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A new Framework of ERP Systems Implementation Success

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Abstract

This thesis is a research work which aims to define, structure and explain success within the ERP specific context through a new approach, given the shortage in literature of frameworks, either innovative or not, about this topic and the absence of an univocal definition of IS/ERP success. By means of a deep literature analysis on four IS/ERP research streams - success, failure, technology acceptance and adoption, theories of fit - and of the definition, supported by field results, of the peculiarities which make an ERP project different from an IS generic one, a sound foundation for the building phase has been created. Negating and contextualizing in the ERP environment the main kinds of IS failure, which are univocally defined and accepted in literature, the modeling phase has yielded an ERP failure negation model. Six new constructs and ten new relationships have been hypothesized and the result fully meets the requirements list defined in the planning phase. Although further works are necessary in order to verify their validity, the proposed model is fitted out with several examples of measure items for each construct, predisposing it for potential practical applications in terms of addressing ERP projects and measuring success.

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List of Abbreviations

Abbreviation	Meaning
D&M	DeLone and McLean
IS	Information System
IT	Information Technology
G&T	Goodhue and Thompson
M&T	Markus and Tanis
TPC	Technology-To-Performance Chain
TTF	Task-Technology Fit
ESS	Enterprise System Success
ES	Enterprise System (often used as synonym of ERP system)
CSF	Critical Success Factor
CFF	Critical Failure Factor
BU	Business Unit
ATP	Available To Promise
CTP	Capable to Promise
KPI	Key Performance Index
TAM	Technology Acceptance Model
USEF	Perceived usefulness
EOU	Perceived ease of use
ATT	Attitude toward using
BI	Behavioral intention (to use the system)
QUAL	Perceived quality of the output
FUN	Anticipated enjoyment of the system
UTAUT	Unified Theory of Acceptance and Use of Technology
BSC	Balanced Scorecard
BPR	Business Process Reengineering

Introduction

Often practitioners imagine the quest for success as a path crossable by *mechanical* steps: a list of decision points whose outcome is deterministic. Unfortunately, such situations hardly ever occur, especially within projects which involve organizational changes. When behaviors and individual attitudes are important variables in a hypothetical computation, no reliable algorithms can exist and IS/ERP implementations belong to this context. IS success isn't univocally defined in literature due to different reasons. First, it's a multidimensional concept and it has to be inflected on various levels: who perceives project outcomes as a success, which kinds of outcomes constitute success, what constitutes success besides its outcomes and so on. Second, IS success involves more than one research stream, from the theories of fit to the technology acceptance and adoption, and they often offer different perspectives. Third, although it's a consequence of the two previous observations, pertinent measure items aren't accepted unanimously. Moving from an IS generic context to an ERP specific one, these issues become worse. Reasons behind this, adequately described in Chapter 2, are various but the most important ones are higher risks connected to the potential failure, together with all the relevant consequences (in extreme cases, the adopting company can go bankrupt), and the necessary organizational changes linked to the BPR, more or less extensive, that must be managed through strong and well addressed strategies. Concerning ERP implementations, success models are even more rare than those regarding IS generic projects and this is in contrast with what practitioners desire. Furthermore, often they are IS success models lightly readapted with few new constructs and/or relationships or simply mergers among different models without theoretical foundations supporting them.

This thesis work proposes a different logic in facing the issue above, namely not to start from an existing IS success model integrating it but defining a starting point already contextualized within the ERP environment and "filling" it appropriately with constructs and relationships, proposing an approach innovative and, at the same time, not excessively focused on CFFs/CSFs or on ERP implementation phases. In fact, IT/IS research is typically performed on three streams: enabling factors, implementation project management and success. The first stream includes CSFs, CFFs and all the factors that enable success. The second stream concerns implementation models (see i.e. Soh and Markus, 1995; Markus and Tanis, 2000) and the management of IT/IS projects. The third,

which is conceptually different from the other streams, regards success explanation and measurement and it suffers a shortage of ERP specific works: this thesis work is placed within this context.

As innovation in such research streams is usually incremental, the logic above should be based on bricks both sound and accepted in literature. According to this reasoning, a wide literature analysis has been conducted on several topics: IS success, ERP success, success measuring, IS/ERP benefits, technology acceptance and adoption, theories of fit, contingent variables in IS adoption and success, field studies on ERP implementations, IS failure models. This analysis hasn't been performed through a sterile approach but it has been enriched with plenty of observations, considerations, cross-models criticisms and comparisons for identifying a manageable set of shared constructs and relationships. Afterwards, a requirements list has been created as a guideline for the modeling phase. In order to bypass the not univocal definitions of IS success, the building phase started from the four possible IS failures by Lyytinen and Hirschheim (1987), whose definitions are instead clear, univocal, shared and accepted in literature: given these characteristics, the duality property is valid then negating those failures means to assert the IS success. Since IS success definitions are usually incomplete, due to the great number of factors they should include, a success model based upon them could be lacunose while the combination of the four failure definitions results in a meaning that considers all the pertinent stakeholders and all the relevant factors: its negation yields a complete, comprehensive, univocal and sound concept of IS success.

According to what stated previously about the priority of the contextualization within the ERP environment, the modeling phase has gone on with the necessary integrations concerning ERP implementations before defining constructs and relationships for each failure negation. The contextualization process continued for the whole modeling phase, affecting the declension of the four negations on one side and the definition of adequate measure items at all levels on the other side. The result has been labeled as "*ERP failure negation model*" and it fully meets the requirements list drawn up in the planning phase. Although it's based on something already existing in literature, the model contains highly innovative elements in terms of both approach and constructs/relationships and it lends itself for practical applications like comparing different ERP implementations under the same perspective, addressing these projects to success explained through a comprehensive and univocal meaning, measuring success of completed or ongoing ERP projects.

1. Literature Analysis

Chapter 1 contains a deep literature analysis on the following topics: IS success, ERP success, success measuring, IS/ERP benefits, technology acceptance and adoption, theories of fit, contingent variables in IS adoption and success. Different frameworks are analyzed, criticized and compared in order to set out a sound theoretical basis for the modeling phase.

1.2 How to put order in IS success research: DeLone and McLean

One of the most relevant issue in MIS research, like stated by Peter Keen at the first meeting of the International Conference on Information Systems (ICIS) in 1980, is the need of an appropriate definition of the dependent variable. IS success is a wide and multidimensional argument and the pertinent literature is rich in different measure items, which are function of the researchers' specific interests. In example, Ives and Olson (1984) considered "*System Quality*" and "S*ystem Acceptance*[1]" as two classes of MIS outcome variables, Zmud (1979) considered three classes of MIS success ("*User Performance*", "*IS usage*" and "*User Satisfaction*") but further examples can be quoted. If, on one hand, this is an evidence of the broad approach to MIS research, on the other hand it shows how researchers' focus has been addressed to independent variables more than to the dependent variable, like MIS effectiveness or IS success.

D&M (1992) answered to this issue with their well known "*Information system success: the quest for the dependent variable*", proposing an innovative framework for understanding and measuring IS success, labeled as the dependent variable, and the pertinent validation applying it to 180 studies conducted in the 1981-1987 period. D&M's work is, above all, a taxonomy of the wide world of information system success - "[...] *in searching for an I/S success measure* [...] *there are nearly as many measures as there are studies*" (D&M, 1992, p. 61) - and this taxonomy is congruent with previous IS frameworks (fig. 1), highlighting its importance and its wide characterization.

[1] It's a broad construct that includes system usage, system impact on user behavior and information satisfaction. I deepened it mostly within the TAM.

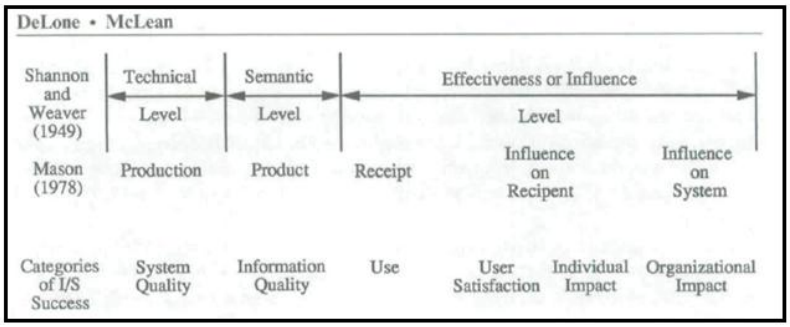


Figure 1: Categories of IS success (from D&M, 1992, p. 62)

According to fig. 1, Shannon and Weaver (1949) stated that the output of an information system can be measured on a technical level (accuracy and efficiency of the IS), semantic level[2] and effectiveness level (how the information impacts on the receiver). Mason (1978) inflected these three levels running over the steps that information faces: an IS yields information and communicates it to a recipient, who *can* be influenced by it, like the system itself. The correspondence between Shannon and Weaver and Mason is evident by re-labeling the term "*effectiveness*" as "*influence*". D&M recovered this king of logic in their taxonomy, outlining six categories of IS success on the same levels that Shannon and Weaver considered: one of these categories belongs to the IS, one to the yielded information, four to the information impact (see fig. 1).

D&M's work is quite empirical: they analyzed a wide amount of past researches, like already said, in order to value the extent of fitness between their taxonomy of IS success and the independent variables used by other researchers, then they built the model establishing precise relationships among the six constructs. It's opinion of who is writing that this isn't only a "*quest for consent*" but it aims to confer a structured order to MIS success: this goes besides an inference's purpose, since D&M original model lacks aspects that will be discussed afterwards, and this is why their work can be considered a strong basis for literature analysis and incremental research on IS success/effectiveness. Before discussing the model, a description of the six variables is desirable:

- <u>System Quality</u>: referring to fig. 1, this aspect relates to a technical level and, then, to evaluating the intrinsic characteristics of the IS (Rai et al., 2002), e.g. efficiency, response time, flexibility (Sedera et al., 2004). Several measures of "*System Quality*" have been developed, like reliability of the computer system, ease of terminal use (Swanson, 1974), system accuracy, aggregation details (Emery, 1971) etc. . "*Not surprisingly, most of these measures are fairly straightforward,*

[2] "[…] *the success of the information in conveying the intended meaning*", D&M (1992), p. 61.

reflecting the more engineering-oriented performance characteristics of the systems in question" (D&M, 1992, p. 64).

- Information Quality: some IS researchers have chosen to study the produced information itself (semantic level, fig. 1) and its desired characteristics, mainly accuracy (D&M, 1992; Bailey and Pearson, 1983; Baroudi and Orlikowski, 1988), content and format (Bailey and Pearson, 1983; Baroudi and Orlikowski, 1988), meaningfulness and timeliness (D&M, 1992) and, secondly, reliability and integrity (Sedera et al., 2004). Literature has plenty of items measuring the IS output and the most part of them reflects the perspective of the user of this information in the extent that they can be used as measures of user satisfaction[3].
- Use: D&M (1992) were not completely clear on this dimension, as firstly they stated that this dimension refers to the information use, namely to the use of the output of an IS by the recipient, and after they describe it like the use of the system itself. In my opinion, there is a practical difference between these two perspectives:

    - Information use: D&M (1992, p. 66) initially described "*Use*" as "*recipient consumption of the output of an information system*" and "*the use of IS reports*", the this dimension clearly refers to the frequency use of the output produced by the IS.
    - System use: in the same page, they treated this construct like "*use of the system*" itself, leaving out of consideration the output, and this perspective has been confirmed, for example, by Bento and Costa (2013, p. 19) which stated that "*it's a dimension that relates the frequency of use of the system*".

  This difference is discussed by Raymond (1990) in p. 87 of this thesis work, distinguishing between online usage and offline usage. Going deep into the matter, D&M true intention is to consider system use and not information use, since they support this point of view mentioning researchers that proposed/used this dimension's perspective ("*System Use*") as a MIS success measure, i.e. Hamilton and Chervany (1981) and Zmud (1979). However, I find that the coexistence of these two interpretations in the same context improper: "*Information Use*" implies that the information has been elaborated, instead "S*ystem Use*" involves a wider process that starts from data input and ends with the output evaluation, passing

[3] See an example of this kind of linkage in Bailey and Pearson (1983).

through an elaboration phase, and this perspective needs for a major number of items for a complete measure. A complete analysis of this dimension should need an effective deepening on *who* uses the system and the purpose of using it, but these issues go besides the aim of this work[4]. Concluding, "*System Use*" can be a controversial dimension but it's probably the easiest to quantify, on condition that the usage is voluntary and that the considered organization monitors system use.

- User satisfaction: it represents users' reaction to the use of IS output, namely the information, on condition that the information is required and then necessary. This dimension is one of the most used in the IS evaluation (Somers and Nelson, 2003) and as success measure for empirical IS research (Ein-Dor and Segev, 1978; Hamilton and Chervany, 1981). Again, "*a key issue is whose satisfaction should be measured*" (D&M, 1992, p. 68) and it depends on the circumstances that are the subject of the research: e.g. chief executives' satisfaction (McKinsey and Company, 1968), sales representatives (Lucas, 1978) and so on. Moreover, multi attribute satisfaction measures have been developed in order to evaluate satisfaction in a more structured way, i.e. see Swanson (1974) or Bailey and Pearson (1983). Anyhow, "*User Satisfaction*" is widely diffused as single measure/dimension of IS success for various reasons. D&M (1992) suggest at least three of them, whose the most effective are the following, in my opinion:

    - Satisfied users are a huge obstacle for denying IS success
    - Most of other measures are hard to obtain

  Despite these reasons, this opinion isn't totally shared among researchers, i.e. Sedera et al. (2004) removed "U*ser Satisfaction*" from their measurement model, using it like a measure item and not a separate dimension, Ifinedo and Nahar (2006b) proposed a model where this dimension was substituted by another.
- Individual impact: the impact of the information on the behavior of the recipient provides indications on performance enhancing (or worsening). Information hasn't an own value per se, it depends on the way it's used by the decision maker, and that's why the information impact, even if individual, shall be assessed in a multidimensional perspective, e.g. improving the understanding of the decision context, changes in user activity or in decision makers' perception of the

[4] Further details in D&M (1992), pp. 66-68.

importance or usefulness of the information system (D&M, 1992), performance of work, learning, individual productivity (Sedera et al., 2004), member participation in decision making as a measure of decision effectiveness in group decision making (DeSanctis and Gallupe, 1987), changes in behavior of whom receives the information (Mason, 1978). Several approaches to the measurement of "*Individual Impact*" of the IS have been considered, i.e.:

- Asking a quantification of information system value in a 1÷10 scale (Cerullo, 1980)
- Asking the maximum amount payable for a particular report (Gallagher, 1974; Lucas, 1978), especially if there is the feeling that the specific information could lead to an appreciable payoff (Hilton and Swieringa, 1982)

I consider the latter approach better than the first as it offers a wider sight of the information potential, even if it's on the frontier between individual and organizational impact.

- Organizational impact: it measures the effect of information on organizational performance. While performance measures are quite important for IS practitioners, MIS academic researchers tend to avoid this kind of measures, except in laboratory studies, due to the difficulty in separating IS contribution to organizational performance from other factors and efforts (D&M, 1992). Measures of "*organizational impact*" are numerous and examples are cost reduction, overall productivity, change to business processes, increases in sales (Sedera et al., 2004), improved company revenues (Lucas, 1973; Hamilton and Chervany, 1981), revenue and cost issues within a cost/benefit analysis (Emery, 1971) that should include intangible benefits associated with the IS, ROI for assessing the success of corporate MIS efforts (Garrity, 1963; McKinsey and Company, 1968), nonfinancial measures like productivity, innovations and product quality (Jenster, 1987), benefits which are harder to quantify like overhead reduction, increases in customer switching costs, barriers to new firm entry, product differentiation (Johnston and Vitale, 1988).

Summarizing D&M approach, "*System Quality*" measures technical success, "*Information Quality*" measures semantic success and the four remaining constructs measure effectiveness success (D&M, 2003). Like showed in the description of these six dimensions, IS success can be measured with a huge amount of variables[5] and a ranking among them doesn't exist: one can be better than another in a specific context, studying a particular objective, considering particular levels of analysis and research methods and so on, but not in an absolute perspective. D&M's taxonomy reduced all these variables to a more manageable set, even if the great number of variables under each dimension still exists and can make hard the results comparison among similar studies. Furthermore, both the six success categories and the specific measures below them confirm the multidimensional nature of MIS success and the need of measuring it in a congruent way, i.e. Ein-Dor and Segev (1978) stated that "*a better measure of MIS success would probably be some weighted average for the criteria mentioned above*" (i.e. criteria like use, profitability, application to major problems, performance, resulting quality decision and user satisfaction).

D&M's next effort has been to recognize that a more compact taxonomy isn't enough for IS success measurement. Steers (1976) stated that organizational effectiveness is a process and not an outcome of a specific elaboration. Under this perspective, I find quite obvious the need of understanding the links among the dimensions of the IS effectiveness process since every process includes constraints, resources and a specific logic that transforms inputs in outputs.

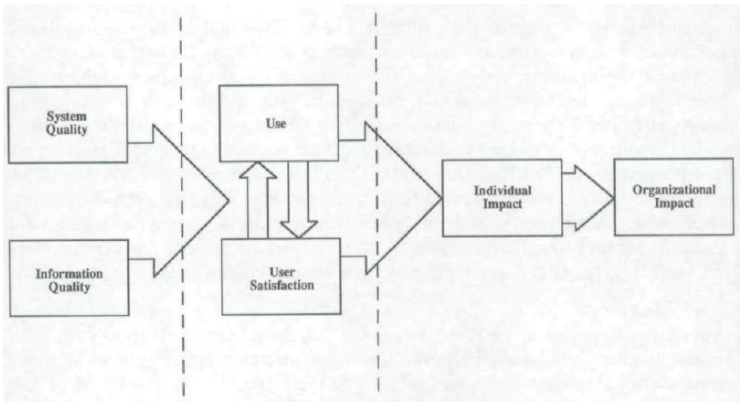


Figure 2: IS success model (from D&M, 1992, p. 87)

A first sight to fig. 2 immediately suggests three properties of the proposed model:

1. It represents a process

[5] For a comprehensive table see D&M (1992), pp. 84-85.

2. It considers causal influences in determining IS success
3. It considers temporal influences in determining IS success

Temporal dimension refers to a first moment in which the IS is created, with its features, "*System Quality*" and "*Information Quality*", a second moment in which users experience the system in a satisfactory or unsatisfactory way and a third moment in which "*Individual Impacts*" collectively result in "*Organizational Impact*" (D&M, 2003). The logical flow among dimensions isn't simply serial and highlights how IS success is the result of different interdependencies. For a better understanding and to respect temporal dimension, I prefer to analyze each link step by step:

- "*System quality and information quality singularly and jointly affect both use and user satisfaction*" (D&M, 1992, p. 83): this means that the quality of both the system itself and the output influence the two use dimensions. I consider this kind of relationship quite interesting: use dimensions aren't only a matter of technical quality but of semantic level too. This is obvious for an user, and then for a field experience, but it can be underestimated in a theoretical perspective, like the present work. This link leads to interesting observations:
    - Like each influence relationship, it can be either positive or negative. I ask myself if D&M took into account compensation effects between a low (high) "*System Quality*" and a high (low) "*Information Quality*" and if it can really happen. Maybe there isn't an universal answer because there isn't an universal user: a manager, like a generic high level user, is interested to some aspects that can be quite secondary for a low level user. This observation can lead to a wide deepening but, all in all, it's besides D&M's purpose: their model aims to provide a structure in MIS success research and to put emphasis on the most important relationships among their constructs. Despite this, I recognize already in this first step the need of a model inclusive of different stakeholders' point of view, as I'll deepen afterwards.
    - Indeed, "*System Quality*" conceptually precedes "*Information Quality*", as the latter quality dimension refers to the IS output, but D&M put "*System Quality*" and "*Information Quality*" in the same temporal dimension: in my opinion, this simplifying hypothesis has a practical implication. Respecting

the true temporal logic, i.e. a manager can stop using the system because it's too slow and this implies a direct (negative) influence on user satisfaction. This example doesn't consider "*Information Quality*" as this process doesn't come to the output, it ends during the elaboration, and it shows how, as a matter of fact, "*System Quality*" and "I*nformation Quality*" don't belong at all to the same temporal dimension. Anyhow, I guess that behind D&M choice there is a wish to generalize the system utilization construct.

  - "*System Quality*" and "*Information Quality*" don't influence each other and I agree with this because it's my opinion that an overlap between these two dimensions exists, and it refers to few technical aspects, but it's partial and it ignores information semantic level.

- *Use and user satisfaction affect each other, positively or negatively* (D&M, 1992, p. 83): the authors didn't talk about the kind of this relationship and I don't really understand if it's linear, if there are specific principles of causality and how "*User Satisfaction*" can influence a priori the use dimension. Again, the choice of placing these two constructs in the same temporal dimension is, for me, a simplifying hypothesis: if I don't use the system, either with low frequency or with a high frequency, I can't express an opinion on my satisfaction as user. Firstly, then, the use dimension affects "*User Satisfaction*" which, after, influences "*Use*" generating an influence loop. I don't really understand the point of introducing a temporal logic, in parallel to the serial logic, if there is the need of twisting it in this way. In order to support the generalizing purpose, maybe the sole causal logic is preferable because it's more general, differently from the temporal logic that, instead, is more stakeholder-dependent.
- "*Use and user satisfaction are direct antecedents of individual impact*" (D&M, 1992, pp. 83, 87): this relationship is clear, direct, univocal and leads to the next temporal step in which impact is assessed (see fig. 2). It's notable that individual impact is obviously caused by an individual dimension ("*User Satisfaction*") respecting the same principle of individuality, but it's caused by the frequency of the system use too, which instead is a more general dimension: this isn't a logical forcing since I consider it congruent with D&M's generalization purpose, as it extends the model scope.

- "*Impact on individual performance should eventually have some organizational impact*" (D&M, 1992, p. 87): the most important part of this statement is "*should eventually*" and, being honest, I don't like it at all. I prefer, and I can accept, a "can have" because it suggests a possibility, instead the used expression calls a strong uncertainty on the relationship itself: it exists (or can exist) or it should exist? Expressions like the way in which that statement has been posited aren't healthy for the model strength and can weaken any influence. I don't understand if D&M's intention is to communicate the possibility that an IS can lead to individual impacts without yielding organizational impacts (like cost reduction, changes to business processes and so on) or also that IS success can be achieved without having organizational impacts.

As a matter of fact, D&M (1992, pp. 87-88) stated that "[...] *confounding results are likely to occur unless all the components identified in the I/S success model are measured or at least controlled. Researchers who neglect to take these factors into account do so at their peril*". An IS success model, consisting of six interdependent constructs, implies that a measurement instrument of the "*overall success*", based on items arbitrarily and partially selected from the six IS success categories, is likely to be problematic. "*Researchers should systematically combine individual measures from the IS success categories to create a comprehensive measurement instrument*" (D&M, 1992, pp. 87-88). This answers to my doubt on the organizational impact dimension: it has to be always considered, even if D&M's statement on the relationship between individual and organizational impacts still leads to ambiguous conclusions. The proposed model put a strong basis for a multidimensional assessment of IS success, considering not six independent variables but six interdependent variables as a whole, and this advice should be applied in the development of further IS success instruments (D&M, 1992).

1.2 DeLone and McLean, ten years after

In 2003 D&M updated their model and evaluated it in front of what they described as "*dramatic change in IS practice, especially the advent and explosive growth of e-commerce*" (D&M, 2003, p. 10), but this choice is motivated by various reasons. The '92 IS success model reached a high consent: in summer of 2002 a citation search showed 285

referred papers in journals and proceedings that referenced D&M model. Unfortunately, some researchers used the model to support their own success variables, ignoring D&M's advice about combining measures from the six IS success categories (see p. 12) in order to develop new measurement instruments. Other researchers, instead, feel the need of validating D&M's model and its causal relationships (i.e. Seddon and Kiew, 1994; Rai et al., 2002)[6]. Despite these efforts, some researchers criticized or extended the model itself, under different perspectives:

- Hard coexistence of process relationships and causal relationships: "[D&M have] *attempted to combine both process and causal explanations of IS success in their model. After working with this model for some years, it has become apparent that the inclusion of both variance and process interpretations in their model leads to so many potentially confusing meanings*" (Seddon, 1997, p. 240). Seddon's statement has a significant weight, as a process relationship (i.e. B follows A) is much less "heavy" than a causal relationship (i.e. A causes B and is responsible of B's increasing or decreasing) and their combination in the same model can be misleading. D&M agreed with Seddon's observation but they stated that his solution to this issue, namely reformulating the IS success model into two partial variance models (Seddon, 1997, p. 245), unduly complicates the model. Anyway, they recognized the need of a contextual variance specification of the model for applications to empirical research and this led to the replacement of impact dimensions with the "*Net Benefits*" dimension, that I analyzed afterwards (pp. 18-19).
- Nature of "*System Use*" variable: Seddon (1997) further suggested that "*System Use*" is a behavior and, as such, it can be used in a process relationship/model and not in a causal one: it must logical precede impacts and benefits but it doesn't cause them. D&M didn't agree with his point of view because their opinion, on the basis of their precedent work (D&M, 1992), is that system use can't be removed from the model and, moreover, it's an appropriate measure of success in most cases.

  The heart of the matter is that "*System Use*" is a complex variable and it should be defined in a more precise way, taking into account the following aspects (D&M, 2003, pp. 16, 17, 21, 23, 27):

[6] See D&M (2003), pp. 13-15 for further validation references.

- Nature of use: i.e. congruency between system full functionality and system (use) purposes.
- Extent of use: time of "*System Use*" can't capture properly the relationship between usage and the realization of expected results (D&M, 2003). This concept is linked to the extent of exploitation of system capabilities, as there is a huge difference in a heavy use of basic functions instead of more advanced ones.
- Quality of use: it's strictly connected to nature and extent of "*System Use*".
- Appropriateness of the use: using system capabilities for decided purposes.
- Informed vs. uninformed use: it should be informed.
- Effective vs. ineffective use
- Mandatory vs. voluntary use: Seddon (1997), as already quoted, argued for the removal of "*System Use*", mostly when system usage is mandatory. D&M rejected this opinion since no system usage is totally mandatory: a high level manager can impose system use to employees but he can use the system on a voluntary basis. Moreover "*System Use*" acquires more importance in an e-commerce perspective and this is another reason for rejecting its removal, in fact "*in e-commerce systems use is largely voluntary*" (Molla and Licker, 2001, p. 6).
- Self reported system usage vs. computer recorded usage: Straub et al. (1995) found that these two measures aren't correlated and they suggested that both measures should be used for the "*Use*" construct because they don't necessarily correlate with one another[7].

Summarizing, in D&M's opinion "*System Use*" still is an important indication of IS success for many systems, especially if informed and effective.

- Difficulty of application: some researchers found difficulty in applying and operationalizing D&M's model in specific research contexts. Even if D&M validated (partially) it ten years after (D&M, 2003), the opinion that the application context influences the importance of success measures is quite shared (see Jiang and Klein, 1999; Whyte et al., 1999; Raymond, 1990, pp. 86-89 of this thesis work). In order to make easier D&M model's application, Seddon et al. (1999)

[7] This issue is recurrent in literature, see table 12 ("Limitations in the methodologies used for testing the TAM" section), p. 74 of this thesis work,.

proposed a matrix, that I analyzed afterwards (pp. 21-25), for classifying IS effectiveness measures keeping into account different stakeholders' perspectives and different types of system.

- Quoting Zhang et al. (2005, p. 59): "[D&M] *claim that the causal relationships that exist between the stages of communication also pertain to the categories of measurement. However, this does not have to follow. If this were so, then one need only be successful at the first stage. Furthermore, IS research now accepts that technical system quality is necessary but not sufficient to ensure IS success; yet the DeLone and McLean model might be seen as suggesting that technical system quality is sufficient*". Being sincere, I don't understand the point of the first part of this criticism, moreover I don't agree with the "*technical system quality*" observation: on one hand it's true that "*System Quality*" mostly refers to engineering-oriented performance characteristics, but D&M also considered a semantic level in the "*Information Quality*" dimension (see fig. 1), so it's evident that technical "*System Quality*" isn't sufficient. Anyway, as I'll deepen, D&M introduced a new dimension, labeled as "*Service Quality*", that reinforces the weight of the semantic level.
- Stakeholders: original D&M's model distinguishes between "*Individual Impact*" and "*Organizational Impact*" but the authors didn't recognize explicitly that IS success perspective is different according to different stakeholders: each stakeholder can come to different conclusions about the success of the same information system (Seddon et al., 1999). In fact, Seddon's re-specification of D&M's model confirms this: "*IS success is thus conceptualized as a value judgment made by an individual, from the point of some stakeholders*" (Seddon, 1997, p. 248).

Before analyzing the IS success model update, I want to deepen the "*independent versus dependent variables*" issue (D&M, 2003, p.17) because it can be useful for my next modeling phase. Several researchers suggested improvements to the original 1992 IS success model, i.e. the introduction of variables like "*user involvement*" or "*top management support*", but D&M rejected these proposals not for technical reasons but for what I prefer to call logical reasons. Variables like the two in the example may cause IS success, which is the dependent variable, but *aren't* part of the success. Another strong example is "*investing in ERP*", that may lead to improving or worsening "*Information*

Quality": the latter is part of the dependent variable (IS success), "*investing in ERP*" is not, it's an independent variable. There is a big conceptual gap between what represents IS success and what leads to it[8].

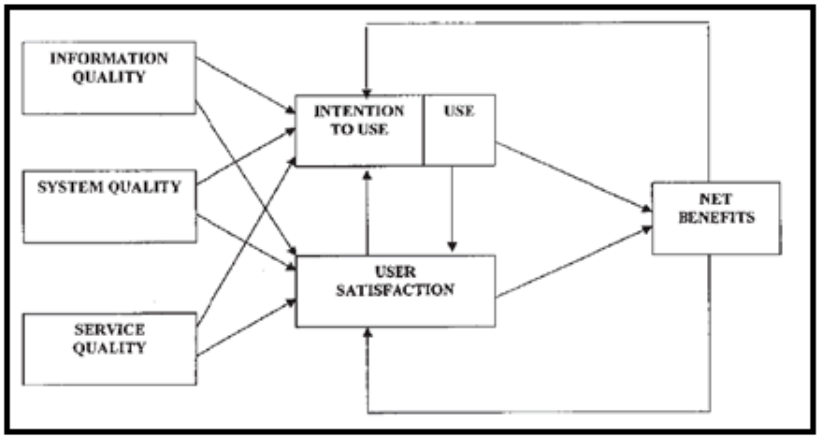


Figure 3: Updated D&M IS Success Model (from D&M, 2003, p. 24)

At first sight, the most immediate update in the model (fig. 3) is the introduction of two new dimensions:

- Service Quality: the introduction of this dimension starts from the idea that IS organizations have a dual role, namely on one hand the role of information provider (information is their output, their product), on the other hand the role of service provider, supplying support for end user developers (D&M, 2003). This point of view suggests to not focus measure efforts only on products, namely the information, but on services of the IS function too. In fact, "[...] *there is a danger that IS researchers will mismeasure IS effectiveness if they do not include in their assessment package a measure of IS service quality*" (Pitt et al., 1995, p. 173): there is the need of including service quality measure as part of IS success and this consideration is quite shared among researchers (i.e. Kettinger and Lee, 1995; Li, 1997; Wilkin and Hevitt, 1999). However the introduction of this new dimension raises three different issues:

    - At 2003 date, the validation of "*Service Quality*" construct hasn't been completed. Some attempts used SERVQUAL measurement instrument, that considers five dimensions (examples are from D&M, 2003, p. 18):
        - Tangible, i.e. "*IS has to up-to-date hardware and software*"
        - Reliability, i.e. "*IS is dependable*"

[8] A deepening on this last statement is in pp. 93-97.

- Responsiveness, i.e. "*IS employees give prompt service to users*"
- Assurance, i.e. "*IS employees have the knowledge to do their job well*"
- Empathy, i.e. "*IS has users' best interests at heart*"

Validation results have been contrasting, e.g. Van Dyke et al. (1997) identified "*problems with the reliability, discriminant validity, convergent validity and predictive validity of the measure*" instead, in their empirical study, Jiang et al. (2002) "*found high convergent validity for the reliability, responsiveness, assurance and empathy of the SERVQUAL scales and found acceptable levels of reliability and discriminant validity among the reliability, responsiveness and empathy scales*" (D&M, 2003, p. 18).

- "*Service Quality*" can be considered like a subset of "*System Quality*" construct, but the actual role of IS requires a separate "*Service Quality*" variable. Furthermore, it's my opinion that "*System Quality"* mostly considers technical features while "*Service Quality*" principally belongs to a semantic level thus, if an overlap exists, it's quite narrow and table 1 supports this.

Dimensions / Levels	TI	SI	EI
System Quality	X		
Information Quality		X	
Service Quality		X	
Intention to Use / Use			X
User Satisfaction			X
Net Benefits			X

Table 1: D&M Model Dimensions and Level Types[9] (from Bento and Costa, 2013, p. 20)

- "*Service Quality*" is a third quality dimension in the model but, like the others, has a variable weight according to the level of analysis. D&M (2003) decompose this level on the IS type dimension: "*to measure the success of a single system, "information quality" and "system quality" may be the most important quality component. For measuring the overall*

[9] TI: technical level, defined as accuracy and efficiency of information system; SI: semantic level, defined as ability of the system to transfer the intended message; EI: efficacy level, it translates the result that information reflects in users (Shannon and Weaver, 1949).

success of the IS department, as opposed to individual systems, "service quality" may become the most important variable" (D&M, 2003, p. 18). I agree with this consideration but I consider it incomplete since I prefer Seddon et al. (1999) approach that took into account, in a particular matrix (already quoted two pages ago) analyzed in pp. 21-25, another dimension besides "*System Type*", namely five different stakeholders/interest groups' perspectives. Moreover, this strengthens Seddon's opinion (Seddon, 1997; Seddon et al., 1999) about the issue that D&M (1992) didn't recognize explicitly that IS success perspective is different according to different stakeholders, as already stated.

Despite of all these observations, D&M (2003, p. 18) believe that "*"service quality", properly measured, deserves to be added to "system quality" and "information quality" as component of IS success*".

- Net Benefits: as observed by Seddon (1997) and Seddon et al. (1999), there is a pressing need to consider different stakeholders' perspectives, since IS impacts go besides the user. Several researchers considered IS impact on work groups (Ishman, 1998; Myers et al., 1998), on industry and interorganizational (Clemons and Row, summer 1993; Clemons et al., fall 1993), on consumers (Brynjolfsson, 1996; Hitt and Brynjolfsson, 1994), on society (Seddon, 1997) and other perspectives can be considered. D&M choice is to not complicate the model including further success measures, as they can be numerous, then they prefer to group all the impact measures into a single category labeled as "*Net Benefits*". This update has been necessary in order to extend IS impact to the context of model's application (D&M, 2003; Wu and Wang, 2006) and to include external factors, besides internal factors, in the scope of the model (Bento and Costa, 2013). Moreover, "*the "net benefits" can measure the impacts on sales, costs and responsiveness. It is the most important dimension in the D&M model*" (Bento and Costa, 2013, p. 18).

  An interesting observation is that the paternity of the term "net benefits" in outcomes characterization belongs to Seddon (1997), that used it six years before D&M, supporting it with another construct labeled as "*consequences*". D&M agreed about "*Net Benefits*" adoption, since it comprises an interesting logic. First, the word *net* highlights that an outcome is a combination of positive and negative outputs and we want to consider the net result, hence this dimension shows the

balance of positive and negative impacts of an IS (Chien, 2004). Second, the term *benefits* is quite general, depending on who perceives these benefits, i.e. the sponsor, the user, a manager and so on, then it can assume different meanings: different stakeholders/actors may have different opinions about what constitutes a benefit to them (Seddon et al., 1999). In my opinion, this isn't a limitation of the model, instead it's an additional reason to correctly define study's extent and scope. In fact, the level of analysis must be addressed (Seddon et al., 1999; Chan, 2000), i.e. individual's perspective, his or her employer, industry's or nation's perspective. Confirming this, D&M (2003, p. 22) stated that "*collapsing "individual" and "organizational impacts" into a single variable, "net benefits", does not make the problem go away. It merely transfers the need to specify the focus of analysis to the researcher*". Moreover, Seddon (1997) suggests, in analyzing the net benefits from different stakeholders' perspectives, to differentiate what is measurable and what is not.

The new D&M's model (fig. 3) presents, obviously, also an update in links among the constructs, even though the basis is still unchanged: quality dimensions, now three, are the independent variables that directly influence "*Intention to Use/Use"* and "*User Satisfaction*", which are the dependent variables (Bento and Costa, 2013, p. 20)[10]. The most innovative relationships in the model are:

- "*Information Quality*", "*System Quality*" and "*Service Quality"* singularly and jointly affect "*Intention to Use/Use*" and "*User Satisfaction*".
- "*Use*" is a multidimensional construct and the considerable amount of below aspects (see pp. 13-14) leads D&M to suggest an alternative measure that can be worthwhile in some contexts: "*Intention to Use*". "*Intention to Use*" is an attitude, while "*Use*" is a behavior and this integration/substitution may resolve some of the critics raised by Seddon (1997) about process relationships versus causal relationships (p. 13). Unfortunately, "[...] *attitudes, and their links with behaviour, are notoriously difficult to measure*" (D&M, 2003, p. 23). Anyway, I agree with D&M's opinion that "*Use*" construct can still fit for each context, but only if it's fully inflected (as in pp. 13-14).

[10] I don't totally agree with this opinion as "*Intention to Use/Use*" and "*User Satisfaction*" aren't, in my opinion, dependent variables but part of the dependent variable (IS success/effectiveness) together with "*Net Benefits*".

- "*Use*" precedes "*User Satisfaction*" in a process sense, as I can't be satisfied or unsatisfied without using the system, and in a causal sense too: positive "*Use*" leads to a greater "*User Satisfaction*". On the other side, if I'm satisfied by the system, "*Intention to Use*", and thus "*Use*", will increase. This logic between "*Use*" and "*User Satisfaction*" is now explicitly stated by D&M, while it was not in their 1992 work, in fact in p. 11 I raised this kind of issue analyzing the original D&M's model but I definitively got my answers in the 2003 update.
- "*Intention to Use/Use"* and "*User Satisfaction*" produce results in terms of "*Net Benefits*". A lack of positive benefits likely can lead to decreased "*Use*" and "*possible discontinuance of the system or of IS department itself (e.g., wholesale outsourcing)*" (D&M, 2003, p. 23). Vice versa, positive benefits can reinforce "*Use*" and "*User Satisfaction*", especially if such benefits are positive from the perspective of the owner or sponsor of the system, as they can directly decide for a continuative firm system use or not. Some empirical studies highlighted that the association between "*Use*" of the system and "*Net Benefits*" has statistically insignificant values and that *"Use"* dimension is necessary but not sufficient by itself to be the cause of "*Net Benefits*" (Geldermann, 1998). This issue is correctly considered by D&M (2003) with the bidirectional relationship between "*Intention to Use/Use*" and "*Net Benefits*" above exposed.

