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Measuring information systems success: a literature review

De Toni A. F. (University of Udine)
Zanutto G. (University of Udine)

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MEASURING INFORMATION SYSTEMS SUCCESS: A LITERATURE REVIEW

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Alberto F. De Toni

*Management Engineering Laboratory,
Department of Electrical, Management and Mechanical Engineering,
University of Udine, Via delle Scienze 208 33100 Udine (UD), Italy
Email: detoni@uniud.it- Tel.+39 0432 558330*

Gianluca Zanutto

*Management Engineering Laboratory,
Department of Electrical, Management and Mechanical Engineering,
University of Udine, Via delle Scienze 208 33100 Udine (UD), Italy
Email: zanutto@uniud.it- Tel.+39 0432 558331*

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Abstract

The focus of this research is the study of different models and theories developed for measuring the success of information systems. In particular, the main purpose of this paper is the investigation of the variables that determine the use and success of information systems supporting Operations Management.

In order to reach the abovementioned objective a literature review on measurement models of IS success has been carried out. The literature review has been performed analyzing 141 papers published in the period 1973-2005.

The theories and models identified for determine the IS success can be organized into three main research streams:

- Technology acceptance
- Task-technology Fit
- IS Success

The main findings of the research are:

- Identification of the factors that determine the success of IS
- Recognition of the analogies and discrepancies between the models or theories identified
- Proposal of a theoretical model based on the abovementioned findings.



Introduction

The growing rapidity in the introduction of new information and communication technologies (ICT) on the market provides to companies new opportunities to support their own business activities. Benefits that are usually attributed to the use of information systems (IS) are, for example, increase of productivity and efficiency in information exchanges, enhance of the quality of service to the customer and cost reduction. Nevertheless, several authors observe that, despite large investments have been made by companies in last decades to introduce new information and communication technologies, it is not easy to assess the benefits gained with these investments, which often turned out to be failures (Mc Carroll, 1991; King, 1994; Gillooly, 1998; Yi and Hwang, 2003; Legris, 2003). Therefore, the assessment of success of an information system is a key aspect to understand the efficacy of investments in this sense.

The focus of this research is the success of web-based information systems (WBIS). WBIS are information systems (IS) based on web technologies which share infrastructure and communication protocols of Internet or Intranets, e.g. the TCP/IP. Due to this feature, WBIS are considered by many people the new generation of information systems (Press, 1999). The wide spread of communication technologies exploited by WBIS, i.e. Internet, make these information systems more pervasive than traditional ones.

In particular, this study focuses on web-based applications supporting Operations Management. Examples are activities such as the order cycle, the integrated management of transport and storage operations (distribution plans), the integrated management of turnover cycle, the monitoring and sharing of production plans, support services for the product development and the quality management process.

Literature Review

A literature analysis has been accomplished to find out the existing theories, models, and measurement tools for the success of web-based information systems. From this analysis come out that since the beginning of the 70's, many researches concentrated upon the identification of factors that influence the success of information systems. Despite some studies has recently attempted to investigate these subjects with regards to web-based information systems (Chen and Heath, 2001; Yi and Hwang, 2003; Klaus et



al., 2003; Stuckenschmidt and van Harmelen, 2004), research-works in this field are still in an early stage and, moreover, those focused on the study of more complex applications are very few. Therefore, in order to understand the mechanism of introduction and to measure the success of web-based information systems into organizations, the models and theories for the determination of success of generic information systems have been analyzed.

The theories that have been identified can be organized into three main research streams:

- Technology acceptance
- Task-technology Fit
- Information Systems Success

However, the literature review has highlighted other models or theories which are related to the three main research streams. These models are summarized in table 1, where is provided the most important reference.

