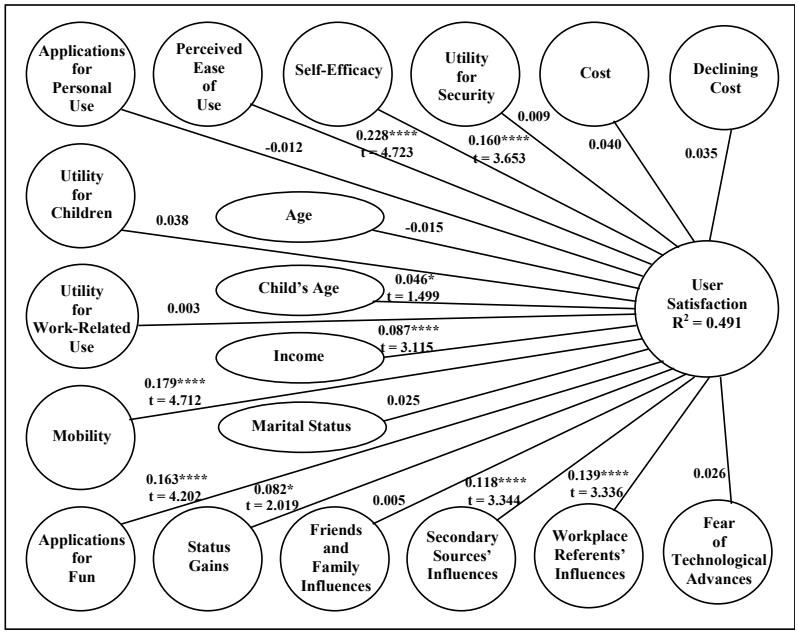


Figure 3 shows that all the variables of the theoretical research model, used as independent variables, are explaining 49.1% of the variance on the dependant variable user satisfaction. And half of these variables are significant, that is, they are determining factors in satisfaction of using a mobile phone by people in household. More specifically, the seven more significant variables are perceived ease of use ($t = 4.723$, beta = 0.228, $p < 0.001$), mobility ($t = 4.712$, beta = 0.179, $p < 0.001$), applications for fun ($t = 4.202$, beta = 0.163, $p < 0.001$), self-efficacy ($t = 3.653$, beta = 0.160, $p < 0.001$), secondary sources' influences ($t = 3.344$, beta = 0.118, $p < 0.001$), workplace referents' influences ($t = 3.336$, beta = 0.139, $p < 0.001$), and income ($t = 3.115$, beta = 0.087, $p < 0.001$). And two other variables are significant at the level of significance requested in this study, that is, $p \leq 0.05$. These are status gains ($t = 2.019$, beta = 0.082, $p < 0.05$) and child's age ($t = 1.499$, beta = 0.046, $p < 0.05$).

And to measure interaction effect of moderator variables (e.g., the life cycle stage characteristics: income (I), marital status (MS), age (A), and child's age (CA)) in order to verify hypotheses 1 to 8, we used the PLS procedure proposed by Chin et al. (2003) (see the paper for more details). On the other hand, in a review of 26 papers assessing interaction effect of moderator variables published between 1991 and 2000 into information systems (IS) journals, Carte and Russell (2003) found nine errors frequently committed by researchers when they estimate such an effect, and provided solutions (see their paper for more details). So we tried to avoid these nine errors in applying their solutions to test hypotheses 1 to 8. Indeed, among others, in the verification of hypotheses 1 to 8 that follows, interaction effect of a moderator variable is significant if, and only if, the path between the latent variable (the multiplication of items of independent and moderator variables forming interaction effect) and the dependent variable is significant, as well as if the change in R^2 coefficient (the difference between the R^2 calculated before the addition of interaction effect and those calculated after the addition of interaction effect (ΔR^2, pronounced delta R^2)) is greater than 0.