Graphically (fig. 3), arrows show relationships in a process sense but positive or negative signs for associations in a causal sense aren't shown and this is consistent with the model purpose of generalization. In fact, while process associations are "always" valid, causal associations should be hypothesized according to the context, i.e. a high "*System Quality*" can be associated with an increasing in "*Use*" and "*User Satisfaction*", then positive "*Net Benefits*" occur (positive causal relationship), vice versa an increased *"Use*" of a poor quality system leads to more dissatisfaction and negative "*Net Benefits*" (negative causal relationship).

The updated model can be adapted to the context of e-commerce too (D&M, 2003, pp. 23-26) and, on the basis of a ten years review, D&M (2003) drew some conclusions:

1. Updated model isn't definitive, it should continue to be tested and challenged.
2. "*Service quality*" dimension has to be added as part of IS success given the importance of IS support, especially in the e-commerce context.

3. It's important to define and measure correctly both dependent and independent variables and to isolate the effect of independent variables on one or more dependent success dimensions.
4. According to the context (contingent variables as size, organizational structure etc.) and the objectives of the empirical research, IS success dimensions and measures should be carefully selected, preferring tested/validated and proven measures to the development of new measures, if possible. The effectiveness matrix by Seddon et al. (1999, pp. 21-25 of this thesis work) can be an useful tool.
5. In order to measure IS success, the number of used measures should be as low as possible.
6. "*System Use*" dimension should be always considered in IS measurement success as voluntary "*System Use*" is now more common with the growth of e-commerce contexts. "*Use*" measures shouldn't consider only the frequency because "*Use*" is a multidimensional construct (nature, level, appropriateness and so on).
7. "*Net Benefits*" dimension measures require more field-research. Satisfaction and usage measures aren't an acceptable alternative to measuring performance directly (i.e. through "*Net Benefits*"). These three variables are correlated but not in a way as strong as using them like mutual substitutes (Yuthas and Young, 1998).

1.3 The matrix of IS effectiveness measures

Seddon et al. (1999) proposed a bidimensional matrix containing 30 possible classes of IS effectiveness measures and the logic below its elaboration is quite linear. The starting point is represented by the "*Seven questions to answer when measuring organizational performance*" by Cameron and Whetten (1983) in table 2. Seddon et al. (1999) suggested that these seven questions are as relevant to psychologists measuring organizational effectiveness as to IT practitioners measuring IS effectiveness. According to this likeness, the authors combined questions 1 and 3 (table 2) in a dimension labeled as "*stakeholders*", inflected in five points of view (from Seddon et al., 1999, p. 6):

1. "*The independent observer who is not involved as a stakeholder*"
2. "*The individual who wants to be better off*"
3. "*The group, which also wants to be better off*"

4. "*The managers or owners who want the organization to be better off*"
5. "*The country which wants the society as a whole to be better off*"

1. From whose perspective is effectiveness being judged?
2. What is the domain of activity? (depends on tasks emphasized in the organization, competencies of the organization, and demands from external forces)
3. What is the level of analysis? (individual, subunit, organization, population, societal)
4. What is the purpose of evaluation?
5. What is time frame is employed? (short, long)
6. What types of data are to be used? (objective or perceptual)
7. Against which referent is effectiveness to be judged? (effectiveness of this organization compared to: some other organization; some ideal level of performance; stated goals of the organization; past performance of the organization; or certain desirable characteristics)

Table 2: Seven questions to answer when measuring organizational performance (from Seddon et al., 1999, p. 5)

In this context, a stakeholder is defined as an individual or a group in whose interests the evaluation of IS success is performed. Using the question 2 (table 2), the second dimension, labeled as "*system*", has been defined on six levels (from Seddon et al., 1999, p. 6):

1. "*an aspect of IT use (e.g., a single algorithm or form of user interface)*"
2. "*a single IT application (e.g., a spreadsheet, a PC, or a library cataloging system)*"
3. "*a type of IT or IT application (e.g., TCP/IP, a GDSS, a TPS, a data warehouse, etc.)*"
4. "*all IT applications used by an organization or sub-organization*"
5. "*an aspect of a system development methodology*"
6. "*the IT function of an organization or sub-organization*"

This implies a total of 5*6=30 possible classes of IS success measures. Each slot in the matrix is the system evaluated from the point of view of the stakeholder. If necessary, each dimension can be further decomposed, i.e. managers in "*managers and owners*" level can be classified in senior managers, IT managers and so on, on condition that each sub-level differs from the others for its judgment about effectiveness. Analyzing the matrix (table 3), it seems obvious that measuring IS effectiveness in different contexts requires very different measures. Hence, Seddon et al. (1999, p. 9) stated that "[...] *a "systematic combination" of six different types of measures as suggested by DeLone and McLean [1992]* [...] *is not going to work*". I agree with this observation but I want to underline that, at present date, D&M already updated their model and in that work they suggested to

define and select IS success dimensions and measures according to the context and the objectives of the empirical research, moreover they encouraged Seddon's matrix use (D&M, 2003, p. 27).

	Stakeholder/ interest group	(1) An **aspect** of IT design or use (e.g., algorithm, query language, or user interface)	(2) a **single** IT application in an organization (e.g., this GDSS)	(3) a **type** of IT or IT application (e.g., **any** GDSS, data warehouse, etc.)	(4) **all** IT applications used by an organization or sub-organization	(5) an aspect of a system development **methodology** (including reengineering)	(6) an **IT function** (or its management) in an organization
(1)	**Independent observer** (stakeholder independent)	*Accuracy or speed of algorithm* [Mookerjee, Mannino and Gilson 1995]	*Performance outcome expectations* after learning to use spreadsheet or word processing package [Compeau and Higgins 1995]	*Communication effectiveness* choice between e-mail and face to face [Zack 1993]	*Cumulative abnormal returns* of firms following IT investment announcements by 97 firms, 1981-1988 [Dos Santos, Peffers, and Mauer 1993]	*Accuracy and consistency* of software estimates [Mukhopadhyay, Vicinanza, and Prietula 1992]	*Important skills for EIS developers* from survey of current practices [Watson, Ranier, and Koh 1991]
(2)	**Individual Primary focus:** Individual better-offness	*User acceptance of Expert System advice* for expert systems with explanation facilities [Ye and Johnson 1995]	*Creative Performance (fluency, novelty, value), satisfaction* of students using creativity enhancement software [Massetti 1996]	*Work-Family conflict* due to after-hours work-related home computer use [Duxbury, Higgins and Mills 1992]	*Self-rated job performance* of users of up to five systems in 25 departments [Goodhue and Thompson 1995]	*User Satisfaction* as consequence of User participation and four moderator variables. [McKeen, Guimaraes, and Wetherbe 1994]	*Service Quality* [Pitt, Watson, and Kavan 1995] (3 firms)
(3)	**Group Primary focus:** Group better-offness	*Post- meeting consensus, degree of confrontiveness, quality of recommendations* in variations in GDSS design [Sambamurthy and Poole 1992]		*Equality of participation, Perceived group performance* in GDSS [McLeod and Liker 1992]			
(4)	**Management or Owners (of a firm) Primary focus:** Organizational better-offness	*Perceived usefulness of computer-based information* for financial and operations management [Kraemer, Danzinger, Dunkle, and King 1993]	*Price premium per gallon* for fuel sold via the Cardlock system [Nault and Dexter 1995]	*Reduced inventory holding costs, Reduced premium freight costs* at Chrysler, following introduction of EDI [Mukhopadhyay, Kekre and Kalathur 1995]	*Sales growth, ROA, labor productivity* [Weill 1992] (33 firms)	*Cost savings, quality improvement, customer satisfaction* from Business Process Reengineering [Caron, Javenpaa and Stoddard 1994]	*Benefits to the firm* flowing from IT outsourcing: [Lacity and Hirscheim 1993]* * not from the three IS journals analyzed.
(5)	**A Country Primary focus:** Society's better-offness			*Evolution of electronic market* for computerized loan origination. [Hess and Kemerer 1994]	*Productivity, and Consumer Surplus* [Hitt and Brynjolfsson 1996] (370 firms, one country)		Not applicable

Table 3: IS effectiveness measures used for different combinations of Stakeholder and System: some examples (from Seddon et al., 1999, p. 7)

According to table 3, each row and each column have a specific application context, briefly described as follows:

- Row 1: it's suitable "[...] *for studies where IS effectiveness is thought to be independent of the needs and wants of different stakeholders* [...] *where objective measures of effectiveness, such as speed or accuracy, are available*" (Seddon et al., 1999, p. 9) and for most experiments where the principal actor in an investigator, that judges objectively IS effectiveness, and not someone that has a personal interest in the system.
- Row 2: it's suitable for studies that want to investigate on benefits from an individual perspective, i.e. increased productivity, better decision making and so on.
- Row 3: it's suitable for studies concerning groups' effectiveness measures.
- Row 4: it's suitable for studies concerning IS effectiveness measures from management or owners of an organization perspective. Especially here, it can be useful a further decomposition, taking into account what quoted above (p. 22), if there isn't goals' congruence among different management levels. IS effectiveness

measures in row 4 are mostly economic, i.e. firm growth, ROA, market share (Weill, 1992) etc. .

- Row 5: it's suitable for studies concerning IS effectiveness measures from a country perspective.

Respond-ent	"From the point of view of your firm, would you describe the data warehousing project a success?"	"From your own personal point of view, would you regard your firm's data warehousing project a success?"
Sales trainee, Firm A	Yes, helps people get the information they want when they want it. Think that it would be very hard to cope without it.	Yes, it would be very hard for me to get information without it. Although get frustrated with it, it is more success than not.
Business analyst, Firm B	Wouldn't have thought so yet, because don't think there are many people on it. Know there was work being done a few months ago to try to introduce new users to it, but don't know..	Yes, largely I would. Have some concerns now because of incomplete data, but generally has from my point of view. Has made data far more accessible.
IT informant, Firm C	Yes, absolutely. The fact that they want to do more is a good indicator. Decision has been made to "warehouse the world".	Yes, as above, but has taken longer than expected, and will never be finished.
Senior Manager Marketing, Firm C	Yes, achieved the objects it set out to achieve.	Yes and no, was a success but … In my opinion project was far too technically driven.

Table 4: transcript responses from interviewees about Data Warehousing success (from Seddon et al., 1999, p. 12)

Table 4 on the left shows some examples of answers collected for a study of Data Warehousing success (Seddon and Benjamin, 1988). It's evident that project success meaning is different if considered from an individual perspective rather than a firm perspective and this is only another reason to support different stakeholders' point of view in IS success measure.

- Columns from 1 to 4: their meaning is consistent with the corresponding system levels, described in p. 22.
- Column 5: "[it] *is concerned with the effectiveness of systems for changing information systems*" (Seddon et al., 1999, p. 11), including reengineering. Studies in this column are mostly developed on effectiveness of different methodologies for developing IS, hence the dimension "*system*" is represented by the methodologies themselves.
- Column 6: here, studies consider the "*system*" dimension as represented by the organization's IS/IT function and by how much it's effective.

The generalizability of this framework has been tested (see Seddon et al., 1999, pp. 13-18) following the same D&M's approach, namely classifying the IS effectiveness measures used in prior studies. The test has been based on over 600 studies and it had a positive outcome. Often, the classification has been hard but possible and this has to encourage researchers and practitioners in doing it with an appropriate effort.
Concluding, Seddon et al. (1999) recommendations are:

- Appropriate measures of IS effectiveness, from different stakeholders' views, should be combined in studies. The diversity of these measures isn't a problem, unlike D&M (1992) opinion.
- Researchers and practitioners requiring IS effectiveness measures should make an effort in answering to all seven questions in table 2 *before* starting an evaluation.
- For each IS effectiveness evaluation, "*type of system*" and "*stakeholder*" have to be clear, even if the matrix isn't used for the measurement purpose.

Moreover, I want to add a personal observation. Seddon et al. (1999, p. 4) stated that the purpose of their work "[...] *is to present an alternative to DeLone and McLean's model of IS success*". In my opinion, this matrix can't be defined as a true model, even if the approach to the theoretical framework is innovative. Instead I see it like an useful tool that has to be used as an essential support to whatever IS success model a researcher or practitioner wants to use: this tool adds structure to IS effectiveness measures and I recommend its use.

1.4 TPC model: how much relevant are fit issues in IS success?

According to D&M (1992), MIS success is also constituted by "*Individual Impact*" and "*Organizational Impact*", that in D&M (2003) have been merged into "*Net Benefits*". Instead of "*IS success*" or *"IS effectiveness*", Goodhue and Thompson (1995) chose "*Individual Performance Impacts*" as the dependent variable, in order to investigate the linkage between IT and individual performance. The title I chose for this paragraph is, therefore, a provocation: G&T (1995) work purpose isn't directly connected to IS success analysis, although D&M's (1992) "*Individual Impact*" involves individual performance. A reasonable kind of link among the two quoted works, then, exists and that's why I included G&T in the literature analysis.

The proposed model is called Technology-To-Performance Chain (TPC) and aims to draw a linkage between performance and technology applying two complementary streams of research:

1. Utilization stream: it uses user attitudes as predictors of IS utilization (Lucas, 1975; Davis, 1989; Doll and Torkzadeh, 1991)[11]. Using a simplified logic, aspects of the

[11] See G&T (1995), p. 214 for further references.

technology, i.e. high quality system (Lucas, 1975), lead to user attitudes about systems, like usefulness (Davis, 1989) or user information satisfaction (Baroudi et al., 1986). These attitudes, to which other situational factors should be added, i.e. social norms (Hartwick and Barki, 1994; Moore and Benbasat, 1992), lead to the intention to utilize systems and an increased utilization leads to positive performance impacts: therefore, a link between technology characteristics and performance impact is drawn (see fig. 4). Anyhow, this stream of research has some limitations. First, utilization isn't always voluntary, in fact D&M (2003) underlined this aspect. Mandatory use, even if system usage is never totally mandatory (see p. 14), changes "*Use*" meaning as users can see it like a responsibilities issue (how jobs are designed and so on) and not a matter of usefulness of systems or attitudes toward using them. With mandatory settings, "[...] *performance impacts will depend increasingly upon task-technology fit rather than utilization*" (G&T, 1995, p. 216). Furthermore, increased utilization doesn't always lead to a better performance: i.e. if the system has a low "*TTF*", it will not yield a performance enhancement, although poor systems may still be utilized due to social factors like ignorance and so on.

2. Task-Technology Fit (TTF) stream: "*the Task-technology fit (TTF) theory has the main clear statement that IT is more likely to have a positive impact on individual performance and can be used if the capabilities of the IT match the tasks that the user must perform*" (Kronbichler et al., 2010, p. 296). It's a matter of the degree of congruence between technology support to individuals performing their tasks and the tasks themselves, where a task is a generic process that transforms inputs in outputs. This is a simple model, not much structured: "*TTF*" determines performance and, eventually, utilization but no utilization predictors are taken into account, unlike as the utilization stream does (see fig. 4). The relationship between IS[12] positive impact on performance and "*TTF*" has been already suggested by Goodhue (1988), while the link between fit and utilization has been already investigated on organizational level (Cooper and Zmud, 1990; Tornatzky and Klein, 1982) and individual level, although on individual level the system/work fit "[...] *has been found to be a strong predictor of managerial electronic workstation use*" only (Floyd, 1986, 1988).

[12] IS is now considered as the whole organizational function, including policies, IS staff etc. .

Since a weak point of the TTF stream is the absence of the "*Use*" construct, which implies that no performance impacts can be achieved without using the system, a first solution is a merger between TTF stream and utilization stream (see fig. 4).

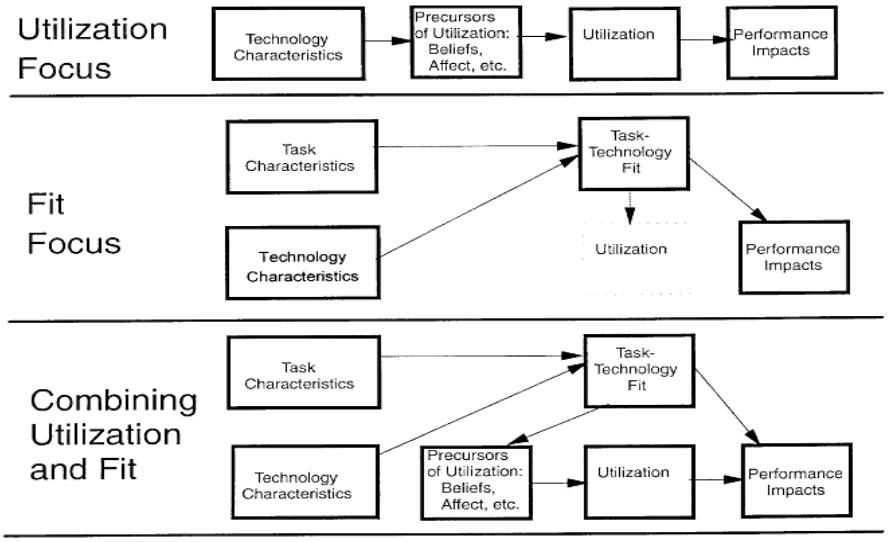


Figure 4: merging different streams into a new approach (from G&T, 1995, p. 215)

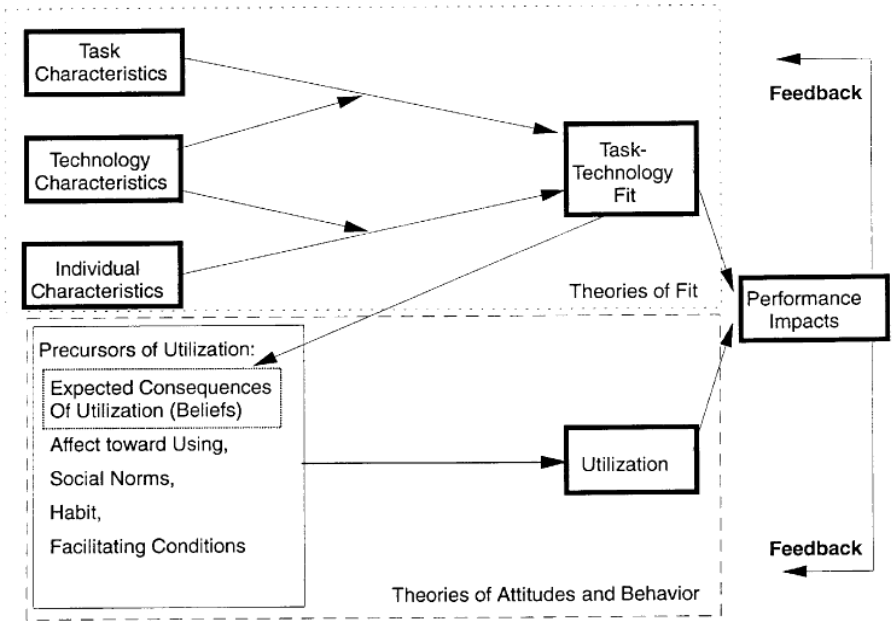


Figure 5: the Technology-to-Performance Chain (from G&T, 1995, p. 217)

A refined combination of the two streams is the TPC model (fig. 5). G&T (1995) stated that this model is consistent with the IS success model by D&M (1992) because they both consider "*Use*" and "*User Attitudes*" about the technology as leading to "*Individual Impact*". I don't really agree, as user attitudes are almost (not totally) absent in D&M (1992), in fact the authors clearly deepened them in their 2003 update, namely eight years

after G&T (1995), with the dual vision of "*Use"* and "*Intention to Use*" (see pp. 19-20). It's doubtless that correspondences between the TPC model and the IS success model (1992 version) exist, but I encourage a comparison with the D&M updated model and not with the original version. Another reason that supports my opinion is that the multidimensional nature of "*Use*", which has been deepened especially in the D&M's 2003 update (see pp. 13-14 of this thesis work), is almost absent in D&M (1992), that contains only little pertinent hints: this allows a better comparison between D&M (2003) and G&T (1995) as the latter included, in the TPC model, the precursors of utilization (see fig. 5) suggested by the theories of attitudes and behavior[13]. However, D&M's 2003 model and the TPC model principally differ in the "*TTF*" construct, besides the fact that TPC model only considers the individual dimension. The major features of the G&T's model (fig. 5) are:

- Technologies: they include both hw/sw/data and user support services (training, help lines etc.).
- Tasks: actions that transform inputs in outputs.
- Individuals: people using the system to accomplish their tasks with a certain performance. Individual characteristics are, i.e., motivation, training, computer experience[14] and they could affect how easily and well the individual utilizes the technology (G&T, 1995).
- TTF: "*TTF is the correspondence between task requirements, individual abilities and the functionality of the technology*" (G&T, 1995, p. 218). The authors suggested that, maybe, a more accurate label for this construct can be Task-individual-technology fit, as the TPC model lies only on individual abilities and impact, but they chose the "*TTF*" label for a simpler use.
- The antecedents of TTF: they are the interactions among task, technology and individual. If the gap between task requirements and technology functionalities is wide, "*TTF*" is consequently low. As a perfect fit between them is quite rare (maybe exists in high customized systems), G&T (1995, p. 218) stated that "*TTF*" decreases when tasks become more demanding in terms of technologies need or when technologies offer less functionalities.

[13] For a deepening on these theories, see i.e. Triandis (1980) and Bagozzi (1982).
[14] Venkatesh and Davis (2000) and Venkatesh and Bala (2008) tested the mediating role of "*experience*" as a separate construct, see fig. 31 and fig. 32.

- Utilization: this refers to the behavior of using technology in completing tasks. G&T (1995) quoted Trice and Treacy (1988) for the need of refining the conceptualization of this construct. On this subject, I again suggest to share D&M's (2003, pp. 16, 17, 21, 23, 27) perspective on "*Use*" like a multidimensional construct (see pp. 13-14), moreover also D&M (2003, p. 23) defined "*Use*" as a behavior, while "*Intention to Use*" as an attitude (see p. 19), and this can be a further commonality. Anyway, this doesn't mean that G&T and D&M attributed the same meaning to "*Use*", I'm only encouraging a logical decomposition of the "*Utilization*" construct without suggesting a specific way in doing this: the "*Utilization*" construct is different from the D&M's "*Use*" construct because the former takes into account only an individual perspective (and this is true for the TPC model as a whole too). According to the TPC model, the precursors of utilization (see fig. 5) would lead to the individual's decision to use (or not) the system then, in case of a specific system utilized for a single and defined task, the focus is about this dichotomous choice: "*Utilization*" is conceptualized as "*the binary condition of use or no-use*" (G&T, 1995, p. 218) because the length of the utilization is consequence of task size and/or "*TTF*" and not of the choice of using the system. In case of multiple tasks, a way of conceptualization is the sum of the decisions to use divided by the number of tasks: i.e. using (always at individual level, but for more tasks) the system three times for four tasks is quite different from using it three times again, but for twenty tasks. Generalizing this approach to the single task case, the sum of the decisions to use the system can still be a good measurement's solution and I want to underline that this latter operationalization isn't a frequency of use because it doesn't refer to a temporal dimension but to the number of tasks, which here is one. It's important to underline also that the TPC model includes both voluntary and mandatory utilization without differences: i.e. utilization is mandatory when policies and/or social norms overpower beliefs and so on (see fig. 5).
- The antecedents of utilization: they are the precursors in fig. 5, suggested by the theories of attitudes and behavior.
- The impact of TTF on utilization: as shown in fig. 5, it isn't direct but passes through the beliefs about the expected consequences of system utilization. The model is drawn in this way because "*TTF*" should be an important variable in order to understand if "[...] *systems are believed to be more useful, more important, or*

give more relative advantage" (G&T, 1995, p. 218). However, according to fig. 5, beliefs about the expected consequences of system utilization aren't the only determinants of systems' utilization.

- Performance impacts: high "*TTF*" increases performance impacts (at individual level, since this is the context of the TPC model) of the system, independently from the reason of utilization, moreover it increases the probability of utilization. Furthermore, "*utilization*" yields the same effects on performance impacts (fig. 5). The reason behind the "*TTF*" relationship is that high "*TTF*" means a narrow gap between the functionalities offered by the system and the requirements of the task, keeping into account individual abilities.
- Feedbacks: in the TPC model, they are expected after performance impacts have been yielded. A first kind of feedback refers to future utilization: an user can experience a better (or worse) impact on individual performance than what he was expecting, affecting therefore positively (negatively) the future utilization. A second kind of feedback concerns learning, namely a user may learn, through the experience, better ways of using the technology, enhancing the fit between technology and his individual abilities and, then, improving the overall "*TTF*".

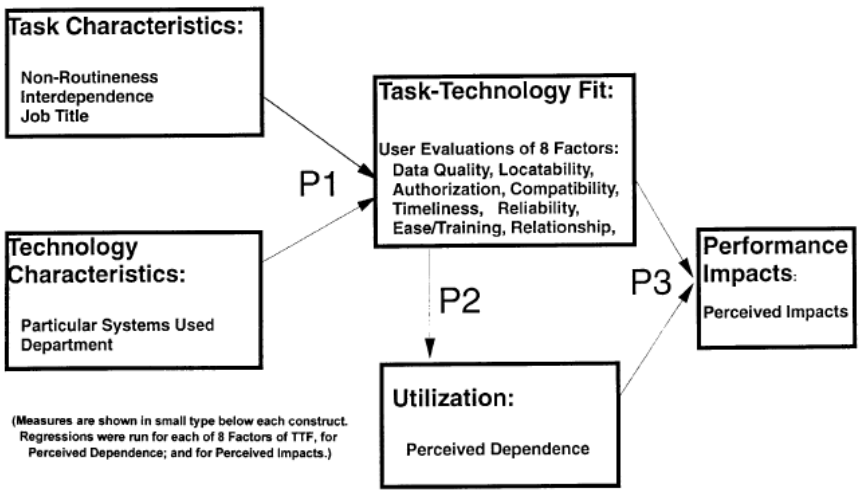


Figure 6: The subset of TPC to be tested (simplified model) with measurements and analyses to be conducted (from G&T, 1995, p. 225)

G&T empirically tested their model but, as TPC is a large one, they tested a reduced model. Considering the whole model, some relationships have already been isolatedly tested by other researchers[15], but none tested the full scope of the model. The reduced model (fig. 6) is mainly focused on "*TTF*" role and on its links. The biggest change from

[15] See G&T (1995), p. 219 for details.

the original model is the direct link between "*TTF*" and "*Utilization*" and this can seem an attempt at bypassing "*expected consequences of utilization (beliefs)*" (see fig. 5). As a matter of fact, the purpose is opposite because G&T (1995, p. 219) stated two assumptions for their simplified model:

1. "*TTF will strongly influence user beliefs about expected consequences of utilization*".
2. "*User beliefs will have an effect on utilization*".

These assumptions are quite heavy and constitute part of the authors validation's purpose, which consists in the three propositions labeled as P1, P2 and P3[16] in fig. 6. The same figure shows used measurements and I want to underline the one considered for the "*Utilization*" construct because it's different from what said about this construct's operationalization in p. 29. "*Utilization*" can be conceptualized as a binary condition of use or no-use, considering the sum of the decision to use divided by the number of tasks: this expresses the proportion of time users choose to utilize system. Unfortunately, this is an ideal solution, due to the significant difficulty in measuring it in a field study. Then, G&T (1995, p. 223) proposed a different way to conceptualize utilization, namely "[...] *as the extent to which the information systems have been integrated into each individual's work routine, whether by individual choice or by organizational mandate*", operationalizing it asking users how much dependent they are by the systems available in their organization, using a three-point scale[17]: that's why fig. 6 shows "perceived dependence" as a measure of "*Utilization*".

Anyway, G&T (1995, p. 223) stated that, while structuring the validation work, "[...] *there was also the problem of mandatory use. In many field situations, use of a system may be mandated as part of a job description. For example, a claims processor with the insurance company (Company B)* [it's one of the companies involved in the validation process] *had no choice but to use the system provided by his or her department. Regardless of the claims processor's evaluation of the system, it was not possible to process claims without using it*" (I labeled this statement as "S1"). Moreover, in the section where the authors described the used constructs from a theoretical perspective (and not a practical one as a field validation), they stated that "[...] *both voluntary and mandatory utilization are*

[16] These propositions will be quoted afterwards. For further details, see G&T (1995), p. 219.
[17] 0 (not very dependent), 1 (somewhat dependent), 2 (very dependent).

reflected in the model. Mandatory use can be thought of as a situation where social norms to use a system are very strong and overpower other considerations such as beliefs about expected consequences and affect" (G&T, 1995, p. 218; I labeled this statement as "S2"). These two quoted statements are congruent each other but, in my opinion, they raises a conflict. In both S1 and S2 statement, mandatory utilization is a matter of policies and social norms overwhelming beliefs and so on. S1 has been expressed in a field validation context, which concerns the simplified model in fig. 6, S2 has been expressed in a theoretical context, where the TPC has been built, which concerns the whole model (fig. 5). The simplified model is based on the two assumptions in p. 31, but neither these two assumptions nor the three tested propositions (which belongs to the same test context) include precursors of utilization, like social norms, which instead are fundamental in justifying mandatory use in the TPC model. Unfortunately, the incongruence that I'm raising is quite abstract, even if it's on a logical dimension, and maybe a graphical approach can be useful (fig. 7). An overview of the propositions P1, P2 and P3 that G&T (1995, p. 219) stated for their validation purpose is necessary:

- Proposition 1: "*user evaluations of task technology fit will be affected by both task characteristics and characteristics of the technology*".
- Proposition 2: "*user evaluations of task technology fit will influence the utilization of information systems by individuals*".
- Proposition 3: "*user evaluations of task technology fit will have additional explanatory power in predicting perceived performance impacts beyond that from utilization alone*".

According to fig. 7, it's possible to state that:

- S1 ←→ S2: there can be congruence between them as they both recognize the existence of mandatory use, even if in two different contexts.
- S2 ←→ TPC model (theoretical context): there is congruence because S2 recognizes mandatory use as likely caused by strong social norms overpowering other considerations such as beliefs, and beliefs belong to the TPC model (in the theoretical context) among the precursors of utilization.

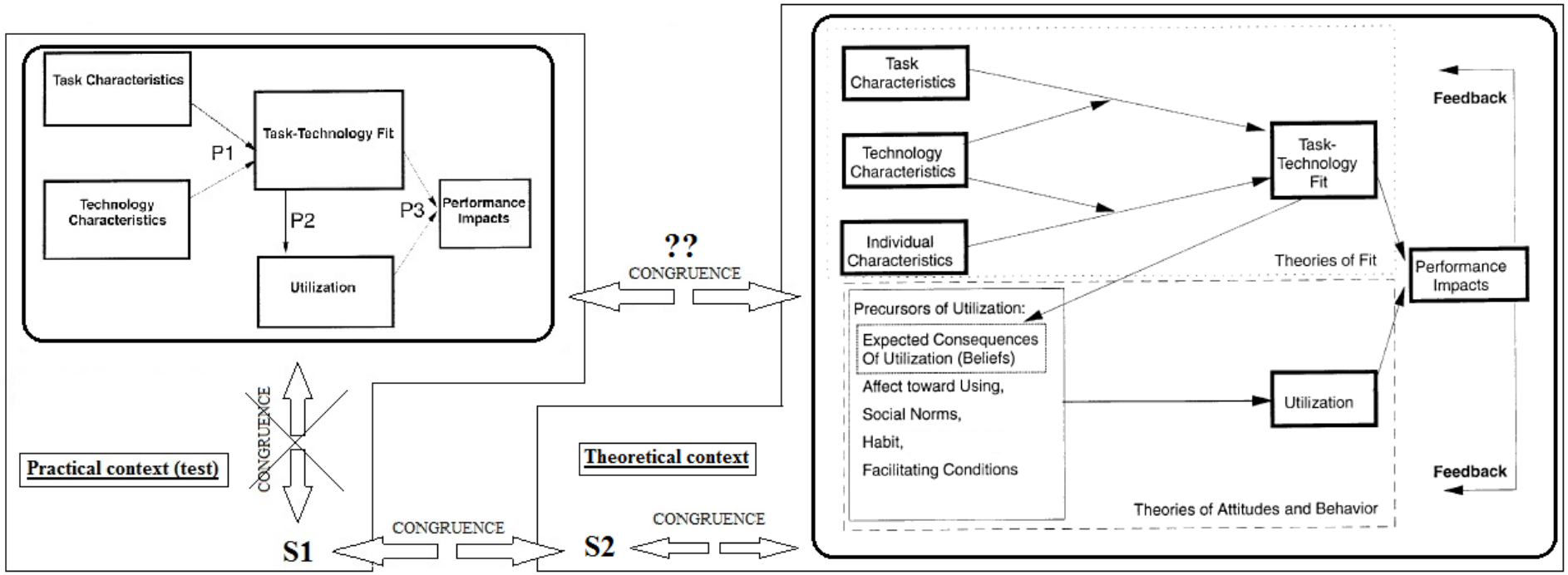


Figure 7: example about the congruence issue, showing why validation of the simplified model (fig.6) may not lead to the whole TPC (fig. 5) validation

- S1 ←→ simplified model (practical context): practical context, namely the testing environment, includes P1, P2, P3 and the simplified model but none of these four objects include precursors of utilization, like social norms, then overpowering social norms can't justify mandatory use because they are not taken into account in this context.

Mandatory use is only an example I'm using to state that the simplified model has its meaning but I have doubts about the fact that its test/validation can lead to a TPC validation, as they are too much different, and that's why I made the congruence example. It's my opinion that, in the simplified model, the shortcut between "*TTF*" and "*Utilization*" could compromise the generalization because precursors of utilization, under my personal perspective, are too important for being replaced by the two assumptions stated by G&T (1995, p. 219, or p. 31 of this thesis work), even if they include beliefs (but not social norms).
Leaving out of consideration my doubts about generalization/validation, G&T (1995) came to positive conclusions about testing the three propositions within the simplified model:

- P1: do task and technology characteristics predict "*TTF*"? Moderate evidences that user evaluations of TTF are function of both system characteristics and task characteristics have been found.
- P2: does "*TTF*" predict "*Utilization*"? Evidences of this relationship are more ambiguous. One of G&T's opinions on this result is that, at least in companies involved in testing, "[...] *utilization could cause beliefs about TTF through feedback from performance outcomes*" (G&T, 1995, p. 228) and I don't agree, for several reasons:

    - The investigated causal relationship goes from user evaluation of "*TTF*" to "*Utilization*" and not vice versa (at least not in the tested model), hence justifying results with a feedback that implies a causal relationship from "*utilization*" to beliefs about "*TTF*" can be improper.
    - In TPC model, "*TTF*" influences "*Utilization*" through beliefs (see fig. 5). A causal relationship from "*Utilization*" to beliefs about "*TTF*" through the performance outcome feedback could create another direct loop (it is represented by the red dashed line in fig. 8): this loop should be direct unlike feedback loop, that instead is general as it refers to the whole

"Theories of Attitudes and Behavior" context. The direct loop, then, could lower "*TTF*" weight in the model and this can be a self-contradiction because user evaluations about "*TTF*" must be the most important dimension in the TPC model.

- The simplified tested (fig. 6) model doesn't include feedbacks and this can lead to an incongruence between the tested model and testing purposes and results interpretation.

Ambiguous results on P2 can be caused by the incongruence issues I raised (the incongruence example). Anyway, G&T (1995, p. 228) adopted a precautionary approach in drawing conclusions and the parenthetic clause "[...] *at least in these companies*" (talking about companies involved in testing) allowed them to suggest different kinds of hypotheses. Furthermore "[...] *evidence of previous research showing the impact of usefulness (Adams, et al., 1992; Davis, et al. 1989; Mathieson, 1991), relative advantage (Moore and Benbasat, 1992), and importance (Hartwick and Barki, 1994) on utilization suggests at least under some circumstances a link between TTF and utilization exists*" (G&T, 1995, p. 229). In my opinion, if this link between "*TTF*" and "*Utilization*" exists under the quoted particular circumstances, beliefs about "*TTF*" could have a lower weight, since they can be bypassed by a direct link between "*TTF*" and "*Utilization*", but the two assumptions (p. 31) stated by G&T for the simplified model avoid this lowering.

- P3: does "*TTF*" predict "*performance impact*" better than "*utilization*" alone? Strong evidence that both "*TTF*" and "*utilization*" must be included in predicting performance has been found.

An important observation about the TPC model is that it includes both user evaluations (on "*TTF*") and on "*Utilization"* and they jointly influence "*Performance Impacts*", then they can't be considered like stand-alone dimensions (see P3 results above). Many researchers (i.e. Lucas, 1975, 1981) suggested that "*Utilization*" is an appropriate surrogate of IS success when use is voluntary and user evaluations (i.e. about "*TTF*") are appropriate when use is mandatory, but P3 results aren't consistent with this observation, even if we would assume that "*TTF*" and "*Utilization*" are highly correlated. Then, another important logic of the TPC model states that user involvement (i.e. user attitudes) can affect both user commitment to utilize system and, in a different way, the fit/quality of the system and this

is quite important in system implementation and for IS problems diagnostics (G&T, 1995, p. 230).