Table 1 – Theories and models analyzed (Zanutto, 2005)

Theory or Model			Main Reference	
1	TAM	Technology Acceptance Model	Davis, 1986,	MIT PhD Dissertation
			Davis 1989	MIS Quarterly
2	TTF	Task Technology Fit	Goodhue e Thompson, 1995	MIS Quarterly
3	ISS	IS Success Model	DeLone e McLean, 1992,	Information Systems Research
4	TRA	Theory of Reasoned Action	Ajzen e Fishbein, 1970	Journal of Personality and Social Psychology
			Ajzen e Fishbein, 1975	Addison-Wesley, MA – USA
5	TPB	Theory of Planned Behavior	Ajzen e Fishbein, 1980	Prentice-Hall, Englewood Cliffs, NJ
			Ajzen, 1988	Dorsey Press, Chicago
6	SLT	Social Learning Theory	Miller e Dollard, 1941	Yale Univer. Press, New Haven
7	SCT	Social Cognitive Theory	Bandura A., 1986	Prentice Hal Englewood Cliffs, NJ
			Wood e Bandura, 1989	Academy of Management Review
8	IDT	Innovation Diffusion Theory	Rogers, 1962	The Free Press, New York
9	ET	Expectancy Theory	Vroom, 1964	Wiley, New York
10	TCD	Theory of Cognitive Dissonance	Festinger, 1957	Stanford University Press., Stanford, California
			Festinger Leon, 1973	Franco Angeli, Milano

With reference to the three main streams, the literature review has showed different versions of the models which were developed. Among these, the versions which are selected for this meta-analyses are characterized by:

- an empirical study



- the constructs and relationships of the original model are preserved
- the methodological approach of the research is described in detail

Table 2 shows the number of papers analyzed with reference to the scientific journal concerning the three research streams. The original model of the three main research streams are showed in the following paragraphs.

Table 2 – Paper analyzed with reference to the three main research streams (Zanutto, 2005)

RIVISTA	TAM	TTF	ISS	Totale
MIS Quarterly	14	2	3	19
Information & Management	6	3	8	17
Decision Sciences	10	1	2	13
Management Science	7	3		10
Information and Organization	6	1		7
Journal of Management Information Systems	5		2	7
Academy of Management Review	4	1		5
American Psychologist	4			4
Information Systems Research		1	3	4
Communications of the ACM		3		3
Decision Support Systems	3			3
International Journal of Information Management	1	2		3
Journal of Computer Information Systems	3			3
J. of the American Society for Information Science	3			3
The International Journal of Management Science	1		2	3
Administrative Science Quarterly	2			2
Database for Advances in Information Systems	2			2
Group decision and negotiation	2			2
Journal of applied Psychology	2			2
Journal of Personality and Social Psychology	2			2
Journal of System and Software		2		2
Organizational Behavior and Human Performance		2		2
Psychological Review	2			2
Altri (un solo riferimento per rivista)	17	3	1	21
Paper totali per teoria	96	24	21	141
Periodo pubblicazioni	1941-2004	1973-2001	1988-2003	1941 - 2004

Technology Acceptance Model

As for the first research stream, the reference theory is the so called theory of technology acceptance (TAM), proposed by Fred Davis (1989) and widely developed in following years. This theory aims to evaluate how the acceptance of a technology influences the use of the technology itself. This theory find its foundation on the idea that perceived ease of use and perceived usefulness finally determine the attitude towards the technology and its actual use.

Davis (1989) defines Perceived Usefulness (PU) as:

“...The extend people believe an application will help them to perform their job better ...”
(Davis, 1989)

And the Perceived Ease of Use (PEOU) as:

“...the degree to which a person believes that using a particular system would be free of effort...” (Davis, 1989)

According to Davis (1986, 1989), Perceived Usefulness and Perceived Ease of Use are determinants of Attitude towards Use, Behavioral Intention to Use, and Actual Use of an Information System. Figure 1 shows the relationships in the original TAM model.

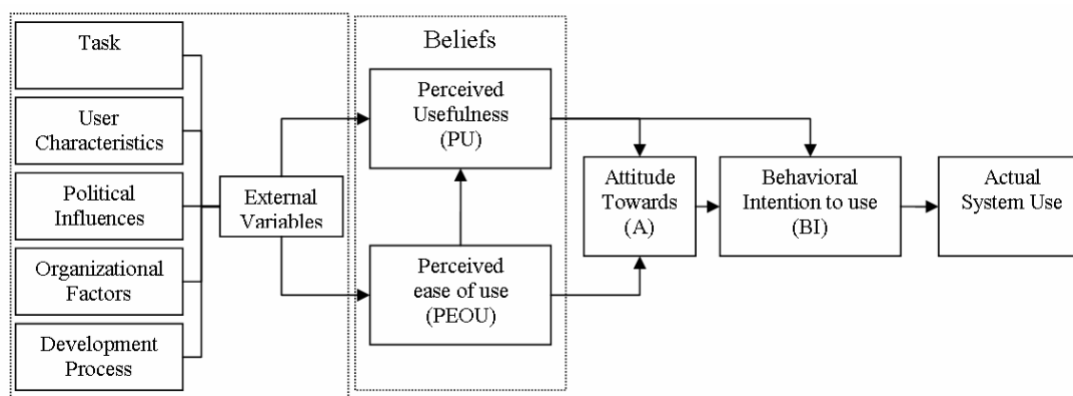


Figure 1 – Technology Acceptance Model (Davis, 1986; Davis 1989)