For a matter of space, given that the test of hypotheses 1 to 8 required the development of several PLS structural equation models (two models per hypothesis, that is, 16 models), we summarize PLS analyses to test each hypothesis. And, as for the PLS model developed to get the significant variables in the study and the percentage of variance explained by all the variables of the theoretical research model previously (see Figure 3), for each PLS model developed, we used the PLS bootstrap resampling procedure with an iteration of 100 sub-sample extracted from the initial sample (505 Cameroonian people) to ensure the stability of the model.

Concerning hypothesis 1 related to the independent variable applications for personal use (APU), the path from the latent variable APU*MS*A to the dependent variable user satisfaction is significant ($t = 1.808$, beta = 0.156, $p < 0.05$) and there is a change in R^2 ($\Delta R^2 = 0.015$). Thus, as we expected, the moderator variables marital status and age have an influence on the relationship between applications for personal use and satisfaction of using a mobile phone by people in household. Also hypothesis 1 is supported. The scenario is similar for hypothesis 2 related to the independent variable utility for children (UC). The path from the latent variable UC*CA to the dependent variable user satisfaction is very significant ($t = 2.836$, beta = 0.181, $p < 0.001$) and there is a substantial change in R^2 ($\Delta R^2 = 0.014$). So, as we formulated in the hypothesis, the moderator variable child's age has an influence on the relationship between utility for children and satisfaction of using a mobile phone by people in household. As a result, hypothesis 2 is

supported. For hypothesis 3 related to the independent variable utility for work-related use (UWRU), the path from the latent variable UWRU*A to the dependent variable user satisfaction is significant (t = 2.333, beta = 0.180, p < 0.01) and there is a change in R^2 ($\hat{}R^2$ = 0.015). Then, as we thought, the moderator variable age has an influence on the relationship between utility for work-related use and satisfaction of using a mobile phone by people in household. Hypothesis 3 is therefore also supported. Regarding hypothesis 4 related to the independent variable applications for fun (AF), the scenario is different. The path from the latent variable AF*A to the dependent variable user satisfaction is not significant (t = 0.106, beta = 0.010) but there is a small change in R^2 ($\hat{}R^2$ = 0.002). Contrary to our expectations, the moderator variable age has not an influence on the relationship between applications for fun and satisfaction of using a mobile phone by people in household. As a result, hypothesis 4 is not supported. And the scenario is similar for hypothesis 5 related to the independent variable status gains (SG). The path from the latent variable SG*A to the dependent variable user satisfaction is not significant (t = 0.148, beta = 0.149) but there is a change in R^2 ($\hat{}R^2$ = 0.012). Then, contrary to what we thought, the moderator variable age has not an influence on the relationship between status gains and satisfaction of using a mobile phone by people in household. Consequently, as hypothesis 4, hypothesis 5 is not supported.

In the case of hypothesis 6-a related to the independent variable friends and family influences (FFI), the path from the latent variable FFI*MS*A*I to the dependent variable user satisfaction is significant (t = 2.265, beta = 0.096, p < 0.01) and there is a substantial change in R^2 ($\hat{}R^2$ = 0.028). So, as we expected, the moderator variables marital status, age, and income have an influence on the relationship between friends and family influences and satisfaction of using a mobile phone by people in household. Hypothesis 6-a is then supported. Concerning hypothesis 6-b related to the independent variable secondary sources' influences (SSI), the path from the latent variable SSI*MS*A*I to the dependent variable user satisfaction is very significant (t = 2.843, beta = 0.090, p < 0.005) and there is a huge change in R^2 ($\hat{}R^2$ = 0.033). Thus, as we thought, the moderator variables marital status, age, and income have an influence on the relationship between secondary sources' influences and satisfaction of using a mobile phone by people in household. And hypothesis 6-b is also supported. But the scenario is different for hypothesis 6-c related to the independent variable workplace referents' influences (WRI). The path from the latent variable WRI*MS*A*I to the dependent variable user satisfaction is not significant (t = 0.035, beta = 0.002) but there is a substantial change in R^2 ($\hat{}R^2$ = 0.026). Then, contrary to what we formulated in the hypothesis, the moderator variables marital status, age, and income have not an influence on the relationship between workplace referents' influences and satisfaction of using a mobile phone by people in household. As a result, hypothesis 6-c is not supported.