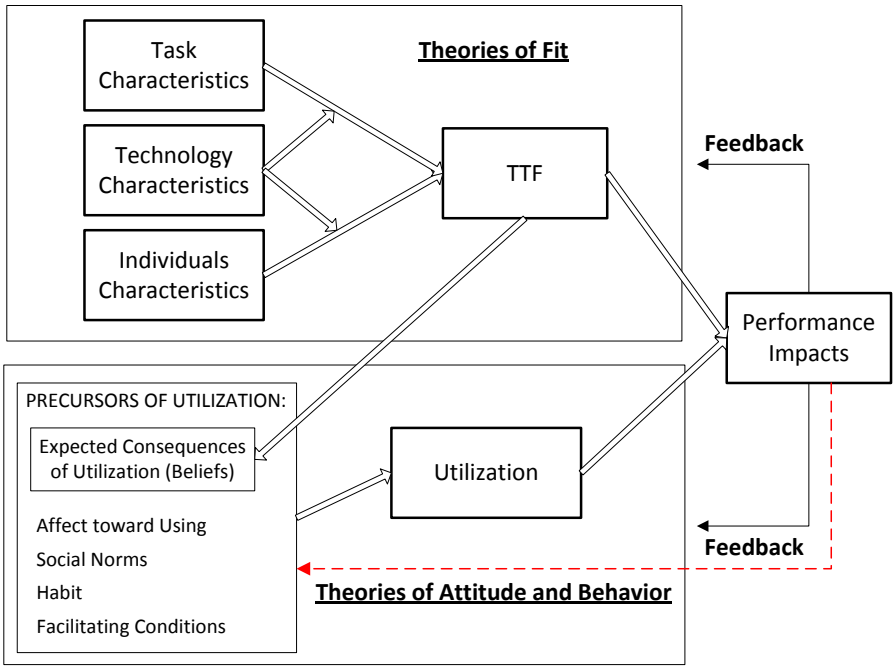


Figure 8: the hypothesized direct loop

1.5 The IS-impact model and its derivatives

This section starts with an analysis of an ESS measurement model by Gable et al. (2003). Even if I consider it as poor in explaining success, it's quite useful because it suggests several measurement items for some widespread constructs and it considers multiple perspectives through an holistic approach. Subsequently, an integration and contextualization of this model within the ERP environment by Ifinedo (2006) has been analyzed, introducing two useful constructs. Finally, an update by Gable et al. (2008) of the original model has been analyzed for two reasons: it significantly improves the understanding of the original model and it questions the utility of both "*Use*" and "*User Satisfaction*" in explaining the IS-impact, defined in p. 48, through a more articulated approach respect to the one elaborated in the 2003 version.

1.5.1 A 4-dimensional measurement framework: the importance of a robust approach

The models by D&M (1992) and G&T (1995) provide interesting frameworks for understanding what composes IS success and, secondly, for measuring IS success, even if they show weak points that led to revisions, updates, enrichments. Unfortunately, mostly for D&M (1992), authors recommendations have been often ignored, i.e. D&M's conclusion about systematically combining measures of all the six dimensions of their model, and not only few of them, taking into account contingent variables as organizational structure, size and so on. Furthermore, the kind of relationships (i.e. process sense and causal sense) among constructs within the models is often fuzzy and this contributes to create clashing results in literature. I don't judge this as a matter of "each researcher wants to cut out his own space" but as lack of uniformity about scope, approach and context of research. The idea of adding value to the state of the art needs for the possibility of comparing results but, in my opinion, this is quite difficult within the limits of a "young" topic like IS success, i.e. "*Evidence of IS success has been mixed with some studies showing positive impacts of IS in organizations (e.g., Barua et al. 1991; Barua and Lee 1997; Brynjolfsson and Hitt 1996; Lehr and Lichtenberg 1999; Mukherjee 2001), while others have shown nil or detrimental impacts (e.g., Attewell and Rule 1984; Brynjolfsson and Yang 1996; Quinn and Cameron 1988; Wilson 1993)*" (Gable et al., 2003, p. 576). IS success research context if full of discordant results and opinions and that's why I'm persuaded about D&M (1992, 2003) works weight, as they established a regular basis even if they are questionable (i.e. Seddon, 1997, as already said). But, if on one hand I consider D&M results as a fixed starting point, on the other hand I consider the approach of Gable et al. (2003) as a robust research framework that, in my opinion, a researcher should at least read.

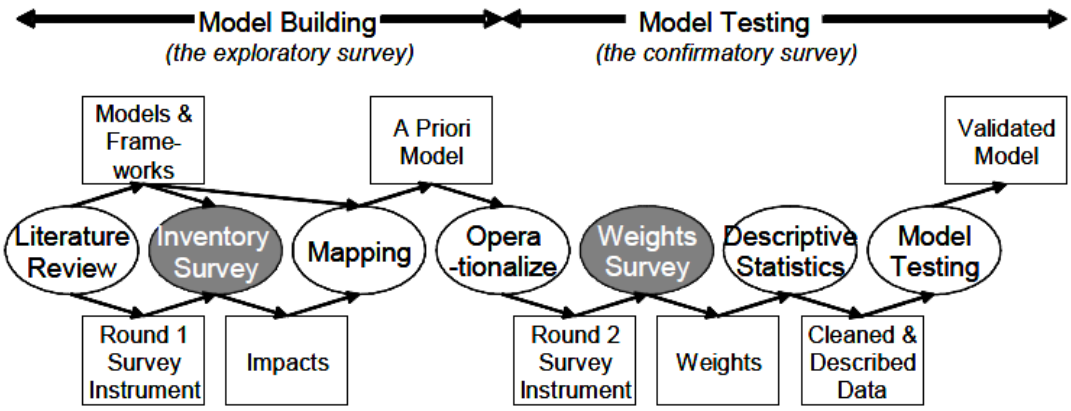


Figure 9: Study Design (from Gable et al., 2003, p. 577)

Gable et al. (2003) presented a validated measurement model for assessing ESS (Enterprise System Success, they use the terms ERP and ES interchangeably[18]) from multiple perspectives. Their study used a dual survey approach (fig. 9) similar to that proposed by Mackenzie and House (1979). In fig. 9, ellipses represent the main phases while rectangles are the key inputs and outputs. The first step consists in an exploratory inventory survey, which aims to identify a set of ES success dimensions and measures that have to be included in the preliminary model, labeled as "*a priori model*", in the model building phase. The second step consists in a confirmatory weights survey for testing model validity. Moreover, in addition to the two survey rounds, a series of expert workshops with industry and academic experts has been conducted. Without going deep into each phase of fig. 9, the most interesting steps (interesting because they have a direct influence on the model analysis) are:

- Mapping: when inventory survey results are available, it's necessary to synthesize them. Gable and colleagues didn't use new/non tested logics for this step but they applied the two main approaches for data coding and synthesis the literature suggests, namely a top-down and a bottom-up approach[19]. Using approaches that are already and positively diffused in literature necessarily leads to structured results, whether they are good or bad. This is also consistent, on a conceptual level, with the advice of D&M (1992; 2003, p. 19) of using already validated and shared measures of the IS dimensions. The idea is to use instruments whose effectiveness has been widely confirmed and, in my opinion, this shouldn't be considered as an additional constraint but like a good opportunity to lower the probability of confutation/criticism about the obtained results.
- Selecting, adapting and operationalizing the selected framework: according to what said above, Gable et al. (2003) selected the D&M's model (1992 version) and mapped first-round survey impacts in it[20], with the support of three academic and two senior business analysts (again, a "panel of experts" is a widely shared instrument). Then, the same D&M's model has been used as a basis for starting the ES success model drawing, even if the "*Use*" construct has been excluded. "[...] *many feel* [the use construct] *to be an inappropriate measure of IS success (e.g.,*

[18] See details in Gable et al. (2003), p. 576, note 1.
[19] See details in Chan et al. (2000).
[20] D&M (1992) hasn't been the only reference but it has been the most suited among all. See Gable et al. (2003), p. 580 for further details.

Barki and Huff 1985; Gelderman 1998; Seddon 1997; Young 1989; Yuthas and Young 1998)" (Gable et al., 2003, p. 580), mostly because "*usage, either perceived or actual, is only pertinent when such use is not mandatory*" (D&M, 1992, p. 68). Moreover, when system use isn't voluntary, the extent and the measure of system use provide not much about the success of the system (Robey, 1979; Welke and Konsynski, 1980) and these reasons, in addition to the fact that the ES investigated in the first survey step by Gable and colleagues was mandatory, led to "*Use*" omission. I agree with this choice, even if the study took into account D&M's original model and not the 2003 update (I suppose that, at the submission date of Gable et al. (2003) work, the model by D&M, 2003, wasn't been published yet), in which instead the dual vision of "*Intention to Use/Use*" and the multidimensional approach to the "*Use*" dimension go besides the issue of mandatory use (see pp. 14, 19-20).

Another matter of controversy concerns the "*User Satisfaction*" construct. Gable et al. (2003) observed that, often, it didn't measure satisfaction but a mix of multiple dimensions of success (e.g. quality and impact), furthermore "[...] *our expectation ultimately was that pure satisfaction items alone do not reflect a separate dimension of success, but rather measures of overall success*" (Gable et al., 2003, p. 581). Anyway, they included it in the preliminary *a priori* model, in order to test its discriminant validity, even if they agreed with Teo and Wong (1998) about not considering satisfaction as a distinct dimension. I agree with an eventual exclusion of "*User Satisfaction*" construct, although the authors themselves stated that it doesn't reflect a separate dimension of success *if alone* (see the above quote), while D&M (1992, 2003) linked it with "*Intention to Use/Use*" in a framework context. It's my opinion that every IS construct, if considered alone, is simply a measure of the overall success, but constructs acquire the "dimension status" if correctly linked, if relationship kinds are univocally determined, if the kind of variables has been defined (i.e. dependent or independent) and so on: it's the theoretical framework as a whole that determines the true nature of a construct. Concerning this, I want to quote Melone (1990) that highlighted the subjectivity in the selection of a single effectiveness measure: if the aim is to gain a global view of success, it's critical "[...] *that the complete set of success dimensions* [have to] *be employed, not a selected subset*".

A third issue about D&M (1992) IS success model is the excessive focus of organizational impacts measures on economic and financial aspects. It's well-known that an ERP project includes intangible benefits and that economic and financial measures, in their classical meaning and approach, can't capture its whole value. Basically, I agree with this observation, mostly on D&M's dearth of non-economic/non-financial measures, but I don't agree with Gable et al. (2003) specific words on this subject, because of two reasons. First, they still consider D&M's original model while, in the 2003 update, organizational and individual impacts were merged into the "*Net Benefits*" dimension, with all the pertinent consequences that I already discussed in the appropriate paragraph (pp. 18-19). Second, Gable et al. (2003, p. 581) suggested to integrate D&M (1992) organizational impacts measures with other measures, i.e. the BSC by Kaplan and Norton (1992) or measures from Shang and Seddon (2000), while in p. 580, note 5, they stated that "*Reasons for dropping the Shang and Seddon (2000) framework include overlaps between the constructs and measures; its strong emphasis on top managerial perspective (not a holistic view); and its somewhat narrow emphasis on organizational performance*". The framework by Shang and Seddon (2000) (p. 93 of this thesis work*)* is, more or less, a classification of the benefits of ERP systems: if the framework has been judged as too much focused on top managerial perspective and as having a narrow emphasis on organizational performance, these aspects have to necessarily be reflected also on its contents, namely the measures, since it's a classification, then Gable et al. (2003) suggested a self-contradiction. Anyway, it's true that D&M's organizational impacts/net benefits measures are excessively focused on economic and financial aspects, but they were aware of this issue and they confirmed it in their 2003 update as already stated in p. 21, in fact "[...] *more field-study research should investigate and incorporate "net benefits" measures*" (D&M, 2003, p. 27). Moreover, they encouraged the use of other validated IS success measurement instruments[21], explicitly quoting the Seddon et al. (1999) bidimensional matrix (D&M, 2003, p. 19) that I analyzed in pp. 21-25. Lastly, D&M suggested non-economic/non-financial net benefits measures like improved decision making or customer welfare in Petter, Delone and Mclean (2008), but this work came five years after Gable et al. (2003), then this isn't a good

[21] D&M (2003), p. 19, "Measurement enhancements" paragraph.

point at all, also because other non-economic/non-financial measures could be added by D&M in that five-years-span but this didn't happen.

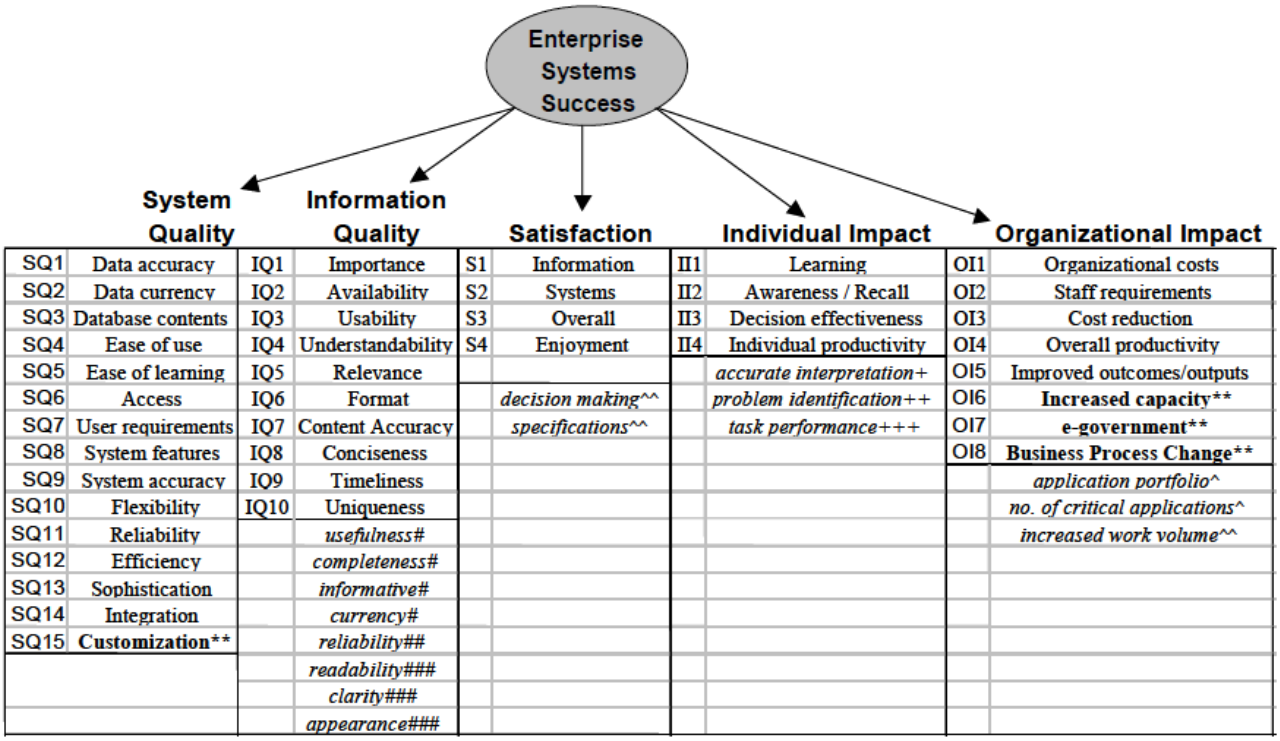
However, this step in Gable et al. (2003) approach also included a wise and adequate choice of ESS measures to be considered, both adding new measures (i.e. customization within "*System Quality*" dimension; e-government, increased capacity and business process change within "*Organizational Impact*" dimension) according to the previous mapping step, and removing other measures in order to respect the established study purpose, namely that "[...] *each measure in out model not only addresses an important aspect of IS success, but also does so in such a manner that it does not overlap with another measure*" (Gable et al., 2003, p. 578), and not considering measures which are incongruent with the holistic view of the instrument design across the organization (Gable et al., 2003, p. 581) - from top management perspective to that of data entry officers - provided by the constructs/measures of the D&M's model (Gable et al., 2003, p. 580)[22].

Fig. 10 shows the *a priori* model, which is the last step of model building macro-phase (see fig. 9): omitted measures are in italic, new measures are in bold. This model, unlike D&M's model, is "[...] *a measurement model for assessing the multidimensional phenomenon of ES success using five separate dimensions of success (constructs): system quality, information quality, satisfaction, individual impact, and organizational impact*" (Gable et al., 2003, p. 582), then no relationships in a process sense or causal sense are addressed. The only hypothesis is that these dimensions are correlated and they are additive measures of ES success.

The following weights survey aimed to validate the *a priori* model and this obviously required an operationalization of the 41 measures belonging to the five constructs, i.e. through questions (possibly taken from previously validated instruments) scored with a Likert scale: results were used to test construct validity, criterion validity and reliability[23]. According to what discussed, Gable and colleagues excluded the satisfaction items from the exploratory factor analysis because they didn't consider satisfaction as a dimension of success. The validated and revised model is shown in fig. 11, it has four quadrants representing the four dimensions of the ESS. The impact dimensions assess the benefits coming (or not) from the system and the quality dimensions reflect the future potential.

[22] Anyway, it's my opinion that this point of view is much more evident in D&M (2003) than in D&M (1992), which is the model quoted by Gable et al. (2003).

[23] See Gable et al. (2003) for details. I didn't include them because they are out of the scope of this work.



System Quality		Information Quality		Satisfaction		Individual Impact		Organizational Impact	
SQ1	Data accuracy	IQ1	Importance	S1	Information	II1	Learning	OI1	Organizational costs
SQ2	Data currency	IQ2	Availability	S2	Systems	II2	Awareness / Recall	OI2	Staff requirements
SQ3	Database contents	IQ3	Usability	S3	Overall	II3	Decision effectiveness	OI3	Cost reduction
SQ4	Ease of use	IQ4	Understandability	S4	Enjoyment	II4	Individual productivity	OI4	Overall productivity
SQ5	Ease of learning	IQ5	Relevance				*accurate interpretation+*	OI5	Improved outcomes/outputs
SQ6	Access	IQ6	Format		*decision making^^*		*problem identification++*	OI6	**Increased capacity****
SQ7	User requirements	IQ7	Content Accuracy		*specifications^^*		*task performance+++*	OI7	**e-government****
SQ8	System features	IQ8	Conciseness					OI8	**Business Process Change****
SQ9	System accuracy	IQ9	Timeliness						*application portfolio^*
SQ10	Flexibility	IQ10	Uniqueness						*no. of critical applications^*
SQ11	Reliability		*usefulness#*						*increased work volume^^*
SQ12	Efficiency		*completeness#*						
SQ13	Sophistication		*informative#*						
SQ14	Integration		*currency#*						
SQ15	**Customization****		*reliability##*						
			readability###						
			clarity###						
			appearance###						

** ERP-related measures identified in the exploratory round (or more generally - contemporary IS related)
# Found to overlap and thus collapsed into single measure of Relevance (IQ5) as all are necessary to determine the relevance of information.
This measure overlapped with the measure Content Accuracy (IQ7) as only information that is accurate is reliable and vice versa.
Found to overlap, thus collapsed into single measure of Format (IQ6) as the format of information determines its readability, clarity & appearance.
+ Deemed a consequence of information quality as one's ability to make accurate interpretation is affected directly by the quality of the information used.
++ Not a general measure applicable only to senior level management and not throughout the organizational levels.
+++ Was felt that Task Performance is largely defined by the measures of Decision Effectiveness (II3) and Individual Productivity (II4).
^ Non-perceptual measures that are incongruent with the rest of the measures in the model and the aim to derive a holistic view across the organization.
^^ Compound measures that are reflected directly by other measures (Specifications by SQ7, SQ8, Decision Making by S1, S2, and Increased Work Volume by SQ4, SQ5, SQ7).

Figure 10: the *a priori* model (from Gable et al, 2003, p. 582)

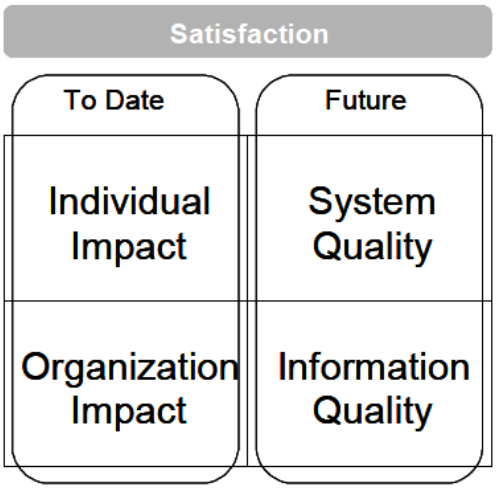


Figure 11: the validated and revised model (from Gable et al., 2003, p. 586)

Some observations are needed:

- This is a measurement model as it doesn't suggest causal/process relationships.
- Use construct is omitted (see pp. 38-39) as a dimension. In light of D&M (2003) update, I don't agree with this choice: for me, it makes sense within the limits of Gable et al. (2003) model, that doesn't address any kind of relationship, and this is one of the reasons that don't persuade me about this work: it lacks proactivity, it's only an ex post evaluation of a measurements mix.
- Satisfaction is considered an overall measure of success and not a separate dimension of ESS.
- I consider this model as an useful integration in ESS measures' choice applied to other models, which include causal relationships instead, because it's quite complete and it has been successfully validated.
- The robust approach to this model drawing makes me more trustful in obtained results.

Gable et al. (2003, p. 587), moreover, stated that "[The study] *presents empirical evidence of the irrelevance of use in the study context*" but this statement is quite hurried (see pp. 38-39). It should be corrected with"[...] *irrelevance of use in the study context* we analyzed" because it's founded on D&M (1992) model, where "*Use*" is only not mandatory[24], combined with an analyzed australian case study where ES use was mandatory (Gable et al., 2003, p. 580). This kind of inference is, in my opinion, not allowed as it needs for further studies on ES voluntary use context and for taking into account D&M's update, where "*Use*" is a multidimensional construct, as I often stated. Among all conclusions drawn by the authors (Gable et al., 2003, pp. 587-588), the most interesting and worthy for a generalization purpose (which it's not explicitly included in Gable et al. (2003) work, unless few words in p. 588) are, under my perspective, the following two:

- The study reflected attention to the mutual exclusivity of the dimensions (no overlaps).
- The study validated the final model from multiple stakeholders' perspectives: management, user and technical.

[24] This is true only for the 1992 version and not for the 2003 update, see pp. 7, 14.

Gable et al. (2003) result is a validated model/instrument to evaluate ESS with a comprehensive set of measures. I consider it as a good support in ESS evaluation, but it lacks relationships among constructs, even though it considers multiple perspectives.

1.5.2 An extension of the 4-dimensional measurement framework

As Gable et al. (2003) model is a measurement model for ESS and not a process/causal model, my interest in it is lower than the one I experienced with D&M (1992, 2003) or G&T (1995) or other works included in this analysis. Anyway, an ESS measurement model can be useful as a support instrument in choosing measures for IS success dimensions, then a brief deepening on an extension of the four-dimensional measurement model still can be useful. Ifinedo (2006) proposed a first extension, studying a finnish and estonian ERP context with the purpose of answering principally to two questions: is Gable et al. (2003) measurement model a second-order factor? Which dimensions are the best surrogate of ERP success?

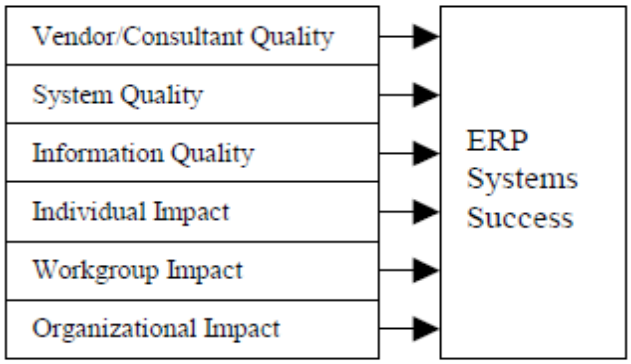


Figure 12: the extended ERP system success measurement model (from Ifinedo, 2006, p. 20)

As shown in fig. 12, two new dimensions have been introduced:

- Workgroup impact: Myers et al. (1996) suggested that IS success models should include this dimension because of the contributions of work teams/groups to organizational productivity, in fact they included it in their D&M's model extension. Ifinedo's point of view on workgroup impact is quite similar and thus he included, in the workgroup meaning, subunits and/or functional departments of an organization.

- Vendor/consultant quality: some empirical evidences in Finland and Estonia (Ifinedo, 2005; Ifinedo and Nahar, 2006a) showed that ERP adopting firms link the role and the quality of their chosen vendors and consultants with the overall ERP success for their organizations. The engage of external expertise is essential for ERP system effectiveness in adopting organizations (Ifinedo, 2006, p. 19) and the adequate choice of this external expertise is a well-known CSF in ERP implementation (i.e. Ko et al., 2005; Sedera et al., 2003). Furthermore, literature suggests that an adequate technical support provided by ERP vendors/consultants leads to improvements, even on a quantitative level, or relevant information and knowledge transfer to the client (i.e. Ko et al., 2005; M&T, 2000). Ifinedo (2006) grouped both vendors and consultants together in the same unique dimension because his purpose has been to identify them in a single external source of expertise concerning ERP implementation. Sedera et al. (2003, p. 1411) suggested to merge consultant and vendor items in a single factor labeled as "*external knowledge player*", then this kind of combination has been already addressed. Moreover, vendors and consultants have another point of contact, namely they share a similar penalty when an ERP implementation goes awry (M&T, 2000).

Before analyzing Ifinedo's discussions and conclusions, I want to highlight that this author took into account the need for relationships in a model (that's one of the issues that I raised on Gable et al. (2003) model, see p. 43) in order to understand something more about causality in IS/ERP success/effectiveness, in fact "[...] *researchers [e.g., 5, 8, 15, 22, 62, 63] make arguments for inter-relationships and interdependency among constituting measures or dimensions of IS success models to be established in order to enhance the predictability value of any ensuing framework or model. In this light, we believe there is a strong link between the dimensions of vendor/consultant quality and each of the other five [e.g., 58, 70]*" (Ifinedo, 2006, p. 19). This quote, in my opinion, shows the limit of a measurement model like that belonging to Gable et al. (2003) and, then, to Ifinedo's extension: IS/ERP dimensions are identified but not interrelated, either among themselves or with ERP success. Ifinedo's statement persuade me ulteriorly about the support "status" of these ERP/IS success measurement model. Ifinedo (2006) concluded that:

- "*Workgroup impact*" and "*Vendor/Consultant Quality*" have been found as relevant dimensions in ERP system success.

- "*System Quality*" and "*Organizational Impact*" were found as the two most important dimensions in assessing ERP system success, at least in private organizations. "[...] *these dimensions might provide the best information for adopting firms regarding ERP success (or their use as surrogates of ERP success)*" (Ifinedo, 2006, p. 27).
- An useful way for researchers and practitioners for using Ifinedo's ERP systems success measurement model is to classify the six constructs in two groups: "quality", which includes "*Vendor/Consultant Quality*", "*System Quality*" and "*Information Quality*", and "impact", which includes "*Individual Impact*", "*Organizational Impact*" and "*Workgroup Impact*". Quality constructs and their measures could be used for assessments during the early periods preceding ERP acquisition, while impact constructs and measures could be used when the impact of ERP to individuals, workgroups and the whole organization have to be assessed. This configuration has been labeled as "model 3" (see fig. 13). Numerical evidences[25] suggested that it's the best configuration, among the six in fig. 13, in explaining ERP success construct variance and then in predicting ERP success: therefore, this model is a third order factor. Ifinedo (2006, p. 24) also observed that high-level managers have the tendency to rate "impacts" measures higher than others do, while lower level employees, which might be using these systems more than higher-level employees, can better assess "quality" dimensions.
- The proposed model can be useful to support future development of new frameworks about ERP success, whishing that they will include the impact of contingency variables like organizational strategy, structure, size and so on (already addressed by D&M, 1992, 2003).

Unfortunately, this study presents limitations in generalizability due to sample smallness, subjective and perceptual measures that may have introduced bias, heterogeneous nature of the ERP systems (top brand like SAP and Oracle and mid-market products as Hans, Scala and Nova) considered in the study. Moreover, Ifinedo proved more prudent and careful than Gable and colleagues. As he conducted his study in a private firms context, he raised doubts about its generalization on public sector organizations (Ifinedo, 2006, p. 26), also because of the limitations above. Instead, Gable et al. (2003, p. 576, 579) took into account

[25] See details in Ifinedo (2006), p. 24.

only the public sector but suggested their model generalization on the private sector (p. 588) without adequate evidences, although their statement is more a hope/feeling.

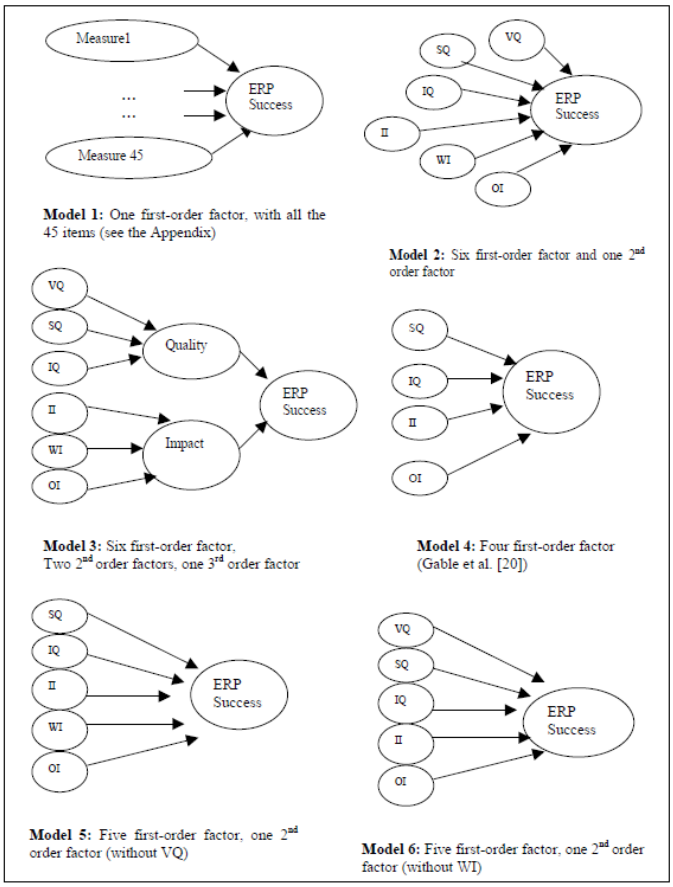


Figure 13: illustration of the alternative ERP systems success models (from Ifinedo, 2006, p.25)

1.5.3 The 4-dimensional measurement framework: 5 years later

Gable and colleagues updated their model in 2008, making observations that improve by far the understanding of the model itself. As the IS is a long-term investment, a continuing flow of benefits into the future is expected from it. Concerning this, Gable et al. (2008, p. 9) stated interesting questions: "*'Is the IS worth keeping?', 'Does the is need changing?' or 'What future impacts will the IS deliver?'* ". These questions look forward and they make clearness on IS "quality" dimension formulated in 2003: it's the best predictor, in their opinion, on future impact of IS. According to Ifinedo (2006), that showed how quality and impact are second order factors before ERP success which in turn is a third order factor (fig. 13, model 3), Gable et al. (2008) exposed their conceptual model in a more compact way (fig. 14).

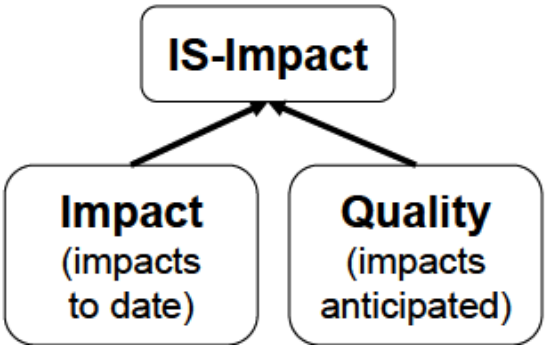


Figure 14: the conceptual model (from Gable et al., 2008, p.10)

They defined the IS-impact of an IS as "[...] *a measure at a point in time, of the stream of net benefits from the IS, to date and anticipated, as perceived by all key-users-groups*" (Gable et al., 2008, p. 10). Therefore, IS-impact is an index representing the stream of net benefits from different perspectives (user, manager, group): the impact half (see fig. 14) measures net benefits to date, quality half is a proxy measure for future impacts[26]: with this observations, Gable and colleagues' 2003 conceptual model is more clear, indeed. Moreover, the authors anticipated, in the conceptual model section (Gable et al., 2008, p. 10, note 5), one of the most important update in their model, namely that quality system and quality information make sense and acquire value proportionally to their contribution to "*Satisfaction*", "*Appropriate Use*" and, lastly, to positive impacts, on both the individual and the organization. Then, constructs like "*Satisfaction*" have now the status of mediator between quality and impact (Gable et al., 2008, p. 11). Even if I deepened this afterwards, to my eyes this is an endeavor of including some kinds of relationship in the measurement model: I consider this quite important because it can be seen as an attempt of hybridization between an IS success measurement model and an IS success model.

As already said in analyzing Gable et al. (2003), I'm interested in their research approach, even if I don't fully appreciate their statements about inferences (see p. 43). I'm not stating this for hedonistic or philological reasons but because they found a way to take into account D&M's model (1992 version) in their update, not only considering the six constructs (even if in their 2003 work they excluded two of them, see pp. 38-39) as dimensions of IS success as in past, but considering the relationships among them too, although literature raised concerns about their validity[27]. A brief description about the adopted approach can add significant value in understanding the conclusions on the model.

[26] These impacts aren't a sure fact, they may happen.
[27] See details in Gable et al. (2008), pp. 7-8.

The starting point is the "IS-net" (fig. 15), originally from Benbasat and Zmud (2003). Without going deep into debates, pros and cons about this theory[28], it's a proposal of IS field identification linking five constructs that should represent a high-level core set of IS. The logic below is that, in addition to studying the IT artifact, it's necessary to consider how this artifact is conceived, how it evolves and is being used and how it yields (and undergoes) impacts in the considered context. Fig. 16 shows how Gable and colleagues contextualized D&M's model (1992 version) in the IS-net: "*Use*" and "*Satisfaction*" mediate between the IT artifact (quality dimensions) and the impact dimensions.

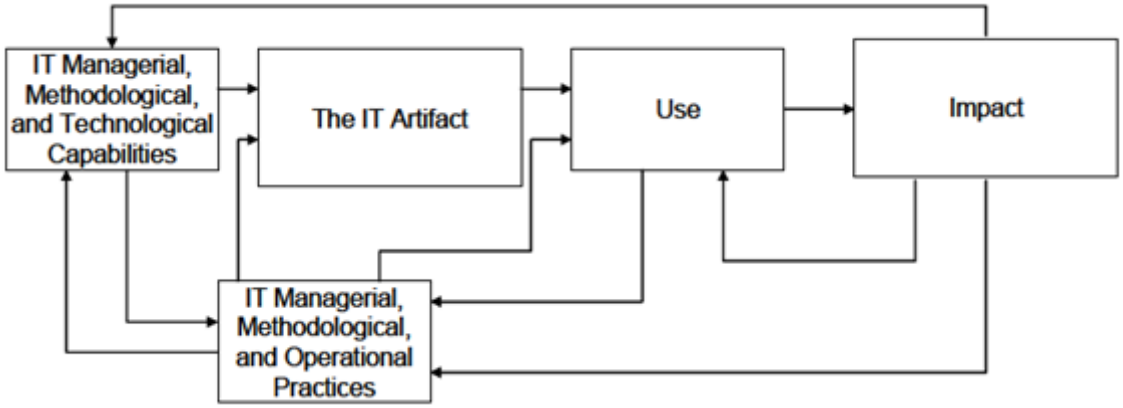


Figure 15: the IT artifact and its immediate nomological net (from Gable et al., 2008, p. 48)

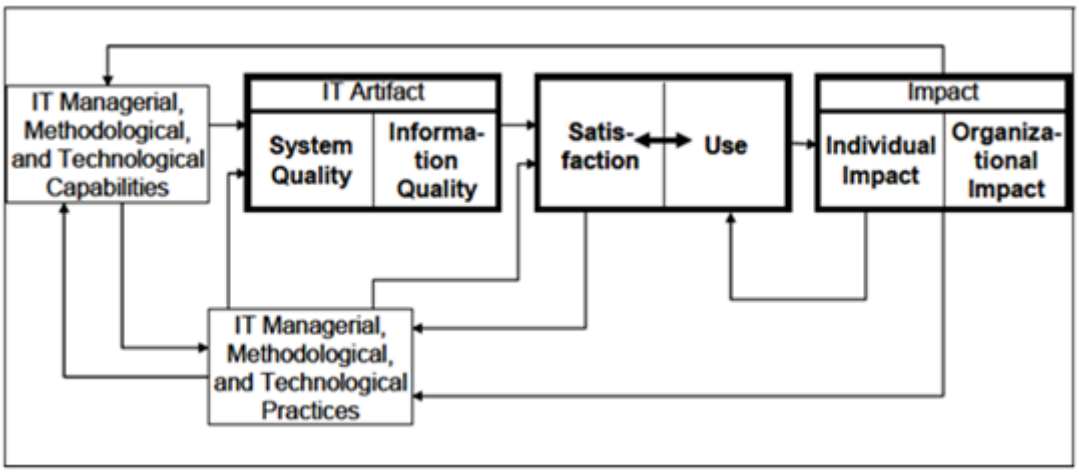


Figure 16: DeLone and McLean (1992) mapped to the IS-Net (from Gable et al., 2008, p. 11)

[28] See details in Gable et al. (2008), appendix A.

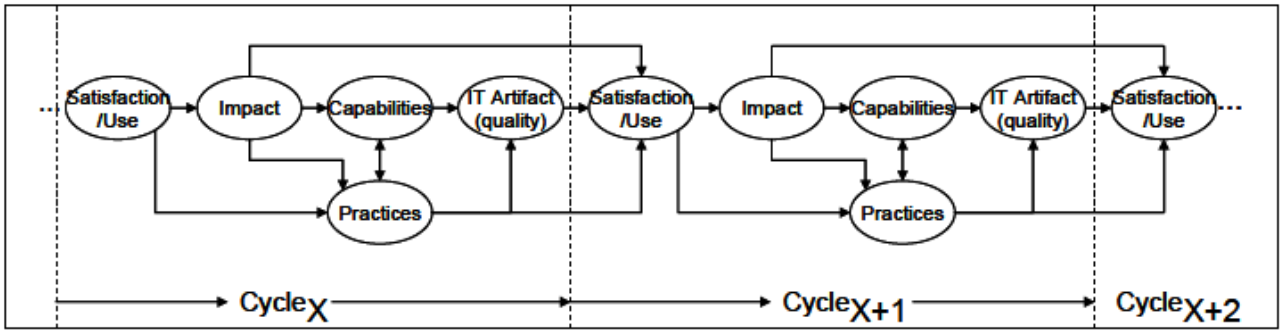


Figure 17: flattening the nomological net eliminating feedback loops (from Gable et al., 2008, p. 12)

As Gable et al. (2003, 2008) placed their model in an unique temporal dimension (measures of net benefits "*to date*" and "*anticipated*" are conceptually carried out in the same temporal instant and they yield a "snapshot" of the system), while fig. 16 reflects the IT artifact and impact at different points in time, fig. 17 has been drawn with no loops and the contextualized IS-net is seen as a cyclic happening: in each cycle, impacts yielded by IS use influence IS capabilities and practices, which in turn will influence the IT artifact (namely the quality dimensions) and, then, "*Satisfaction*" and "*Use*" of the next cycle. This kind of iteration is congruent with D&M (1992) and put the basis for the model's update of Gable and colleagues.