Since Davis’ original model, the TAM has been widely study in the literature. Table 3 shows the most important contributions selected, on a basis of 96 papers selected in the period 1986-2005.



Table 3 – Evolution of TAM (Zanutto, 2005)

Year	Author	Journal / Editor	Findings
1986	F. D. Davis	MIT - PhD Thesis	First paper which developed the fundamental TAM constructs starting from TRA (Theory of Reasoned Action)
1989	F.D. Davis, R.P. Bagozzi, P.L. Warshaw	Management Science	Comparison between TRA and TAM: Perceived Usefulness (PU) determines Behavioral Intention to Use (BI). Perceived Ease of Use (PEOU) determine Behavioral Intention to Use (BI) through Perceived Usefulness (PU)
1989	F.D. Davis	MIS Quarterly	Development of the measurement scales of Perceived Ease of Use (PEOU) and Perceived Usefulness (PU)
1996	V. Venkatesh, F.D. Davis	Decision Science	Addition of the external variable self-efficacy to the original TAM
1996	P.Y.E. Chou	Journal of Management Information Systems	Distinction of Perceived Usefulness (PU) in short and long period
1996	B. Szajna	Management Science	Comparison of pre and post implementation of TAM variables
1998	K. Mathieson, M. Keil	Information & Management	Comparison between TAM and TPB (Theory of Planned Behavior)
1999	H.C. Lucas, V.E. Spiller	Decision Science	Empirical study of TAM with the variable performance, social norms and task
1999	M.T. Dishaw, D.M. Stroug	Information & Management	Integration between TAM and TTF
2000	V. Venkatesh, F.D. Davis	Management Science	TAM's extension (TAM2)
2002	S. Dasgupta, M. Granger, N. McGarry	Group Decision and Negotiation	Empirical study of TAM on e-collaboration information systems
2003	P. Legris, J. Ingham, P. Colletette	Information & Management	TAM needs an integration with new psycho-social variables
2003	H.-P. Shih	Information & Management	Integration between TAM and IBM (Information Behavior Model)
2003	V. Venkatesh, V. Morris, M.G. Davis, F.D. Davis	MIS Quarterly	Development of the Unified Theory of Acceptance and Use of Technology

The relationships between the constructs of the original TAM (Davis, 1989) have been widely studied in the literature. In table 4 are shown the relationships considered in this analysis.

Table 4 – TAM's relationships selected (Zanutto, 2005)

			Independent Variable				
			EV	PEOU	PU	A	BI
Dependent Variable VARIABLE DEPENDENTE	External Variable	EV					
	Perceived Ease of Use	PEOU	I				
	Perceived Usefulness	PU	II	III			
	Attitude towards Use	A		IV	V		
	Behavioral Intention to Use	BI			VI	VII	
	Use	U					VIII



Task-technology Fit

With regards to the second stream, Task/technology Fit (TTF) is the basic model (Goodhue and Thompson, 1995) which aims to investigate the effect of the fit among characteristics of technology, tasks, and users characteristics on the use of information systems and performances of consumers at first, and then on the performances of the organization. According to Goodhue and Thompson (1995) the task Technology Fit (TTF) is:

“...the degree to which a technology assists an individual in performing his or her portfolio of tasks. More specifically, TTF is the correspondence between requirements, individual abilities, and the functionality of the technology...”

Researches about this theme have at first assumed that the consistency of an information system could be measured as interaction effects among the constructs concerning the three classes of characteristics considered (technology, task, and individuals). However some researches (Goodhue, 1995) empirically demonstrated how it is possible to use user evaluation as substitute of fit measurement of the interaction effect among the characteristics of technology, tasks, and individuals (figure 2).

