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Senior executives' use of information technology

Guus G.M. Pijpers[a,*], Theo M.A. Bemelmans[b,1], Fred J. Heemstra[c,2], Kees A.G.M. van Montfort[d,3]

[a]*Philips Electronics, Corporate Purchasing, Zwaanstraat 1, Building TAM, P.O. Box 218, 5600 MD Eindhoven, The Netherlands*
[b]*Eindhoven University of Technology, Technology Management, Department Information and Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands*
[c]*Open University, Department of Economics, Business and Public Administration, P.O. Box 2960, 6401 DL Heerlen, The Netherlands*
[d]*Free University, Faculty of Economics and Econometrics, Department of Econometrics, De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands*

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Abstract

There is a paucity of literature focusing on the ingredients for effective top management, i.e. senior executives, use of Information Technology (IT). In practice, many senior executives argue that they do not see a connection between what IT does and their tasks as executives. Based on the Technology Acceptance Model (TAM), a research model was developed and tested to assess the factors that influence the use of IT by senior executives. A dedicated system supporting the task of a senior executive, an Executive Information System (EIS), was used as the IT tool under review. A large number of external variables were identified and hypothesized, influencing the core elements of TAM. To test the research model using structural equation modeling, cross-sectional data was gathered from eighty-seven senior executives drawn from twenty-one European-based multinationals. The results supported the core TAM and found only a small number of antecedent variables influencing actual use, either directly or indirectly. In addition to identifying the external factors, three of these key variables are under managerial control. They can be used to design organizational or managerial interventions that increase effective utilization of IT.

Keywords: Technology acceptance model; Senior executives; IT usage

1. Introduction

The primary task of senior executives is to manage and control their business. As Mintzberg [28] indicates "In almost every serious study of managerial work the formal information — in other words, information capable of being processed in a computer — does not play a dominant role. Oral information — much of it too early or too 'soft' to formalize, such as gossip and hearsay — and even nonverbal information forms a critical part of every serious managerial job". Davenport [8] argues as one of his 'information facts of life' that "managers prefer to get information from people rather than computers; people add value to raw information by interpreting it and adding context". One could assume, therefore, that it would be in the interests of senior executives to receive adequate information for decision-making rather than be knowledgeable about Information Technology (IT), the main management information tool. Also, one could argue that senior executives need not be involved with how IT is used in an organization, but rather with its deployment.

Senior executives are constantly being told that IT is the key to the success of the business, yet the so-called IT productivity paradox leads managers to believe that investments in IT are reaching unprecedented levels with no commensurate increase in productivity. To measure whether IT investments deliver value, we must assume the technology is being adopted and properly used. Few organizations get full value from their IT investments, either because people have not learned how to use technology well or because managers have not been taught how to manage its benefits [31]. A reason for the poor return on IT investments could be the lack of senior executive involvement in using IT and its applications. Consequently, they have not been able to experience the

* Corresponding author. Tel.: +31-40-278-3689, fax: +31-40-278-7481.
E-mail addresses: guus.pijpers@philips.com (A.G.M. Pijpers), t.m.a.bemelmans@tm.tue.nl (T.M.A. Bemelmans), fred.heemstra@ou.nl (F.J. Heemstra), kvmontfort@feweb.vu.nl (K.A.G.M. van Montfort).
[1] Tel.: +31-40-247-2290; fax: +31-40-243-2612.
[2] Tel.: +31-45-576-2589; fax: +31-45-576-2103.
[3] Tel.: +31-20-444-6028; fax: +31-20-444-6020.

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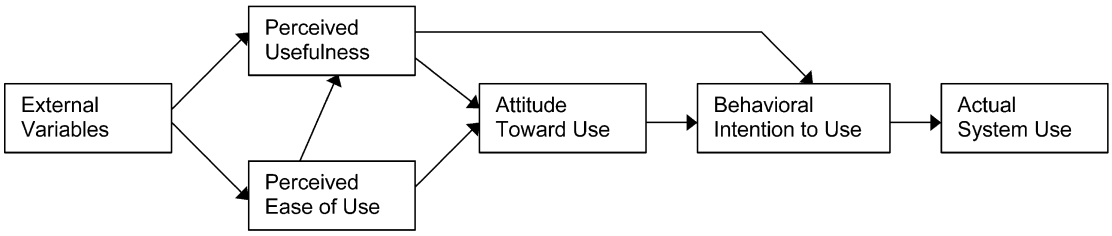

Fig. 1. Technology Acceptance Model.

benefits at first hand. As a result, attitudes remain unchanged.

It could be argued when investigating the acceptance and use of IT that senior executives do not warrant special attention, especially because they form only a small percentage of the total user population. However, recent studies indicate that these individuals should be treated differently [16,22,36]. What distinguishes senior executives' work in particular is the willingness to adopt and use IT, the role model position, the confidentiality and integrity of the information they have access to, and their external orientation, and, hence, the IT tools they require. Senior executives as a rule have limited time to make themselves familiar with all features of any of the information technologies. They are basically indifferent regarding the IT tool as long as they receive the information they need for their decision-making process. It is therefore likely that past studies aimed at assessing the factors that influence end-user adoption of IT, will not hold per se for these executives. Also, their position and role in the organization and the nature of their duties and social/organizational relationship differs from the other members of the company.

In spite of the interest in IT in recent years, little is known about the forces that influence its use or the factors determining senior executive resistance to IT [41].Most research of IT acceptance and use does not distinguish senior executives as a separate group. Moreover, to date, most studies use generic tools as word processors or e-mail systems as IT tools under review. This study sought to identify key factors and relationships likely to influence the use of IT by senior executives, in which IT is restricted to the role of a dedicated tool for senior executives, in other words an Executive Information System (EIS). An EIS was introduced as a support tool for senior executives at the beginning of the eighties. To make effective use of an EIS, managers must accept it, learn how to interact directly with aspects of the hardware and software, and adapt it to their requirements.