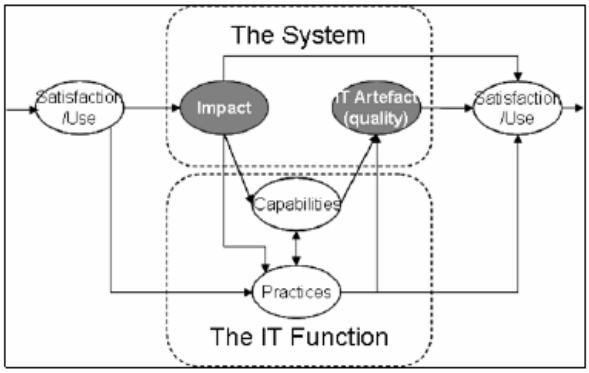


Figure 18: differentiating the system from the IT function (from Gable et al., 2008, p. 12)

Finally, in order to isolate impact and quality dimensions, which are dimensions and measures of IS, from capabilities and practices, which are associated with the IT function[29], constructs have been rearranged (see fig. 18): comparing fig. 17, that shows the final logic, to fig. 18, no relationship has been changed, it has been only a graphical order matter. As already stated (see p. 48), impact and quality are measured at the same point in

[29] The IT function includes "[...] *the central function, other IT capabilities and practices across the organization, and possibly IT capabilities and practices outside the organization - e.g. the outsourcer*" (Gable et al., 2008, p.12, note 9).

time, which is at the end of each cycle. Gable et al. (2008, p. 13) deepened this evaluation approach as follows:

"*Note that with the IS-Impact evaluation approach, Quality is measured at a point in time ('What is the Quality of the system today?'); at the end of a cycle in Figure 3* [fig. 17 in this thesis work]. *Impacts however are measured retrospectively, the question in essence being 'What have been the impacts to date?' Thus, while Impacts precede Capabilities and Practices in the causal flow of the IS-Net (as reflected in a cycle of Figures 1 and 2* [respectively, fig. 14 and 16]*), they are measured retrospectively at the same point in time at which Quality is assessed (our focus being on 'the system' as opposed to 'the IT function'). In combination, Impact and Quality represent a complete measure of the Information System (its flow of net benefits)*"

The above words are quite clear, but I prefer to explain the logic with a personal interpretation, as it provides a graphical support[30] (fig. 19). "*Quality*" should reflect anticipated future impacts (namely the [t+1] benefits) and "*Impacts*" the net benefits to date (namely in [t], present time). If measurements are conducted at the end of the cycle, it's like to translate temporal dimension of one unit forward. If in [t+1] I look to past impacts, it's like to refer to the previous temporal unit (something as [t+1]-1). Referring to fig. 19:

- Measuring "*Quality*" means answering to "*What is the Quality of the system today?*" (Gable et al., 2008, p. 13). It should be the [t+1] instant but, looking back, it becomes the present time [t]: at the end of a cycle I measure what Gable and colleagues described as "*anticipated future impacts*" but, as I'm measuring it at the end, it's equivalent to analyze the actual quality of the system: I measure, in the future (cycle end) the future impacts (I guess that the previous expression [t+1]-1 can address the same information).
- Measuring "*Impact*" means answering to "*What have been the impacts to date?*" (Gable et al., 2008, p. 13). At the end of the cycle I measure what Gable and colleagues described as "*net benefits to date*" but, as I'm measuring it at the end, it's equivalent to analyze the past "*net benefits to date*": I measure, in the future (cycle end), "to date" net benefits (it's like being in [t-1]).

[30] "t" and "t+1" refer to the same cycle (compare fig. 17 to fig. 19).

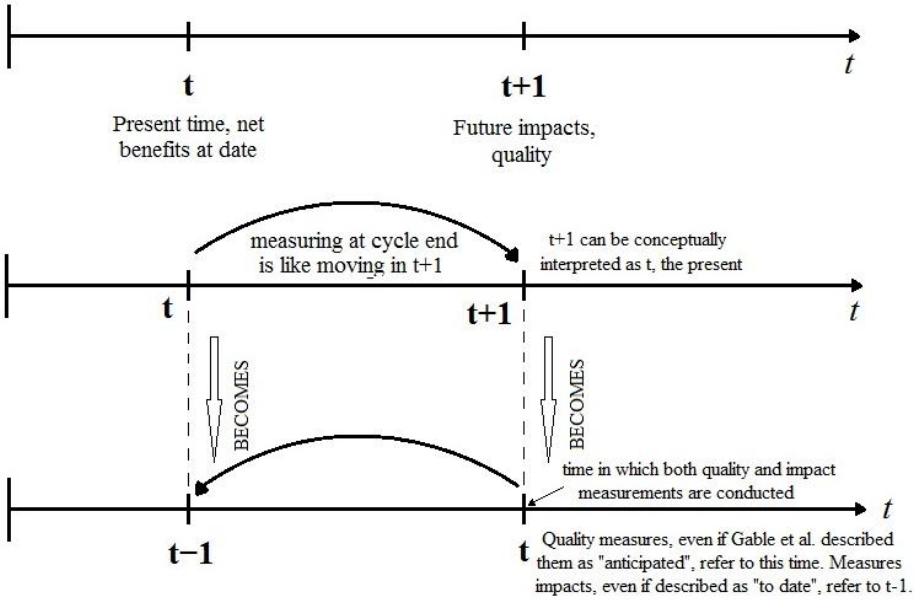


Figure 19: temporal model for IS-impact measurement

As showed in fig. 18, "*Satisfaction*" and "*Use*" precede and follow "*Impact*" and "*Quality*" dimensions, then they should be considered as antecedents and consequences of IS-impact and not their separate dimensions. Anyway, Gable et al. (2008) talked about IS-impact dimensions and not IS-success: on the basis of their definition of IS-impact (see p. 48), I can state that IS-success isn't only a matter of net benefits and, then, IS-impacts and IS-success aren't concepts that can be totally superimposable. These authors excluded again, as in 2003, "*Use*" and "*Satisfaction*" from their measurement models, also quoting several researchers that agree with them[31], i.e. because satisfactions measures are indirectly included in "*Information Quality*" and "*System Quality*". I consider their arguments quite valid in a measurement context, characterized by the requirement of additivity and mutual exclusivity of success measures (no overlaps among IS success measures). In fact, in their work, they explicitly stated this constraint (see Gable et al., 2008, pp. 5-6), but my purpose is to identify IS dimensions in a success context (seeking for relationships) and only after in a measurement context. Some measures may satisfy more than a construct (i.e. both "*Use*" and "*System Quality*") but this doesn't mean, in my opinion, that every measure belonging to a construct has an overlap, even if some of them have it. Anyway, this observation of mine is only a supposition as I don't actually have data for testing, then I agree with Gable and colleagues about the relationship between "*Satisfaction/Use*" and the system (see fig. 18). According to the authors, "*Satisfaction*" and "*Use*" precede and follow "*Impact*" and "*Quality*" and their relationship is consistent with the statements about

[31] See details in Gable et al. (2008), pp. 22-24.

"*Satisfaction/Use*" being indirectly measured through "*Information Quality*", "*System Quality*" and other variables (see Gable et al., 2008, pp. 22-23). On a theoretical level, in my opinion, Gable and colleagues' idea may be that "*Satisfaction*" and "*Use*" measure items can partially explain "*Impact*" and "*Quality*" variance, but the vice versa is false, thus "*Satisfaction*" and "*Use*" are "overwhelmed" on a measurement level. I want to underline two observations:

- I agree about excluding "*Use*" and "*Satisfaction*", but only because this is a measurement context and each measure should be the more additive possible, without overlaps.
- It's my opinion that in the initialization of the model (fig. 17), the first cycle (the cycle number 1) should need for a precise specification. When an user approaches the system for the first time, there can't be a whole "*Satisfaction/Use*" in input to "*Impact*" and "*Practices*". Initially, users use the system but it's soon for expressing a good verdict on "*Satisfaction*": "*Satisfaction*" should be added only after the first "impact and quality cycle", in order to reflect a cycle of transitory before going on running.

Despite everything, I still have some doubts about "*Use*" and "*Satisfaction*" exclusion. In a nutshell, Gable and colleagues' reasoning is:

1. "*Use*" and "*Satisfaction*" are, initially, included because the model starts from D&M (1992): we're in a process/causal context.
2. Evidences show that "*Use*" and "*Satisfaction*" aren't independent dimensions of IS-impact but they are antecedents and consequences of IS-impact (Gable et al., 2008, p. 22-23).

	Key-User-Group						Total			
	Strategic		Operational		Technical		Total		Measures	Citations/ Measure
Dimension	#	%	#	%	#	%	#	%	#	#
System-Quality	44	19%	42	32%	53	54%	139	30%	14	9.9
Information-Quality	60	26%	33	25%	10	10%	103	23%	15	6.9
Individual-Impact	44	19%	27	21%	13	13%	84	18%	12	7.0
Organizational-Impact	66	29%	10	8%	15	15%	91	20%	8	11.4
Satisfaction	12	5%	11	8%	4	4%	27	6%	6	4.5
Use	2	1%	7	5%	3	3%	12	3%	29	0.4
TOTAL	228	100%	130	100%	98	100%	456	100%	84	5.4

Table 5: Mapping of impact-citations (from Gable et al., 2008, p. 20)

#	User Satisfaction Instruments	No of Measures	II		OI		IQ		SQ		Total Overlap	
			#	%	#	%	#	%	#	%	#	%
1	Gallagher (1974)	15	0	0%	2	13%	12	80%	1	7%	15	100%
2	Bailey and Pearson(1983)	18	0	0%	0	0%	9	50%	9	50%	18	100%
3	Ives, Olson, Baroudi (1983)	9	0	0%	1	11%	5	56%	3	33%	9	100%
4	Sanders (1984)	9	7	78%	0	0%	2	22%	0	0%	9	100%
5	Raymond (1985)	10	0	0%	0	0%	6	67%	3	30%	9	90%
6	Franz and Robey (1986)	6	1	20%	0	0%	3	50%	2	33%	6	100%
7	Joshi, Bostrom, Perkins (1986)	14	0	0%	1	8%	7	54%	6	43%	14	100%
8	Baroudi and Orlikowski (1988)	5	0	0%	0	0%	5	100%	0	0%	5	100%
9	Doll and Torkzadeh (1988)	12	0	0%	0	0%	6	50%	6	50%	12	100%
10	Chin, A.Diehl and Norman (1988)	5	0	0%	0	0%	1	20%	4	80%	5	100%
11	Davies (1989)	10	5	50%	0	0%	0	0%	5	50%	10	100%
12	Goodhue (1995)	14	0	0%	1	7%	4	29%	9	64%	14	100%
13	Amoli and Farhoomand (1996)	26	1	4%	1	4%	4	15%	20	77%	26	100%
14	Xiao and Dasguta (2002)	13	0	0%	0	0%	6	46%	6	46%	12	92%
15	Somer, Nelson and Karimi (2003)	12	0	0%	0	0%	6	50%	6	50%	12	100%
16	Ong and Lai (2004)	14	0	0%	0	0%	5	36%	8	57%	13	93%
	Total/ Average Scores	192	14	7%	6	3%	81	42%	88	46%	189	98%

II = Individual Impact, OI = Organization Impact, IQ = Information Quality, SQ = System Quality

Table 6: commonly used satisfaction items and their overlap with the other constructs (from Gable et al., 2008, p. 23)

Table 5 contains results of the impact-citations in the authors' identification survey. They suggested a single specific question, namely "What do you consider have been the impacts of SAP in your agency since its implementation?", concerning the six D&M's IS success dimensions, and it has been found that on 456 totals citations "*Use*" had the largest number of measures (29) but it has been cited least (12 times), with only 0.4 citations per measure, and it had the lowest number of citations in each key-user group. Table 6 shows, through the analysis of 192 satisfaction-related items from 16 satisfaction measurement instruments, that 189 of the 192 satisfaction measures have an overlap with other four constructs and only three items measure satisfaction explicitly. Now we moved in a measurement context.

3. As field evidences show that "*Use*" and "*Satisfaction*" should not be considered as separate IS-impact dimensions, they should be excluded[32]: we moved again from measurement to process/causal context. This is the usual *iter*: if adequate numbers confute theory, the latter has to be changed, or maybe not if field-study suffered some bias for several reasons. After all, measure items have to reflect the constructs and a construct doesn't have a reason to exist in a process/causal context if its measure items are totally, more or less, included in other measurements belonging to other constructs: a total correspondence between process/causal context and measurement context must exist. Anyway, Gable et al. (2008) theory is justified

[32] Note that, unlike "*Satisfaction*", "*Use*" exclusion isn't based on literature but on survey results. Also the authors kept a reserve on this decision (Gable et al., 2008, p. 41).

because they wanted to assess IS-impact, which coincides with "*Net Benefits*" (see definition in p. 48), but IS-success is a multidimensional concept that isn't composed by "*Net Benefits*" only: "*Use*" and "*Satisfaction*" could reflect other IS success dimensions that go over "*Net Benefits*". My main observation is that these two constructs are, maybe, inappropriate in explaining IS-impact as defined by Gable et al. (2008, p. 10) but they can be useful in explaining IS-success, as IS-impact is a subset of IS-success. After all, this IS-impact measurement model purpose is to catch a snapshot of the system and not to state causal relationships (Gable et al., 2008, p. 25).

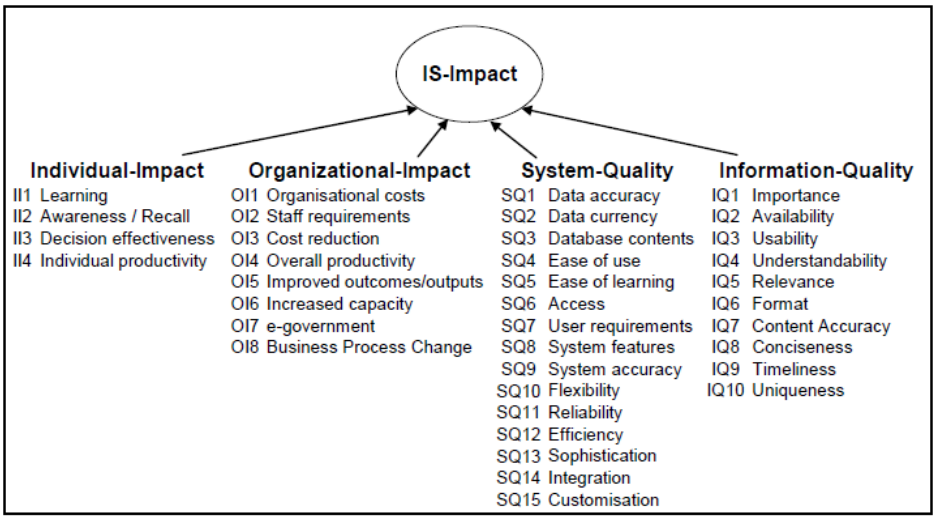


Figure 20: the *a priori* model (from Gable et al., 2008, p. 26)

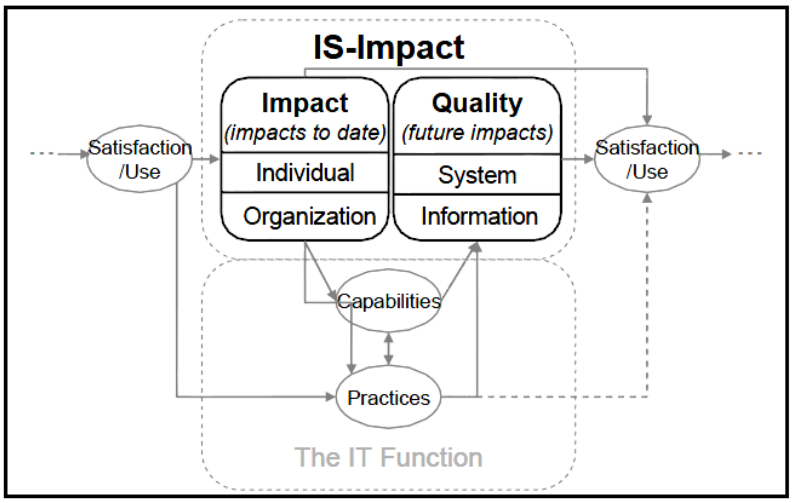


Figure 21: the IS-impact measurement model (from Gable et al., 2008, p. 35)

Fig. 20 shows the *a priori* model and the concerning measurement items, while fig. 21 shows the final model after validation. The dimensions taken into account are (Gable et al., 2008, p. 24):

- "*Individual-Impact is a measure of the extent to which [the IS] has influenced the capabilities and effectiveness, on behalf of the organization, of key-users.*"
- "*Organizational-Impact is a measure of the extent to which [the IS] has promoted improvement in organisational results and capabilities.*"
- "*Information-Quality is a measure of the quality of [the IS] outputs: namely, the quality of the information the system produces in reports and on-screen.*"
- "*System-Quality is a measure of the performance of [the IS] from a technical and design perspective.*"

The model works as already described in pp. 50-52, "*Quality*" and "*Impact*" are not mediated by "*Use*". This model "[...] *is often criticized where the intent of research is to test causality (due to it not technically testing for temporality*[33]*), with the IS-Impact model a 'snapshot' of the system is precisely what is sought*" (Gable et al., 2008, p. 25). Measures belonging to it can be used in evaluating overall IS-impact (namely multi-dimensional key-user-groups net benefits). Moreover, the authors anticipated (Gable et al., 2008, pp. 37-38) that items and dimensions they used substantially covary, i.e. a high (poor) quality system would be of high (poor) quality in all, or most of them, dimensions and measures, "[...] *perhaps due to a common cause e.g. - excellent IT management or an excellent development/implementation team*", and it's not likely having i.e. a high "*System Quality*" and low "*Information Quality*". In practice, four situations can happen[34]:

1. Low quality and low impact: there's probably need for a major re-thinking of the system.
2. Low quality and high impact: it may be the result of a short-term strategy, but investments for raising "*System Quality*" have to be made now for hoping in future gains. Anyway, this is the least likely situation, even if it's possible e.g. "[...] *due to a 'technology swap', where the new system is customized to look like the old in*

[33] One variable should empirically precede the other in temporal order.
[34] Cases in which quality and impact level coincide, namely 1 and 4, are more likely to happen, according to the covariation statement.

hopes of containing costs and minimizing change" (Gable et al., 2008, p. 39, note 43).

3. High quality and low impact: the achieved quality suggests potential for a benefits harvesting quality.
4. High quality and high impact: this is the ultimate goal.

As the field study used the same sample's kind of Gable et al. (2003), the authors underlined the same limitation, about generalization, in using a public sector sample but this time they have been more prudent in suggesting an adoption for private sector, unlike what stated in Gable et al. (2003, p. 588; see also p. 43 of this thesis work), since here they clearly highlighted the need of repeating the entire research cycle with new field results on private sector (Gable et al., 2008, p. 41). Moreover, they kept a reserve on "*Use*" exclusion, as already quoted in p. 54 (note 32).

1.6 Technology acceptance and adoption

In this section of the literature analysis I analyzed the issue of system acceptance and adoption, starting from the most classical model within this research stream: the TAM by Davis (1985). I also discussed the most important criticisms and limitations about the TAM and briefly explored its variants and updates.

1.6.1 Technology Acceptance Model (TAM)

TAM is a theoretical model that investigate the effects of system characteristics on user acceptance of computer-based information systems. It also provides the theoretical basis for a practical "*user acceptance testing*" methodology that can be useful to evaluate proposed new systems prior to their implementation. This test involves a demonstration of system prototypes, under controlled conditions, to potential users and should also measure their motivation to use the alternative systems[35].
The purpose of this model is threefold:

[35] These aspects go besides the purpose of this work. For an example of a generic user acceptance testing procedure, see Davis (1985), pp. 218-225.

- To show the major motivational variables that mediate between system characteristics and its actual use by end-users.
- To highlight how these variables are causally related among them, to system characteristics and to user behavior.
- To understand how the likelihood of user acceptance for proposed new systems can be evaluated through a measure of user motivation prior to system implementation.

In successful systems design, it has been found that involving actual prospective users in testing system prototypes is an effective way to evaluate and refine the proposed design (i.e. Bewley et al, 1983; Card et al., 1978). Usually, a new IS is linked to the will of obtaining some benefits, but these benefits cannot be achieved if users fail to adopt the new system and this is the reason for which TAM model find the relationship between design (system) characteristics and system use (user behavior), leaving initially the use performance aside, and mediating them with motivational processes (see fig. 22).

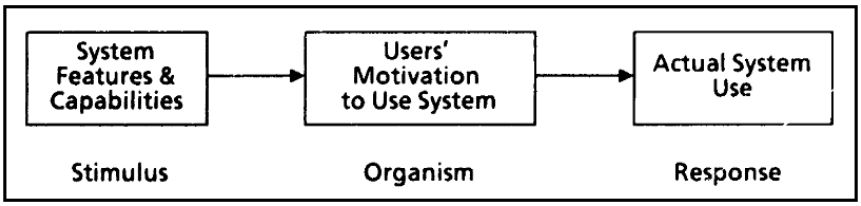


Figure 22: conceptual framework (from Davis, 1985, p. 10)

The characteristics of the system, which are very controllable, influence how much users are motivated to use the system and, in turn, this motivational process influence users actual system use or non-use: TAM is a development of the motivational variables, and their measures, that mediate system features and actual use.

The main logic behind this reasoning is that potential users experience motivational processes quite rapidly after interacting with/being exposed to a new system, then their motivational tendencies are experienced well in advance of the observable behaviors that usually occur after these tendencies. This is the author's starting hypothesis and "*If true, then measurements of user motivation could be takes from users after a relatively brief exposure to a test system*" (Davis, 1985, p. 12). This means that MIS practitioners could gather information about the comparative acceptability of various alternative systems in the early stages of the development process, where the potential of changes is higher,

cheaper and less risky[36]. In order to fully understand TAM, it's necessary to analyze, briefly, the theory chosen as its foundation, namely the Fishbein model (Fishbein, 1967; Fishbein and Ajzen, 1975), which is a well-established theoretical model of human behavior from psychology. In my opinion, a considerable quality of this model is the fact of being based not on a bundle of words but on three equations, partially derived from the statistical regression theory:

- First equation: $B \sim BI_{act} = w_1 \cdot A_{act} + w_2 \cdot SN_{act}$

  B = behavioral criterion, a specific behavior.

  BI_{act} = intention of an individual to perform the behavior B. It can be considered also "[...] *as an individual's subjective probability that he or she will perform a specified behavior"* (Davis, 1985, p. 16)[37].

  A_{act} = attitude toward behavior B. It "[...] *refers to an individual's degree of evaluative affect toward the target behavior*" (Davis, 1985, p. 16)[38].

  SN_{act} = subjective norms referring to "[...] *the person's perception that most people who are important to him think he should or should not perform the behavior in question*" (Fishbein and Ajzen, 1975, p. 302).

  w_1, w_2 = weights, "[...] *estimated via multiple regression to reflect the relative causal influence of the attitudinal and normative components in a given situation, and are expected to vary across situations*" (Davis, 1985, p. 16).

  This equation says that BI_{act} "[...] *is the immediate causal determinant of his or her* [it refers to the user] *overt performance of the behavior B*" (Davis, 1985, p. 16) and this individual intention (BI_{act}) to perform the behavior B is jointly determined by the attitude (A_{act}) toward behavior B and the subjective norm (SN_{act}) regarding behavior B, appropriately weighted with w_1 and w_2.

[36] For a matter of completeness, I want to report the user acceptance testing (Davis, 1985, p. 12). It starts with a brief demonstration of a set of alternative new systems to a sample of potential users in laboratory setting, using hands-on interaction and media support, i.e. videotape to demonstrate systems, then it proceeds with measuring potential users motivation to use the systems in the context of their jobs. The degree of likely acceptance of the system by the users would be predicted upon these measurements: if this acceptance testing proves successful in explaining user acceptance, it would provide valuable information for systems designers and implementors. For a specific example of a procedure of this process, see the previous note of this work.

[37] See Fishbein and Ajzen (1975), p. 288 for further details.

[38] See Fishbein and Ajzen (1975), p. 216 for further details..

- Second equation: $A_{act} = \sum_{i=1}^{n} b_i \cdot e_i$

  b_i = "*belief that performing behavior B will result in consequence i*" or "*person's subjective probability that performing the target behavior will result in salient consequence i*" (Davis, 1985, p. 16).

  e_i = evaluation of consequence i, namely "[...] *an implicit evaluative response*" (Fishbein and Ajzen, 1975, p. 29) to the consequence.

  n = number of salient beliefs, namely the salient perceived consequences (Davis, 1985, p. 26). Fishbein's model doesn't specify which beliefs are operative in a specified context, moreover Fishbein and Ajzen (1975, p. 218) stated that among a relatively large number of beliefs about a given object only a relative small number of them (i.e. the first two or three) are determinants of his attitude. Anyway, literature suggests that no more than five to nine beliefs at a time can be elicited from an individual, then the selection of the determinants is well circumscribed[39].

  This second equation states that attitudes are the result of and are altered by only changes in the individual's belief structure (Fishbein and Ajzen, 1975, p. 253). This is based on the reasoning that "*In our conceptual framework, as a person forms beliefs about an object, he automatically and simultaneously acquires an attitude toward an object*" (Fishbein and Ajzen, 1975, p. 216).

- Third equation: $SN_{act} = \sum_{j=1}^{m} nb_j \cdot mc_j$

  nb_j = "*perceived expectations of specific referent individuals or groups*" (Fishbein and Ajzen, 1975, p. 302) or "*normative belief that referent j wants subject to perform behavior B*" (Davis, 1985, p. 17).

  mc_j = "*motivation to comply with referent j*" (Davis, 1985, p. 17) or "*person's motivation to comply with* [...] *expectations*" (Fishbein and Ajzen, 1975, p. 302).

  m = number of salient referents.

An important characteristic of Fishbein's model, that reverberates on the TAM, is that for obtaining a correct specification of the causal determinants of behavior (i.e. using or not the IS) there should be a correspondence between the way these variables are worded and the elements of the considered behavior (i.e. elements like "target", "action", "context", "time frame") (Fishbein and Ajzen, 1975, p. 369; Ajzen and Fishbein, 1980, p. 34). Then,

[39] Fishbein and Ajzen (1975, p. 218) recommend "[...] *a qualitative free-response elicitation procedure to identify the salient beliefs of a subject population with respect to a given behavior by asking subjects to 'list the characteristics qualities and attributes of the object or the consequences of performing the behavior*" (Davis, 1985, p. 33). Anyway, this procedure has received little validation and some literature evidences showed that resulting beliefs shouldn't automatically be considered as the one's most influential in determining the individual's behavioral decision. See Davis (1985), pp. 33-35 for further details.

in order to predict i.e. IS adoption/use, it's necessary to develop measures that take into account those four elements, which belongs to the behavioral criterion (B) of IS adoption/use: this is the best way for obtaining confident results[40].
Fishbein's model is well-suited for the TAM purposes for several reasons:

- It provides a theory of the motivational linkages between external stimuli ("[...] *of which system characteristics are an instance*" (Davis, 1985, p. 22)) and resulting behavior (see fig. 22).
- It provides criteria for developing measures related to motivational phenomena before they manifest themselves as behavior.
- It integrates "[...] *numerous theoretical perspectives from psychology which have previously been employed in MIS acceptance research*" (Davis, 1985, p. 23).

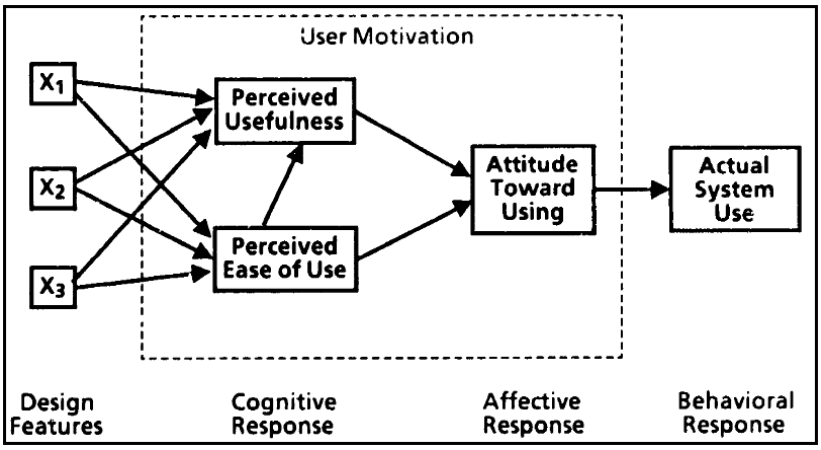


Figure 23: Technology Acceptance Model (from Davis, 1985, p. 24)

Fig. 23 shows the TAM and arrows represent casual relationships. "*According to the model, the potential user's overall attitude toward using a given system is hypothesized to be a major determinant of whether or not he actually uses it*" (Davis, 1985, p. 24). In turn, attitude toward using is determined by two major beliefs: *"Perceived Usefulness*" (labeled as USEF) and "*Perceived Ease of Use*" (labeled as EOU), with a causal relationship from the latter to the former. Perceived usefulness is defined as "[...] *the degree to which an individual believes that using a particular system would enhance his or her job performance*", while perceived ease of use is defined as "[...] *the degree to which an individual believes that using a particular system would be free of physical and mental effort*" (Davis, 1985, p. 26). Both USEF and EOU represent user's beliefs, the perceived

[40] For a further deepening on Fishbein's model, see Davis (1985), pp. 19-23.

consequences, the b_i factors in the second Fishbein's equation (see p. 60). "*Design features*", which are three in fig. 23 but that can obviously be much more numerous, "*directly influence perceived usefulness and perceived ease of use*" (Davis, 1985, p. 24). Since the author himself talks about arrows as "*representing causal relationships*" (Davis, 1985, p. 24), in the former quote I prefer "*directly cause*" to "*directly influence*", even because USEF and EOU concern the system, which is characterized exactly by the design features. Anyway, the relationships are drawn in this way because design features are what Fishbein called external variables[41] then, for the Fishbein's paradigm, they can't yield effects on attitude or behavior directly, but only indirectly through USEF and EOU.
Davis modified Fishbein's equations, adapting them to the required context but keeping their linearity.

1. USE = $\beta_1 \cdot ATT + \varepsilon$
2. ATT = $\beta_1 \cdot EOU + \beta_2 \cdot USEF + \varepsilon$
3. USEF = $\sum_{i=1}^{n} \beta_i \cdot X_i + \beta_{n+1} \cdot EOU + \varepsilon$
4. EOU = $\sum_{i=1}^{n} \beta_i \cdot X_i + \varepsilon$

X_i = design feature i, i = 1, ... , n
EOU = perceived ease of use
USEF = perceived usefulness
ATT = attitude toward using
USE = actual use of the system
β_i = standardized partial regression coefficient
ε = random error term

"*Use refers to an individual's actual direct usage of the given system in the context of his or her job*" (Davis, 1985, p. 25). Thus, "*Use*" is a repeated, multiple-act behavioral criterion (Fishbein and Ajzen, 1975, p. 353) and, being a behavioral criterion, it has the need to get specified in his four elements, like quoted in p. 60: the target is the specified system, the action is the actual direct usage, the context is the individual's job and the time frame is non-specific. According to the meaning of A_{act} (p. 59), Ajzen and Fishbein (1977) recommended that the definition and measurement of attitude (ATT) corresponds in specificity with the definition of the behavioral criterion and this, in my opinion, has two implications. First, it's the reason of why the USE equation is structured in that way, as use

[41] They are labeled in such way as they are characteristics of the behavioral target. See details in Davis (1985), p. 21.

is a behavioral criterion and attitude's definition and measurement, on the basis of the above statement of Ajzen and Fishbein (1977), have to correspond to the definition of the behavioral criterion: that's what happens in the equation, in fact it's a linear function with only one independent variable, a coefficient and an error term. Second, the ATT equation describes attitude, and its structure is equal to that of the first Fishbein's equation (p. 59), which describes the behavioral criterion: this is consistent with the Ajzen and Fishbein (1977) words above. Furthermore, EOU is hypothesized to have a significant direct effect on USEF because, under the same other conditions, a system that is easier to use implies an increased job performance (i.e. greater usefulness) for the user and this could influence positively MIS overall performance.

Setting aside the reasoning behind the design of the four equations and its relationship with the Fishbein's model[42], as it's out of the scope of the present analysis (even if quite interesting), I want to analyze some theoretical aspects that are directly linked to the causal model:

- Relationships between beliefs: TAM includes a causal relationship from EOU to USE. They are both beliefs, but the Fishbein's model doesn't explicitly take into account relationships between beliefs: observing the second Fishbein's equation (p. 60), beliefs are summed together and they all have a unit weight ("[...] *have essentially assumed that the weight is 1.0 and can thus be neglected*" (Fishbein and Ajzen, 1975, p. 241). Strangely, Fishbein and Ajzen (1975) themselves put great emphasis on relationships among beliefs in theorizing the processes of belief formation. They theorized "descriptive beliefs", formed through direct observation of objects or events, and "inferential beliefs", formed in ways that go beyond directly observable phenomena. Then, EOU may be seen as a descriptive belief, in the context of potential user acceptance test, formed through the direct experience of the subjects with the target system(s). Instead, USEF can be considered as an inferential belief, "*requiring subjects to estimate the effect of the system on their job performance in the absence of any direct experience of using the system in their job*" (Davis, 1985, p. 32). Therefore, the addressed causal relationship between the two beliefs is consistent with the Fishbein's model and the theories of belief formation upon which it's founded.

[42] See details in Davis (1985), pp. 27-32.

- Salient beliefs: EOU and USEF are hypothesized to be the salient beliefs in the context of potential user acceptance test (see the second Fishbein's equation, p. 60) to the extent that they exert a causal influence on ATT. If this relationship of mediation between design features and ATT proves as false through validation, this should suggest that one or more other salient beliefs have been omitted.
- Subjective norm: the subjective norm component of Fishbein's model (see first and third Fishbein's equations, pp. 59-60) isn't included in the TAM, either as a construct or in the equations, because, in the considered context (namely potential user acceptance testing of a given system), subjects don't have information about the expectations of their salient referents on their usage of the system, moreover they see the system for the first time. Then, these reasons justify the absence of perceived social normative influences.
- Behavioral intention: also the behavioral intention (BI, see the first Fishbein's equation, p. 59) has been omitted, in fact there's no trace of it either as construct or as equation. The main reason is that intention is the result of a decision that an individual made and it's formed through a mental process which can require a significant time period (Davis, 1985, p. 38), proportional to the importance of the decision (and the choice of using or not the system in the context of a job is a quite important decision). In the potential user acceptance testing context, subject's motivation to use the given system is measured directly after demonstrating the system to the user, then the time required to form intention should not elapse prior to measurement. Measuring the intention before it's formed can introduce bias that reduces the ability of a measured intention to predict a future behavior (Davis, 1985, p. 39). In cases where subjects have not formed intention against a behavior, the attitude should predict the behavior better than intention (Warshaw and Davis, 1985). Davis (1985) theorized that the attitude regarding the behavior (in the acceptance test context) has been already formed at the time of measurement then, even if usually intention causally mediate between attitude and behavior, since it isn't totally formed in that point of time the author preferred to evaluate directly the relationship between attitude and future behavior: that's why the mediating role of intention is omitted in the model, under condition that the attitude construct corresponds to the behavioral criterion in specificity with respect to target, action, context and time-frame elements.

Fig. 24 shows the TAM extended for literature review. Obviously, I'm not interested in the review development but in the reasons for which it has been developed. Davis (1985) addressed it on three levels: MIS lab experiments ("[...] *typically employed multi-time period decision-making simulations using student subjects*" (Davis, 1985, p. 44), MIS field studies and human factors literature.

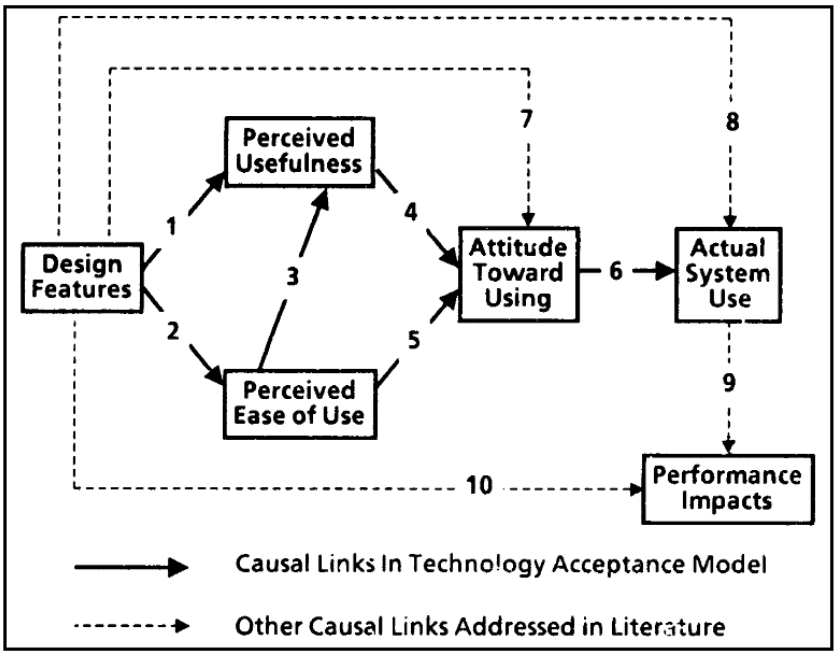


Figure 24: Technology Acceptance Model extended for literature review (from Davis, 1985, p. 43)

MIS Lab Experiments	Causal Relationships									
	Within TAM						Outside TAM			
	1	2	3	4	5	6	7	8	9	10
Benbasat & Schroeder 1977								●		●
Chervany & Dickson 1974										●
DeSanctis 1983						●				
Lucas 1981	●						●			●
Lucas & Neilson 1980										●
Lusk & Kersnick 1979										●
Remus 1984										●
Zmud 1978	●	●								
Zmud, Blocher & Moffie 1983										●
Technology Acceptance Model	●	●	●	●	●	●				

Table 7: Relationships between prior MIS lab experiments and proposed model (from Davis, 1985, p. 45)

MIS Field Studies	Causal Relationships									
	Within TAM						Outside TAM			
	1	2	3	4	5	6	7	8	9	10
Barber & Lucas 1983							●			●
Fudge & Lodish 1977									●	
Fuerst & Cheney 1982						●				
Ginzberg 1981				●		●				
Ives, Olson & Baroudi 1983				●	●					
King & Epstein 1983				●	●					
Lucas 1975						●			●	
Lucas 1978						●				
Maish 1979						●				
Robey 1979				●		●				
Robey & Zeller 1978				●		●				
Schewe 1976					●	●				
Schultz & Slevin 1975				●						
Swanson 1974						●				
Technology Acceptance Model	●	●	●	●	●	●				

Table 8: Relationship Between Prior MIS Field Studies and Proposed Model (from Davis, 1985, p. 50)

Human Factors Experiments	Causal Relationships									
	1	2	3	4	5	6	7	8	9	10
Bewley, et al. 1983		●					●			●
Brosey & Shneiderman 1978										●
Card, English & Burr 1978										●
Card, Moran & Newell 1980										●
Good 1982		●					●			●
Gould, Conti & Hovanyecz 1983							●	●	●	●
Greenblatt & Waxman 1978										●
Ledgard et al. 1980							●			●
Lochovsky & Tsichristzis 1977										●
Magers 1983	●	●					●			●
Malone 1981						●	●	●		
Miller 1977	●	●					●			●
Poller & Garter 1983		●								●
Price & Cordova 1983										●
Reisner, et al 1975										●
Roberts & Moran 1983										●
Shneiderman et al. 1977									●	
Thomas & Gould 1975										●
Welty & Stemple 1981										●
Technology Acceptance Model	●	●	●	●	●	●				

Table 9: relationship between prior human factors experiments and proposed model (from Davis, 1985, p. 59)

Tables 7, 8 and 9 show which studies, among those taken into account by the author, investigated which relationships, according to fig. 24. Comparing tables, it's evident that all the six relationships of the TAM have an empirical support, except for the link between EOU and USEF. At the same time, another useful result is that none of the reviewed studies analyzed all six of the TAM relationships, then TAM is both an integration of

previous findings and a better specification of them. Taking a look to table 7, we can observe that MIS laboratory studies mostly investigated the effects of design variables, with increasing attention to attitudinal and perceptual variables and using some form of performance criterion as the dependent variable. On the other hand, they generally didn't address relationships among perceptions, attitudes and usage behavior. Instead, MIS field studies (table 8) focused their attention on perceptual and attitudinal determinants of usage behavior generally ignoring system characteristics, which are "*one of the key managerially controllable variables affecting these behavioral determinants*" (Davis, 1985, p. 68). TAM integrates these two approaches considering, on one side, design features' effect on perceptions and, on the other side, the effects of perceptions on attitudes and behavior (Davis, 1985, pp. 68-69).