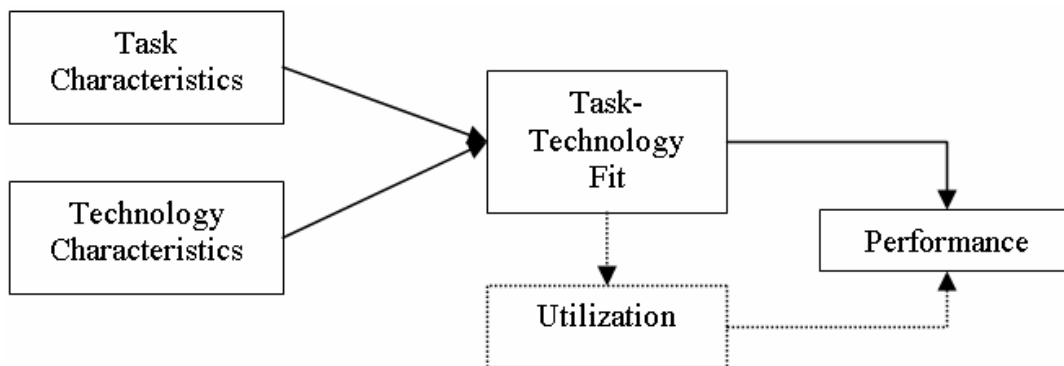


Figure 2 – Task-technology Fit (Goodhue and Thompson 1995)

Information System Success Model

Finally, the third research stream about information systems success is based on the Information System Success Model (ISS) (DeLone and McLean, 1992; 2003) also called the D&M model. This model, in its final version, aims to measure the impact of some characteristics of technology (information, system, and service quality) on the variables “user satisfaction”, “intension to use” “use”, and “net benefits”. The objective



of the ISS model is to determine the final benefit deriving from the use of information system both in individual and organizational terms (figure 3).

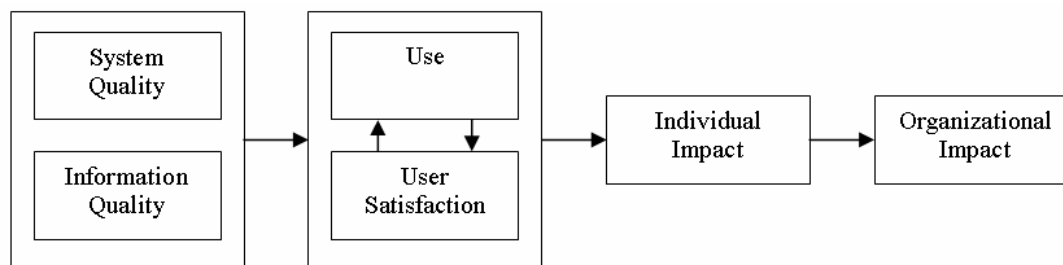


Figure 3 – Information System Success Model (De Lone, Mc Lean 1992)

Literature analysis highlighted that the models and theories developed within the three research streams, though theoretically precise, turn out to be very difficult to be practically applied (e.g. Legris et al., 2003) because of an approach that is too much linked to their theoretical sphere (e.g. psychology or sociology).

Moreover, empirical validation of mentioned models have been often carried out on university students that used software with low complexity. On the contrary, it is fundamental to study the validity of this models with regards to more complex applications and organization contexts.

Meta-analysis

Starting from the literature analysis conducted, we noted that the three main streams are not alternatives but complementary in determining the success of an information system. As a matter of fact, we consider them as different view points of the success of an information system. On this base, we developed a model which proposes an integrated view among these perspectives.

In order to recognize of the analogies and discrepancies between the models or theories identified, the analysis conducted can be split in two steps (fig. 4):

- analysis of the constructs and variables (fig. 4 – A)
- identification and analysis of the relationships among the variables (fig. 4 – B).