Regarding hypothesis 7-a related to the independent variable fear of technological advances (FTA), the path from the latent variable FTA*A*I to the dependent variable user satisfaction is very significant (t = 3.364, beta = 0.186, p < 0.001) and there is a huge change in R^2 ($\hat{}R^2$ = 0.039). Thus, as we expected, the moderator variables age and income have an influence on the relationship between fear of technological advances and satisfaction of using a mobile phone by people in household. Hypothesis 7-a is therefore supported. And the scenario is similar for hypothesis 7-b related to the independent variable declining cost (DC). The path from

the latent variable DC*A*I to the dependent variable user satisfaction is significant (t = 1.766, beta = 0.123, $p < 0.05$) and there is a substantial change in R^2 ($\hat{}R^2 = 0.027$). So, as we thought, the moderator variables age and income have an influence on the relationship between declining cost and satisfaction of using a mobile phone by people in household. Consequently, hypothesis 7-b is also supported. But the scenario is different for hypothesis 7-c related to the independent variable cost (C). The path from the latent variable C*A*I to the dependent variable user satisfaction is not significant (t = 0.795, beta = 0.040) but there is a substantial change in R^2 ($\hat{}R^2 = 0.027$). Thus, contrary to our expectations, the moderator variables age and income have not an influence on the relationship between cost and satisfaction of using a mobile phone by people in household. As a result, hypothesis 7-c is not supported.

Finally, concerning hypothesis 8-a related to the independent variable perceived ease of use (PEU), the path from the latent variable PEU*A to the dependent variable user satisfaction is significant (t = 1.635, beta = -0.098, $p < 0.05$) and there is a small change in R^2 ($\hat{}R^2 = 0.003$). So, as we formulated in the hypothesis, the moderator variable age has an influence on the relationship between perceived ease of use and satisfaction of using a mobile phone by people in household. And hypothesis 8-a is then supported. The scenario is similar regarding hypothesis 8-b related to the independent variable self-efficacy (SE). The path from the latent variable SE*A to the dependent variable user satisfaction is significant (t = 1.644, beta = 0.137, $p < 0.05$) and there is a change in R^2 ($\hat{}R^2 = 0.004$). So, as we thought, the moderator variable age has an influence on the relationship between self-efficacy and satisfaction of using a mobile phone by people in household. Consequently, hypothesis 8-b is also supported.

In the next and last section of the paper, we discuss about some implications of the more important findings of the two studies.

DISCUSSION AND CONCLUSIONS

This last section is devoted to a discussion about the more important findings of the two studies and some conclusions. And, to support our discussion and conclusions, we provide the reader with a more detailed view of the PLS structural equation models developed to get the significant variables in the two studies, including the percentage of variance explained by each variable (see Table 5 and Table 6).

Atlantic Canada's Study

As shown in Table 5 (and Figure 2), the nineteen independent variables examined in the study explained 34.7 percent ($R^2 = 0.347$) of the variance in satisfaction in the use of mobile phone by people in household. And we can also see in Table 5 that the nine variables who showed to be significant (see also the significant beta path coefficients in Figure 2), that is, utility for work-related use, utility for security, mobility, applications for fun, declining cost, cost, perceived ease of use, marital status and child's age, explained alone 24.6 percent of the variance

in satisfaction of using a mobile phone by people in household. Thus, these nine variables are assuredly very important factors to take into account in future studies on the mobile phone and on the part of mobile phone providers, and more particularly perceived ease of use and utility for security which explained alone 18.7 percent of this variance (see Table 5). It is very interesting to see here that the two new variables that we added to the Brown and Venkatesh's (2005) research model, that is utility for security and mobility, showed to be very significant ($p < 0.001$ and $p < 0.05$, respectively; see Table 5) in satisfaction of using a mobile phone by people in household. Indeed, this study showed that people are, to some extent, using a mobile phone for a matter of security (the mobile phone is useful for their own security and those of their families) and mobility (the mobile phone provides them with the possibility to use only this telephone to perform all their personal and professional activities). So here are two new variables which we can add to the integrated research model of MATH and household life cycle characteristics suggested by Brown and Venkatesh (2005) to test in future studies. In addition, these two new variables may be included in the sales marketing plan of mobile phone providers.