Empirical test of TAM has been conducted by the author in order to investigate some hypotheses[43]. According to fig. 25 and to table 10, the test confirmed several of the hypotheses and disconfirmed others. The most important evidences are that:

- USEF has a significant direct effect on USE and an indirect effect on USE via ATT.
- The effect of system on USEF has been found to be non significant.
- The effect of EOU on ATT has been found to be non significant.
- The characteristics of the system have a direct effect on ATT.

Causal Link		Point Estimate			95% Confidence Interval	
Ind. Var.	Dep. Var.	β	Std. Error	Sig. Level	Lower Bound	Upper Bound
System	EOU	-.210	.073	.004	-.352	-.068
System	USEF	-.014	.059	.812	-.129	.101
EOU	USEF	.630	.059	.000	.515	.745
System	ATT	-.159	.051	.002	-.259	-.059
EOU	ATT	.104	.066	.112	-.027	.235
USEF	ATT	.651	.064	.000	.524	.778
USEF	USE	.435	.090	.000	.258	.612
ATT	USE	.205	.090	.022	.029	.381

Table 10: TAM parameter estimates and 95% confidence intervals - survey data (from Davis, 1985, p. 108)

[43] I didn't report them as it was superfluous, but details are in Davis (1985), p. 72.

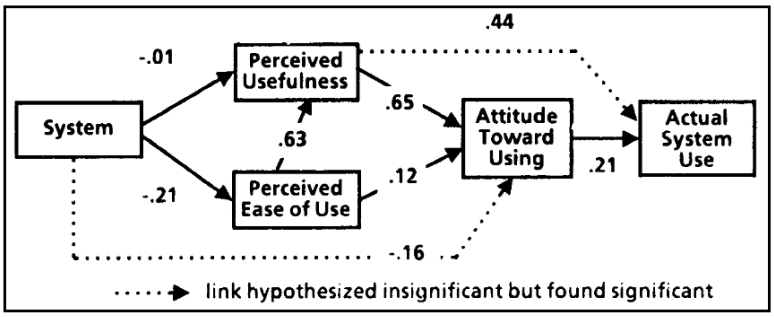


Figure 25: causal diagram of model validation results - survey (from Davis, 1985, p. 109)

These results led the author to some practical observations (Davis, 1985, pp. 112-115):

- TAM should incorporate the direct link from USEF to "*Actual System Use*" as a permanent feature.
- USEF direct influence on "*Actual System Use*" is more than double than the influence exerted on actual system use by ATT (regression coefficients are 0.44 and 0.21 for USEF and ATT respectively, see table 10) and this means that the original designed model underscored the importance of the USEF variable, as its direct link with "*Actual System Use*" wasn't included. Moreover, USEF influence on ATT is about triple than the influence exerted from EOA on ATT (in fact, regression coefficients are 0.65 and 0.12, see table 10) and this suggests that EOU doesn't have a significant direct effect on ATT, as hypothesized by Davis, but instead it influences ATT only in an indirect way through a strong effect (0.64) on USEF. These evidences suggests "*to rethink the role of the usefulness variable*" (Davis, 1985 p. 113). According to the definition of USEF (p. 61), it may seem that USEF is a "net" construct, namely that it considers benefits as well as the costs of using the target system in enhancing user performance (i.e. Einhorn and Hogart, 1981; Johnson and Payne, 1985). As EOU, or more precisely its inverse (the effort of using), may be seen as a part of the cost in using the given system from the user's perspective, this should explain why EOU influences ATT mostly through USEF (0.63 vs. 0.12, see table 10). This point of view upon EOU and USEF should be reflected on their measure items.
- The lack of a significant relationship between the system and USEF could be affected by the kind of systems analyzed in the test[44].

[44] See details in Davis (1985), pp. 113-114.

- The relationship between system and ATT has been found significant (with a -0.16 regression coefficient, see table 10), even if hypothesized by Davis as insignificant (1985, p. 72). Then, the mediating role of USEF and EOU alone may provide a fundamental but incomplete contribution in explaining cognitive mechanisms between system and ATT, then perhaps other possible variables should be added to the model. USE can be seen like an instrumental behavior, carried out for the performance gains and associated rewards (extrinsic rewards). Actually, people use systems in part because they enjoy the relative use (intrinsic reward) and not only for the positive consequences of performance enhancing. Then, an example of variable that could be added is "*Anticipated Enjoyment of Using*" (Davis, 1985, p. 115).

Davis (1985), on the basis of such observations and other numerical results, theorized TAM2 and TAM 3[45]. A brief overview of their formulation and relationships is as follows.

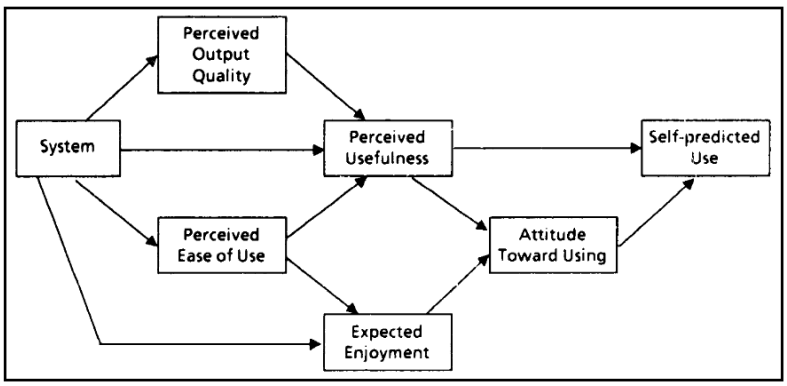


Figure 26: TAM2 hypothesized relationships (from Davis, 1985, p. 137)

- Two additional variables have been introduced: "*Perceived Quality of the Output*" (QUAL) and "*Anticipated Enjoyment of the System*" (FUN). The former is a "*measure of the benefit of using the system*" (Davis, 1985, p. 138) while the latter has been introduced "*in order to address the issue of intrinsic motivation*" (Davis, 1985, p. 115) and the rationale behind their introduction has been already addressed (see p. 69), respectively with the benefits and the intrinsic rewards argumentation.
- Direct link from EOU and ATT has been removed because found as insignificant (see table 10) and for the above reasoning: as EOU places emphasis on intrinsic motivation, its relationship with ATT is now mediated by FUN. EOU should

[45] TAM2 by Venkatesh and Davis (2000) and TAM3 by Venkatesh and Bala (2008) are not the same TAM2 and TAM3 addressed by Davis (1985).

influence FUN because an easier-to-use system may be more enjoyable to use and, consequently, an increased FUN should increase ATT. Moreover, TAM2 includes a direct link from system to FUN since system characteristics can make the system more fun to use, but don't necessarily increase EOU. The chain system-FUN-ATT may explain the direct effect of system on ATT, found as significant in fig. 25 (see also table 10).

- Direct link between system and USEF has been retained on the basis of the consideration above (p. 68) and because there wasn't a basis for assuming that EOU and QUAL "*represent an exhaustive account of the cost-benefit considerations that are salient for evaluating these systems*" (Davis, 1985, p. 138; pp. 68-69 of this thesis work).

TAM2 has been largely supported by Davis (1985) experimental data, with one interesting observation: the relationship between EOU and QUAL has been theorized as insignificant but has been found as significant.

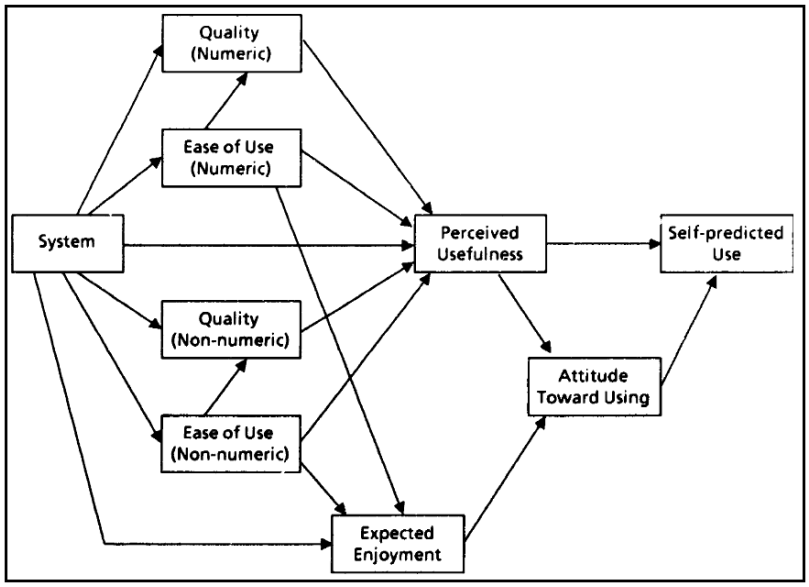


Figure 27: TAM3 hypothesized relationships (from Davis, 1985, p. 143)

According to fig. 27), TAM3 broke down EOU and QUAL to a task specific level, as opposed to general perceptions, and this because EOU and QUAL may vary according to the nature of the assigned task (that must be performed with the given system). Other observations are:

- TAM3 includes the importance/relevance (IMPORT) of specific tasks, because a system with both EOU and QUAL high but that doesn't support important tasks

(important for the user's job) or a system with both EOU and QUAL slightly low but that can perform additional, even if not very important, tasks may be perceived as less useful than another system with good EOU, decent QUAL but that supports important tasks, although they are few. This implies that USEF should be jointly influenced by system's perceived costs and benefits, specific for a particular task domain, and the IMPORT to the individual to that task domain. In order to conciliate the individual perspective (IMPORT, benefits, costs and job requirements) and the system perspective (perceived costs and benefits, system capabilities), USEF has to be mathematically expressed as:

$$\text{USEF}_{\text{system}} = \sum_{task} (BENEFIT_{task,system} - COST_{task,system}) \cdot IMPORT_{task}$$

- "*Numeric*" and "*non-numeric*" in fig. 27 refer to the specific tasks performed by the two particular systems considered by Davis (1985) in his tests[46] then, in a generalization perspective, they can be ignored.
- TAM3 includes a direct link from EOU to QUAL: in TAM2 it was hypothesized as insignificant but it has been found as significant. This result can be due to the particularities of the two systems analyzed by Davis (1985, p. 173) in his tests, then further tests are needed.

Therefore, TAM3 has the indubitable value of being more detailed (task breakdown), including the fit between a system and its capabilities on one side and users' job needs on the other (see the equation above), and identifying groups of users homogeneous about specific system configurations (IMPORT).
Davis (1985, pp. 225-228) addressed directions for future research, briefly reported as follows:

- Subjective vs. objective EOU and USEF: i.e. objective EOU may be more appropriate for non-discretionary systems (like order entry systems: an order can't be processed with the system if it isn't in the system itself), while subjective EOU may be more appropriate for discretionary systems, in which subjectivity "*is a key determinant of the success of the system*" (Davis, 1985, p. 226). Similar analyses should be addressed for USEF too.

[46] In particular, they refer to the possibility of using numeric graphs functions (i.e. bar charts, pie charts etc.) and non-numeric graphs (flowcharts, diagrams etc.) functions.

- User adoption as goal: some users may consider the given system adoption as a goal, that obviously can be not achieved due to ability limitations: after all the TAM, in his different versions, considers acceptance and use of a new system as "*a behavior that is largely under the volitional control of the potential user*" (Davis, 1985, p. 226). Research could investigate how expectancies and consequences of success/failure affect users' motivation to attempt to adopt the target system.
- Subjective norm component: I already described them (see p. 59) and the reasoning behind its exclusion from the TAM as justified by Davis (p. 64). Anyhow, Davis (1985, p. 226) suggested that this component has potential explanatory power in predicting organizational adoption of systems, as processes of social influence could mediate between system features and individual's attitudinal belief structure.

1.6.2 A critical review of the Technology Acceptance Model

In spite of my sincere appreciation for TAM theorization, which is both effective and elegant, it's a thirty years old work. A lot of researchers investigated its relationships, which have been tested both singly and grouped in subsets (i.e. Taylor and Todd, 1995; Jackson et al., 1997; Hu et al., 1999)[47]. As a broad analysis of all of those works is surely too expensive in terms of time and effort, I preferred to choose two works that constitute a good criticism to the TAM: Legris et al. (2003) and Chuttur (2009). Moreover, the first includes a significant amount of references and the second is quite recent.

Some researchers carried out replications of TAM, i.e. Adams et al. (1992) showed, in the results of their study for testing TAM's EOU and USEF variables, that TAM kept its consistency in predicting and explaining system adoption. Another replication by Hendrickson et al. (1993) showed that, for both USEF and EOU, "*the scale items exhibited significant test-retest reliability result*" (Chuttur, 2009, p. 11) while Subramanian (1994) found evidence that supports previous results of TAM studies. A strong step forward in TAM evolving has been Davis et al. (1989) work because they stated that in some cases, given a system perceived as useful, a potential user can form a strong BI the system without forming ATT (see fig. 28, it's the direct link from USEF to BI).

[47] See Legris et al., 2003,p. 195, table 2 for further references.

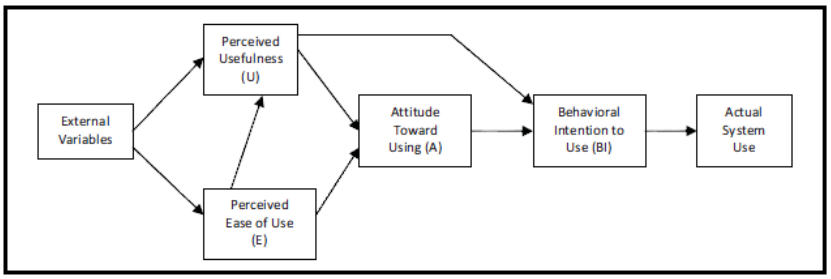


Figure 28: modified version of TAM (from Davis et al., 1989, p. 985)

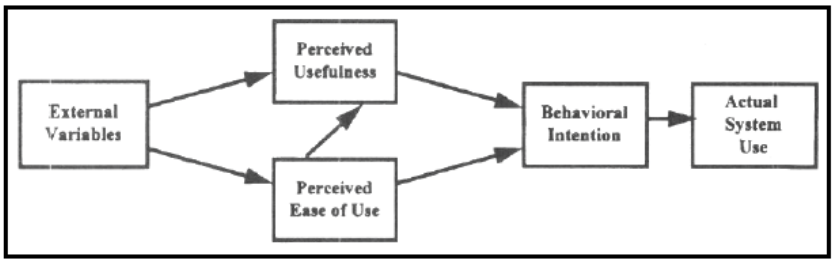


Figure 29: final version of TAM (from Venkatesh and Davis, 1996, p. 453)

Davis et al. (1989) results found a strong correlation between BI and self-reported system usage, with USEF responsible, for the greatest part, of BI, EOU was found to have a small but significant effect on BI, moreover both USEF and EOU were found to have a direct influence on BI. These results led Venkatesh and Davis (1996) to modify the TAM as in fig. 29: the elimination of the ATT construct and the introduction of the BI construct is consistent with Davis (1985, p. 109) results showing a direct link between USEF and USE (fig. 25), with the exception that now this link is mediated by BI. An additional criticism to the original TAM is that system features are only a subset of all the external variables that might influence individual's beliefs towards a system. The external variables construct includes system characteristics, but also user training, user participation in design and the nature of the implementation process (Venkatesh and Davis, 1996). All these evolutions and changes highlight how the TAM is in a continuous processing, on the basis of new field-experimental evidences. TAM has been stressed with multiple meta analyses (table 11) to consolidate previous findings. Most part of these studies found (Chuttur, 2009, pp. 13-14):

Applications, participants, country and setting used for applying TAM (Yousafzai et al., 2007), Sharp, 2006, King et al., 2006, Ma et al., 2004, Lee et al., 2003, and, Legris et al., 2003)

Variation in TAM application	Examples
Applications	Email, voicemail, fax, dial-up system, e-commerce application, groupware, word processor, spreadsheet, presentation software, database program, case tools, hospital IS, Decision support system, Expert support system, and telemedicine technology.
Country	USA, UK, Taiwan, Hong Kong, Switzerland, Japan, Australia, Turkey, Canada, Kuweit, Nigeria, France, Singapore, China, and Finland.
Type of Study	Lab study, Field study and Web surveys
Participants	Students (undergraduate and graduates), knowledge workers, physicians, bank managers, programmer analysts, IT vendor specialists, computer programmers, internet users, brokers, and sales assistants.

Table 11: some of the main applications, participants, countries and settings for TAM testing (from Chuttur, 2009, p. 13)

- Mixed results for the direct relationship from EOU to system use.

- Strong evidence to support TAM as a model for predicting system usage behavior.
- Significant statistical result for the high influence of USEF on BI.
- Most TAM research is focused on voluntary contexts, therefore further investigations on mandatory settings is needed.
- The general items that measured USEF and EOU made difficult to identify the reasons behind the USEF and EOU variables used in the model.

To address these issues, TAM has been therefore extended, i.e. TAM2 (Venkatesh and Davis, 2000) or TAM3 (Venkatesh and Bala, 2008). Chuttur (2009, pp. 16-17) gathered, from literature, numerous limitations of the TAM in three categories, which I rearranged in the following table:

Limitations in the methodologies used for testing the TAM
• Self reported use data, instead of real actual use data, are often used to measure system use. Self-reported used data is a subjective measure, unreliable in measuring the "*actual use of the system*" construct (Legris et al., 2003; Yousafzai et al., 2007). • Several TAM studies' results can't be generalized since they use students as participants in controlled environment and students can have different motivations for system usage, i.e. grades, rewards and so on (Lee et al., 2003; Legris et al., 2003; Yousafzai et al., 2007). • Very few studies systems that were for mandatory use (Yousafzai et al., 2007)
Limitations in the variables and relationships present within the TAM model
• Yang and Yoo (2003) didn't agree with the choice of Davis et al. (1989) of eliminating ATT because they suggested that it may have a strong influence on system use. Then, they suggested two additional attitude variables, affective and cognitive, and their results showed that the affective attitude variable has been found as insignificant in predicting system use, while the cognitive attitude variable has been found as very significant. • Brown et al. (2002) conducted a study on the TAM in a mandatory context and they found that, with mandatory settings, EOU is more significant that USEF in predicting system use. This evidence contrasts Davis (1985) results that shows, in voluntary settings, USEF as more influencing than EOU on system acceptance. • Burton-James and Hubona (2006) found that EOU and USEF may not mediate the influence of all the external factors on system use: some external factors (i.e. system experience, level of education, age) may exert a direct influence on system use.
Limitations in the theoretical foundation for the TAM
• Bagozzi (2007) questioned the theoretical strength of the link between BI and use. • BI may not be enough representative of actual use because the time span between intention and adoption could be influenced by other factors that could undermine the decision of adoption (Bagozzi,

2007).

- TAM is a deterministic model, the choice of adopting or not the system is assumed to be totally determined by the potential used intention to act and an individual, as such, can reformulate his intention on the basis of evaluations and reflections: this means that TAM could not be suitable for predicting system use (Bagozzi, 2007).

Table 12: TAM limitations in literature

Legris et al. (2003) consulted 80 articles, keeping only 22 of them the basis of some criteria for analysis. Considering the TAM constructs in fig. 30 and the dashed red arrows (they are new relationships tested in literature) in addition to the original relationships, these authors summarized the tests' results (table 13) showing that there is a high proportion of positive findings for all the relations but a number of inconsistencies too: this means that the variables considered in the model are not sufficient to predict IT adoption (Legris et al., 2003, p. 193).

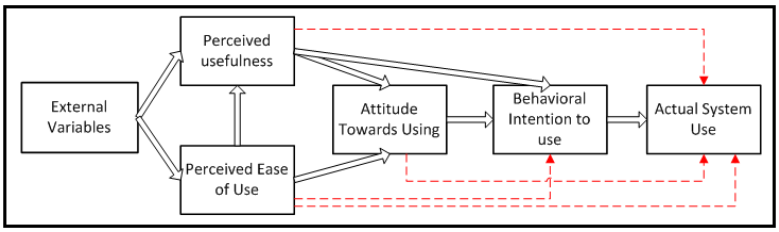


Figure 30: TAM by Davis et al. (1989, p. 985) with four new relationships hypothesized in literature

	PEOU–PU	PU–AT	PEOU–AT	PU–BI	PEOU–BI	AT–BI	AT–U	BI–U	PEOU–U	PU–U
Positive relation	21	12	10	16	10	7	3	10	4	8
Non-significant relation	5	1	3	3	3	4	0	1	5	5
Negative relation	0	1	0	0	0	0	0	0	0	0
Not tested	2	14	15	9	15	17	25	17	19	15

Table 13: results about tested relationships in literature (from Legris et al., 2003, p. 196)[48]

Moreover, there is a great variance in these studies' settings:

- ATT and BI: some studies include both ATT and BI, others only one of them, or ignored both measuring only the direct effect on use.
- Use: a part of the considered studies measured it through self-reporting and only one measured it with an automatic tool. In 10 other studies, use was not measured because it was either mandatory or simply ignored.

[48] Abbreviations used in the table are quite intuitive, even if different from which I'm using in this work. The only one that can implies confusion is "U", that refers to "*Actual system use*".

- External variables: among the 22 studies there isn't a clear pattern in choosing the external variables (see Legris et al., 2003, p. 196, table 5), moreover external variables suggested by Burton-James and Hubona (2006) in table 12 have been rarely considered. Anyway, these studies confirmed the mediating role of EOU and USEF between external variables and use.
- Measures of USEF, EOU, ATT and BI: the internal consistency of the items used for these measures in the 2 studies has been found acceptable/reasonable.

A significant result of a meta-analysis conducted by Legris et al. (2003, p. 202) is that, according to some researchers (i.e. Agarwal and Prasad, 1997; Lucas and Spitler, 1999; Szajna, 1996), TAM should be modified to include further variables in order to explain more than 40% of system use[49]. Then, integrating what reported in table 12, other important limitations of the TAM are:

- Although meta-analysis results are mostly convergent, situations where they are conflicting exist (Legris et al., 2003). Moreover, in my opinion, it isn't possible to reach a total convergence due to the great number of variables in play.
- A lot of TAM studies examined the introduction of office automation software or systems development applications. "*We think that research would benefit from examining the introduction of business process applications*" (Legris et al., 2003, p. 202).
- TAM context considers IS as an independent issue in organizational dynamics. Orlikowski and Hofman (1997) suggested that process change effectiveness relies on the interdependence among the technology, the organizational context and the change model used to manage the change, and this suggests that increasing TAM predictive power over 40% may be difficult without an integration of organizational and social factors (Legris et al., 2003, p. 202).
- Some researchers arose skepticisms about the application and the theoretical accuracy of the model (Chuttur, 2009).
- "*Research on TAM may have reached a saturation level, such that future research will focus in developing new models that would exploit the strengths of the TAM model while discarding its weaknesses*" (Chuttur, 2009, p. 17).

[49] Empirical studies proved that the TAM predicts about 40% of a system's use, see Ajzen and Fishbein (1980) and Hu et al. (1999).

1.6.3 TAM 2 and TAM 3: should I have to analyze them?

The purpose of my literature analysis isn't only informative, but I want to understand the extent to which it's possible to "stress" a model in a change perspective. As this work aims to suggest a new IS success model, I consider as indispensable to understand the limits within which I can twist and combine existing models. Under this perspective, since I already deepened the TAM, I don't want to go deep into TAM2 and TAM3 in the same way, but I prefer to see an overview of them highlighting principal changes without analyzing all the validation aspects. After all, I quoted, commented and criticized (if considered necessary in my opinion) all the fundamental relationships of the models that I took into account, for both process/causal and measurement contexts: I already went deep in the basis, therefore I don't feel the need of analyzing TAM's extensions in great detail. I've done this for D&M update only because it's one of the few IS success models, while TAM takes into account only the adoption/use success, which is a subset of the more wide IS success.

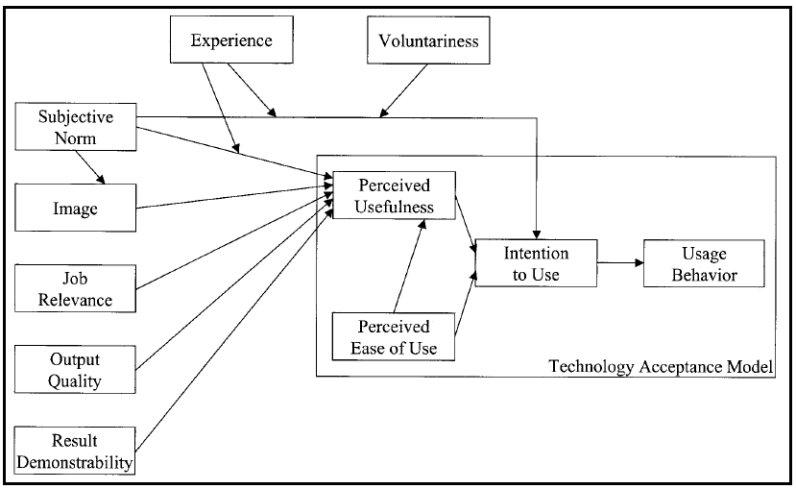


Figure 31: TAM2 (from Venkatesh and Davis, 2000, p. 188)

This TAM2 version relies on the evidence that literature showed about how much USEF is a strong determinant of usage intentions, with standardized regression coefficients typically around 0.6, while EOU usually exhibits a less consistent effect on intention. In spite of this, the determinants of EOU have been a research subject more than the determinants of USEF and this justifies the enrichment in fig. 31. The most part of TAM2 constructs can be grouped in two kinds of processes:

1. Social influence processes:

    a. Subjective norm[50]: it influences "*Intention to Use*" directly and through USEF[51] (see pp. 59, 64, 72).
    b. Voluntariness: "*the extent to which potential adopters perceive the adoption decision to be non-mandatory (Agarwal and Prasad, 1997; Hartwick and Barki, 1994; Moore and Benbasat, 1991)*" (Venkatesh and Davis, 2000, p. 188). In fact, "*The direct effect of subjective norm over and above perceived usefulness and perceived ease of use will occur in mandatory, but not voluntary, system usage settings*" (Venkatesh and Davis, 2000, p. 188). Then, voluntariness is a variable with a moderating role.
    c. Image: "*the degree to which use of an innovation is perceived to enhance one's* [...] *status in one's social system*" (Moore and Benbasat, 1991, p. 195). People often conform themselves to a social norm for a matter of image within a reference group (Kelman, 1958). According to fig. 31, "*Image*" should mediate between subjective norm and USEF.

2. Cognitive instrumental processes:

    a. Job relevance: potential user's judgment of job relevance is defined as "*individual's perception regarding the degree to which the target system is applicable to his or her job*" (Venkatesh and Davis, 2000, p. 191), namely a judgment on the system capability in supporting one's job within a task.
    b. Output quality: how well the system performs supported tasks. Davis (1985) posited a similar construct, labeled as "*Perceived Quality of the Output*" (see fig. 26, p. 69), but there are significant differences in both their meaning and structure: the similarity mostly refers to their label.
    c. Result demonstrability: "*tangibility of the results of using the innovation*" (Moore and Benbasat, 1991, p. 203). If a given system yields, in a relevant job, good results desired by an user but it produces them in an unclear way, users are unlikely to understand the usefulness of this system.
    d. Perceived ease of use: already largely discussed, see p. 61 for the definition.

[50] See details on "*Subjective Norm*" in pp. 59, 64, 72 of this thesis work.
[51] See details in Venkatesh and Davis (2000), pp. 188-189.

The "*Experience*" construct in fig. 31 doesn't belong to the categories above. It expresses the experience in using a target system and Venkatesh and Davis (2000) suggested that an increased system experience may decrease over time the direct effect of "*Subjective Norm*" on "*Intention to Use*" and on USEF since, as experience grows, system's strengths and weaknesses are known and the normative influences subsides (Venkatesh and Davis, 2000).

A summary of field results pooled across four studies and three measurement periods is available in Venkatesh and Davis (2000, p. 197, fig. 2) and it confirms that all the relationships hypothesized in TAM2 have been supported, moreover all the variables influencing USEF explained up to 60% of its variance (Venkatesh and Davis, 2000, p. 198)[52].

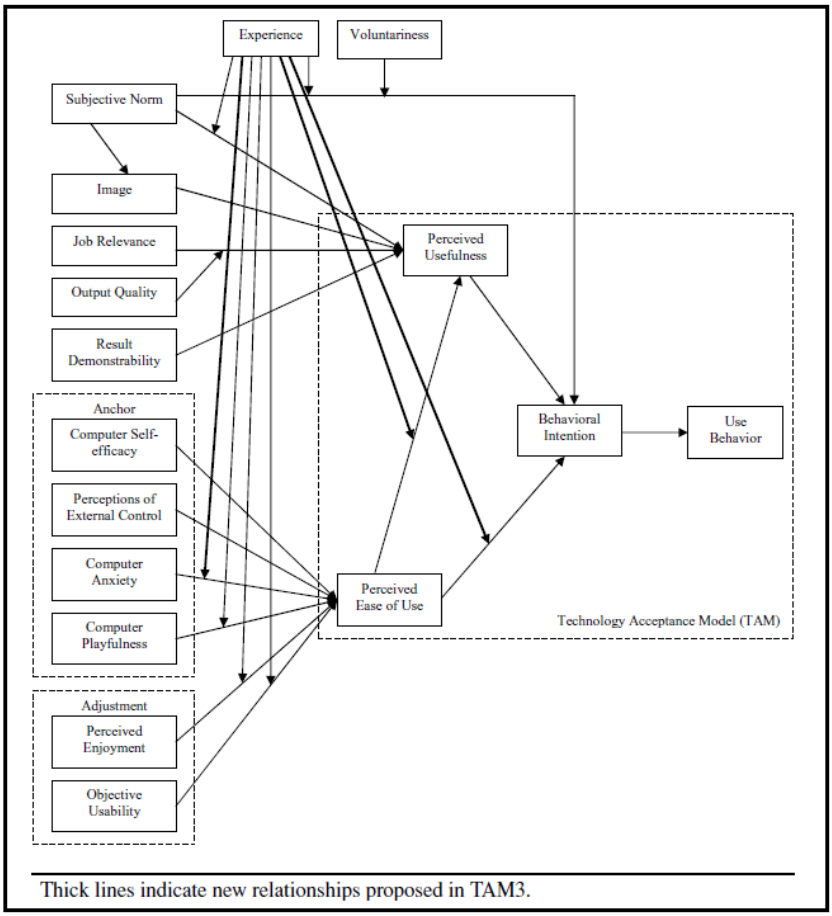


Figure 32: TAM 3 (from Venkatesh and Bala, 2008, p. 280)

TAM3 (fig. 32) is a combination of TAM2 by Venkatesh and Davis (2000) and the model of the determinants of perceived ease of use (Venkatesh, 2000), but without crossover

[52] Details on limitations, discussions and implications are available in Venkatesh and Davis (2000), pp. 198-200.

effects between the determinants of EOU and USEF. Field's results of TAM3's tests were generally consistent with those belonging to tests conducted on the two separate models above. In numbers, TAM3 has been able to explain:

- Between 52% and 67% of the variance in USEF across different time periods and models.
- Between 43% and 52% of the variance in EOU across different points of measurements and models.
- Between 40% and 53% of the variance in BI across different time periods and models.
- Between 34% and 36% of the variance in USE across different time periods and models.

Moreover, the three new hypothesized relationships (thick lines in fig. 32) were all supported. My main doubt is whether all this work is truly useful. I'm not expressing a judgment on the quality of the TAM3 but on the direction of the literature. It's very probable (maybe obvious) that, adding further variables, the explained variance of USER, EOU, BI and USE will increase but, as in each regressive method or in PCA or factorial analysis, the contribute of each further variable in explaining variance will decrease. TAM3 shows 13 new variables compared to the original TAM version (Davis, 1985; see fig. 23, 24 of this thesis work) and, for the observation above, it's quite normal that explained variance can be higher: if research still continues on this trend, we'll have models with 40 variables. I'm stating this provocation as I agree with Chuttur (2009, p. 17; p. 76) about the saturation of research on TAM, but without ignoring its unquestionable value.

	Preimplementation Interventions				Postimplementation Interventions		
	Design Characteristics	User Participation	Management Support	Incentive Alignment	Training	Organizational Support	Peer Support
Determinants of Perceived Usefulness							
Subjective Norm		X	X	X			X
Image			X	X			X
Job Relevance	X	X	X	X	X	X	X
Output Quality	X	X	X	X	X	X	X
Result Demonstrability	X	X	X	X	X	X	X
Determinants of Perceived Ease of Use							
Computer Self-Efficacy					X		
Perceptions of Ext. Control		X	X			X	X
Computer Anxiety		X			X	X	
Computer Playfulness		X			X		
Perceived Enjoyment	X	X		X	X		
Objective Usability	X	X			X		

X indicates a particular intervention can potentially influence a particular determinant of perceived usefulness or perceived ease of use.

Table 14: summary of interventions (from Venkatesh and Bala, 2008, p. 292)

In my opinion, the true added value in the work of Venkatesh and Bala (2008) is represented by table 14. On the basis of the stage models of IT implementation, posited by Cooper and Zmud (1990) and Saga and Zmud (1994), they suggested interventions for influencing the determinants of USEF and EOU that, then, should increase the probability of system use/adoption by the users[53]. These stages are defined as follows (Venkatesh and Bala, 2008, p. 292):

- Preimplementation:
    - Initiation: "*identification of organizational problems/opportunities that warrant a technology solution*".
    - Adoption: "*organizational decision to adopt and install a technology*".
    - Adaptation: "*modification processes directed toward individual / organizational needs to better fit the technology with the work setting*".
- Post implementation:
    - Acceptance: "*efforts undertaken to induce organizational members to commit to the use of technology*".
    - Routinization: "*alterations that occur within work systems to account for technology such that these systems are no longer perceived as new or out-of-the ordinary*".
    - Infusion: "*technology becomes more deeply embedded within the organization's work system*".

1.7 Combining models

For the reasons explained in p. 77 about "stressing" a model, I briefly want to analyze the possibility of combining different models for reaching more explanatory power. Actually, I don't have a deep interest in understanding if these research efforts led to significant results but I want to know how much daring are these combinations. In fact, i.e. TAM3 (Venkatesh and Bala, 2008) posited three new relationships but combined two different works (see pp. 79-80) using 21 already stated relationships (see fig. 32) and 17 already

[53] Details on the seven kinds of intervention, according to table 14, are in Venkatesh and Bala (2008), pp. 292-301.

introduced constructs, mostly limiting the work on confirming previous results in a combined way[54]. My idea is that already successful tested relationships can be used in merging models to add a validated structure to a work, contribution that has to be placed side by side with new relationships for supporting them in order to understand how far it's possible to try combinations, even if consequent results will show the inconsistence of the new links. Then, I considered three works in the following order: Smyth (2001), Dishaw et al. (2002), Venkatesh et al. (2003).