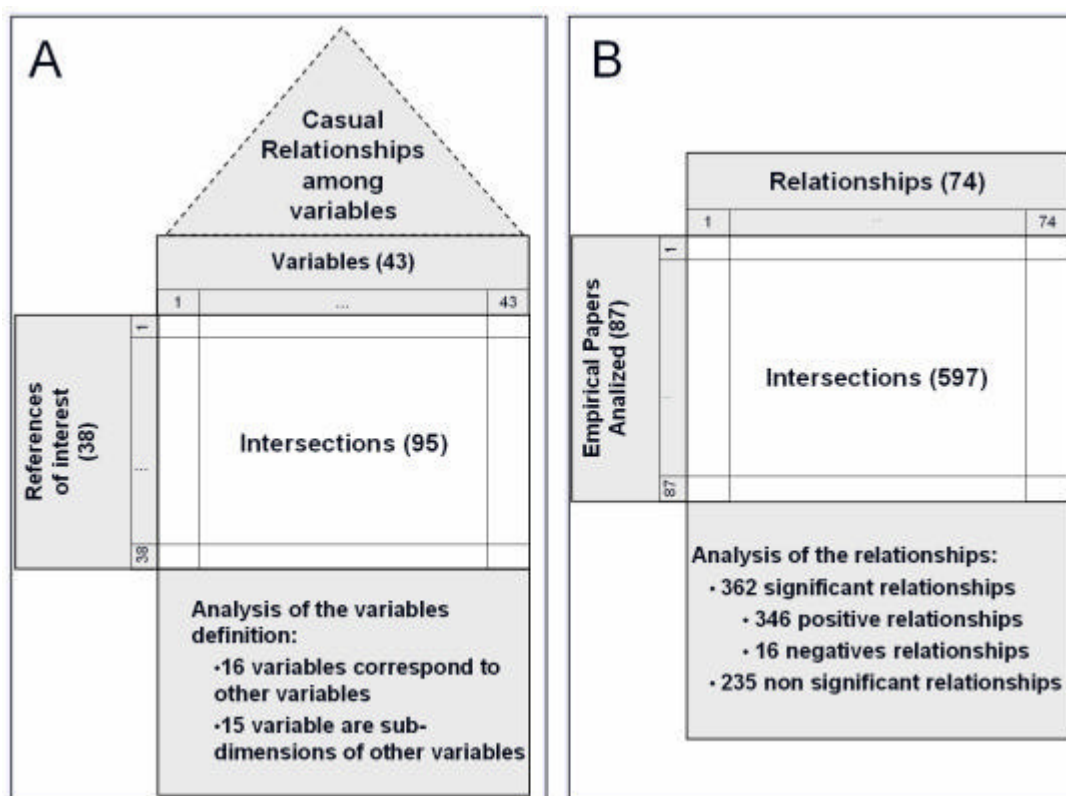


Figure 4 – The meta-analysis process (Zanutto, 2005)

The first step – analysis of the constructs and variables – was aimed to study and compare the definitions of the constructs. Starting from 38 papers selected (table 5), this analysis allowed to identify similarities and discrepancies among different definitions.



Table 5 – References for the analysis of the constructs and variables (Zanutto, 2005)

	Reference	TAM	TTF	ISS
1	Agarwal R. e Prasad J. (1997)	X		
2	Bailey J.E. e Pearson S.W. (1983)			X
3	Bajai A. e Nidumolu S.R. (1998)	X		
4	Chau P.Y.K. (1996)	X		
5	Davis F.D. (1989)	X		
6	DeLone W.H. e McLean E.R. (1992)			X
7	DeLone W.H. e McLean E.R. (2002)			X
8	Dishaw M.T. e Strong D.M. (1999)	X		
9	Etazadi-Amoli J. E Farhomad A.F. (1996)			X
10	Gefen D. e Keil M. (1998)		X	
11	Gelderman M. (1995)			X
12	Goodhue R. e Thompson D. (1995)		X	
13	Guimares T. e Igbaria M. (200)			X
14	Hu P.J. et al. (1999)	X		
15	Igbaria M. e Tan M. (1997)			X
16	Jackson et al. (1997)			X
17	Jurison J. (1996)			X
18	Karahan E. et al. (1999)	X		
19	Keil et al. (1995)	X		
20	Legris P. et al. (2003)	X		
21	Lucas H.C. e Spitler V.K. (1999)	X		
22	Mathieson K. e Keil M. (1998)	X		
23	Mathieson K (1991)	X		
24	Seddon P.B. e Kiew (1994)			X
25	Shih H.P. (2003)	X		
26	Subramanian G.H. (1994)	X		
27	Szajna B. (1996)	X		
28	Taylor S. e Todd P. (1995)	X		
29	Teng J. E Calhoun K. (1996)			X
30	Teo T.S.H. e Wong P.K. (1998)			X
31	Torkzaden G. e Doll W.J. (1999)			X
32	Venkatesh V. e Davis F.D. (1996)	X		
33	Venkatesh V. e Davis F.D. (2000)	X		
34	Venkatesh V. et al. (2003)	X		
35	Weil P. e Vitale M. (1999)			X
36	Wixom W.H. e Watson M. (2001)			X
37	Yoon Y. et al. (1998)			X
38	Yuthas K. E Yong S.T. (1998)			X

In particular, we selected 43 variables which produced 95 intersections with the 38 references selected. From the analysis of the 95 intersections, we find that 16 variables correspond to other variable characterized by different names. Moreover, 15 variables are sub-dimensions of other variables.