The study had a number of objectives:

1. What are the major factors that influence senior executives' use of IT, and in particular an EIS?
2. Which of these factors influence the actual use of an EIS, either directly or indirectly through user beliefs and attitude?
3. Is there a parsimonious model to predict senior executives' use of IT?

Grounded in a well-established theory, the study used a heterogeneous sample of multinational companies that can be expected to have ample experience with IT. Investigating the antecedents of IT acceptance and use will help in identifying what interventions are required to increase the use of IT. Effective and increased use of managerial IT tools will give senior executives improved access to better information, leading in turn to more effective decision-making in their jobs.

The remainder of this paper is organized as follows. Section 2 begins with an elucidation of the Technology Acceptance Model. This will be followed by the research model and hypotheses, which are based on the TAM. Then the methodology of the study is described, followed by the results of our analysis. Section 2 introduces a practical application of the results. Finally, the paper ends with a discussion and conclusion.

2. The Technology Acceptance Model

Different models have been used over the last ten to twenty years as a basis for investigating the acceptance and use of IT. The most salient models include the Innovation diffusion theory [29,33], the Theory of Reasoned Action (TRA, [3,13]), and the TAM, [9,11]. Of these models, the TAM (Fig. 1), originally developed by Davis [9] to predict computer-usage behavior, has emerged as a powerful model. The goal of TAM is to provide an explanation of general determinants of computer acceptance that would help explain user behavior across a broad range of end-user computing technologies and user populations [11]. The model was originally developed to predict and explain future user behavior based on simple measures taken after a very brief period of interaction with a system. Subsequent research has used and extended the model for various situations, both when introducing new information technologies as well as for explaining the use of IT that has already been implemented (Fig. 1).

Neither Davis [9] nor Davis et al. [11] fully investigated the external factors in their model. Furthermore, very little research to date has looked at these external variables for their influence on usage behavior as mediated by the belief and attitude constructs, although recent studies found a number of variables [42,43]. If usage is to improve, first and foremost the variables actually influencing the

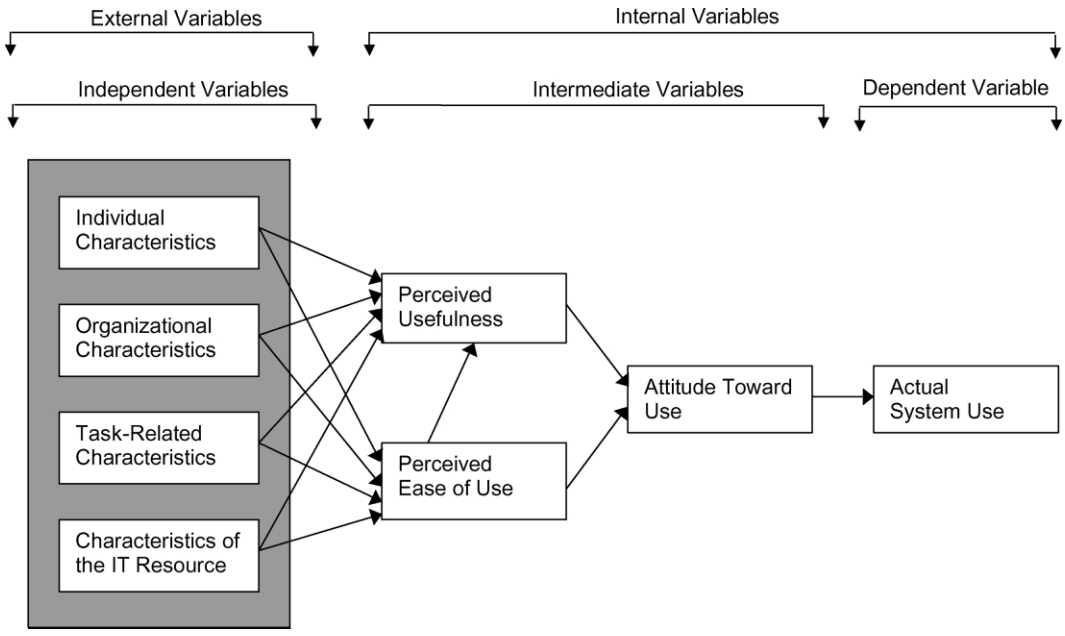

Fig. 2. Theoretical research model.

formation of beliefs in technology acceptance must be identified. As Agarwal and Prasad [2] purport external variables are the only channels for influencing behavior as the intermediate and dependent variables in TAM are hypothesized to be an internal psychological process. The TAM is derived from TRA [3,13]. With TAM, 'The goal is to [be] … capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified' [11]. In TAM, actual system use is determined by behavioral intention to use. In turn, this behavior is related to attitude towards using the system. There is also a relationship with perceived usefulness and behavioral intention to use. TAM asserts that the influence of external variables upon user behavior is mediated through user beliefs and attitudes. *Beliefs* denote a degree of instrumentality tied to an action whereas *attitudes* are purely affective. Beliefs relate to an individual's subjective assessment that performing some behavior will result in a specific consequence, whereas attitudes relate to an individual's positive or negative affective feelings about performing the behavior.