1.7.1 Building on G&T's work: TTF as indicator of ERP success

"*TTF*" construct measures congruence among task, technology (i.e. ERP) and individual (user) and these three factors influence system acceptance (Kronbichler et al., 2010). Robert Smyth adopted part of the TPC model to draw an update and he chose this way because literature lacks an established theory to explain ERP success factors (Smyth, 2001). At the date of publication, the modified model has been described as "preliminary" because author's research was still in progress. As a matter of fact, Smyth didn't take into account the whole TPC model, but only the "Theories of Fit" part (see fig. 5). "*TTF*" is the same construct described by G&T (1995, p. 218), but contextualized on ERP and not on a generic IS, therefore it measures the degree of match among ERP package capabilities/features, the tasks assigned to users of that package and the skills and attitudes of the individual users. The choice of the "*TTF*" construct brings with it also the G&T (1995) conclusions about the pertinent testing, namely that user evaluation of "*TTF*" is a good measure of "*TTF*" and that "*TTF*" is a strong indicator of IS implementation success as it yields performance impacts. Smyth (2001) added two other success indicators, that are already accepted in literature: "*Perceived usefulness*", called "*aggregate organizational benefits*" by Ives and Olson (1984), and "*User Satisfaction*",

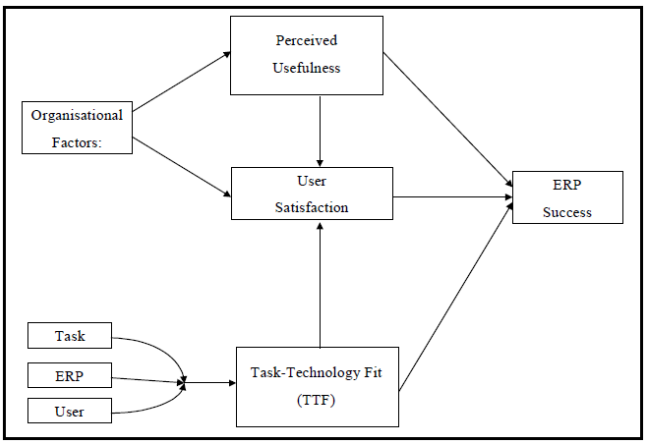


Figure 33: ERP success model (from Smyth, 2001, p. 1230)

[54] As observed in p. 81, TAM3 yielded also another added value (see table 14), but now I'm omitting it as superfluous in this topic.

which is the same construct introduced by D&M (1992). These two dimensions, in addition to "*TTF*", are shown as the most important indicators in ERP success in Smyth's model. Organizational factors, i.e. top management commitment, the presence of an ERP champion, organizational culture and organizational policies, directly influence "*Perceived Usefulness*" and "*User Satisfaction*" (this influence of organization-specific organizational factors has been already described in IS implementation theory, i.e. Robey, 1995). User satisfaction is, then, influenced by organizational factors in a direct way and in an indirect way through "*Perceived Usefulness*", moreover it's influenced by "*TTF*".
This model has been drawn in a research conducted using the case study approach, which examines a phenomenon in its real life context, and its purpose is understanding and explaining ERP success with empirical fact finding and analysis and the support of established theory. In particular, the case study on an australian reality broadly supported the proposed ERP success model, showing that:

- ERP package richness ("*Technology Characteristics*") can be a source of complexity for the users (low "*TTF*").
- Users accustomed with small/simple packages and with specific features of information reports ("*Individual Characteristics*") can lead to dissatisfaction in using a powerful and wide package like SAP.
- Poor "*TTF*" leads to poor "*User Satisfaction*" and both lead to low ERP success.
- A large and expensive package adoption, acquired for relative simple applications and low volumes of transaction, if perceived like a heavy overload (low "*Perceived Usefulness*") can lead to the decision of abandoning the package.

1.7.2 Merging on three levels: Dishaw et al. (2002)

Dishaw and Strong (1999) combined TAM (Davis, 1989) and "*TTF*" (G&T, 1995) into the comprehensive model in fig. 34, arguing that those models capture two different aspects of users' choices to utilize IT: TAM assumes that users' beliefs and attitudes toward using determine if users exhibit the behavioral intention to use the system, while "*TTF*" (within TPC model by G&T, 1995) has a more rational approach and assumes that users choose to use IT because it provides benefits (i.e. improved job performance) regardless of their attitude toward the IT (Goodhue, 1995). Fig. 34 shows that "*TTF*" is hypothesized as antecedent of the TAM constructs (USEF and EOU) and also as having a direct effect on

utilization. This is an innovation, as TAM usually considers how the system supports the user's task only indirectly through USEF, in fact TAM "*focuses much more on the technology than the ability of the technology to support users as they perform their tasks, which is the core focus of the TTF model*" (Dishaw et al., 2002, p. 1022). Dishaw and Strong (1999) found a strong and statistically very significant relationship between "*TTF*" and EOU and between EOU and USEF.

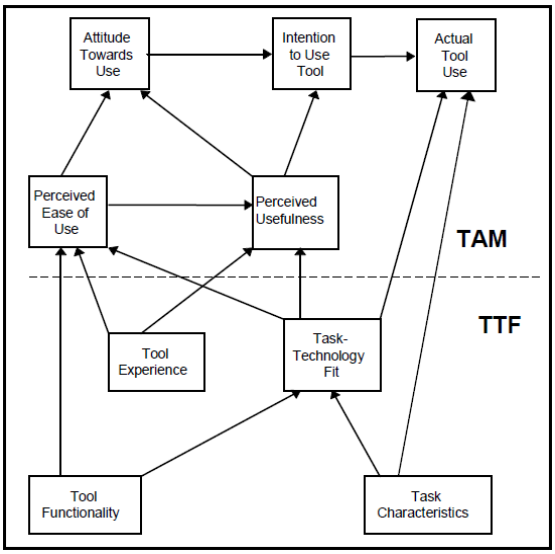


Figure 34: TAM/TTF integrated model (from Dishaw et al., 2002, p. 1023)

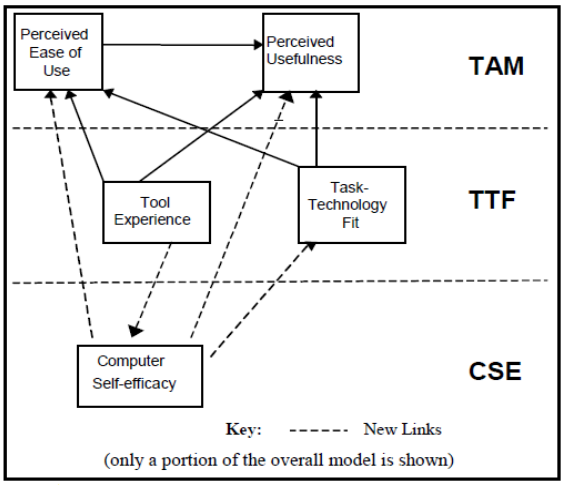


Figure 35: adding CSE to the TAM/TTF integrated model (from Dishaw et al., 2002, p. 1025)

Dishaw et al. (2002) updated the model in fig. 34, drawing the model in fig. 35. "*Computer self-efficacy*" (CSE) has been defined as "*a judgment of one's ability to use a computer*" (Dishaw et al., 2002, p. 1023) and it's a specialized definition of "self-efficacy"[55], namely a person's belief in his/her ability to accomplish a task (Compeau and Higgins, 1995). TAM, "*TTF*" and CSE have been already investigated and they demonstrated, individually, their explanatory power about the choice of using a system and how much users choose to use it. A portion of the overall combined model is in fig. 35: some relationships, i.e. the one between CSE and EOU or the one between "*Experience*" and EOU, have been already tested but the introduction of "*TTF*" implies the need of new validations. Confirming the idea stated in pp. 81-82, the goal of Dishaw et al. (2002, p. 1024) has been to understand if the addition (combination) of CSE to the TAM+"*TTF*" model could increase the predictive/explanatory power.

[55] See details on "*CSE*" and "*self-efficacy*" in Dishaw et al. (2002), pp. 1023-1024.

1.7.3 Unified Theory of Acceptance and Use of Technology

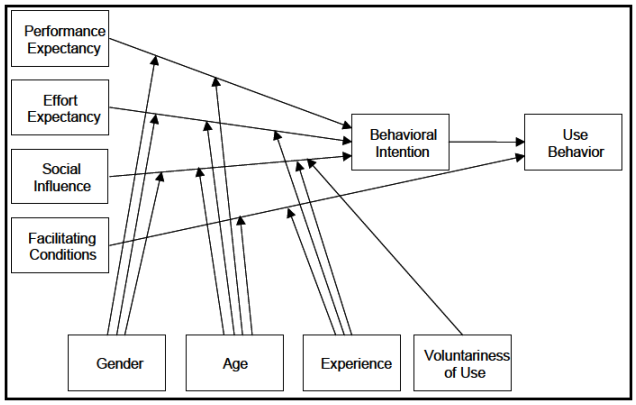


Figure 36: research model (from Venkatesh et al., 2003, p. 447)

Fig. 36 shows the UTAUT model, which is one of the results by Venkatesh et al. (2003). This model has been formulated unifying and integrating the considerable number of eight different models:

1. The theory of reasoned action
2. The TAM
3. The motivational model
4. The theory of planned behavior
5. A model combining the TAM and the theory of planned behavior
6. The model of PC utilization
7. The innovation diffusion theory
8. The social cognitive theory

According to the authors, "*UTAUT* [...] *provides a useful tool for managers needing to assess the likelihood of success for new technology introductions and helps them understand the drivers of acceptance in order to proactively design interventions (including training, marketing, etc.) targeted at populations of users that may be less inclined to adopt and use new systems*" (Venkatesh et al., 2003, pp. 425-426). The model's design has been preceded by an analysis of the eight models above, seeking for similarities and differences[56]. Without going deep into the model and the hypotheses stated by the authors[57], an interesting UTAUT's aspect is that it doesn't include ATT as influencing BI, differently from Davis et al. (1989) and from the theory of reasoned action (Fishbein and Ajzen, 1975), in fact ATT construct is omitted in fig. 36. Validation results of this model confirmed all the hypothesized relationships and showed that UTAUT is able to account for 70% of the variance (adjusted R^2) in usage intention, which is a considerable improvement over any of the eight models and their extensions.

[56] See details in Venkatesh et al. (2003), pp. 427-446.
[57] See details in Venkatesh et al. (2003), pp. 446-456.

1.8 Contingent variables and IS success

D&M (1992, p. 88) stated that "*the selection of success measures should also consider the contingency variables, such as the independent variables being researched; the organizational strategy, structure size, and environment of the organization being studies; the technology being employed; and the task and individual characteristics of the system under investigation (Weill and Olson 1989)*". Schultz and Slevin (1975) and Ein-Dor and Segev (1978) were among the first researchers in pointing out that the organizational context (i.e. size, maturity, resources, time frame) can be a determinant of IS success. For Raymond (1990), literature recognized the importance of the organizational environment in IS context but it lacked empirical research on this class of variables. Some studies already analyzed the relationships among size, structure and the sophistication/structure of the IS function but, at the publication date of Raymond (1990), they neglected to empirically relate these constructs to IS success (Ein-Dor and Segev, 1982; Lehman, 1985; Olson and Chervany, 1980).

In light of this lack, Raymond (1990) drew a research model that links the five organizational context variables proposed by Ein-Dor and Segev (1978) and systems' success. These variables are:

- Organizational size: Ein-Dor and Segev (1978) initially stated that IS success was less likely in smaller organizations due to poor resources, low development of structure and functions, low managerial and technical expertise on development, operation and usage of an IS, even if new generation software and hardware allowed small firms to increase IS sophistication and success. Empirical studies, at 1990 date, didn't find a direct link between size and user satisfaction or system usage, while results about the relationship between size and IS sophistication are mixed.
- Organizational maturity: Ein-Dor and Segev (1978) also stated that more mature organizations can more likely implement IS successfully, mostly measuring maturity through the formalization, namely the degree to which organizational processes are systematized and formalized with rules, procedures and management practices. "*Formalization has been positively related to greater decentralization of IS development, greater control of IS project selection and management [28], and better user attitudes toward an information system [31]*" (Raymond, 1990, p. 7).

Raymond's logic is that a mature organization provides an environment which is more compatible for IS development and usage, then it's assumed that such organizations can reach higher levels of IS sophistication and success.

- Organizational resources: Ein-Dor and Segev (1978) argued that IS failures are caused also by understaffing, underpowered hardware and/or inadequate software, but empirical results linking these causes to user satisfaction and/or usage rate are mixed. Anyway, it's right to hypothesize that more resources can mean more powerful hardware and software, more top-management support and, then, higher levels of IS sophistication.
- Organizational time frame: Ein-Dor and Segev (1978) proposed that organizations with a shorter time frame are less likely to implement IS successfully and that organizational time frame is directly associated with size and IS structure. Raymond (1990), on this basis, hypothesize that a longer organizational time frame should lead to higher levels of IS sophistication and success.
- IS sophistication: it's the managerial and technical sophistication in implementing, operating and using IS. Ein-Dor and Segev (1978) posited that an IS function which is independent from other organizational functions and located higher in the hierarchy would increase the likelihood of IS success: as IS function determines strategies, policies and technologies of organization's IS, it's licit to assume that greater IS success will result from increasing the sophistication of the function. Raymond (1990) hypothesized a mediating role of IS sophistication between organizational context and IS success.
- IS success: IT strictly isn't an Ein-Dor and Segev (1978) variable but it's part of the proposed model. In this literature analysis, I deeply showed several surrogates constructs of IS success, taking into account that IS final goals are the net benefits at different levels and, ultimately, organizational effectiveness. Raymond (1990) considered a behavioral approach, choosing "*offline usage*" and "*online usage*": "*offline usage*" happens when user interaction with the system is limited to the use of printed reports in output from the system or to access through an intermediary, while "*online usage*" happens when the user interacts with the system in first person and through a terminal. These two different types of use aren't necessarily related (Srinivasan, 1985). The other approach considered by Raymond (1990) lies on user attitudes, in particular on user satisfaction.

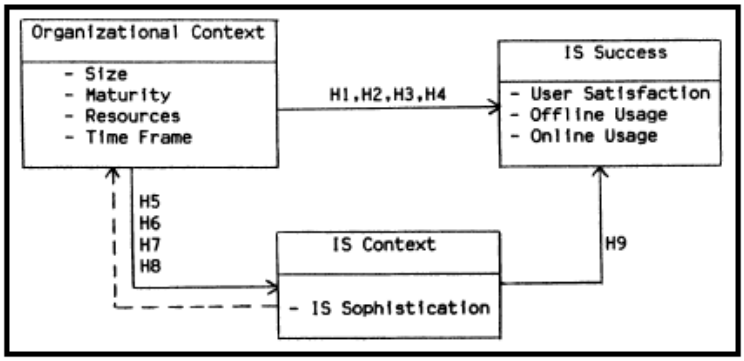


Figure 37: research model of the relationship between the organizational context and IS success (from Raymond, 1990, p. 6)

Fig. 37 shows the theorized model. Briefly, Raymond's hypotheses and results[58] are:

- H1: "*the larger the organization, the higher the level of IS success*". "*Size*" has been found positively related to "*user satisfaction*" and "*online usage*", but not to "*offline usage*".
- H2: "*the higher the level of organizational maturity, the higher the level of IS success*". "*Organizational maturity*" has been found positively related to "*user satisfaction*" and "*offline usage*", but not to "*online usage*".
- H3: "*the more organizational resources allocated to IS, the higher the level of IS success*". No evidence has been found to confirm this hypothesis.
- H4: "*the longer the organizational time frame, the higher the level of IS success*". Organizational "*time frame*" has been found positively and very significantly related to "*user satisfaction*" and "*online usage*", but not to "*offline usage*".
- H5: "*the larger the organization, the higher the level of IS sophistication*". Larger firms tend to have a more sophisticated IS function.
- H6: "*the higher the level of organizational maturity, the higher the level of IS sophistication*". Also this hypothesis has been supported.
- H7: "*the more organizational resources allocated to IS, the higher the level of IS sophistication*". A highly significant association between "*resources*" and "*IS sophistication*" has been found.
- H8: "*the longer the organizational time frame, the higher the level of IS sophistication*". No evidence has been found to confirm this hypothesis.
- H9: "*the higher the level of IS sophistication, the higher the level of IS success*". A confirmatory evidence for this hypothesis has been found.

[58] For details on the measure items of each variable, see Raymond (1990), pp. 11-13.

Unfortunately, the size and the nature of the used sample (small and medium-sized manufacturing firms) are a limitation for study's results. Other factors that should be studied, related to IS success, can be the uncertainty of the extra-organizational environment and other dimensions of organizational maturity as centralization and integration.

1.9 How to measure ERP ultimate goal

According to D&M (2003), net benefits are the main reason for ERP implementation if they take into account different stakeholders' perspectives[59]. I analyzed different ways to measure them (i.e. Gable et al., 2003, 2008; Ifinedo, 2006; Seddon, 1997), with pros and cons, but I want to include another instrument as it isn't a new idea but a contextualization, in the ERP sphere, of an already existing approach: the Balanced Scorecard (BSC). Basically, BSC is a framework to structure the relevant key performance indicators for performance management (Kaplan and Norton, 1992, 1993). It consists of four perspectives (financial, internal processes, customer, innovation & learning), then it goes besides traditional financial measures and accounts for a wider range of ERP effects (Martinsons et al., 1999), in fact each of the four perspectives has its own key indicators. In one of their applications of the BSC, Wright et al. (1999, p. 33) considered ERP software SAP R/3 as a part of the innovation & learning perspective, but Rosemann and Wiese (1999, p. 774) stated that "*It seems to be reasonable to apply the entire Balanced Scorecard also for the evaluation of software performance*". In detail, they suggested a BSC approach that can be used to evaluate the project performance in implementing ERP software[60] and another BSC approach, named operational BSC, which measures the business performance controlling ERP software and, then, is more interesting than the former, in the present work context.

[59] The latter aspect on multiple stakeholders' perspectives has been addressed also by Gable et al. (2003, 2008), Seddon (1997).

[60] This approach isn't pertinent to the present work, then it has been omitted. See details in Rosemann and Wiese (1999), pp. 775-778.

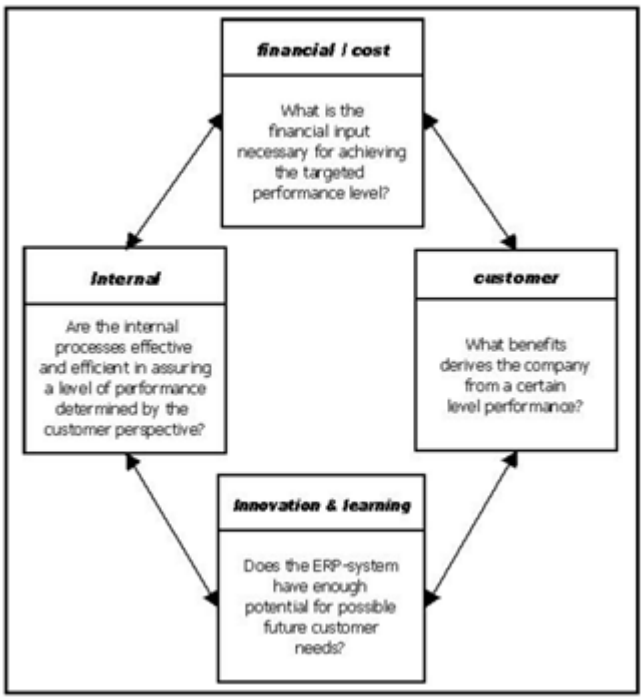


Figure 38: the ERP operational BSC (from Kronbichler et al., 2012, p. 292)

The operational BSC requires an adjustment to the four standard perspectives for contextualizing the classical BSC within ERP systems (fig. 38):

- Financial perspective: an ERP is a capital investment that causes both expenses and revenues. The latter aren't easily quantifiable in an objective way, even in the case where transfer prices are used for the IT department's services. Financial perspective can be analyzed through the gaps between actual expenses and budgeted expenses (see table 15), but not only for evaluating the quality of the already taken decisions (i.e. I'm spending more than what I budgeted), e.g. "[...] *negative deviations of actual training costs versus budgeted costs may indicate that the system's functions are not efficiently used by staff members. By contrast, a continuous increase in external consulting expenses may point to deficiencies in the internal training staff's competence*" (Rosemann and Wiese, 1999, p. 779).

Goal	Measure				
	Cost center		Maintenance		Training
	Cost category		budget	actual	budget	actual
Compliance with budget	Hardware	absolute				
		change				
	Software	absolute				
		change				
	Consulting	absolute				
		change				

Table 15: the financial perspective (from Rosemann and Wiese, 1999, p. 780)

- Customer perspective: the word "customers" has a wide meaning and usually can also include suppliers, subcontractors and so on. In this context, it refers to the internal customers of the ERP system, namely its users, on which the system has a direct effect[61]. According to table 16, ERP's coverage of business processes is maybe the most useful measure. Two interesting coverage aspects (measures) are:

Goal	Measure
Coverage of business processes	% of covered process types
	% of covered business transactions
	% of covered transactions valued good or fair
Reduction of bottlenecks	% of transaction not finished on schedule
	% of cancelled telephone order processes due to non-competitive system response time

Table 16: the customer perspective (from Rosemann and Wiese, 1999, p. 780)

  - The share of kinds of business processes covered by the ERP, i.e. the retailing sector with business process types like "classical" retailing, third party orders, settlement, promotion and customer service.
  - The share of total transaction volume handled by the system versus transactions performed outside of it.

- Internal process perspective: it concerns the internal conditions for satisfying the expectations of the customers above. These conditions can be grouped into processes needed for operating the system (table 17) on one side, and those for improving and enhancing system capabilities (table 18) on the other side. I.e., essential measures for evaluating the ERP internal processes are:

Goal	Measure
Reduction of operational problems	# of problems with customer order processing
	% of problems with customer order processing
	# of problems with warehouse processes
	# of problems with standard reports
	# of problems with reports on demand
Availability of the ERP-system	average system availabilty
	average downtime
	maximum downtime
Avoidance of operational bottlenecks	average response time in order processing
	average response time in order processing in the peak time
	average # of OLTP-transactions
	maximum # of OLTP-transactions

Table 17: the internal process perspective - operational view (from Rosemann and Wiese, 1999, p. 781)

  - Number and type of trends in user complaints in order to rank and resolve system defects.
  - Response time, transaction volume and their respective evolution over time (and others) for bottlenecks identification.

[61] This doesn't mean that also external customers of the ERP can't be considered.

A prerequisite for maintaining and enhancing an IT system in a development perspective is the use of latest releases ("actuality of the system", see table 18), then measures like "*average time to upgrade the system*"[62] or "*number of releases not (yet) introduced in the firm's system*" are needed. Other useful measures can be:

Goal	Measure
Actuality of the system	average time to upgrade the system release levels behind the actual level
Improvement in system development	punctuality index of system delivery quality index
Avoidance of developer-bottlenecks	average workload per developer rate of sick leave per developer % of modules covered by more than 2 developers

Table 18: the internal process perspective - development view (from Rosemann and Wiese, 1999, p. 782)

- *Punctuality index of system delivery*: actual time needed for development as compared to schedule.
- *Quality index*: it refers to the developed software.

Further indexes of system development are in table 18.

- Innovation & learning perspective: it concerns company's ability to effectively use ERP's functions as well as to system enhancement and improvement. This ability depends on human resources' know how (both users and IT staff), then an useful indicator is "*level of training courses*", measured by the amount of time of expenses spent. Other measures should consider the dependence on external consultants (and, therefore, the know how transfer) and the possibility to fall back on the system provider for support and maintenance (see table 19).

Goal	Measure
Qualification	# of training hours per user # of training hours per developer qualification index of developer
Independency of consultants	# of consultant days per module in use > 2 years # of consultant days per module in use < 2 years
Reliability of software vendor	# releases per year # of functional additions # of new customers

Table 19: the innovation & learning perspective (from Rosemann and Wiese, 1999, p. 782)

As ERP BSC is more focused on software performance than on net benefits, although there is a certain overlap between them, I want to suggest an useful benefits classification for ERP systems by Shang and Seddon (2000). I already quoted it in the present work as Gable

[62] It's the average time gap between the introduction in the market of a new available release and the time it becomes operative in the system.

et al. (2003) supported its utilization in a first moment and criticized it in a second moment[63]. This classification groups ERP benefits in five main dimensions:

1. Operational benefits: they are strictly linked to streamlining processes and automating transactions.
2. Managerial benefits: they are mostly informational benefits focused on senior managers of information system and they might help in achieving better resource management, improved decision making and planning, performance improvement in different operating divisions of the organization.
3. Strategic benefits: "*ERP systems, with their large scale of business involvement and internal/external integration capabilities, could assist in achieving*" (Shang and Seddon, 2000, p. 1006) various strategic benefits.
4. IT infrastructure benefits: ERP systems need for an integrated infrastructure that could be used to achieve different benefits.
5. Organizational benefits IT tools, accumulated information and application knowledge can facilitate organizational learning behavior, a flattened organizational structure, empowering and so on.

These five dimensions have a total of 25 sub-dimensions and, for each of them, Shang and Seddon (2000, pp. 1011-1013) suggested several measures[64].

1.10 The determinants of IS success

I started this literature analysis with DeLone and McLean and I want to end it with some DeLone considerations. This choice is motivated by the date in which these considerations have been addressed, namely in proceedings of a seminar in 2009. Taking into account D&M (2003) model, DeLone stated that "*understanding the determinants of IS success is important because those success factors may be leveraged and controlled to improve IS success*" (DeLone, 2009, slide 2). Obviously, in my opinion, this is a wish that can be fully achieved if there will be a model able to explain a great part of IS success: a leverage effect with a model that, i.e., explains the 30% of IS success variance isn't really effective.

[63] I pointed out and discussed this contradiction in p. 40.
[64] This classification is in Appendix A, pp. 187-188 of this thesis work.

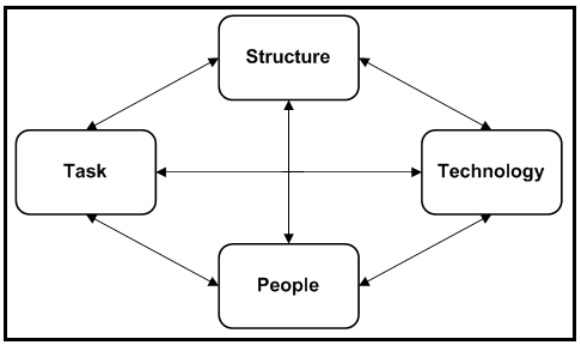


Figure 39: diamond of organizational change (Levitt, 1965)

On the basis of Levitt's diamond of organizational change (fig39), DeLone (2009) addressed a literature analysis with the following theoretical background:

- For Levitt (1965), organizations have four interdependent variables: tasks, people, structure and technology (IT)
- A change in one of these variables will affect the others
- IS success is likely affected by the interaction among these four variables
- The antecedents (causes) of IS success should include each of the four dimensions
- Basis of social technical theory of IS from Bostrom and Heinen (1977)

The literature analysis covered the timeframe from 1992 to 2007, focusing only on direct effects on IS success and ignoring moderating variables' hypotheses. The results, showed as follows, have been organized in six dimensions that, for DeLone, are the antecedents (causes) of IS success. For each of them, few questions have been proposed by the author in order to understand the direction of future research. Table 20 shows how strong is, on the basis of DeLone's literature review, the support of the considered determinant on IS success. "Support" refers to the support from the various research works to the D&M (2003) model.

Antecedents of success	Determinants	Level of support
Task characteristics	• TTF (except System Quality) • Task Difficulty	*Strong Support*
	• TTF (System Quality ONLY)	*No Support*
	• Task Interdependence • Task Significance • Task Variability • Task Specificity	*Insufficient Data*
User characteristics	• Attitudes • Self-Efficacy • Reasonable User Expectations	*Strong Support*

	• Organizational Role • Technology Experience (System Quality ONLY)	
	• Education	*Mixed Support*
	• Technology Experience (Net Benefits ONLY)	*No Support*
	• Age • Gender • Organizational Tenure • Department • Personality	*Insufficient Data*
Social characteristics	• Subjective Norms	*Mixed Support*
	• Image • Visibility • Peer Support	*Insufficient Data*
Project characteristics	• User Involvement • Relationship/Trust	*Strong Support*
	• Third Party Relationship • Developer Skill	*Mixed Support*
	• IT Planning • Development Approach • Project Management Skills • Domain Expert Knowledge	*Insufficient Data*
Organizational characteristics	• Management Support • Extrinsic Motivation • Management Processes • Organizational Competence • IT Infrastructure	*Strong Support*
	• IT Investment • Organization's External Environment	*Mixed Support*
	• IS Governance • Organizational Size	*Insufficient Data*
Technology characteristics	• Type of IS	*Mixed Support*
	• Time of Implementation • Voluntariness	*No Support*

Table 20: results from literature review (from DeLone, 2009, slides 15-25)

1. Task characteristics (table 20; it concerns the "*task*" dimension of Levitt's diamond): it's necessary to understand "*the relationship between specific task characteristics (i.e. task interdependence, task significance, task variability, and task specificity) and dimensions of IS success*" (DeLone, 2009, slide 16).
2. User characteristics (table 20; it concerns the "*people*" dimension of Levitt's diamond): "*Which user attitudes are most important in predicting IS success? What is the relationship between Self-Efficacy and Intention to Use?*" (DeLone, 2009, slide 18).

3. Social characteristics (table 20; it concerns the "*people*" dimension of Levitt's diamond): "*Is there a direct relationship between social characteristics and IS success?*" (DeLone, 2009, slide 20).
4. Project characteristics (table 20; it concerns the "*structure*" dimension of Levitt's diamond): "*Does Developer Skill influence User Satisfaction? What is the impact of a third party (such as a consultant of vendor) on IS success?*" (DeLone, 2009, slide 22).
5. Organizational characteristics (table 20; it concerns the "*structure*" dimension of Levitt's diamond): "*What is the nature of the relationship between IT investment and Net Benefits? Which factors of organizational environment (i.e., competitiveness of the industry, partner relationships) are most important in terms of impacting IS success?*" (DeLone, 2009, slide 24).
6. Technology characteristics (table 20; it concerns the "*technology*" dimension of Levitt's diamond): "*What types of information systems are most likely to provide Net Benefits?*" (DeLone, 2009, slide 26).

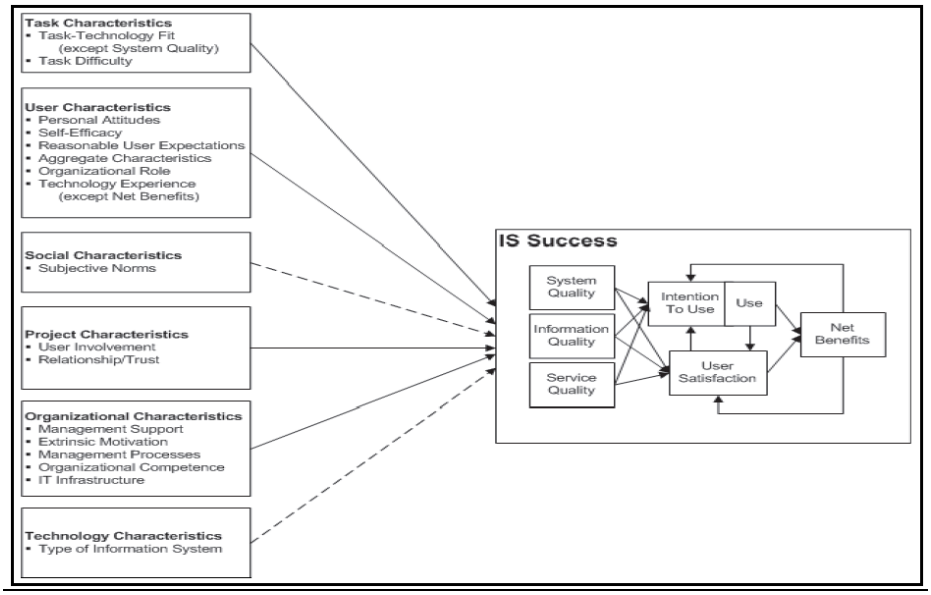


Figure 40: determinants of IS success model (from DeLone, 2009, slide 27)

Fig. 40 shows the result: IS success model with the addition of the determinants' framework, namely what is IS success and what causes it. This new big framework implies the need of studying cause and effect success models for each individual dimension (i.e. one investigating which factor has the highest influence on use: "*User Attitudes*", "M*anagement Support*", "*Extrinsic Motivation*" etc.): although some of them have been

already analyzed in literature, the simultaneous introduction of all these relationships can lead to different results.

In my opinion, this DeLone's work clarifies, in a definitive way, the D&M's perspective. Their model, both the 1992 version and the 2003 update, has not to be seen as simply a set of constructs representing a surrogate of IS success, as it represents the IS success itself in its dimensions. My personal point of view is that sometimes in literature there is a tendency to overlap measurement aspects of IS success with the IS success meaning itself. All the theoretical constructs that I described in this literature analysis are usually IS success dimensions, but they are utilized as a surrogate of the IS success/effectiveness since there isn't a simple, univocal and clear way to measure it directly. DeLone (2009) highlighted this aspect distinguishing what causes IS success (the determinant of IS success model) from what constitutes IS success (D&M's model). Each construct in fig. 40 has its own measure items but only some of them are an expression of IS success: making an attempt to enrich the IS success model means to introduce new constructs and/or new relationships and not to enhance the measures set. Measurement items should leave causal relationships out of consideration because they describe a state or a change in a state and not the ways you can reach that state. If a hypothetical model where some constructs explain the total variance of IS success exists, maybe the total number of measure items could be lower as the leverage power of each construct could overwhelm the need of a multidimensional measure[65]. Besides process/causal models, I analyzed also IS success measurement models because they can suggest new constructs that could be considered for drawing new relationships with IS success and not because their theoretical support (i.e. hypotheses about new valid measurement items) is fundamental in determining new IS dimensions. Anyway, DeLone (2009) clearly showed the most productive way for conducting future research, namely those factors that were not adequately tested or that led to mixed results (see table 20). In my opinion, literature has already addressed the most important constructs in IS success: an incremental innovation should be find among new causal relationships and new mediating effects.

[65] I could be not really interested in capturing every measurement's aspect of a construct if I know that all the constructs can explain the total variance of a phenomenon.

2. Within the ERP context

Chapter 2 is the prelude to the modeling phase. First, outcomes of real ERP projects have been analyzed, getting evidences which are useful for the next building chapter. Afterwards, ERP projects complexity factors have been identified and discussed, highlighting how they make an implementation of an ERP system different from that of a generic IS. Further field evidences have been analyzed for understanding how and if implementing organizations perceive the success of their ERP projects. Finally, three IS failure models have been compared for completing the literature's overview.

2.1 ERP projects and failure: a brief overview

According to Markus and Tanis (2000, p. 176), enterprise systems are "*commercial software packages that enable the integration of transaction-oriented data and business processes throughout an organization (and perhaps eventually throughout the entire interorganizational supply chain)*" and they include ERP software. ERP system implementations are costly, in terms of both time and resources, and complex: these two aspects often cause large investments and relatively high implementation failure rates (Suraweera et al., 2009). Evidences in literature suggest that:

- The ERP failure rate may be even more than 50% and about 20% of attempted ERP adoptions are turned to be complete failures (Escalle et al., 1999; Trunick, 1999).
- On average, ERP projects have been 178% over budget, took 2.5 times as long as intended and delivered only 30% of promised benefits. Moreover, 75% ERP projects were considered as a failure and cannot be accepted (Huang et al., 2004).
- Referring to China, the successful implementation rate is extremely low at only 10% (Zhu and Ma, 1999).
- Panorama Consulting Group conducted a survey about ERP implementation during 2010, involving 185 participants from 57 countries (30% from North America, 70% from around the world). Results showed that 61.1% of respondents said ERP implementations took longer than expected, 74.1% stated bloated budget and 48% felt that realization of benefits was less than 50%. Robbins-Gioia, a management consulting services provides located in Virginia, performed a survey with 232

respondents which showed 36% of companies had ERP systems and 51% considered their ERP implementations as a fail (Hidayanto et al., 2013).

- "[...] *about 70% of ERP implementations fail to deliver anticipated benefits (Al-Mashari, 2000) and three quarters of these projects are unsuccessful (Griffith, Zammuto, & Aiman-Smith, 1999; Hong & Kim, 2002; Kuhar, Maheshwari, & Kumar, 2005)*" (Hanafizadeh and Ravasan, 2011, p. 23).
- ERP failure rate has been estimated as 60÷90% (Kwack and Lee, 2008).
- According to a survey of 117 organizations conducted by the Conference Board, 40% of ERP projects failed to meet the business case (Cooke et al., 2001).
- "*Approximately 90 percent of ERP implementations are late or over budget, which may due to poor cost and schedule estimations or changes in project scope rather than project management failure*" (Holland and Light, 1999, p. 30).
- About half of ERP implementations fails to meet expectations (Stefanou, 2000).
- "*Majed (2000) reported that 70% of ERP implementations did not achieve their estimated benefits. In other studies, the percentage of ERP implementations that can be classified as "failures" ranges from 40% to 60% or higher (Langenwalter, 2000)*" (Wong et al., 2005, p. 493).
- 90% of SAP R/3 ERP projects runs late (Scott and Vessey, 2002).

Literature, then, isn't concordant on a narrow range of the ERP failure rate (and, in my opinion, this is normal as different researchers considered different samples with their own culture and contingent variables) but it's clear that, conceptually, ERP means considerable risks. Furthermore, an exceedingly poor performance/net benefits can lead to "*possible discontinuance of the system or of IS department itself (e.g., wholesale outsourcing)*" (D&M, 2003, p. 23) and, in extreme cases, to bankruptcy (M&T, 2000; Markus, Axline et al., 2000) or significant losses. Calleam Consulting Group (2014) created a "catalogue of catastrophe", in part concerning ERP projects' failures, and some records can be useful to understand the extent of losses, which refer to well-known companies too:

- Avon Products: the project consisted in a new back-end ERP system and a new tablet enabling e-commerce front-end to allow canadian sales agents to use their tablets to showcase the products and then immediately check inventory and secure orders online. The expected saving was approximately $40M per year. On 9 Dec

2013 the project has been abandoned with a write-off of between $100M and $125M.

- USA department of defense: as the Air Force included over 700 systems, many duplicative, stand-alone or ineffective, the department decided to integrate them into a single ERP. Original scheduling was 2004-2012 with a $3B budget. In 2012 the Air Force spent the whole budget yielding what they described as "negligible benefits" and that they would need $1.1B more to deploy just 25% of the original scope. Even with such a scaled back proposal, project end has been extended to 2020.
- Fox Meyer Drugs: a $65M investment in an ERP system and new warehousing facilities resulted in a $40B write down in share value and, after, in bankruptcy. The company was sold off for just $80M to rival McKesson Corporation.
- Queensland health - Government of Queensland: the program aimed to use an ERP system to centralize, standardize and integrate the management of basic HR functions across all the government departments. In addition to the initial direct cost of 64.5M AUD (Australian Dollars), it was necessary to spend +1.2B AUD over 8 years of subsequent operations.

Other examples of significant disasters are suggested by CIO Magazine (2009):

- Nike: in 2000, a $400M upgrade to supply chain and ERP systems resulted in $100M in lost sales, 20% stock dip and a collection of class-action lawsuits.
- Waste Management: garbage-disposal giant Waste Management began, in 2008, a legal saga with SAP over a 18 months ERP software installation, claiming SAP executives participated in a fraudulent sales scheme that resulted in a massive failure.

These cases highlight the potential risks associated with an ERP project but numbers can't catch all the risks hidden behind an ERP implementation. ERP implementation can be defined as a "*socio-technical challenge which requires a fundamentally different outlook from previous technologically driven innovation (Kalbasi, 2007; Al-Fawaz, 2008)*" (Suraweera et al., 2009, p. 81). A successful implementation allows the organizations to collect various benefits through an integration of the complete (if needed) range of business processes. Each transaction is entered, recorded, processed, monitored and

reported from a single information and IT architecture. Each kind of benefit achievable with successful ERP implementations is yielded by a real-time updated, unique and shared database and, for Davenport (2000), they imply reduced cycle times, faster information transactions, better financial management, lay groundwork for e-commerce and make tacit knowledge explicit.