Table 5 (Atlantic Canada's Study)
Beta Path Coefficients, T-Values, and
Percentages of Variance Explained of Variables

Variable	*Beta*	*t*	R^2
Applications for Personal Use	0.054	0.925	0.002
Utility for Children	-0.039	0.726	0.001
Utility for Work-Related Use	-0.119**	2.263	0.008
Utility for Security	0.210****	4.379	0.104
Mobility	0.079*	1.704	0.004
Applications for Fun	0.089*	1.764	0.004
Status Gains	-0.029	0.511	0.000
Friends and Family Influences	0.022	0.357	0.000
Secondary Sources' Influences	0.015	0.248	0.001
Workplace Referents' Influences	-0.020	0.314	0.000
Fear of Technological Advances	-0.059	0.551	0.005
Declining Cost	0.111**	2.137	0.011
Cost	0.125*	1.794	0.021
Perceived Ease of Use	0.355****	5.180	0.083
Self-Efficacy	-0.019	0.271	0.069
Income	-0.059	0.687	0.001
Marital Status	-0.111*	1.892	0.000
Age	-0.076	0.640	0.014
Child's Age	0.201**	2.323	0.011

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

In the large-scale study in which Brown and Venkatesh (2005) integrated MATH and some household life cycle characteristics (as moderating variables), the integrated model explained 74 percent of the variance in intention to adopt a personal computer for home use, a substantial increase of 24 percent over baseline MATH that explained 50 percent of the variance.

In the present study, we used the integrated model proposed by Brown and Venkatesh (2005). We also added two new independent variables to the model, that is, utility for security and mobility. And we used the household life cycle variables as moderating variables in the research model as did Brown and Venkatesh (2005). Finally, given that we investigated the perceptions of people already using a mobile phone instead of those having the intention to adopt a mobile phone, as did Brown and Venkatesh (2005) for the personal computer, we used the dependent variable user satisfaction instead of behavioral intention. And the model explained 34.7 percent of the variance in satisfaction of using a mobile phone by people in household (see Table 5 and Figure 2). Thus, in this study, our theoretical research model explained a smaller percentage of variance than those explained by MATH alone (without the household life cycle characteristics and using behavioral intention as dependent variable).

Further, in a previous study in which we investigated the intention to buy a mobile phone by people in household (see Fillion & Berthelot, 2007), we also used the theoretical research model suggested by Brown and Venkatesh (2005) to which we added the same two independent variables utility for security and mobility than we included in the present study in which we investigated satisfaction in the use of mobile phone by people in household. And our model explained 50 percent of the variance in intention to buy a mobile phone, while in the present study our model explained 34.7 percent of the variance in satisfaction of using a mobile phone. Of course, the dependent variable was different in the two studies. Indeed, we used behavioral intention in the previous study and user satisfaction in this study. Hence we can see that the variable behavioral intention is probably more appropriate as dependent variable in the research model proposed by Brown and Venkatesh (2005) than is user satisfaction, even when the model is augmented of some new independent variables. Further, with the addition of the life cycle stage variables income, marital status, age and child's age as moderating variables to the model, as did Brown and Venkatesh (2005), to test our research hypotheses, we have just observed a 3.1 percent increase in variance explained, that is, 37.8 percent. However, it is to be noted that, in the model we used in this study, more independent variables showed to be good predictors in satisfaction of using a mobile phone by people in household than did independent variables in the model we used in the previous study in intention to adopt a mobile phone for household use. So, although the result of our test seems, at first, not to be very conclusive, in this study, we found several interesting things to advance knowledge in this new and exciting field of adoption and use of technology in households.