Davis [9] posits that two salient beliefs determine attitudes towards using the system: perceived usefulness (PU) and perceived ease of use (PEOU). Within TAM, PU is defined as 'the degree to which a user believes that using the system will enhance his or her performance'. PEOU is defined as 'the degree to which the user believes that using the system will be free from effort'. According to Davis, PEOU has a direct influence on PU. Finally, the original TAM indicates that PU and PEOU are also determined by external variables. An important purpose of TAM is to provide a basis for tracing the impact of external factors on internal beliefs, attitudes, and intentions. Davis et al. [11] state that representing beliefs separately allows the researcher to trace the influence of these external variables on ultimate behavior more effectively. From a practical standpoint, it enables an investigator to formulate improved strategies for influencing user acceptance via controllable external interventions.

Various researchers and practitioners (see Refs. [14,32 for an overview) have empirically tested TAM, using different methodologies, IT resources, and subjects. To date, TAM has accumulated fairly satisfactory empirical support. Most studies used the original TAM, whereas others adapted TAM to gain new insights. Furthermore, most of the studies showed that the two salient beliefs, PU and PEOU, predict actual system usage. Most researchers use TAM to provide insights into the acceptance of computer technology, focusing on the determinants of usage rather than on the external factors affecting these determinants (PEOU, PU, and attitude).

3. Research model and hypotheses

The focus of this study is exclusively on senior executives and their use of an EIS. In the available literature on TAM studies, a few studies [1,16,20,21,22,23] targeted senior executives, next to other user groups, in their user populations. Based on the original TAM the theoretical research model is presented in (Fig. 2). The major difference with the original TAM is the exclusion of one variable-behavioral intention to use — from the research model. The constituent TAM model elements have evolved over time [9,10,11], most notably by excluding the behavioral intention to use

Table 1
Summary of hypotheses

Construct	No.	Relationship
A. Individual characteristics		
Demographics		
Age	H.A.1	Negative
Gender	H.A.2	Men more positive than women
Education	H.A.3	Positive
Managerial and IT knowledge		
Professional experience	H.A.4	Positive
Computer (IT) experience	H.A.5	Positive
Computer (IT) training	H.A.6	Positive
Personality of the manager		
Cognitive Style — Brain	H.A.7	Analytical and directive cognitive styles more positively in their attitude than conceptual and behavioral cognitive styles
Cognitive style — Orientation	H.A.8	Analytical and conceptual cognitive styles more positively in their attitude than directive and behavioral cognitive styles
Computer anxiety	H.A.9	Negative
Computer self-efficacy	H.A.10	Positive
Individual culture	H.A.11	Cultural influences
User involvement	H.A.12	Positive
Perceived fun/enjoyment	H.A.13	Positive
B. Organizational characteristics		
Company characteristics		
Organizational structure	H.B.1	A high degree of centralization and formalization negative
Organizational size	H.B.2	Positive
IT maturity	H.B.3	Positive
Organizational support	H.B.4	Positive
Social factors		
Organizational culture	H.B.5	Cultural influences
Organizational usage	H.B.6	Positive
Social pressure	H.B.7	Positive
Environmental characteristic		
Environmental uncertainty	H.B.8	Positive
Competitor behavior	H.B.9	Positive
C. Task-related characteristics		
Task difficulty	H.C.1	Positive
Task variability	H.C.2	Positive
D. Characteristics of the IT resource		
Accessibility	H.D.1	Positive
Implementation process	H.D.2	Positive
User interface	H.D.3	Positive
Mediating variables		
Perceived ease of use	H.M.1	Positive to perceived Usefulness
Perceived ease of use	H.M.2	Positive to attitude toward use
Perceived usefulness	H.M.3	Positive to attitude toward use
Attitude toward use	H.M.4	Positive to use of the EIS

construct when actual or self-reported usage measures are available. Other researchers [1,4,29,39] also dropped behavioral intention to use because they were interested in actual behavior (system usage) and not intentions. Moreover, behavioral intention to use is dealing with future behavior, whereas in our model acceptance of the IT tool has already taken place. However, Davis' representations of TAM have always included an attitudinal construct. The attitude towards use construct is essential because TAM asserts that the principal influence of the belief constructs is on attitudes that subsequently influence usage behavior, rather than on usage behavior directly (Fig. 2).

Venkatesh and Davis [42,43] identified antecedent variables of PU and PEOU. Other researchers also have attempted to identify external variables, which might influence beliefs, attitude toward use, and system usage, although few studies have been conducted on senior executive behavior toward information technologies. A number of studies using TAM identified numerous external variables, yet no consistent groups of variables have been found. Apart from TAM, several other research areas were used as research perspectives for the present study, e.g. innovation theory, management support systems, and personal computers. The extensive literature analysis resulted in a large

Table 2
Respondent demographics

Item	Mean	S.D.
Age (range: 26–64)	40.47	8.21
Years of work in present firm (job tenure)	11.53	8.11
Years of work in present position	3.86	3.94
Years of work in a managerial position	8.45	6.20

number of variables and relationships with regard to the theoretical research model. These variables have been posited or demonstrated to be associated with perceptions, attitudes toward IT or system usage in previous research. A review of the relevant literature [32] also suggest the external, independent variables can be categorized into (A) individual characteristics, (B) organizational characteristics, (C) task-related characteristics, and (D) characteristics of the IT resource (Table 1). Each category is further broken down into subcategories, if applicable. The internal variables were all taken from the original TAM (Table 1).

As can be seen in Table 1, 27 external variables were found in relevant research and were hypothesized influencing the two belief constructs. The relationship between each variable and the belief construct is taken from evidence in literature. Although one might expect certain variables to be more important than others, it is assumed in this model that all external variables are not correlated. Section 8 of this article deals with the validity of this assumption. Table 1 shows all variables and their relationships, which form the basis for the hypotheses to be examined.