Literature deeply analyzed the critical success factors (CSFs) behind an ERP implementation, but the CSFs approach adopts a static view which can be inadequate in explaining dynamics of the implementation strategy and it's not adequate, if alone, to explain how the transition to success happens (Aladwani, 2001), although a supporting role of CSFs to ERP implementations has been found to achieve success (Suraweera et al., 2009). Moreover, results of research on CSFs often consisted in classifications of these factors within the phases of ERP implementation process models neglecting the specific phase, prior to ERP planning/software selection phase, in which adequate analyses of business requirement in preparation to ERP projects should be addressed: this lack can result in organizations failing to achieve expected benefits from their implementations (Sammon and Adam, 2005). This topic is included in the "organizational readiness for ERP implementation" stream: extensive preparation prior to ERP implementation is a key to success of an ERP project and can allow the organization to dodge the project failure (Razmi et al., 2008). Moreover, a readiness assessment also identifies the areas which are perceived as the organization's weakness, in order to improve them for readiness enhancing.

An ERP implementation is almost different from a classical IS/IT project. In this context, there is the need of going besides traditional project management principles (Holland and Light, 1999), even if a low level of project management skills in the early stage of the implementation project is one of the most important reasons of the high failure rate (Somers and Nelson, 2004). As I deepened afterwards, ERP project is a matter of change management, cultural misfits (Zhang et al., 2005; Soh et al., 2000; Smyth, 2001; Shanks et al., 2000), technical and organizational aspects involving multiple stakeholders often in different geographical locations. Traditional project management challenges are amplified in this environment: the implementation is more difficult, expensive and failure-prone (Markus, Tanis and van Fenema, 2000) and the complexity suggests that results obtained in other simpler technology implementation environments are not readily applicable to ERP contexts (Amoako-Gyampah and Salam, 2004). While some peculiarities of ERP

implementations arise from specific characteristics of these systems, others refer to various management issues:

- Integration of information: this integration through a company refers to information in a wide meaning, namely financial and accounting information, human resources information, supply chain information, customer information, and its achieving depends on setting up the system in particular ways (M&T, 2000), starting from the chartering phase. "Setting up" means choosing which package modules to install, setting software parameters to represent the company's sales force, products' configuration etc. . Then, for M&T (2000) business model definition strongly influences integration and, thus, the ERP implementation. Even with an ERP, benefits belonging to a successful integration can be not achievable, i.e. if a company purchases and installs only a single module of the ERP package.
- Packages: ERP are commercial packages of modular solutions and this has consequences on the project itself. This characteristic changes the system life cycle as can imply, generally, no need for programming (customizations are not advisable) and puts emphasis on skills that in IT environment usually have low importance, i.e. mapping organizational requirements using processes and terminology employed by the vendor (in IT, instead, almost always the customer expresses them in its own terms and words). Moreover, the purchase of an ERP implies a long term relationship with the software vendor and other external actors and this can lead to external influences on plans for maintenance and enhancement of the package and, thus, to the need of manage this kind of relationships during and after the ERP project: this exposes the company to further risks, i.e. the vendor goes out of business or lacks the resources for continued technical development[66].
- System Assembly: "*What is integrated is the software, not the computing platform on which it runs*" (M&T, 2000, p. 178). ERP adopting organizations can face great difficulty in integrating the new enterprise software with their already existing bundle of hardware, operating systems, database management systems software and telecommunications suited to their specific needs in terms of organizational size, structure and geographic distribution. The difficulty is in part due to the lack of relevant knowledge and skills then, often, system integration requires technical experts from different fields.

[66] If this happens during the ERP project, it can be a condemn for the company itself.

Summarizing, M&T (2000) identified five reasons which make ERP systems a particular topic in IS research:

1. Financial costs and risks: I already quoted several examples about these risks. The need of studying ERP project success and failure arose mainly from this perspective.
2. Technical issues: they start from software selection approaches and continue with enterprise modeling tools and techniques, configuration, system and software architectures, data processing etc. .
3. Managerial issues: they go from the involvement of parties from many different organizations to implications on the company business model, on its IS functions, on management of personnel, on skill acquisition and retention and on project management, project sponsorship, user involvement, change management, vendor management, strategic use of IT, BPR.
4. IT adoption, use and impact: "[...] *how extensively they* [the ERP systems] *are used within the organizations, how faithfully they are used, and how effectively they are used*" (M&T, 2000, p. 183), how these ERP systems have large potential impacts at all levels[67], interorganizational information systems.
5. Integration: the extent to which ERP systems are bound up in restructuring organizations, integration with external actors (i.e. vendors, system integrators etc.) in a long term IT development, internal integration on information and system level.

Re-arranging these five reasons, Esteves and Pastor (2000) defined two macro-dimensions which are relevant in ERP implementation: organizational dimension and technological dimension. The organizational dimensions can be further detailed in four sub-dimensions (Esteves et al., 2001; Al-Mashari and Zairi, 2000; Mandal and Gunasekaran, 2003):

- Business Process Management
- Project Management
- Change Management
- Human Resources Management

[67] Individual and societal (skills required, employment etc.), work system (i.e. business process efficiency), organizational (i.e. business results), interorganizational (i.e. impact on supply chain). Further examples are in M&T (2000), p. 183.

There is also another sub-dimension, namely the financial one, but it's usually considered as a direct consequence of the complexity of such projects. The deployment of all these dimensions, including the technological one, explains the peculiarities that characterize an ERP system implementation and that make it different from another IT project.

2.2 ERP projects complexity

The organizational dimension plays a significant role in such projects as, almost always, there's the need of changes in business processes and this factor can make difficult to understand if the value added by a successful ERP project arises from the ERP system itself or from changes in the organizational dimension. The extent of business transformation has been put in relation to the range of potential benefits (fig. 41) identifying different strategies: a medium-high/high level of both the dimensions is what is expected from an organization adopting an ERP.

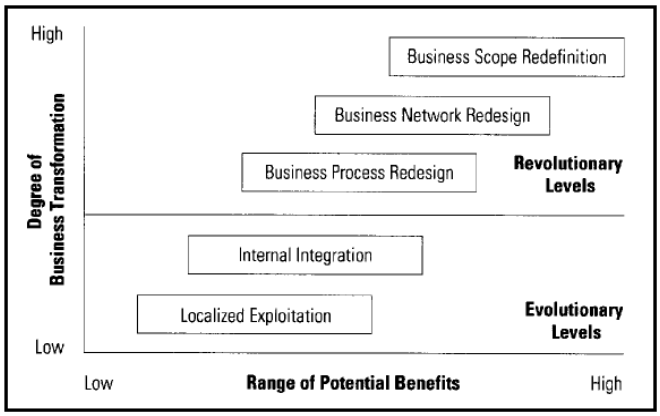


Figure 41: five levels of IT-enabled business transformation (from Venkatraman, 1994, p. 74)

- Localized exploitation: it's a local automation of existing procedures. It requires a minimal intervention that should yield performance enhancing in those processes to which the above procedures refer.
- Internal integration: business processes structure remains unchanged but efforts are realized in order to achieve integration between existing processes and the IS. The focus is both on organizational integration and on procedures automation.
- BPR: it's a partial or total reengineering of business processes and it impacts on both procedures and organizational structure.
- Business network redesign: it requires changes that overstep organizational boundaries and affect the existing relationships between organization and its partners. It consists in an integration of the internal business processes with partners through information & competencies sharing and exchange: this "pooling" can avoid the adoption of expensive vertical integrated solutions.

- Business scope redefinition: the logic is suing the technological innovation as leverage for a redefinition of the competitive ambit through strong and stable interorganizational relationships (i.e. joint ventures, long-term contracts etc.).

Literature has widely discussed about the need of a BPR within an ERP project. It's more costly, almost by a factor of 3-10, than the ERP software itself and these costs include high consultancy fees charged by consultants and system integrators, the heavy reengineering focus generally adopted by implementing companies and the need to replace high percentage of existing information technology infrastructure in order to support the ERP systems (Austin et al., 2003). Mainstream literature suggests that a BPR is necessary, with all the pertinent risks and efforts, and its extent depends on management will (i.e. how much we can - and we want - enhance and optimize our business processes on the basis of the analyses of the gaps between real as-is and theoretical as-is, theoretical as-is and theoretical to-be) and on fit issues (fit between theoretical to-be and best practices incorporated in the various possible ERP choices). ERP implementation should, at least, aim to the BPR position in fig. 41: this aspect is often a deterrent and it represents a strong difference compared to other IT projects. Obviously, it isn't necessary if the company's business processes are already aligned to the best practices incorporated in the potential ERP package but this is a rare exception as, in most cases, companies work with an existing gap between how they effectively work (real as-is) and how they think/should work (theoretical as-is), namely they are often sub-optimized on their own bases.
Taking into account the decomposition of the organizational dimension in sub-dimensions (p. 103), it's possible to highlight other peculiarities of the ERP projects:

- Business Process Management: within an ERP project, adopting firms should privilege BPR in order to fully exploit the IT potentialities (Davenport, 1993; Hammer, 1995). A BPR implies changes in operative modalities and a redistribution of both decisional responsibilities and strategic weight of each organizational function. Then, for Kirchmer (1998) and Shtub (1999) ERP projects require on one hand specific competencies for business processes design and reengineering and, on the other hand, particular organizational and managerial skills. The need of these skills is lower if the management prefers to improve the fit between business processes and best practices incorporated in the package through software modifications, but this solution introduces issues in terms of higher costs

(customization and maintenance), lower system stability, lower compatibility with new releases[68].

- Project Management: ERP projects are so much complex and pervasive on both technological and organizational level that require, besides the project team (that is usually sufficient in other IT projects), a steering committee which is responsible for initial strategic choices within the ERP implementation, i.e. definition of the implementation scope[69], selection of external actors (vendor, system integrator etc.), composition of the project team, BPR choices, change management policies, implementation strategies, business processes and BUs that have to be involved in the implementation, which functionalities of the package will be implemented, all the decisions on existing hardware and technologies and so on. Although an overlap between steering committee and project team exists, the latter must include a heterogeneous set of skills and competencies, both technological and strategic/organizational because, given the nature of the ERP, this can determine the implementation success or failure (Somers and Nelson, 2004). In fact, ERP projects require the management of heterogeneous issues like:

    - Scope, time frame, costs, implementation's evaluation parameters.
    - Management of numerous stakeholders, both internal and external, which have different needs and expectations (financial, organizational, technological etc.).
    - Satisfaction of both explicit and implicit requirements.

  Moreover, complexity and average length of ERP projects often make the desired results fuzzy: it's important to share a clear vision of the objectives (Wallace and Kremzar, 2001).
- Change Management: according to Tardivo (2002), the higher the number of implemented modules, the deeper the necessary process reengineering and, then, the greater the risk of losing sight of the implementation objectives in favor of the extent of organizational change. ERP system adoption, differently from other IT projects, yields such intense impacts that, if people aren't adequately prepared to

[68] The trade off is partially reduced by the introduction of vertical solutions, which are extremely and natively adapted for the specific requirements of particular industrial sectors.
[69] It's equivalent to define a priori the level of change that the ERP project will lead to the adopting organization, usually a hard matter.

manage pertinent changes at all the levels (individual, organizational, operational, technological etc.), implementation's expected consequences will be denial, resistance and chaos (Umble et al., 2003). In order to avoid in the people[70] the feeling of lack of involvement, two actions are needed: on one side, the project manager shall act for reducing the time span between people immobility (first reaction to the change) and the negotiation phase (organizational and technological changes are discussed for taking into account people's needs), on the other side the steering committee has the responsibility of change communication and diffusion. These two actions should avoid two of the most important and peculiar ERP project failure causes, namely the lack of communicational aspects (low top management commitment, or good but badly communicated commitment) and of executive aspects (i.e. insufficient human resources planning). The costs of such actions and their effectiveness are strictly linked to the necessary coordination activities[71] and to their costs.

- Human Resources Management: it has to be considered on two different levels. On one level, human resources management within ERP implementation consists in managing those components of individual behavior (i.e. age, managerial level, education level, informatics competencies, relationship with IT etc.) which can affect change resistance due to the perceived risk by individuals about ERP system adoption[72] and to individual habits, that will be inevitably influenced by the abandonment/modification of the already established procedures. On another level, human resources management should also consider individual's expectations, which can significantly increase customization costs. It has to be clear that pre-implementation training and goals communication and sharing can yield a positive attitude towards the ERP project but they can't ensure to get through a strong organizational resistance: alternative mechanisms are necessary, i.e. empowerment, job rotation/enlargement, rewards and incentives systems directly linked to the ERP project.

As already stated in p. 103, ERP implementation complexity is affected by a technological dimension too. The most relevant technological issues in ERP projects are:

[70] Not only among members of project team and steering committee but also in everyone will use ERP system functionalities.
[71] For example, Mintzberg's coordination mechanisms, see details in Mintzberg (1979).
[72] It refers to the whole ERP project, not simply to the software adoption.

- Customization: the most part of ERP adopting organizations prefers those ERP solutions that minimize software modifications level (Lee et al., 2003) and this means that a BPR, light or heavy, is needed. Anyway, some organizations prefer to custom the system for a better fit with their processes, although this implies all the consequences stated in pp. 105-106. The result is usually a trade-off between operative modalities desired by the organization (a BPR is conducted anyway) and those offered by the system (Davenport, 1998) and, then, among economic suitability, system functionalities and customization level. ERP vendors offer vertical solutions that usually provide a better fit with those procedures which are sector-specific, lowering the need of customizations. However, literature suggested that it's preferable to adapt business processes to the incorporated best practices instead of pursuing customizations (Themistocleous et al., 2001; Sumner, 1999; Holland and Light, 1999), even if Themistocleous et al. (2001) found that 32% of the sample analyzed in their study, despite all, customized some modules.
- Integration issues: one of the most relevant issues in ERP projects is the integration of the new system with the already implemented applications, i.e. legacy systems or best of breed solutions (Themistocleous et al., 2001). In fact, ERP packages usually cover about 90% of all the business requirements and processes and it's licit to support the remaining 10% with best of breed applications, legacy systems or ERP modules belonging to suites different from the principal one. Integration can be achieved through various solutions[73] and each of them introduces new issues within the ERP implementation, like selection of the technological partner responsible for the integration, use of proprietary solutions and so on.
- Data migration: together with data conversion and validation, it's the most complex and hard phase within the transition from legacy system to the ERP one, also because data inconsistency issue is often even denied by adopting organizations (Slater, 1998). This is a complexity factor that characterize ERP projects because it requires both a planning phase and an executive phase. The planning phase is conducted together with the technological partner, it's propedeutical to the executive phase and it should consider also future potential data requirements that

[73] See specialized literature for details as this specific topic is out of the present work's scope.

don't strictly relate to the actual migration. The executive phase, also called "data normalization phase", includes various activities[74].

- Legacy system: usually, ERP is meant to replace legacy systems, which support specific functional areas. In legacy systems the information is spread across several different computer systems generating both direct and indirect costs. Direct costs include maintaining the different systems (often hard or impossible due to their structure and to the lack of the pertinent technical documentation), entering data more than once, having to reformat data from one system to use it in another. Indirect costs reflect the costs of communication failures, which arise i.e. when in a company the manufacturing system can't "talk" to its sales and ordering system or to its financial-reporting system (Davenport, 1998). An existing legacy system requires the selection and management of a treatment strategy, with a black box or white box approach, and this introduces in the ERP project new complexity factors, among which data migration is only a part, although the most difficult.

2.3 ERP success and failure

People rarely define terms such as success and failure (M&T, 2000) and, maybe, it isn't even strictly necessary as often people mean different things when talking about ERP success, i.e. project managers and implementation consultants (all the people whose job is to implement the system) usually define success in terms of completing the project on time and within budget, while people whose job is ERP system adoption and use for achieving business results define success as a smooth transition from shakedown to onward to upward phase and as the achievement of business improvements, like inventory reductions, better decision making and so on. Then, success can be very different if considered at different points in time, on different dimensions or from different points of view (Larsen and Myers, 1997). In fact, while project managers and implementers aim to declare success in a short run, executives and investors aim to it for the long haul. A clear example of the importance of considering ERP success at multiple points in time has been showed in a study conducted by Larsen and Myers (1997), in which a successfully ERP implementation

[74] Data profiling and extraction (data classification on the basis of criteria like application domain, transactional data specific for a single module etc., data extraction), data elimination (some data become useless or redundant in the new system), data transformation (i.e. because the ERP supports only a specific format/extension), data testing and validation (it's a check on the compliance with the migration specifications), data transfer.

was terminated later when the company merged with another. For M&T (2000), a single measure of ERP success can't be sufficient for all the concerns an organization's executives might have about the enterprise system experience. In fact, ERP adopting organizations should consider a set of success metrics addressing different dimensions (financial, technical, human etc.) at different points in time. An example of a minimum set of success metrics, reflecting different meanings of success within an ERP project, can be the following[75]:

- Success in the project phase: it's possible to use classic project metrics (budget, time) in addition to other metrics concerning the functional scope (i.e. number of effectively installed functionalities compared to the number of functionalities that should be installed).
- Success in the shakedown phase: early operational metrics[76] are needed in order to understand how business operations perform in the period after the system becomes operational until "normal operation" is achieved. Even if a performance dip is usual in the shakedown phase (Ross and Vitale, 2000), exceedingly poor performance can lead to internal or external pressures to uninstall the system and, in extreme cases, to bankruptcy. Here, success can consist in both minimizing the duration of the transitional period and resolving early operational problems quickly.
- Success in the onward and upward phase: here, metrics[77] have to measure "*how the organization performs at various times after normal business operation have been achieved*" (M&T, 2000, p. 186).

A further evidence in supporting the theory of assessing success in different points in time is that "*companies with disastrous project and shakedown metrics but high levels of subsequent business benefits from enterprise systems* [..., and] *companies with acceptable project and shakedown metrics that could not identify business benefits from installing the system*" (M&T, 2000, p. 186) have been found, moreover also Larsen and Myers (1997) found that an ERP experience could be an early success and a later failure.

[75] Metrics in the example refer to the Enterprise System Experience Cycle by M&T (2000, p. 189), in Appendix B, p. 189, fig. 51 of this thesis work.
[76] Examples of these metrics are in M&T (2000), p. 185 and Markus, Axline et al. (2000), p. 246 or pp. 135-136 of this thesis work.
[77] Examples of these metrics are in M&T (2000), p. 186 and Markus, Axline et al. (2000), p. 246 or pp. 137-138 of this thesis work.

It's quite common, also within ERP projects, to judge success in relation to the organization's unique goals or to use objectives, expectations and perceptions of the adopters as the standard for defining and measuring success (M&T, 2000; Markus, Axline et al., 2000). On one hand, this is correct since, i.e., if a company stops using the ERP system because corporate objectives are judged as not achievable, it doesn't matter if a third party (e.g. an outside observer) assesses the ERP implementation as successful. Another example: "*two organizations with identical improvements in inventory carrying costs can be judged successful in different ways, if the one's goals were to replace its legacy systems (more successful than expected) and the other's were to achieve an increase in market share (less successful than expected)*" (M&T, 2000, p. 186). On the other hand, both company goals and people objectives (and expectations) about ERP systems may be inadequate for defining and measuring ERP success because they may be insufficiently ambitious compared to ERP system capabilities, i.e. a company that is losing market share because it isn't able to promise deliveries/orders satisfaction would be blameworthy if it adopts an ERP for reasons that don't include installation and use of ATP functions. Vice versa, they may be overly ambitious and then unrealizable, no matter what people do[78].
Markus, Axline et al. (2000) conducted a study in which they analyzed and interpreted interviews and results about approximately 40 companies that challenged, successfully or not, an ERP project. Without going deep into study's goal and gathered information[79], some interesting evidences have been found:

- Many companies experienced moderate to severe business disruption when their ERP systems "went live", difficulty diagnosis problems and difficulty recovering from them. Sometimes, "normal" operations were achieved only by permanently increasing staffing levels and reducing expectations about labor efficiency. Anyway, this didn't mean that ERP implementation has been a failure.
- A number of companies achieved their budget and schedule targets but had to cut scope, often substantially. In one of these companies, scope reductions led to failure later on: the company didn't achieve the business results it had hoped for.
- One of the companies which significantly reduced project scope implemented only 15% of the ERP functionality it had originally planned to implement but, despite

[78] In order to overcome all these issues, M&T (2000) introduced the concept of *optimal success* for defining and measuring ERP success. Further details are in M&T (2000), pp. 186-187.
[79] For details, see Markus, Axline et al. (2000), pp. 251-259.

this, it claimed to have achieved substantial inventory reductions. This result shows that it's possible, for "failed" projects, to achieve eventual business success.

- Larger organizations, which usually challenged larger ERP projects, "*were less likely to judge the overall ERP experience as unsuccessful when the project budget and schedule were not met*" (Markus, Axline et al., 2000, p. 255). Moreover, larger organizations put more emphasis than smaller ones on starting planning for the onward and upward phase during the project phase and on the importance of learning how to challenge ERP implementations better each time. The latter aspect is strictly linked to the management control system learning goal, in a rollout perspective.
- As already observed by Larsen and Myers (1997) (p. 110), evidences confirmed that some companies which achieved success in the project phase classified their ERP projects as failures later on.
- One company successfully implemented SAP R/3 within time but claimed to have not achieved business performance improvements because it didn't reengineer its processes.
- Several companies in the onward and upward phase could not say if they had achieved business benefits from using the ERP system[80]. One of the reasons for this issue is that sometimes companies don't set out to achieve measurable business results and, then, they don't obtain them or they don't realize that they obtained them. In support of this evidence, Ifinedo (2006, p. 15) stated that, within two of his previous studies, only some companies had any formal evaluation of the success of their ERP while others simply didn't perform such evaluations. Moreover, quoting results of a survey conducted by Robbins-Gioia (the same one already quoted in pp. 98-99) "*46% of the participants noted that while their organization had an ERP system in place* [...], *they did not feel their organization understood how to use the system to improve the way they conduct business*" and this information suggests that "*ERP adopting firms do not know what to assess or evaluate to ensure that the technology enables them realize their organizational goals*" (Ifinedo, 2006, p. 15).

Summarizing, within ERP experience early success (success on project measures) is not closely and necessarily linked to later success (success on business measures) and early

[80] These companies gave various reasons for their inability to assess their results. Details on them are in Markus, Axline et al. (2000), pp. 255, 259.

failure (failure on project measures) isn't closely and necessarily linked to later failure (failure on business measures). On a practical level, practitioners want to know the processes by which some companies realize better or worse ERP project outcomes than others do and what makes this difference, if all the companies experience the same problems within ERP implementations and how answers are related to the outcomes. Unfortunately, ERP success is mined by problems and some of them (i.e. lack of resources or turnover of personnel) can arise in each phase of an ERP project. These problems may or may not be perceived as such and, even if people perceive them as problems, they may or may not be solved with appropriate actions: this implies that unresolved or bad resolved problems can affect success later. Concerning this, I want to quote a significant statement about ERP success by Markus, Axline et al. (2000, p. 264):

"[...] *the connections between starting conditions, experienced problems and outcomes in the ERP experience are not deterministic. While this can be construed as bad news for academic theory, it is good news for both ERP adopters and for IS researchers. For ERP adopters it means that it is possible to succeed with ERP despite bad luck, some mistakes and even early failures. For researchers it means that there is much more work to be done in order to understand problem recognition and resolution behaviours and how they interact to result in successful and unsuccessful outcomes.*"

Besides the "success" concept, literature also investigated its complementary: the "failure" concept. Its study can suggest useful ways for dodging it and it's possible to define critical failure factors (CFFs, the dual of CSFs[81]) as "*the key aspects (areas) were "things must go wrong" in order for the ERP implementation process to achieve a high level of failure*" (Wong et al., 2005, p. 494). Like CSFs, also CFFs have an importance in an IS/ERP project, in fact Flowers (1996) analyzed large systems failure cases to show that the performance of software systems projects is a function of how CFFs are managed among various dimensions: organizational, financial, technical, human, political and the interactions among them.

The failure topic, as the success one, lacks an univocal definition as it's multidimensional, for example:

[81] Usually, but not always, CFFs are the CSFs' negation, i.e. poor top management support or poor knowledge transfer. For details on CFFs see i.e. Wong et al. (2005), Yeo (2002), Miyamoto et al. (2013), Aloini et al. (2007).

- "*An ERP implementation is considered a failure if it does not achieve a substantial proportion of its potential organizational benefits (Davenport, 1998; Umble et al., 2003)*" (Chen et al., 2009, p. 158).
- "*Practitioners tend to discuss the impact of the failure of ERP implementation in a relative sense, referring to the shutting down of the system, being able to use only part of the ERP system, suffering business loss, dropping market price, losing both market share and competitive advantage due to implementation failure, and so on (Deutsch, 1998; Diederich, 1998; Nelson and Ramstad, 1999)*" (Wong et al., 2005, pp. 493-494).

In my opinion, these definitions don't reflect the ERP projects complexity described in pp. 104-109 and a more structured approach is needed. Usually, theory about IS doesn't fit totally for ERP environment due to all the pertinent particularities showed in the previous pages but failure theories are quite adequate for ERP projects too because, in opposition to success theories, they start from a specific state (i.e. a specific failure) and they search for factors, like CFFs, backwards. Moreover, they distinguish different kinds of failure, exactly like different kinds of success exist. A brief analysis of these theories can be a valuable help in understanding success dynamics, since they are dual:

- Flowers (1996) stated that a failure of an IS occurs if any of the following situations happens (Yeo, 2002):
    - The whole system doesn't operate as expected and its overall performance is sub-optimal.
    - On implementation, it does not perform as originally intended or if it's so user-hostile that is rejected by users and/or underutilized.
    - Development costs exceed the benefits the system may bring throughout its useful life.
    - The IS development is abandoned before its completion due to problems with project management or system complexity.
- Potentially strategic ISs, like the ERP ones, are more prone to failure than other systems for various reasons (described in pp. 104-109) and, in particular, because they are significantly innovative, complex, involve significant organizational change and many stakeholders, cross intra and interorganizational boundaries

(Hart, 2006). Lyytinen and Hirschheim (1987) defined four major categories of IS failure that fit also for ERP projects:

- Correspondence failure: "*this is the most common form of IS failure discussed in literature and typically reflects a management perspective on failure*" (Beynon-Davis, 1995, p. 1156). It's based on the hypothesis that system objectives, requirements and specifications are fully determined in the early phases of the project and that their achievement can be accurately measured. Correspondence failure occurs when there is a lack of correspondence between objectives and evaluation of the IS (Beynon-Davis, 1995), namely when design objectives are not met (Kimble and Selby, 2000). Yeo (2002) suggested that the considered performance measures are mainly based on cost-benefits analyses employed for managerial control over the system implementation but, in my opinion, measures should go besides a cost-benefits perspective i.e. if the former planning required a minimum specific threshold of transactional volumes that have to be supported by the system and the resulting ERP doesn't support it, a correspondence failure occurred and it has been detected without a cost-benefits analysis. Obviously, it's possible to place this measure in a cost-benefits analysis but it isn't strictly necessary. Anyway, I want to underline that correspondence failure refers to the system dimension (its objectives, requirements and specifications) and not to the project dimensions and its fit between what has been planned and what has been realized/performed. Moreover correspondence failure, in a goal-seeking perspective, doesn't distinguish between a system's objective missed i.e. for technical/managerial reasons and a situation in which users may not necessarily accept systems that meet design objectives and specifications. For Wang et al. (2013, p. 861), "*in some small and medium sized enterprises, corresponding failure is prominent because the majority of ERP systems are designed for large enterprises*".
- Process failure: it occurs when the system development process cannot be managed within the allocated budget and/or time schedule, then this is a "*project level failure attributed to unsatisfactory project management performance*" (Yeo, 2002, p. 242). Going deep, process failure has two

likely outcomes. The first is that the planned the planned IS isn't workable at all, "*often due to difficulties or irresolvable problems in designing, implementing or configuring the IS*" (Miyamoto et al., 2013, p. 79). The second is the more common outcome, already described in previous pages, and concerns an IS that results workable but with cost or time overruns, often both: this overspending leads to limitations of system benefits (Kimble and Selby, 2000; Miyamoto et al., 2013). In order to lower the impact of a process failure, the delivered system may be reduced in scope or complexity (Hart, 2006). Process failure, then, coincides with the project failure strict meaning and, according to the numbers in pp. 98-99, it's maybe the most frequent kind of failure in ERP projects. Anyhow, this kind of failure is often widespread among big IT projects and it's applicable to all projects, large and small, IT or non-IT, because it summarizes the three golden constituents, namely schedule, quality and budget, and put emphasis on the "faster-better-cheaper" concept[82] even if, in a strict meaning, the quality dimension is a side issue, compared to time and budget, in process failure as it refers to the less common outcome described above.

- Interaction failure: it occurs when the system meets its planned objectives, requirements and specifications (then there isn't a correspondence failure) but its users reject it or don't use it as intended (Hart, 2006), namely users' attitude towards the system is negative (Want et al., 2013, p. 861). As I already widely discussed about the "use" in IS/ERP environment and its relationship with user attitudes and user satisfaction, heavy usage doesn't necessarily mean high user satisfaction and improved task performance because it may be the result of mandatory settings, persuasion or lack of alternatives besides using the system (Yeo, 2002). Referring to the latter aspect, "*such systems* [systems which experienced an interaction failure] *may be avoided by their intended users in favour of unofficial "shadow" systems, often developed by the users themselves*" (Hart, 2006, slide 7).

[82] The importance of this triptych has been addressed also by Daniel Goldin, NASA ex administrator, see further details in Pate-Cornell and Dillon (2001). Moreover, "*although some may argue that longer schedule, more accommodative specifications, and larger budget can help meet any challenge,* [...] *these constituents has little to do with the success of a project. Instead, the lack of oversight on any of these constituents is the major cause of project failure*" (Chen et al., 2009, p. 158).

- Expectation failure: multiple stakeholders' groups are typically involved in IS development and expectation failure occurs when the IS fails to meet requirements, expectations or values of one or more of these stakeholders' groups: then, an ERP project may be a failure for a specific stakeholders group but not for another. This kind of failure is perceived as "*a gap between some existing situation and a desired situation for members of a particular stakeholder group*" (Beynon-Davis, 1995, p. 1156). Unlike the other three failure notions, this considers the point of view of different stakeholders and goes besides the neutral technical artifact: this is consistent with the way I structured the literature analysis on success models.

- Sauer (1993) criticized the model proposed by Lyytinen and Hirschheim (1987) for its plurality and posited another one. According to fig. 42, the IS is a product of a coalition of stakeholders, that includes project organization, which at a particular point in time develops, operates and maintains the IS. The triangle is completed with the supporters, which promote and provide support to the project and require benefits from the IS. On this basis, Sauer (1993) considered an IS as a failure only when there is a development or operation termination, namely when the level of dissatisfaction of supporters with the system rises to the extent when there is no longer enough support to sustain it. System's goal is the survival and the system isn't "*considered a failure as long as it survives and continues to attract support in resources*" (Yeo, 2002, p. 243). Problems in any of the three relationships in fig. 42 lead to difficulties for the other two and, if not solved, to the failure. In details, "*IS failure*" is indicated by the cessation of all the work related to the system, instead a total abandonment of the project is labeled as "*termination failure*"[83]. Sauer's model is applicable to ERP environment but, in my opinion, its compactness can be adequate for a generic IS project but doesn't capture explicitly all the complexity behind an ERP

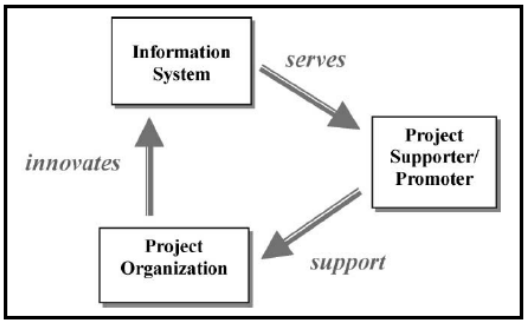


Figure 42: triangle of dependences (from Yeo, 2002, p. 243)

[83] For a deepening on the difference between "*termination failure*" (Sauer, 1993) and "*expectation failure*" (Lyytinen and Hirschheim, 1987), see Baynon-Davis (1995), p. 1157.

implementation, then I prefer the model yielded by Lyytinen and Hirschheim (1987)[84].

This overview of IS failure's models confirms that an ERP project, as described in previous pages, is susceptible of several potential failures and this is aggravated by risks that are more numerous and more significant than the ones in others IT/IS projects.

[84] This choice will be detailed in pp. 121-122 of this thesis work.

3. Modeling phase: building time

Previous chapters highlighted several evidences, briefly summarized as follows:

- Literature lacks ERP success models covering all the aspects of an ERP implementation, i.e. Smyth (2001) proposed an ERP success model mostly considering only technological and organizational dimensions and only superficially.
- Literature recognized the multidimensional nature of IS success but rarely, and not in an adequate way, yielded specific models for the ERP success.
- Proposed models are often too much focused on CSFs or ERP implementation phases. Furthermore, they usually reproposed old logics by adding new elements (constructs or relationships) but rarely by introducing new approaches.
- It's my opinion that existing success models, i.e. D&M (1992, 2003), reached the saturation level. Their nature has been explored and enriched for several years and, since ERP literature has been widely developed during time, a new approach to success is needed.
- ERP implementation topic includes a plenty of failure cases which can be useful for developing a new success model. Some failure models have been already proposed (pp. 114-118) but they aren't ERP specific and they usually present logics based upon CFFs.

Anyhow, as stated in pp. 81-82, I'm trustful about merging parts of existing models in order to exploit a sound theoretical basis for building something that may respect the requirements of novelty and usefulness. In my opinion, sometimes literature goes away from practitioners' world, for example the IS success model by D&M has been often criticized[85] even if it has been the first one to address efforts in aiming to IS success, defining what is important and what may be superfluous. Moreover, I don't understand the point of stating that the IS success model is "*lacking of theoretical grounding*" (Gable et al., 2008, p. 7): in my opinion, that work has been so innovative that it's a sound theoretical grounding itself, given the shortage of works on the IS success topic. As already stated, for being effective a model must suggest what has to be done for achieving specific goals and

[85] See examples in Gable et al. (2008), pp. 2-3, 7-8, and Seddon (1997).

for dodging major risks and failures[86] and I want to add that if a model is able to do this, theoretical aspects could become secondary and they might need to change in order to follow the empirical evidence. On this basis, I want to propose an ERP success model able to satisfy the following requirements, besides the novelty and usefulness ones:

1. It should be based on elements widely shared and accepted in literature.
2. It must suggest a new approach.
3. It has to be ERP specific, considering organizational, technological and project dimensions.
4. Points of view of different stakeholders have to be taken into account.
5. It must not be too much complicated in his building and application.
6. Its success meaning has to be univocal and comprehensive.
7. It should not directly include neither CSFs/CFFs nor ERP implementation models. It's obvious that some measures, for example those related to net benefits, will be collected in different point in time, namely in different ERP implementation phases, but this aspect belongs to a measurement level while, actually, I'm only on a theoretical level and still in a conceptual phase. At the same time, CSFs like "adequate management skills" or "top management support" are fundamental in ERP implementations but, as the possession of other skills, they don't constitute success per se and, then, they can't be included in a model which aims to explain the ERP success through some independent variables.

These requirements define my design specifications, that will address the whole modeling phase.

3.1 A first step in the right direction

Requirements #1 and #2 can seem contradictory but it's a false problem. My efforts must be addressed to get over the tradeoff between the need of elements already shared and accepted in literature on one side and the need of something both new and useful on the other side. This is maybe the most hard part because a hazarded approach could compromise the whole modeling phase, making this work useless. My purpose is, then, choosing a reliable starting basis and using it as first step. In my foregoing literature

[86] Both CFFs and CSFs have an important supporting role in doing this.

analysis I found discordant considerations about what IS/ERP success means and this is consistent with evidences collected from the field (see pp. 111-112). As there isn't identity of views on this subject, the best approach might be to start choosing one definition of ERP success on the basis of some criteria, but its multidimensional nature greatly complicates the selection. For a such complex process, structured selection tools and logics are needed but often their results are biased by subjectivity, while I'm searching for an objective concept from which starting. In my opinion, the best solution is to explore the dual aspect of success, namely the failure, and this makes sense for several reasons:

- Information included in it is useful because complementary
- Failure models in IS environment are few but widely accepted and shared
- The concept of failure holds a lot of latent information: assuming to find a way to define its nature in an univocal way, failure achievement is equivalent to the renouncement of success in all its meanings, dimensions, points of view. This is a good opportunity because, in literature, IS failure topic is much more compact that that of IS success and this implies a more likely possibility to manage a reduced set of information but achieving the same result.
- Literature includes a plenty of ERP implementation failure cases that, as well as the success ones, provide additional information

In pp. 114-118 I described three IS failure models, judging the one by Lyytinen and Hirschheim (1987) as the most appropriate for this work. In fact, the models by Sauer (1993) and Flowers (1996) point out few conditions that, if violated, lead to IS failure. This can be true in a generic IS environment but not in an ERP one because evidences from case studies (Markus, Axline et al., 2000, p. 111-112 of this thesis work) showed, for example, how an early ERP failure (success) can result in a later success (failure). ERP project characteristics in a success perspective are so various and complex that they can't be summarized in a single dichotomous condition (ERP success or failure) because, in my opinion, this kind of aggregation in an ERP context leads to information losses. For Flowers (1996), an IS failure occurs when the system is rejected by its users but this doesn't provide information neither on failure dynamics nor on an eventual later success in case of partial rejection. For Sauer (1993), an IS is considered as a failure when it doesn't attract anymore support in resources and then when there is no longer enough support to sustain it due to the excessive level of dissatisfaction of its supporters, but this neglects

cases in which an escalation occurs, namely when there are signals about an incoming failure but the management still provides support and resources, dazzled by a good payoff that, unfortunately, will never be achieved[87]. Instead, the model by Lyytinen and Hirschheim (1987, pp. 114-117 of this thesis work) reflects various dynamics of failure through four kinds of IS failure and this provides a wider coverage of aspects concerning the IS failure respect to other models. Thus, the failure concept isn't defined by a statement but through the combination of different kinds of failure, suggesting an univocal and comprehensive approach to this topic. Moreover, the model by Lyytinen and Hirschheim (1987) is widespread and accepted in literature and this is an indirect indication about its validity.