First, we found nine very important variables that seem to be good predictors in satisfaction of using a mobile phone by people in household, and more particularly perceived ease of use, utility for work-related use, declining cost as well as the two new variables that we added to the Brown and Venkatesh's (2005) model, utility for security and mobility (see Table 5). These nine variables are also very important to take into account by mobile phone providers to design new mobile phones still better adapted to people's needs and to perform their sales marketing. Second, we found that people are, to some extent, using a mobile phone for a matter

of security and mobility, given our two new variables utility for security and mobility showed to be very significant (see Table 5). Third, we found that it is probably much more appropriate to use the dependent variable behavioral intention instead of user satisfaction in the model proposed by Brown and Venkatesh (2005), even augmented of our two new independent variables utility for security and mobility, given the percentage of variance explained in intention to adopt a mobile phone for household use in our previous study is relatively higher. But, according to us, it is also appropriate to include user satisfaction as dependent variable in the model given we found more good predictors in satisfaction in the use of mobile phone in this study than in the previous one in which we used behavioral intention as dependent variable. The dependent variable *use behavior* proposed by Thompson et al. (1991) may also be tested in future studies. Also, we suggest the test of new independent variables which may explain a greater percentage of variance in satisfaction of using a mobile phone by people in household in future studies. To that end, we recommend three new independent variables in the next paragraph. Finally, the results of this study provided the evidence that it is far better to use the household life cycle variables as moderating variables in the model, as did Brown and Venkatesh (2005), given the percentage of variance explained in intention to adopt a new technology in household by the model tested by these authors was significantly higher. Indeed, we used the household life cycle variables as moderating variables in the theoretical research model of this study instead of independent variables, as we have made in the previous study, and the percentage of variance explained by the model in satisfaction of using a mobile phone by people in household has been higher.

It would be interesting in future studies to add some other new variables to the actual theoretical research model (those suggested by Brown and Venkatesh (2005) augmented with the two new variables that we tested in the present study, depending on the technology examined naturally) in order to try to explain still more variance in satisfaction of using a new technology in household. For example, the variable *attention* might be added in social outcomes (a lot of people, particularly young and old people, are feeling to be alone in the actual stressing world, in which both men and women are working and get very busy, so the mobile phone might be a good way to communicate with other people every time and everywhere to get the feeling to be less alone), the variable *social norm* might also be added in social outcomes (who knows, people might be using a mobile phone just to do as everybody!), and the variable *control* might be added in utilitarian outcomes (some people might be using a mobile phone to control other people in their family or others; maybe another kind of Big Brother!). It would be also interesting to test the actual model in other situations and with other populations. For example, in a subsequent study, we tested the actual model with Atlantic Canadian people who are using high speed Internet at home. As in this study, we used the dependent variable user satisfaction given the respondents were already using high speed Internet.

Regarding the limitations of this study, as pointed out by Brown and Venkatesh (2005), the primary limitation is the reliance on a single informant. It is possible that other members of the household would have provided different responses concerning the motivations to use a

mobile phone at home. Future research in household use of technology should incorporate responses from multiple members of the household to truly assess the nature of household use. A second limitation of the study is that it was conducted in only one area in Atlantic Canada. If the study would have been carried out in the whole Atlantic Canada, its results would be of a higher level of generalization. But the fact that the sample of the study was a randomized sample allows a high level of generalization of its results. Another limitation of the study is the administration of the survey instrument over the telephone. Some respondents might have not very well understood some items of the survey instrument over the telephone and then provided more or less precise ratings on these items, introducing the possibility of some response bias. But the method we privileged in this study to administer the survey instrument is not an exception to the rule: each method has its own limitations!

Cameroon Africa's Study

Table 6 (Cameroon Africa's Study)
Beta Path Coefficients, T-Values, and
Percentages of Variance Explained of Variables

Variable	***Beta***	***t***	***R^2***
Applications for Personal Use	-0.012	0.237	0.001
Utility for Children	0.038	0.866	0.000
Utility for Work-Related Use	0.003	0.071	0.000
Utility for Security	0.009	0.263	0.000
Mobility	0.179****	4.712	0.024
Applications for Fun	0.163****	4.202	0.067
Status Gains	0.082*	2.019	0.088
Friends and Family Influences	0.005	0.113	0.025
Secondary Sources' Influences	0.118****	3.344	0.029
Workplace Referents' Influences	0.139****	3.336	0.020
Fear of Technological Advances	0.026	0.719	0.002
Declining Cost	0.035	0.943	0.002
Cost	0.040	1.003	0.003
Perceived Ease of Use	0.228****	4.723	0.175
Self-Efficacy	0.160****	3.653	0.024
Income	0.087****	3.115	0.008
Marital Status	0.025	0.672	0.015
Age	-0.015	0.540	0.000
Child's Age	0.046*	1.499	0.008

*$p < 0.05$; ****$p < 0.001$ (one-tailed test).