The second step – identification and analysis of the relationships among the variables – is aimed to study the significance of the relationships among the variables identified. Starting from the “roof” of the matrix in figure 4-A, 74 relationships have been identified (figure 4-B). The analysis of these 74 relationships, have been carried out on the basis of 87 empirical researches. The intersections identified are 597. Table 6 shows the results of these analysis, distinguishing significant and non significant relationships and positive and negative coefficient. In particular, we found 362 significant relationships, among these 346 relationships have positive coefficient and 16 relationships have negative coefficient and 235 non significant relationships.



Table 6 – Relationships analyzed (Zanutto, 2005)

Relationship	Significant relationship		Non Significant relationship	Total
	Positive coefficient	Negative coefficient		
EOU→UTP	26		6	32
INF→INT	8		18	26
UTP→INT	17		7	24
EOU→INT	13		8	21
A→INT	15		6	21
UTP→A	12	1	3	16
UTP→UEF	9		5	14
EOU→A	12		2	14
EOU→UEF	7		6	13
IMP→INT			10	10
INT→UEF	6		3	9
EX→INT	7		1	8
INT→UTP	4		3	7
INT→A	7			7
UEF→II	7			7
ASS→INT		7		7
RD→UTP	5			5
INF→UTP	5			5
SQ→II	5			5
US→II	5			5
CIE→INT			5	5
CIZ→INT			5	5
PBC→INT	4		1	5
ASS→A	1		3	4
CIZ→A		4		4
EE→INT	2		2	4
SQ→UEF	3		1	4
INT→EOU			3	3
RD→INT			3	3
UEF→EOU			3	3
UEF→UTP			3	3
CIA→INT	3			3
INT→INF	3			3
IQ→II	3			3
UTP→PP	3			3
A→PP	2		1	3
UEF→INT	2		1	3
AN→INT		3		3
A→UEF	2			2
II→OI	2			2
RV→INT	2			2
RV→INT	2			2
US→OI	2			2
CMP→INT		2		2
TSK→TTx		2		2
TTx→UEF		2		2
Others (*)	1			1

(*): A→UTP; CIE→EOU; CIE→UTP; CT→TTx; IMG→UTP; IQ→OI; IQ→UEF; IQ→US; JR→UTP; INF→IMG; SQ→OI; SQ→US; TTx→EOU; UEF→A

Proposal of a Theoretical Model

Starting from the literature analyses carried out, the theoretical model is directed to highlight the variables that play an important role in determining the success of web-based information systems.

The theoretical proposition formulated can be represented as shown in figure 5. The direct relationships are represented by continuous lines whilst the interaction effects are represented by a broken lines.