4. Methodology

4.1. Sample and procedure

This section describes the research method used to test the research model and hypotheses. The research approach seeks to justify its appropriateness in the context of the study. The following characteristics describe the research process. The study used descriptive and exploratory methods to investigate and evaluate the factors influencing executives' use of IT, as well as an explanatory method to achieve a parsimonious model for investigating relationships between different aspects of the phenomenon under review. The unit of analysis is at the individual level, studied at one point in time. Given the limited time available to most senior executives and the time required for a longitudinal study, it was decided that this cross-sectional approach would be most appropriate. Prospective participating organizations were subject to a number of criteria for the purpose of this study, For instance, the EIS system as part of an ERP system with a large market share, had to have been in operation for some time. The sample method used to identify the participating organizations can best be described as purposive sampling, because the sample elements are regarded as best representing the target population.

It is clear that field studies conducted in an organization produce superior results to a laboratory study. This is because in a field setting an EIS is an integral part of the manager's job. Furthermore, a properly defined field study offers the researcher the opportunity to test the theory in realistic settings so as to best understand a senior executive's attitude and behavior. One possible drawback is the relatively uncontrolled environment. By carefully selecting the subjects and technology used, concerns about the issue of control can be mitigated. Initially, two alternatives for data collection were considered, (1) a survey and (2) a personal interview. Given the research model, a great deal of information needed to be gathered from respondents. As managers are difficult to get hold off and often do not have time available for in-depth interviews, it was decided to use a questionnaire to test the research model and its hypotheses.

Both a pretest and a pilot test were conducted to assess the quality of the English questionnaire. For the field study, a number of organizations were identified as prospective candidates. A sponsoring manager was sought to represent each organization. This sponsoring manager was, first and foremost, selected because he or she had sufficient understanding of the willingness to participate, access to the right managerial level, and was most likely or best equipped to persuade busy senior executives to take part in the survey. A total of 314 questionnaires were sent to 31 companies for distribution by their designated contact persons. Senior executives were carefully selected by the contact persons. The data for this study was gathered during the spring and summer of 1999. A total of 87 usable questionnaires were returned, a response rate of 27.7%.

4.2. Measures

The operationalization of the constructs is based, where possible, on existing construct measures were taken from previous research. In some instances, existing measures have been adapted, while in other constructs changes in the wording have been made.

4.3. Data analysis

Table 2 gives general information about the respondents. The population was comprised of senior executives, because nearly all of the participating companies were European multinationals, and the majority of respondents are one or two levels below the Board of Management (Table 2).

The research model depicted in Fig. 2 was analyzed using the Structural Equation Modeling (SEM) technique, supported by AMOS 4.0 software, a SPSS statistical software package module. SEM estimates a series of separate, but interdependent, multiple regression equations simultaneously and consists of a number of statistical techniques that can be used in various theoretical models. When applying SEM, many researchers [17,19,25,27,35] propose a two-stage process, (1) estimating the measurement model, and

(2) investigating the structural model. In a measurement model an investigation into the structure between indicators (items or questions) and constructs is carried out. A number of indicators are taken together to represent one construct. In practice, at least four to five indicators for each construct are recommended [17], as it is often necessary to omit a number of indicators to arrive at a suitable measurement model. Testing the measurement models means estimating the reliability coefficients and validity of the instruments. The measurement model is then modified to create the 'best' model and the structural equation model is analyzed. The structural model specifies the causal relationships (paths) between the constructs as posited by underlying theories. Together, the structural and the measurement models form a network of constructs and measures. The item weights and loadings indicate the strength of measures, while estimated path coefficients indicate the strength and sign of the theoretical relationship.

Contrary to the theoretical considerations above, this study uses a dedicated approach for the analysis process of the various models. Before SEM can take place, the theoretical model needs to be elucidated further. As can be seen from Fig. 2 and Table 1, 27 external variables are hypothesized influencing the two belief constructs. Even when we take into account the constructs not used in the remainder of the modeling process, a large number of external variables still remain to be assessed in addition to the intermediate and dependent constructs. As Hair et al. [17] note, the desire to include all variables must be balanced against the practical limitations of SEM. They therefore recommend limiting the number of concepts to 20 otherwise interpreting the results becomes more difficult.

As approach for this part of the research process, all external variables were grouped into submodels, typically corresponding to the eight categories identified (see Table 1: e.g. demographics, social factors). These submodels were used to evaluate the significance of each external variable in the submodel (e.g. for the demographics submodel: age, gender, education), which suggests that this variable would also have a significant impact in the total model as represented in Fig. 1. Of course only the measures that 'passed' the measurement modeling phase, were used in the submodels. Clearly, a single-stage analysis is the best approach. This is possible because of the strong theoretical rationale and highly reliable measures [17] of the theoretical model, which is also confirmed by the results of the measurement model.

5. Results

5.1. Measurement model

Initial screening indicated that the data were normally distributed, outliers were not detected, and the sample size was slightly above the recommended value [17]. Furthermore, initial data screening led to four constructs being dropped from the model to be tested, due to variance and correlation concerns. The dependent variable, system use, indicated a major concern. A significant negative correlation exists between the usage frequency and the usage amount for the population under review. Given the nature of the EIS system, typically used for ad hoc information at dedicated times with relatively long intervals (e.g. weeks), it does not come as a surprise. In light of the importance of the system use construct in the study, it was decided to revise the model to incorporate both indicators. The dependent variable was divided in two absolute usage indicators, (1) usage frequency and (2) usage amount.