As shown in Table 6 (and Figure 3), the nineteen independent variables examined in the study explained 49.1 percent ($R^2 = 0.491$) of the variance in satisfaction in the use of mobile phone by people in household. And we can also see in Table 6 that the nine variables who showed to be significant (see also the significant beta path coefficients in Figure 3), that is, mobility, applications for fun, status gains, secondary source's influences, workplace referents' influences,

perceived ease of use, self-efficacy, income, and child's age explained alone 44.3 percent of the variance in satisfaction of using a mobile phone by people in household. Thus, these nine variables are assuredly very important factors to take into account in future studies on the mobile phone and on the part of mobile phone providers, and more particularly perceived ease of use, status gains and applications for fun which explained alone 33 percent of this variance (see Table 6). It is very interesting to see here that one of the two new variables that we added to the Brown and Venkatesh's (2005) theoretical research model, that is mobility, showed to be very significant ($p < 0.001$) in satisfaction of using a mobile phone by people in household. Indeed, this study showed that people are, to some extent, using a mobile phone for a matter of mobility (the mobile phone provides them with the possibility to use only this telephone to perform all their personal and professional activities). So here are a new variable that we can add to the integrated research model of MATH and household life cycle characteristics suggested by Brown and Venkatesh (2005) to test in future studies. In addition, this new variable may be included in the sales marketing plan of mobile phone providers.

In the large-scale study in which Brown and Venkatesh (2005) integrated MATH and some household life cycle characteristics (as moderating variables), the integrated model explained 74 percent of the variance in intention to adopt a personal computer for home use, a substantial increase of 24 percent over baseline MATH that explained 50 percent of the variance. In the present study, we used the integrated model proposed by Brown and Venkatesh (2005). We also added two new independent variables to the model, that is, utility for security and mobility. And we used the household life cycle variables as moderating variables in the research model as did Brown and Venkatesh (2005). Finally, given that we investigated the perceptions of people already using a mobile phone instead of those having the intention to adopt a mobile phone, as did Brown and Venkatesh (2005) for the personal computer, we used the dependent variable user satisfaction instead of behavioral intention. And the model explained 49.1 percent of the variance in satisfaction of using a mobile phone by people in household (see Table 6 and Figure 3). As a result, in this study, our theoretical research model explained the same percentage of variance than those explained by MATH alone (without the household life cycle characteristics and using behavioral intention as dependent variable).

Further, in a previous study in which we investigated the intention to buy a mobile phone by people in household (see Fillion & Berthelot, 2007), we also used the theoretical research model suggested by Brown and Venkatesh (2005) to which we added the same two independent variables utility for security and mobility than we included in this study in which we investigated satisfaction in the use of mobile phone by people in household. And our model explained 50 percent of the variance in intention to buy a mobile phone, exactly as in this study where our model explained 50 percent of the variance in satisfaction of using a mobile phone. Of course, the dependent variable was different in the two studies. Indeed, we used behavioral intention in the previous study and user satisfaction in the present study. Hence we can conclude that the variable user satisfaction is as much appropriate as dependent variable in the theoretical research

model suggested by Brown and Venkatesh (2005) than is behavioral intention. In addition, in the model we used in this study, more independent variables showed to be good predictors in satisfaction of using a mobile phone by people in household than did independent variables in the model we used in the previous study in intention to adopt a mobile phone for household use. Finally, in this study, we found several interesting things to help advance knowledge in this new and exciting field of adoption and use of technology in households.