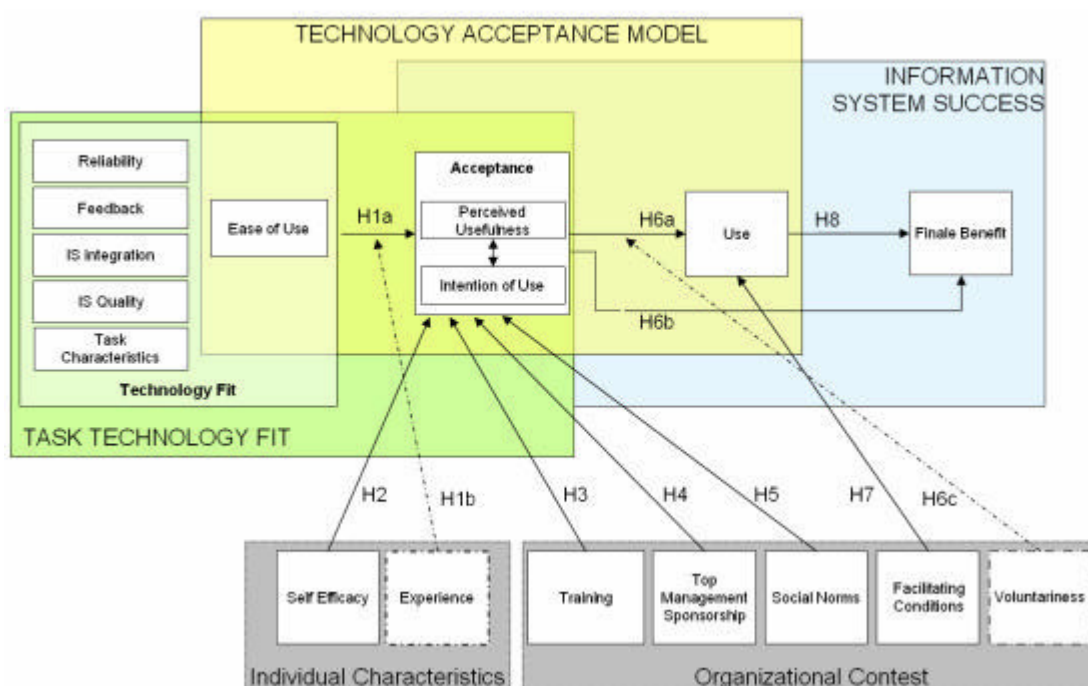


Figure 5 – Theoretical model proposed (Zanutto, 2005)

Moreover, in figure 5 is it possible to recognize the original theory of the variables included. For instance, the variable “Use” comes from TAM (Davis, 1989), ISS model (DeLone and McLean, 2003); “Intention to Use” comes from TAM (Davis, 1989), TTF (Goodhue and Thompson, 1995) and ISS model (DeLone and McLean, 2003).

Table 7 summarizes the hypothesis formulated on the basis of the meta-analysis conducted and previously summarized. For each hypothesis it is provided the main references.



Table 7 – Hypothesis formulated (Zanutto, 2005)

Hypothesis	Relationship		References
H1a	Technology Fit	→ Acceptance	Goodhue and Thompson, 1995; Venkatesh and Davis, 2000; Ravagnani, 2000
H1b	Technology Fit x Experience	→ Acceptance	Agarwal and Prasad, 1997; Venkatesh et al., 2003
H2	Self Efficacy	→ Acceptance	Adams, et al., 1992; Venkatesh, 2000
H3	Training	→ Acceptance	Goodhue and Thompson, 1995
H4	Top Management Sponsorship	→ Acceptance	-
H5	Social Norms	→ Acceptance	Hartwick and Barki, 1994; Venkatesh and Davis, 2000; Venkatesh et al., 2003; Ravagnani, 2000
H8a	Acceptance	→ Use	Adams, et al., 1992; Davis, 1989; Davis et al., 1989; Mathieson, 1991; Thompson, et al., 1991; Keil et al., 1995; Chau, 1996; Agarwal and Prasad, 1997; Gefen and Keil, 1998
H8b	Acceptance	→ Final Benefit	DeLone and McLean, 1992; DeLone and McLean 2003; Rai, et al., 2002
H8c	Acceptance x Voluntariness	→ Use	Venkatesh and Davis, 2000; Venkatesh et al., 2003
H7	Facilitating Conditions	→ Use	Thompson et al., 1991; Venkatesh et al., 2003
H8	Use	→ Final Benefit	Goodhue and Thompson, 1995; DeLone and McLean 2003

Future developments

Starting from the theoretical model developed, the next step of the research will concern an empirical study to evaluate the validity of the model.

The analysis we are going to perform consists in the following activities:

- Preliminary analysis to determine the characteristics and proprieties of the dataset and state the quality measurement and data-entry;
- Explorative Factor Analysis to analyze the data structure and purify the measures;
- Reliability Analysis to asses the internal consistency reliability;
- Confirmative Factor Analysis to asses the multivariate normality, multicollinearity, and convergent and discriminant validity;
- Test of the theoretical model (without interactions effects) to asses the significance of the structural relationships hypothesized;
- Test of the theoretical model (with interactions effects) to assess the significance of the interaction relationships hypothesized

Finally, due to multiple relationships of dependent and independent variables and the presence of interactions effects among variables, we are going to use a structural equation model approach.



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