In this study we distinguished between content validity, the extent to which the items are a good measure of the domain of each variable, and construct validity, the extent to which an instrument measures what it is intended to measure. Two important dimensions of construct validity are (a) convergent validity and (b) discriminant validity [20]. Convergent validity is the extent to which each measure correlates with other measures of the same construct [5] and is assessed by analyzing the factor loading score for each item. Most items loaded satisfactorily, at around 0.30 or more, in line with the recommended value of Hair et al. [17]. Discriminant validity is the extent to which each measure of a construct does not correlate with the measures of other constructs [5]. This is assessed by examining the correlations of potentially overlapping constructs. The correlations of any pair of measures did not exceed the criterion (0.90 and above) as suggested by Hair et al. [17], which implies that there is no multicollinearity between the various constructs. Reliability, measured by Cronbach's alpha, refers to the consistency of the measurement. After deleting a few indicators from constructs that initially represented a low alpha score, the scale reliabilities were generally found to be exceeding the recommended value of 0.50 [17].

5.2. Structural model

The next phase in the research is to assess the structural model using the revised measurement model. One of the objectives of this study is to examine the influence of the external variables both directly *and* indirectly on actual usage. To investigate this notion, three structural models were defined to introduce direct links between each of the external variables and the two belief constructs, the two dependent variables, usage frequency and usage amount, and the attitude construct. Model 1 consisted of the core TAM model and direct relationships of all external variables and both belief constructs. Next to these relationships, additional relationships between all external variables and the two usage variables were introduced in model 2. Finally, model 3 consisted of direct relationships between all external variables and the beliefs, usage, and attitude constructs. Note that the three models are different — they are not

Table 3
Comparison of goodness-of-fit measures

Goodness-of-fit measure	Recommended value	Model 1	Model 2	Model 3
Chi-square/degrees of freedom	≤ 3.0	1.884	1.686	1.685
Goodness-of-fit index (GFI)	≥ 0.90	0.509	0.550	0.564
Adjusted goodness-of-fit index (AGFI)	≥ 0.80	0.456	0.489	0.504
Normed fit index (NFI)	≥ 0.90	0.382	0.426	0.457
Comparative fit index (CFI)	≥ 0.90	0.552	0.627	0.658
Root mean square error of approximation (RMSEA)	≤ 0.05	0.101	0.089	0.089

nested in any way — but the results will be compared at the end of this section to select the best theoretical model. The theoretical model in Fig. 2 was used to test the various relationships, the hypotheses, between the constructs. The assessment was conducted using the Maximum Likelihood estimation procedure. The statistical significance of the regression coefficients was determined using the t-statistics procedure.

As mentioned, a single-stage analysis was conducted for the various submodels. The results of assessing the submodels indicated a number of constructs had no significance at all. This meant that only 16 of the original 27 variables were further tested in the three research models. The best theoretical model was assessed with a number of goodness-of-fit indices, as recommended by various authors [5,18,35]. The squared multiple correlation coefficient (R^2) was assessed, which provides a measure of the predictive power of the model and the fit of the structural part of the model. Results indicate the values of R^2 in all three models are high to very high.

The recommended values and the actual values found in this study are summarized in Table 3. Interpreting the contents of Table 3 leads to the following results. The chi-square/degrees of freedom indicator is below the recommended value and indicates a good fit. Most other fit indices indicate a reasonable fit of model and data. In consecutive models, the actual fit values improve, yet still not near or above the recommended values. In a discussion on the use of SEM in management information systems research, Ref. [6] notes that models with good fit indices may still be considered poor based on other measures such as R^2 and factor loadings. In our case, the path coefficients and R^2 values indicate a good to very good fit. In any case, interpreting the results should be done carefully (see also Table 4).

The third model includes all significant relations of the two other models and is the 'best' model available. Table 4 shows this model, where, for reasons of clarity, only significant relationships are reported. The table below shows that a number of external variables had a significant effect on

Table 4
Estimates of the parameters of structural equation model 3. (*$p < 0.05$, **$p < 0.01$ or better)

From	To				
	Perceived usefulness	Perceived ease of use	Attitude toward use	Actual usage frequency	Actual usage amount
Age	−0.479*	−0.438**		0.785**	0.873**
Gender				0.144**	
Education	0.318**	0.272**		0.350**	
Professional experience	0.132*			−0.112*	−0.191**
Computer (IT) experience[a]					
Cognitive style — Brain			0.270**		
Cognitive style — Orientation[a]					
Computer anxiety		−0.197**			
Perceived fun/enjoyment	0.568**	0.413**		−0.465**	0.208**
Organizational size	−0.127**				0.191**
IT maturity[a]					
Organizational support				0.218**	
Social pressure[a]					
Accessibility	0.340**	0.362**			
Implementation process					−0.126*
User interface[a]					
Perceived usefulness			0.466**		
Perceived ease of use			0.305*		
Attitude toward use				0.284**	−0.105*
R^2	0.881	0.839	0.631	0.830	0.924

[a] constructs were tested but showed no significant relationship.