First, we found nine very important variables that seem to be good predictors in satisfaction of using a mobile phone by people in household, and more particularly perceived ease of use, status gains and applications for fun, as well as one of the two new variables that we added to the Brown and Venkatesh's (2005) model, mobility (see Table 6). These nine variables are also very important to take into account by mobile phone providers to design new mobile phones still better adapted to people's needs and to perform their sales marketing. Second, we found that people are, to some extent, using a mobile phone for a matter of mobility, given our new variable mobility showed to be very significant (see Table 6). Third, we found that it is as much appropriate to use the dependent variable user satisfaction than the dependent variable behavioral intention in the research model proposed by Brown and Venkatesh (2005), given the percentage of variance explained in intention to adopt a mobile phone for household use in our previous study is similar to those of using a mobile phone in household in this study. The dependent variable *use behavior* proposed by Thompson et al. (1991) may also be tested in future studies. Also, we suggest the test of new independent variables that may explain a greater percentage of variance in satisfaction of using a mobile phone by people in household in future studies. To that end, we recommend three new independent variables in the next paragraph. Finally, the results of this study provided the evidence that it is far better to use the household life cycle variables as moderating variables in the research model, as did Brown and Venkatesh (2005), given the percentage of variance explained in intention to adopt a new technology in household by the model tested by these authors was significantly higher. Indeed, we used the household life cycle variables as moderating variables in the theoretical research model of this study instead of independent variables, as we have made in two previous study (see Fillion & Berthelot, 2007; Fillion & Le Dinh, 2008; Fillion & Booto Ekionea, 2010), and the percentage of variance explained by the model both in intention to adopt a mobile phone and in satisfaction of using a mobile phone by people in household has been each time higher (up to 4 percent higher).

It would be interesting in future studies to add some other new variables to the actual theoretical research model (those suggested by Brown and Venkatesh (2005) augmented with the two new variables we tested in several previous studies (see Fillion & Berthelot, 2007; Fillion & Le Dinh, 2008; Fillion & Booto Ekionea, 2010), depending on the technology examined naturally, in order to try to explain still more variance in satisfaction of using a new technology in household. For example, the variable *attention* may be added in social outcomes (a lot of people, particularly young and old people, are feeling to be alone in our actual stressing world, in which both men and women are working and get very busy, so the mobile phone may be an excellent way to

communicate with other people every time and everywhere to get the feeling to be less alone), the variable *social norm* may also be added in social outcomes (who knows, people may be using a mobile phone just to do as everybody!), and the variable *control* may be added in utilitarian outcomes (some people may be using a mobile phone to control other people in their family or others; may be another kind of Big Brother!). It would be also interesting to test the actual theoretical research model in other situations and with other populations.

Regarding the limitations of this study, as pointed out by Brown and Venkatesh (2005), the primary limitation is the reliance on a single informant. It is possible that other members of the household would have provided different responses concerning the motivations to use a mobile phone at home. Future research in household use of technology should incorporate responses from multiple members of the household to truly assess the nature of household use. A second limitation of the study is that it was conducted in a limited area of Cameroon. If the study would have been carried out in the whole Cameroon, its results would be of a higher level of generalization. But the fact that the sample of the study was a randomized sample allows a high level of generalization of its results. Another limitation of the study is the administration of the survey instrument in-person by three different research assistants. Some respondents may have differently understood some items of the survey instrument depending on different explanations from the part of the three research assistants and then provided more or less precise ratings on these items, introducing the possibility of some response bias. But the method we privileged in this study to administer the survey instrument is not an exception to the rule. Each method has its strengths and limitations.

To conclude, we can see that the significant variables are relatively different in the two studies (Atlantic vs. Cameroon). Indeed, the comparison of the two studies clearly shows that Cameroonian people are not using the mobile phone for all the same reasons than Atlantic people. So this is an extremely interesting and useful finding. But much more research will be needed on the use of technology in households in order to better understand its impacts on people's daily life. The research will allow, among others, at least to minimize, if not to remove, some negative impacts of technology in people's daily life in the future and to develop new technologies still better adapted to people's needs. So we will continue to inquire into this very exciting field.

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