Table 5
Characteristics of the controllable external variables

External variable	Values	Perceived usefulness	Perceived ease of use	Attitude toward use	Actual system use
Computer self-efficacy	low		low		
	high		high		
Perceived fun/enjoyment	low	low	low		low
	high	high	high		high
Organizational support	low				low
	high				high

PU, PEOU, and attitude. The results also show that there are only a few variables directly influencing usage frequency or usage amount. Furthermore, five constructs that were tested showed no significant relationship in either of the three structural models. As hypothesized, attitude toward use was determined jointly by PU and PEOU. Consistent with most research in TAM both PU and PEOU exhibit roughly equivalent influence on the acceptance and use of an EIS. The hypothesis that PEOU is a significant predictor of perceived usefulness was however, not confirmed. A possible explanation in this study is that ease of use is only significant during the early stages of an EIS's use and becomes less important with increased exposure to the technology [37]. Senior executives have to get used to a new system; so an easy to use interface is probably beneficial in determining their perceptions about the system's functionality. Another plausible explanation is that senior executives want to spend as little time as possible learning about the EIS to be able to use it properly. Ease of use is not perceived to them to be related to the functionality of the EIS — i.e. its usefulness — because it interferes with their daily routine and managerial tasks. Finally, attitude had a positive relationship with usage frequency and a negative relationship with usage amount. An explanation consistent with the context of this study is that the majority of EIS systems investigated usually had a weekly or monthly information cycle. Research data shows that more than half the respondents used the EISs control function. Indicating in other words that work is carried out at regular intervals for a limited amount of time.

In conclusion, several general and important inferences can be made. First, the core TAM model has been corroborated in this study with one difference, the path between PEOU and PU. Second, of the eight subcategories used to classify the 27 external variables, three categories — social factors, environmental characteristics, and task-related characteristics — had no variable with a significant relationship. Third, although various other studies showed a number of external variables influencing the two beliefs, this study could not confirm this relationship. Fourth, it was surprising to see that most significant variables originated in the individual characteristics category. Finally, we have to pay attention to the sample size of our analysis. The sample size is equal to 87, while there are about 27 unknown structural equation coefficients in the most extended model. Our sample size is not that large using the role of five respondents for each unknown regression coefficient. This can cause sampling errors in the estimation procedure. Therefore, we have to be careful to make conclusions. Only t-values with probability levels smaller than 0.05 can give strong confidence for real non-zero regression coefficients.

6. Practical application

Based upon the results of the study, a new model was built that can predict how senior executives will use IT. The model should help to identify what interventions are required to increase the use of IT. Effective and increased use of managerial IT tools will give senior executives improved access to better information, leading in turn to more effective decision-making in their jobs. In the evaluation on which variables and relationships, described in Table 4, should be included in the model, different sets of variables were identified. First, the variables gender and organizational size were excluded from the model due to sample data reasons. Gender was excluded because 87% of the total population were male and the answers for organizational size were unlikely to reflect the size of the company. Second, the variables accessibility and implementation process were denoted as prerequisites for effective use of an IT tool and, hence, used as background information. Four variables were denoted as an uncontrollable set of variables — age, education, professional experience, and cognitive style. Uncontrollable means these variables, such as age or professional managerial experience, cannot be easily manipulated. Cognitive style is innate and therefore hard to influence, whereas education is completed long before the senior executive has achieved his present position. The final three variables are described as controllable — computer self-efficacy, perceived fun/enjoyment, and organizational support. Controllable variables means that one can influence or even manipulate factors as part of a goal or objective to improve knowledge, change perceptions or increase use. Computer anxiety, a negative affective response, represents the feelings of apprehension or anxiety that one experiences when using computers, was replaced in the model by computer self-efficacy, which reflects an individual's belief about his or her capabilities to use computers. Because successful and increased use and,

as a result, improved performance is the objective of an IT tool, one should concentrate more on users who are confident of their ability to use an IT tool rather than users who are anxious about using computers or an IT tool. All relationships described in Table 4 as well as the core TAM model are part of the model. Table 5 shows the characteristics of the three controllable external variables. It should be noted that the values of the external variables are on a continuum instead of only two discrete values.

The role of the three controllable variables is important, because the external variables are the only ways for influencing beliefs and behavior so as to encourage system use, because the intermediate and dependent variables in this model, as in TAM, are an internal psychological process. In accordance with the goal of the model, one can predict use and, as a consequence, intervene with appropriate measures to steer use in the desired direction. A few examples of these interventions will help provide an understanding of the practical application.

Organizational support is under the full control of the company in that as a rule more support yields more and better use. It is assumed that qualified IT personnel are available to the end user so that problems can be resolved by providing relatively easy access to expertise. Furthermore, top management proactively encourages IT use and allocates sufficient resources for the support function. Organizational support has a direct effect on usage (Table 5) and is the easiest to effect. Moreover, support employees can indeed help increase computer self-efficacy among senior executives by explaining and demonstrating the fun element of IT tools. Support staff should focus on encouraging anxious individuals to use IT. The reverse training mechanism, whereby young knowledge workers in effect train senior, mostly older, colleagues is a good example of an organizational support intervention. Some organizations employ a reverse mentoring approach, similar to a qualified adviser with one-to-one sessions. It should be intensely personal and the advisers should be preferably company insiders. Rogers [33] argues that managers learn best from peers, who act as change agents. These interventions can also deal with the limited time most senior executives have available and, at the same time, the speed and capacity with which they familiarize themselves with new ideas or situations. Of course, the reverse training and the reverse mentoring approaches must fit the corporate culture and organizational structure.

Perceived fun/enjoyment is an interesting construct as it theoretically represents an intrinsic motivator for system use. As demonstrated by Davis et al. [12], if potential users perceive IT usage as intrinsically increasing their utilities (e.g. if such usage provides them enjoyment or social status among their peers), they will be motivated to use it appropriately. So next to providing staff, special attention could be given to the fun factor of IT. For this intervention, the Internet and its huge amount of fun information is a good starting point. By combining this with business information, e.g. daily or weekly e-mail newsletters with interesting links, the role of IT and the IT tool in the specific area of the senior executive could be given the right focus. And although the Internet is often viewed as a source of entertainment rather that directly related to work [38], this view is changing rapidly as e-business initiatives multiply.

As for computer self-efficacy, the intervention is aimed at the perception level of senior executives who are increasingly concerned about understanding the value of information and IT. To change their mindsets they need to improve their self-confidence and IT literacy before they positively embrace IT. Venkatesh and Davis [42] have already noted that millions of dollars have been wasted on systems that are rejected, often because of usability issues, while a key part of the problem could well be the users, who do not possess a good, positive computer self-efficacy belief. It should be kept in mind that computer self-efficacy is not about basic IT tasks, but refers to the ability to apply IT skills to broader tasks [7]. Computer self-efficacy in this respect is about influencing ease of use perceptions, rather than emphasizing the functions of the IT tool. To reinforce computer self-efficacy, Torkzadeh et al. [40] emphasized the importance of continuous improvement programs so that executives will not fall behind so much they cannot catch up. Measures to improve senior executives' self-efficacy would be instrumental in this respect, e.g. top management could urge every senior executive to use available information systems, promulgating they support its use with enough resources in time, money, and personnel. However, executives do not gain computer self-efficacy overnight, but need to develop IT skills and perception continuously.

7. Discussion

To our knowledge, no previous study has ever targeted the combination of senior executives, a dedicated IT tool for these managers, factors influencing IT use, and the application of a robust theoretical model. In this study, a research model was used to identify key factors and relationships likely to influence the acceptance and usage of IT by senior executives. The results support the theory that the link between the two beliefs and attitude as well as between attitude and actual usage is strong. The study also found that external variables influence usage behavior, but the results suggest that the belief constructs do not fully mediate this influence. Of the eight subcategories used to arrange the external variables, five subcategories had significant variables that are all related to the individual senior executive. The effects of individual characteristics on the acceptance and use of IT does not come as a surprise as these senior executives have achieved the managerial position they are in because of their ability to make far-reaching decisions on a daily basis based on trust in their own capability and knowledge. Unlike middle managers and other professionals, senior executives have privileges such

as autonomy, prestige, and power. It is therefore likely that their differences in attitude and use of IT are also based on these attributes.

Subjective norm, a person's perception that most people who are important to him or her should or should not perform the behavior in question [13], is not included in the original TAM. A number of recent studies [26,43,44] have been conducted on the variable subjective norm and found strong direct relationships between subjective norms and usage. The most surprising finding in this study, however, was the lack of significance of the social pressure construct, similar to subjective norm (see Table 2). One reason for this might be that senior executives are appointed for their vision, style, and personality and hence are not likely to be highly influenced by peers or subordinates. Any mandate imposed on them about using IT for their job is doomed to fail. Also, it is likely that the influence of peers and superiors will diminish to non-significance over time with increasing experience with the target system. Another possible explanation is that the usefulness of an EIS is individually rather than collectively determined in the case of systems such as e-mail. Social norms with respect to an EIS might therefore have no measurable effect on the senior executive. Finally, it is also highly likely that our results are due to the fact that senior executives do not really have visible superiors. They are also not required by subordinates to use IT, and are obliged to decide themselves how they will use IT. The effect of social environment on senior executive perceptions and use of IT in this study is therefore very low.

7.1. Limitations

No research is without limitations and this study is no exception to the rule. The nature of managerial work is such that the tasks of any senior executive are complex, highly fragmented, often taking place in an ambiguous context, and that verbal communication is paramount. In a field study that is aimed at understanding and explaining the behavior of these managers, one should define precisely what is being investigated and what the goal of the study is. Senior executives as a rule have little patience with unclear instructions in a questionnaire that they are supposed to complete or terminology that is unfamiliar to them. It is precisely because of the latter that a pretest and a pilot test was conducted, yet it still may be possible that the, mostly non-native English, respondents did not fully understand some of the almost 200 questions. Also, the study would have benefited from a longitudinal approach, as it would probably have provided richer insights into the explanation of IT acceptance factors and confirm causal linkages. Time and resource limitations, however, made a longitudinal study infeasible.

As already noted earlier, external variables are not correlated but have a direct relationship with either beliefs, attitude or use constructs. Various TAM studies have shown this assumption cannot be corroborated. Apart from a sequential order of the various external variables, these studies also found a time-dependent order and lagged effects. Furthermore, as Seddon [34] posits, the importance of learning needs to be explicitly recognized in a model that predicts IS use, most likely in a feedback loop. More research is needed to measure whether senior executive perceptions of a system change over time, and continue to play a key role in the decision-making process on whether to use (or continue using) a system.

7.2. Future research directions

Several avenues for future research emerge from this study. First, the findings of this study in some cases indicate that a number of external variables are not independent components in the theoretical research model, but are dependent on one another. Identifying these external variables and the directionality of their relationships is also a promising avenue for further research, although at all times variables and their intended relationships should be guided by theory.

Second, an avenue worth investigation is social pressure. The rationale is that new managerial tools, promoted as successors of an EIS, are likely to be based on collaborative team effort and, as a consequence, social norms of peers and possibly subordinates are becoming influential for actual use [24]. In light of the importance of organizational support in this study, which is based to a certain extent on support from colleagues, it is our belief that the social environment of the senior executive will play a more important role once technical obstacles present in most IT tools are finally resolved.

Third, another perspective that should be investigated are the individual and organizational interventions aimed at helping the senior executive become sufficiently IT literate for his job. Taking IT use seriously requires managers dedicating resources to help users build effective use habits and to have resources available over time to support not just the evolving technology but also people's evolving use [31]. Further, experimental research is needed to design interventions to successfully manipulate the key controllable interventions to foster favorable perceptions, and eventually create better acceptance and increased usage.

Finally, the original TAM comprises two salient beliefs determining attitude towards using the system. However, the role of perceived fun/enjoyment could also prove promising ground for further research. As was shown, perceived fun/enjoyment is a central element affecting beliefs, attitude and use. Comparisons between IT tools and systems considered fun to use and those which are less fun to use might help researchers understand this factor better. Investigating the importance of perceived fun/enjoyment as an additional belief variable in the core TAM model can be a subject of interest. Moreover, it might be intuitively appealing to investigate the role and importance of

perceived fun/enjoyment across cultures and, hence, gain a better understanding of IT acceptance and use. This is especially important as managerial IT tools, using, for example, Internet technologies, are becoming increasingly international and cross-cultural.

8. Conclusion

The study results provide support for the core TAM model as an adequate and parsimonious conceptualization of acceptance behavior and the salience of usefulness and ease of use beliefs. However, where TAM assumes that the influence of external variables on use is channeled through the two beliefs, this research study also found variables that directly influence attitude and use. Perhaps the most significant finding is the key role perceived fun/enjoyment plays as an external variable in influencing beliefs, attitude, and usage. Our research corroborates the general tendency to focus on a system's fun component, which the rapid growth of the Internet appears to have encouraged. An investigation of the fun component of the TAM appears to be a very promising line of research as nowadays most information systems aimed at senior executives are built around Internet technology and appearance. Moreover, by emphasizing the entertainment value of managerial IT tools, computer anxiety of senior executives can be diminished and, at the same time, computer self-efficacy improved. The study's results also suggest that one of the prime tasks of an organization is to build a good support organization to help senior executives. This results in more self-confident, IT literate, managers.

One of the key limitations of TAM is that while it provides information valuable for predicting acceptance and use, it does not tell us how such perceptions are formed or how they can be manipulated to foster acceptance and increased usage. As described above, the combination of senior executives and a dedicated IT tool for these managers resulted in a limited number of variables influencing their beliefs, attitude, and use. By understanding these antecedents, it is now possible to design interventions that manipulate these key determinants. As was shown, only three variables — organizational support, perceived fun/enjoyment, and computer self-efficacy — need to be taken into account in defining intervention programs. These variables are under the direct control of an organization. Any intervention aimed at improving the use of an IT tool should optimize these key controllable variables.

Because senior executives have little time to play around with new technologies, the model described here can substantially reduce the time and effort required to learn how to effectively use these new tools. Moreover, developments in technologies like the Internet and PC office packages appear to imply that certain information can only be unlocked using this technology. It is likely that senior executives constitute a separate category in IT acceptance and use.

In the new economy senior executives must begin thinking about how people use information, not how they use IT tools. Having the right managerial IT tools in place is necessary, but not sufficient for good information and information use. Too many managers still believe that once the right technology is in place, appropriate information use will follow. The ability of an organization to deal with a changing environment depends on the flexibility and dedication of their senior executives in leveraging information and IT for improved business performance. As a result, it is not the IT investments that are important but how IT is used by every employee from the top to the bottom of a company. Also, if the company is becoming more dependent on sharing and using information and knowledge, senior managers should pay particular attention to the cultural values and behaviors associated with information and IT use in their company.

Executives must use IT so that they can serve the needs of the members of their organization: above all this involves communicating with one another. New technologies such as the Internet can serve this goal. Even the PC, primarily used to date to access the Internet, is being rapidly replaced by information appliances with dedicated functions. Interestingly enough, the PC was the front end of the Executive Information System investigated in this research. Gershenfeld [15] and Norman [30] argue that the PC is perhaps the most frustrating technology ever produced in that it is not task-specific. They advocate that any IT tool should be designed in such a way that it fits the task it is supposed to support. Perhaps this explains why most executives are quick to take to new gadgets such as mobile phones, PDAs, and electronic organizers, all of which have dedicated functions. Finally, it is worth noting that although the Internet may only be one of many communications channels, it undoubtedly has been the driver behind the change in attitudes by many executives to the opportunities IT offers.

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Guus G.M. Pijpers *is the Chief Information Officer (CIO) at Philips Electronics in Eindhoven, the Netherlands. Previously he worked as an Information Manager, IT Auditor and Management Consultant at Akzo Nobel, KPMG and Philips Electronics, respectively. He received his Ph.D. in Management Science and Computer Science from Eindhoven University of Technology, the Netherlands, in 2001. He holds a Master Degree in Management Science and a Master Degree in Computer Science from the Open University, the Netherlands. His work, interests and research focuses on the use of information and Information Technology by higher management levels in an organization as well as the adoption, use, and effects of e-business on business processes and organizational entities.*

Theo M.A. Bemelmans *is already more than 20 years full professor at the Eindhoven University of Technology. Before he was invited for a chair in Management Information Systems, he worked as a controller and information manager at Oce Van der Grinten, a large international firm in copying machinery and services. Actually, he also acts part time as a quality manager in a highly qualified auditing agency for large governmental systems (The Expertise Center at The Hague).*

Fred J. Heemstra *is a full professor in Management Science and Computer Science at the Open University, the Netherlands. From 1994 until 2000 he was the Dean of the department of Economics, Business and Public Administration. Previously he worked at Twente University, Eindhoven University of Technology, Polytech Brabant and as a management consultant at Infoligic and Vreelandgroup. Heemstra holds a Master Degree and a PhD degree in Industrial Engineering from Eindhoven University of Technology. His work, interests and research focuses on Management of IT, particularly IT Risk Management, Software Management, IT Cost Benefit Management, Software Cost Estimation and Control, Software Quality Management, Software Requirement Management, IT Project Management and Information Economics.*

Kees A.G.M. van Montfort *is an associate professor at the Free University in Amsterdam, the Netherlands. His lectures and research are in the field of applied statistics and research methodology.*