The logic I want to use is based on the negation of the four kinds of failure: thanks to the duality property, negating these failures means to assert success. One can argue that this is an useless double negation because failure's denial means success per se and then defining success directly is more convenient, but this isn't necessarily true. IS success definitions in literature are often incomplete and lacunose due to the numerous factors that should be taken into account. In order to obtain a comprehensive definition, a merging of different existing definitions should be performed to fill the gaps in each single source but it would provide a too much structured and wide formulation. A similar problem concerns the IS failure definitions, even if they are less numerous, and this is quite obvious because it's the complementary issue. Instead, it's my opinion that the four kinds of IS failure suggested by Lyytinen and Hirschheim (1987) provide a different perspective: their formulation is essential and elementary, suggesting in few words which aspects should be considered but without declining them in factors. If I had to judge them as definitions, they aren't very formal and comprehensive but they have a double benefit: on one side they consider a practical perspective, involving all the relevant aspects of an IS project, on the other side they contain a lot of latent information which make them suitable for an ERP contextualization. In a nutshell, as they are concise but, at the same time, full of potential

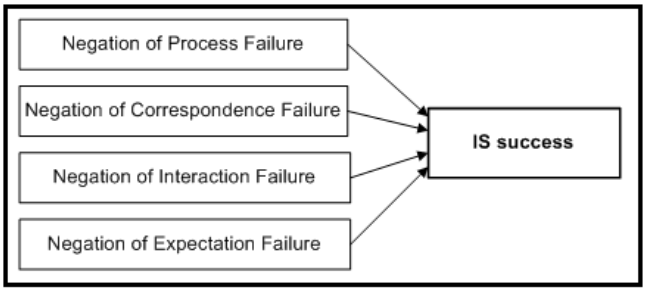


Figure 43: preliminary version of the model

[87] For example the FoxMeyer Drugs case, see details in Scott (1999).

declensions, their negation defines IS success in an extremely wide way: through a few words, it provides an approach that is potentially complete.

The initial model I'm proposing is quite simple but it highlights a first problem concerning the four relationships drawn in fig. 43 and the weight of each failure negation. Field evidences (pp. 111-112) show how process failure, in terms of time and/or budget violation[88], is extremely widespread within ERP implementations but this doesn't mean that a consequent ERP failure will occur. Instead, usually a correspondence failure prevents IS success, unless a shrinkage of project scope and/or goals is chosen. I don't want to set specific weights because it makes no sense as the relative importance of each failure within an ERP project can change according to the contingent situation. Despite this, a practitioner/researcher using a model like the one in fig. 43, even if it's still preliminary, should consider this aspect.

3.2 Moving from an IS context to an ERP specific one

The model in fig. 43 can be adequate for the IS success but it's still incomplete for an ERP environment because it neglects part of the ERP project characteristics analyzed in pp. 105-107. A great part of this contextualization process must be necessarily postponed to the moment in which I'll detail each construct for each failure negation, but few considerations can be done even in this initial phase. In fact, according to the definitions of the four failures (pp. 115-117), none of them explicitly includes aspects concerning neither contingent variables nor resistance to change, while they are significant in ERP implementations. Given this lack, an idea could be to introduce another construct that includes all these aspects and that can support the four negations in achieving success: the organizational readiness. As a matter of fact, a choice like this could compromise the whole model and this can be understood through the following quote, which is a common opinion among both researchers and practitioners: "*the success of an ERP implementation greatly depends on the state of readiness of the company*" (Hanafizadeh and Ravasan, 2011, pp. 24-25). Organizational readiness is then an enabling condition for success, exactly like other determinants, but it can't be a part of IS success because no one would measure it in order to understand if IS success has been achieved. It has an indubitable

[88] This is the most likely outcome of a process failure but not the only possible one, see pp. 115-116.

leading role among success determinants, especially within the ERP context (see pp. 101, 106-107), but it can't be part of the model I'm building because it's out of scope.

Besides its exclusion, a deepening on "*Organizational readiness*" within the ERP context for integrating what stated in Chapter 2 can be useful. "*Organizational readiness*" is a multi-level construct because it can be analyzed at the level of individual, group, unit, department or organization but its meaning isn't univocal. Some describe it in structural terms, focusing on organization's financial, material, human and informational resources while others specifically refer to commitment of organization members for change and to efficacy in implementing organizational change (Weiner, 2009). From my point of view, the right interpretation of this construct, within the context of this modeling phase, should be more focused on change management aspects. This doesn't mean that resource endowment isn't important but it has the same weight, more or less, in each significant (and generic) IS project while change management issues are much more relevant in an ERP environment for the reasons stated in pp. 101, 106-107. Moreover, according to Weiner (2009) there is the possibility that a more receptive organizational context, achievable through various factors, may be a determinant of readiness rather than being readiness itself[89] and, for this reason, I want to minimize the introduction of readiness factors in this model as I prefer to focus on the readiness concept itself.

The creation of readiness for change has been proposed as a major prescription for reducing resistance (Piderit, 2000) and, then, the ERP implementation failure rate (Eby et al., 2000). Obviously, organizational readiness for change may be necessary but not always sufficient so that change happens, i.e. if a specific ERP module is useless in a particular context (and this can occur for different reasons), the readiness towards that module doesn't mean that its implementation becomes necessary: "*[…] change for change sake does not necessarily lead to more effective outcomes […]. Implementation of fads or technologies that are not relevant or consistent with the culture of the organization may also be counterproductive. In the long run, however, these changes are not likely to survive because of the likelihood of staff resistance*" (Lehman et al., 2002, p. 198). Sometimes resistance to the desired change is so excessive and immediate that some researchers suggested that it may be easier and less costly to start a completely new organization than changing the existing one (Thompson and Luthans, 1990).

[89] Anyway, receptive contexts don't directly and necessarily translate into readiness.

In a nutshell, in contextualizing this construct within ERP implementations, aspects that have to be included from my point of view, in addition to what I previously stated about organizational readiness in Chapter 2, are:

- Change Management in a wide meaning, namely focusing on creating an environment where the change can be implemented (Motwani et al., 2002). Within ERP implementations, change management is a process aiming to identify, manage, overcome incompatibilities (and tracking permanent changes) between structure, tools and types of information provided by ERP systems on one side and organizational readiness structure and processes existing in adopting companies on the other side. In addition to those in p. 107), typical activities are project championship, training, communication rewards and incentives: all these activities must be performed, if necessary, to assist employees in being motivated and prepared for change, creating readiness for change on one hand and overcoming resistance to change on the other hand (Cummings and Worley, 2005). Given the need for change, it's my opinion that change management is the way through which it's possible to achieve organizational readiness and this is a complex process involving several factors that are propedeutical to get over user's resistance , for example:

    - Shared experience, including experience with past efforts for change, for promoting the commonality of perceptions about readiness among organization members (Klein and Kozlowski, 2000).
    - Broader organizational processes like attraction, selection, socialization and attrition (Weiner, 2009).
    - Management of the two fundamental sources of resistance to innovation suggested by Sheth (1981): perception of the people about the risk associated with the decision to adopt the innovation (i.e. the decision to accept an ERP system) and habits that refer to current routine practices which will be likely modified/eliminated/twisted by the introduction of the new system.
    - Individual readiness for change, which is achieved when one understands, believes and intends to change because of a perceived need.

- Relationship between readiness for change and other variables or constructs, i.e. individual contribution to change effort, active-passive job, job change self-efficacy, job demands (Cunningham et al., 2002), job satisfaction and effective job performance (McNabb and Sepic, 1995), job knowledge and skills, social relationships in the workplace, organizational culture, management-leadership relationships (Hanpachern et al., 1998).

Change management, users' resistance and all the pertinent issues influence not only the initial decision about to proceed/not proceed but also the implementation strategy within an ERP project because they are strictly related to the BPR. In fact, the extent of change directly influences the consequent change management activities in terms of both efforts and resistance overcoming. In order to describe this kind of relationship, Capaldo and Rippa (2010) presented the organizational assessment matrix (fig. 44) in which the ERP implementation strategy is function of two variables[90]:

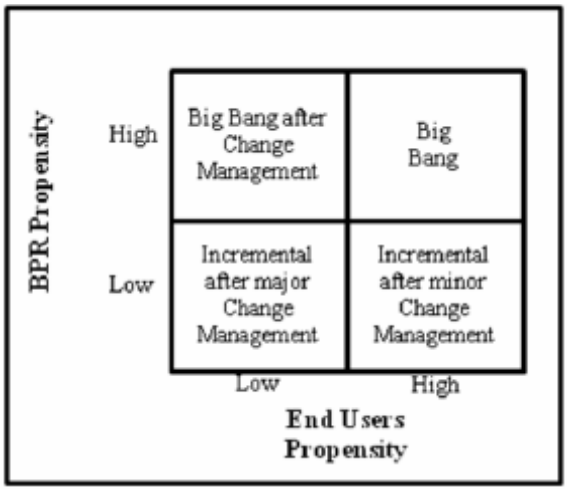


Figure 44: Organizational matrix of strategic choice (from Capaldo and Rippa, 2010, p.6)

- BPR propensity: *"ERP systems are process oriented; therefore only in a process-based organization they can completely express their integration potentiality. In this way, criticalities such as resistance to change and difficulties in redesign the process are reduced*" (Capaldo and Rippa, 2010, p. 5).
- End user propensity: it expresses end users' readiness level.

Without going deep into each quadrant, as it's not strictly important in this work, I want to underline how readiness (propensity) is linked to the extent of change management efforts and how much it's relevant within ERP implementations.

[90] Examples of activities concerning these two dimensions are in Capaldo and Rippa, 2010, p. 6). For further details see Capaldo and Rippa (2009).

- Communication: I described communication needs in p. 107, suggesting what the project manager and the steering committee should do in terms of, respectively, executive aspects and communicational aspects, but further considerations are necessary. For Armenakis and Harris (2002, p. 169) "*some of the negative responses to organizational changes are caused by leaders' oversight of the importance of communicating a consistent change message*". A lot of institutions/companies consider communication as granted, assuming that they will easily accept the change that an ERP brings (Higgins, 2006), but this can be a huge mistake as communication is one of the most challenging tasks in ERP projects (Bhatti, 2005). Usually "*organizational members are unlikely to hold common perceptions of readiness when leaders communicate inconsistent messages*" (Weiner, 2009) and that's why it's necessary to have a communication plan, determining factors like frequency, methods, purpose, target, target audience. Even if this latter statement is fundamental, it mostly concerns the pertinent CSFs (i.e. effective communication): I described it for a matter of completeness but it's totally secondary in structuring this "*Organizational readiness*" construct. Armenakis and Harris (2002) provided a theoretical framework for communication suggesting five message domains, that can be applied in ERP projects too, in order to achieve organizational readiness shaping "*individual's motivations, positive (readiness and support) or negative (resistance), toward the change*" (Armenakis and Harris, 2002, p. 170):

    1. Discrepancy: it concerns the feeling regarding if change is needed and it's usually associated to the definition of the gap between organization's current performance and the desired end-state, which in ERP contexts can be defined by the adoption of the best practices incorporated in the package. The change message must persuade individuals that, in the current situation, there's something wrong (or worse than it could be) and something needs to change.
    2. Efficacy: it refers to the feeling regarding confidence in one's ability to succeed (Bandura, 1986). In my opinion, in ERP environments this aspects can be linked to the quality (reputation) of the chosen vendor/consultants and to all of these internal variables which can yield a positive leverage in

terms of persuasion. These variables should mostly belong to the management level, including both steering committee and project team.

3. Appropriateness: it refers to the correct reaction which aims to fix the gap identified by discrepancy. It's important because individuals may feel that some form of change is needed but they may disagree with the specific proposed change, i.e. a specific ERP package, particular aspects of the BPR and so on. Within communication, the reaction above, even if appropriate, can yield a kind of resistance that could suggest modifications to the project itself.
4. Principal support: every change requires resources and commitment and this is even more true in ERP implementations because the lack of top management support is maybe the most widespread CFF. This communicational aspect should overcome skepticism and unwillingness, in fact Nutt (1986) found that the most successful change tactics in his study were those in which members of the change target perceived early and continuing change support.
5. Personal valence: it clarifies the intrinsic and extrinsic benefits of the change on an individual level, answering to the question "what is in it for me?". The individual assessment should take into account positive and negative outcomes, the fairness of the change and the manner in which individuals are treated (Cobb et al., 1995).

Aladwani (2001), in his framework for managing change associated with ERP, suggested a communication strategy on two levels that can be considered, in my opinion, as an integration of the five communication domains[91]:

- An "*effective communication strategy is to inform potential users of the benefits of ERP*" (Aladwani, 2001, p. 270). Armenakis and Harris (2002) considered individual benefits in the "personal valence" domain but they neglected general benefits and all those benefits which aren't individual and it's opinion of who's writing that this is a relevant lack: correcting it, top

[91] This consideration can seem ambiguous as Aladwani's work belongs to 2001 while the one by Armenakis and Harris has been published in 2002. As a matter of fact, the five key change message components have been suggested by Armenakis et al. (2000), so it's correct to consider Aladwani (2001) as a possible integration in the ERP context. Anyway, the whole framework by Aladwani (2001) can be useful in ERP implementations.

management "*can create more effective awareness for the ERP system*" (Aladwani, 2001, p. 270). This aspect is necessary to watch out from unrealistic workers' expectations, both on system level and on individual level, because they may worsen the resistance problem.

- Another communication strategy concerns a general description of how the ERP system will work and also this awareness aspect is neglected in the framework by Armenakis and Harris (2002). As a customer can be reluctant in buying a product without knowing it, likewise ERP potential users can be reluctant to adopt the system if they don't know how it works. Teaching how the ERP system works is important to create awareness (Stratman and Roth, 1999) and, then, for overcoming resistance and achieving organizational readiness. For example, the management should explain the general inputs and outputs of the system, which departments will provide the data and so on.

For conveying the change message, Armenakis et al. (1993) suggested three strategies:

- Persuasive communication: direct communication efforts.
- Active participation: involving people in activities designed to have them learn directly.
- Management of information: managing internal and external information making the views of others available.

Each strategy uses specific tools[92] but they aren't necessarily binding: the principal aspect is to convey adequately a change message crafted with all the features above, taking into account those aspects that specifically belong to the ERP environment, as those suggested by Aladwani (2001).

- Culture and Climate: for Wilson (1989) "*culture is to an organization what personality is to an individual*". It defines which behaviors are acceptable, the ways that problems are addressed, how relationships evolve, how work is done (McNabb and Sepic, 1995). Climate is often considered as a synonym for culture but this isn't correct because it's "*a reflection of culture that is distorted by the qualities and*

[92] See details in Armenakis and Harris (2002), pp. 171-172.

abilities of people" (McNabb and Sepic, 1995, p. 373). Then, climate is influenced by the existing culture and, if necessary, both have to be modified to improve the acceptance of change (obviously before the change initiative begins) since readiness for change is a reflection of the interaction of people with the organization's culture and climate. Hanafizadeh and Ravasan (2011, pp. 32-33), in their framework for ERP readiness assessment based on the McKinsey 7S model by Peters and Waterman (1982), stated how culture "*can cause mismatch problems during the ERP implementation process*" and how "*the culture* [have to] *be reshaped to fit the demands of the new technology*", thus it's directly involved in every BPR issue. For Ke and Wei (2008), organizational culture in ERP contexts can be characterized by factors like learning and development, participative decision making (this includes low level management), support and collaboration, tolerance of conflicts and risks. For Higgins (2006) an ERP project must not include barriers in attitudes and working relationships because they can destroy chances of project success. Culture (and then climate) in ERP implementations is related to readiness through several aspects, for example:

- History of changes well performed by the adopting organization
- Effectiveness of the steering committee in conducting meetings
- Achievement of goals through consensus-based decisions and without major conflicts
- Assessment of the general attitude toward the ERP implementation

Obviously, this list isn't exhaustive but it highlights how, in order to enable the overall success of the ERP project, roadblocks due to an invariable culture need for, in their management, support from employees, which have to shape culture adapting it to the necessary change. Under this perspective, a culture that is inadequate for an ERP project and that isn't shaped appropriately can be a major impediment for the change. According to this logic, Stefanou (1999) stated that, for being successful, every implementation of ERP systems requires a corporate culture that emphasizes the value of sharing common goals besides individual pursuits and the value of trust between partners, employees, managers and corporations.

Assessing organizational readiness can lead to better estimates of both budget and time and to their formal modification, if needed (Soh et al., 2000; Razmi et al., 2008) but, as a matter of fact, this construct usually includes other aspects that I didn't consider, i.e. project championship, resource allocation, responsibilities' assignment, project team composition, project scope, ERP vision and goals, all the aspects about existing systems and processes, decision mechanism (Razmi et al., 2008), training, vendor commitment (Suraweera et al., 2009), skills and all the other ERP readiness factors. The reason behind my choice can be summarized in the following quote: "*it is often said that ERP implementation is about people, not process or technology*" (Bingi et al., 1999). Change management and its sub-aspects, like communication and culture, are in my opinion the most relevant factors in challenging an ERP project because they aren't strictly linked to a dichotomous condition (i.e. the adopting organization does/doesn't have an adequate technological infrastructure) but they are processes which need, and deserve, a planning phase and that heavily influence every BPR choice. I'm not stating that other readiness factors are useless but my opinion is that they are less relevant in an ERP adoption. I want to underline that the overlap between readiness factors and CSFs is only partial and that's why factors like "top management support" aren't explicitly included in the "*Organizational readiness*" construct that I'm considering but they are indirectly, maybe partially[93], considered within the change management, i.e. "top management support" can be related to communicational aspects belonging to the steering committee. I guess it's possible to include in the "*Organizational readiness"* construct every other readiness factor a practitioner/researcher considers as absolutely necessary but the choice of including other factors besides the most relevant ones in terms of change management (on a general level), communication and culture (in detail) can yield two kinds of problems. First, it could introduce new relationships that will necessarily need reviews on their theoretical foundations and further field analysis. Second, new measure items will be introduced, complicating relationships net on one hand and increasing the risk of overlapping measures on the other hand. Obviously, these are general issues as they don't subsist in this modeling phase due to the exclusion of "*Organizational readiness*" for the reasons in pp. 123-124.
About the measurement level of "*Organizational readiness*", literature suggests several specific assessment frameworks. They usually cover all the aspects concerning the organizational readiness, also those besides the change management: according to what

[93] The term "partially" isn't used here in a negative meaning, instead it indicates that some factors could be fully considered within other theoretical constructs.

stated previously on the proposed structure of this construct, a researcher/practitioner could use only the pertinent measures neglecting the others. Examples of useful frameworks are the BEST[94] (Better Enterprise SysTem implementation) by Wognum et al. (2004) or others which are ERP specific, like those proposed by Razmi et al. (2008), Raymond et al. (2006), Hanafizadeh and Ravasan (2011). Moreover, any other framework which is adequate for measuring readiness for change can be useful, even if it's quite general. For example, McNabb and Sepic (1995) measured organizational culture in terms of structure, employee role clarity, social interaction and support through multi-item scales, while they measured climate through items related to environment, communication, role conflict, supervisory support. About communication, every measure related to the effectiveness of the pertinent plan can be adequate: frequency, goals achieving and so on. My idea is that every item measuring the change management process can be useful, without neglecting tools like questionnaires, interviews etc. . Then, even if I quoted several examples, I don't feel the need of quoting specific and irremissible measures for change management, communication and culture because my point of view is that they directly depend from the selected change management strategies[95].

According to what stated in p. 123 about possible different weights for each failure, one can argue about relationships existing among the four failure negations. I recognize their existence but, in my opinion, they don't add value to the model as my purpose is to define and analyze the direct role of the four negations in explaining success and not in understanding how a kind of failure can influence another one[96]. This is strictly connected to another issue about the contextualization of the model within ERP implementations. In fact, fig. 43 could suggest that achieving the four negations means achieving the IS success, but two new problems arise:

- IS success can be achieved even if a failure occurs. As quoted in pp. 110-112, early failures can result in later success, or an ERP project in which time and/or budget overruns occurred (thus a process failure happened) can be a success all the same.
- There is the need to explain the ERP success and not a generic IS success.

[94] It has been developed for utilizations in all kinds of ES rather than specific ERP systems.

[95] Examples of change management strategies for ERP implementations are in Aladwani (2001), pp. 269-274.

[96] Further details about this choice are in note 98, p. 134. I can't explain these details at this point of the modeling phase because, before doing it, further theoretical considerations are needed. I recommend to respect this priority for a better understanding.

The first problem has been already (but partially) addressed in p. 123, suggesting that each failure hasn't the same importance. A strong solution is to redefine the "*IS success*" construct as "*IS full success*", which can be achieved if and only if all the four kinds of failure are negated: i.e., if all the negations but the process failure one are achieved, the project can likely be a success[97] but it is absolutely not a full success. About the second problem, theoretical considerations stated about the exclusion of "*Organizational Readiness*" (pp. 123-124) address this issue to the phase in which each failure box will be filled. Since the next step is to specify all the four negations in terms of ERP implementations, it's licit to turn "*IS full success*" into "*ERP full success*", as showed in fig. 45. Although the model is quite similar to the one in fig. 43, it now includes further theoretical foundations about the absence of aspects like relationships between negations or like the organizational readiness, then it's more sound than the previous one and it took a first step to the ERP contextualization.

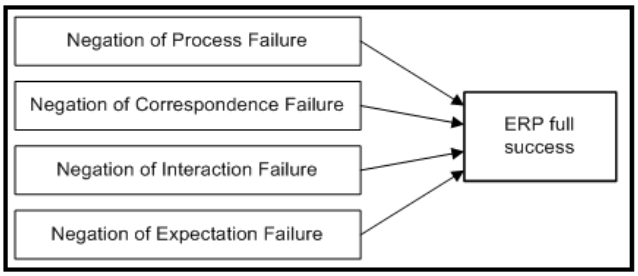


Figure 45: overview of the ERP specific success model

As last aspect of this step of the building phase, I want to state some considerations about feedbacks from the "*ERP full success*" construct. Analyzing the IS success model by D&M (2003) in fig. 3, the achievement of the goals ("*Net Benefits*") yields a positive effect on "*Intention to Use/Use*" and on "*User Satisfaction*", creating a virtuous circle. Moving into my model, it's possible to hypothesize that achieving "*ERP full success*" may yield similar positive effects on some constructs. This relationship can be true if there is the need to make explicit these effects within each failure negation in fig. 45. Maybe for someone this can seem a greedy occasion for identifying some kinds of loops in the proposed model but I'm questioning their usefulness. I'm creating this model for explaining success within ERP projects and, according to the way I structured the "*ERP full success*" construct, the goal is a dichotomous condition: it isn't possible to achieve, for example, 50% of "*ERP full success*" but only 0% or it as a whole. On the basis of what stated above, if "*ERP full success*" is achieved, it means that all the four negations have been achieved thus it isn't important if the achievement of the full success can improve these negations because they have been already accomplished. Then, feedbacks from "*ERP full success*" are, in my

[97] According to numbers in p. 98-99, process failure is quite common.

opinion, superfluous because they refer to a kind of logic that doesn't add value to this model's purpose: explaining success within ERP implementations, nothing more.

3.3 Opening all the boxes: what does mean each failure negation?

Each negation in fig. 45 is like a little independent model[98] and the following step is to detail them in terms of both constructs and relationships. Each measure I'll suggest is only an example: further ones are well accepted, if consistent with the theoretical foundations I'm considering as basis for the modeling phase (i.e. the four kinds of failure by Lyytinen and Hirschheim, 1987). Moreover, in order to satisfy requirement #4 in p. 120, it's possible to add, for each pertinent construct, a specific number of dummy variables for distinguishing a same item measured under the perspective of a specific stakeholder rather than another one, either external or internal, which interacts with the system or in whose interests the ERP project is challenged and some net benefits are desired. This is valid for *each* construct within the model I'm proposing and for *each* factor or measure item a practitioner or a researcher consider as relevant, i.e. in the "*Use*" construct, in the "*Net Benefits*" one, in "*Perceived Ease of Use*" or "*Perceived Usefulness*" and so on. This doesn't unduly complicate the model because it isn't binding, but it's an occasion to use simple variables for differentiating and collecting contributions (both positive and negative) from different stakeholders, which have to be identified in advance, to the "*ERP full success*" achievement.

3.3.1 Negation of Process Failure

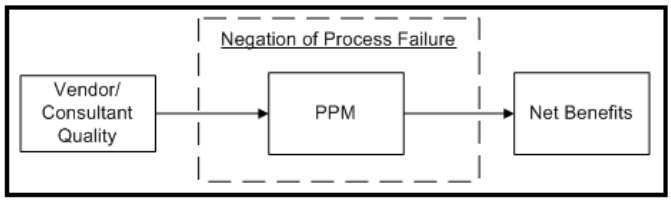


Figure 46: Negation of Process Failure

It requires the negation of the two process failure possible outcomes, namely it occurs when the planned ERP is workable because there aren't irresolvable problems in designing, implementing or configuring it and when the whole project complies with both the

[98] Independent because I want to consider them as such within the global model but, as stated in p. 132, kinds of relationship among them exist even if I don't recognize them as useful, given the model's purpose. In fact, if a specific failure occurs, it doesn't matter if its occurrence influences the probability of occurrence of another failure because, on the basis of the "*ERP full success*" definition, the occurrence of even only one of the four failures denies the achievement of the full success.

established time and budget. While the first condition is quite probable as it concerns the negation of the less likely outcome[99], the second one is much more rare[100] and my idea is to consider it as a dichotomous condition (time and/or budget overrun does/doesn't occur) formalized through a construct labeled as "*PPM*" (Project Planning and Management). Its measure items should reflect events that could lead to time and/or budget overrun and this implies that, although classical project metrics[101] about planned schedule and budget are needed, further measures are necessary. Actually, I prefer to focus the analysis on those measures whose results can be relevant within the specific ERP context. In literature, ERP implementation models recognize the difference between the transitional period and the normal operations phase and, within them, a same measure item can have different importance. Given that a practitioner/researcher can use all the time and budget measures (aggregated or not) he considers as significant within the context I just defined, the operationalization of the "*PPM*" construct requires also early operational metric, which usually refer to success in the shakedown phase. After system go-live, according to Ross and Vitale (2000) a performance dip is very common. Besides what described in p. 110, in this phase it's useless to consider long term measures while elements that can significantly change in a short term are much more relevant. Examples can be found in the operational ambit and, obviously, measures shouldn't be analyzed comparing them to project goals (they will be hopefully achieved on running) but considering their trend and eventual operational issues connected with them, i.e. bug corrections, changing configuration settings, upgrading IT infrastructure, revising business practices and procedures and retraining users (Markus, Axline et al., 2000, p. 249, table 1). M&T (2000, p. 185) and Markus, Axline et al. (2000, p. 246) suggested the following examples:

- Operating labor costs: it should be licit to expect a reduction of these costs, mostly due to the adoption of the new business processes within the BPR.
- Time required to fill an order: is it lower than the previous one? If not, what caused this anomaly? Is it due to integration issues?
- Partial orders filled
- Orders shipped with errors
- Inventory levels

[99] See details in pp. 115-116.
[100] See details in pp. 98-99.
[101] They mostly refer to the project phase, according to the Enterprise System Experience Cycle by M&T (2000, p. 189), see fig. 51 in Appendix B of this thesis work.

- Inventory turnover
- Process cycle times
- Length of time before KPIs and business impacts return to normal, namely to the level before the performance dip.
- Short term negative impacts on organization's suppliers and customers, i.e. average time on hold, lost calls, lost sales, customer satisfaction levels and so on.

If measures like these don't have the desired trend then some operational problems are likely occurred. During the shakedown phase, experiencing business losses is quite common but, as already quoted in p. 99, exceedingly poor performance can lead to internal or external pressures to uninstall the system and, in extreme cases, to bankruptcy. As success in this phase can consist in both minimizing the duration of the transitional period and resolving early operational problems quickly, unsatisfactory measures can lead to an increase of length of the shakedown phase, requiring further time and money, thus increasing the probability of a process failure. The last statement can seem misleading because, usually, the project in a strict meaning ends with the go-live date, namely when the shakedown phase starts. Unfortunately, "*planning beyond go-live is incomprehensible to most executives and project team members, especially when they are stuck in the weeds of an implementation*" (Kimberling, 2012), then situations in which the project is concluded in a hurried way for avoiding budget and/or time overrun are likely to occur and this implies a greater number of issues in the shakedown phase, which means more money and more time required. These extra time and money don't belong to those time and budget which are directly associated with the project, but my idea is to consider the early operational metrics above within the "*PPM*" construct in order to make explicit, within the model, these aspects belonging to the transitional period and to highlight their relationship with classical project metrics, since they are fundamental for the "*ERP full success*". If the shakedown phase goes on for too long requiring an increase in terms of budget and/or time, the project can be abandoned turning into a complete failure: this confirms that relationships among the four failures, and then among their negations, exist but I don't take them into account within the model for the reasons already explained in p. 132. Summarizing, my opinion is that the shakedown phase has to be considered within the "*Negation of Process Failure*" but only in the terms described above: i.e. the willingness to "close" the project as soon as possible in order to avoid budget and/or time overrun (namely for avoiding a process failure) can lead to the cutting of important activities like

users training or to the need of further activities in the shakedown phase (i.e. new customizations) and this underlines how "*PPM*" and transitional period measures are linked. Any other measure which refers to a point in time after normal operation has been achieved after the go-live date isn't pertinent.

As showed in fig. 46, "*PPM*" is directly linked to "*Net Benefits*" through a specific relationship. The "*Net Benefits*" construct is exactly the one proposed by Seddon (1997) and used by D&M (2003) in their model and it has been already described in pp. 18-19 of this thesis work with its multiple stakeholders' perspective. In the specific context of the "*Negation of Process Failure*", net benefits refer to *each* stakeholder expecting them at *each* level and they include both tangible, intangible, quantifiable and hard to quantify benefits[102] and each pertinent goal linked to the project[103]. An useful, but not exhaustive, list of ERP net benefits is the one proposed by Shang and Seddon (2000) in Appendix A, pp. 187-188 of this thesis work, partially described in p. 61. "*Net Benefits*" can be measured through long term (business) results, which usually refer to success in the Onward and Upward phase[104]. Their measure items should reflect "*how the organization performs at various times after normal business operation has been achieved*" (Markus and Tanis, 2000, p. 186). Long term measures are needed in order to understand if the business results connected with the ERP project have been achieved, if further ongoing improvements in business results besides the expected results have been (or will be) achieved and if other non-business results have been achieved (i.e. ease in adopting new ERP releases). All these results can be achieved in different points in time and that's why measures should be distributed during time after operations returned to normal. M&T (2000, p. 186) and Markus, Axline et al. (2000, p. 250, table 1) suggested the following examples:

- Achievement of planned results in terms of IT operation costs, inventory carrying costs, business process costs, cycle time etc.
- Use of data and decision analyses produced by the system[105]

[102] The IS effectiveness matrix by Seddon et al. (1999) in table 3 or the ERP operational BSC by Rosemann and Wiese (1999, pp. 57-60 of this thesis work) can be used for their operationalization and measurement.

[103] But not to the system as a physical artifact: objectives concerning it are purely technical and they are considered as requirements to be met, whose evidences come from "*System Quality*" measures.

[104] See the Enterprise System Experience Cycle by M&T (2000, p. 189), see fig. 51 in Appendix B of this thesis work.

[105] This should be considered as an item belonging only to the "*Use*" construct for avoiding overlaps among measures. I included it in this list because the quoted researchers described it within benefits but I don't consider it as adequate. Opinions in literature about this issue aren't univocal, see Chapter 1.

- Ongoing improvements in business results after planned results have been achieved (hypothesizing that normal operation has been already reached after go-live)
- Ease in developing, adopting and implementing additional innovations in technology, business practices and managerial decision making
- Original decision to implement ERP still makes sense in light of subsequent business decisions and events, i.e. mergers and acquisitions
- Over time, decreases in length (and, in my opinion, in costs too) of project planning and shakedown phases for subsequent ERP implementations[106]
- ROI, even if it isn't adequate in its classical version for ERP investments due to intangible benefits and future options
- Better management decision making attributable to higher quality data
- Maintenance of internal enterprise system competence (among both IT specialists and end users)
- Ease of upgrading to later versions of the ERP
- Continuous improvement of users' IT skills

This list isn't exhaustive but it offers a good starting point. As for the early operational metrics, other measures can be used under condition that they hold coherence with the theoretical foundations I'm considering as basis for the modeling phase (i.e. the four kinds of failure by Lyytinen and Hirschheim, 1987) and if they meet the requirements in p. 1, especially the need of measures reflecting different stakeholders' perspectives. According to the need of measuring performance at various point in time after normal business operation has been achieved, Markus, Axline et al. (2000) warned researchers/practitioners about some achievement conditions related to net benefits, in fact some of these benefits cannot occur until:

- Users have learned how to use the system well
- Managers have used the data collected by the system in order to achieve business decision and plan improvements in business processes
- Additional changes are made in business processes, practices, software configuration etc.

[106] As stated in p. 112, this aspect is strictly linked to the management control system learning goal in a rollout perspective and usually it interests large organization much more than smaller ones.

The relationship between "*PPM*" and "*Net Benefits*" isn't a causal relationship. It has to be clear that I'm not stating that remaining within the limits of budget and/or time implies the certain achievement of some benefits. The pertinent link I drew (fig. 46) is partially related to what I quoted in p. 116 from Kimble and Selby (2000) and Miyamoto et al. (2013), namely that a process failure leads to limitations of system benefits. Stating that this influence is deterministic isn't advisable but it's licit to hypothesize that, if a process failure occurs (it isn't negated), it could exert a restricting effect on the potential benefits. Instead, if the process failure is correctly negated, it could enable the achievement of some "*Net Benefits*"[107]. Given this observation, the "*Net Benefits*" construct doesn't strictly belong to the "*Negation of Process Failure*" as it doesn't affect it and it isn't part of it, instead it's influenced by its outcome (see fig. 46).

The "*Vendor/Consultant Quality*" construct by Ifinedo (2006) has been already discussed in p. 27. A similar construct has been previously addressed by Sedera et al. (2003, p. 1411). Even if some may argue that it may be an exogenous factor required for ERP success, I agree with Ifinedo (2006) in considering it as part of the ERP success. In fact, costs associated with vendor and consultants are really relevant within an ERP implementation budget and figures like vendor go besides economic and financial aspects because they are actors of a long (hopefully) term relationship with the implementing company. I know that this latter statement goes over the project in a strict meaning but "*Vendor/Consultant Quality*" can heavily influence project costs and time too, i.e. because they can help in minimizing the transitional period length. Moreover, according to the definition of process failure in pp. 115-116, vendor and consultants could resolve difficulties or could avoid irresolvable problems in designing, implementing or configuring the system, exerting a positive effect on the negation of this failure. It's possible to hypothesize a positive effect of "*Vendor/Consultant Quality*" on "*Net Benefits*" but, in my opinion, this is risky because this quality construct can't assure the achievement of the benefits in the way I defined them. Instead, I consider as licit to assume that "*Vendor/Consultant Quality*" can affect these benefits through a mediating role of "*PPM*", namely through the relationship (which isn't a pure causal link, see above) between "*PPM*" and "*Net Benefits*". In order to measure this new quality construct, it's possible to use the

[107] See further details about "*Net Benefits*" boxes in pp. 144-145.

questionnaire realized by Ifinedo (2006)[108] for his study, structuring possible answers with a 1÷7 Likert scale[109] and adapting each question to potential vendor/consultants.

According to what stated above, "*Vendor/Consultant Quality*" have to be considered also like an output. Under this perspective, an implementing company can measure and explain the ERP success assessing its relationship (hoping for a long-term one) with these kinds of actors after the end of the ERP project in a strict meaning. This is a generalization because a company can interact with someone else, like a re-seller, but it's useful to address this logic. A "good and healthy" long-term relationship is hypothesized as part of the ERP success and it should be assessed in different points in time. For appropriate measurement frameworks and items, refer to the pertinent literature[110].

3.3.2 Negation of Correspondence Failure

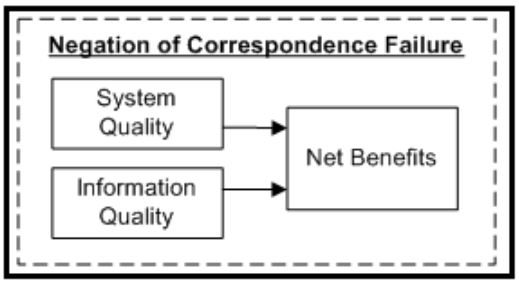


Figure 47: Negation of Correspondence Failure

It occurs when system/design objectives, requirements and specifications are met. According to the definition of correspondence failure in p. 115, it concerns only the system thus aspects and features which are not directly connected with it are not relevant in this context. Pertinent measure items have to reflect an evaluation of the system in order to detect a lack between it and its objectives. In their IS success model, D&M (1992, 2003) described the system on both a technical level and a semantic level through, respectively, "*System Quality*" and "*Information Quality*" and I consider this approach as adequate. Moreover, it has been successfully used by several other researchers, i.e. Gable et al. (2003, 2008), Ifinedo (2006)[111]. Thus, "*System Quality*" is the same construct introduced by D&M (1992, see p. 2 of this thesis work) and it's described by the desirable technical characteristics of the system, i.e. flexibility, reliability, ease of learning, response times and system features like intuitiveness, sophistication and so on (Petter et al., 2008). "*Perceived Ease of Use*" is perhaps the most common measure of "*System Quality*" but it doesn't

[108] See table 23 in Appendix C of this thesis work, items 20÷24.
[109] For example 1 = "strongly agree", 2 = "disagree", 3 = "somewhat disagree", 4 = "neutral", 5 = "somewhat agree", 6 = "agree", 7 = "strongly agree".
[110] This is a so wide and complex measurement that it's impossible to generalize because it depends from the adopting organization goals and development strategies.
[111] See Chapter 1 for further details.

capture all the information of this construct (Petter et al., 2008) and I agree. Measures of this construct are numerous and quite diversified, for example:

- Rivard et al. (1997) developed and tested a measurement tool consisting of 40 items which measure eight system quality factors: reliability, portability, user friendliness, understandability, effectiveness, maintainability, economy and verifiability. I consider "understandability" and "user friendliness" as more adequate for other constructs because they involve behavioral and subjective aspects that go besides a pure technical context. Moreover I don't like the introduction of an economic factor because aspects like it are declinable for each other "*System Quality*" factor, i.e. economy of maintainability, economy of reliability and so on: it's only a matter of correspondence in terms of unitary costs.
- Coombs et al. (2001) developed their own indexes of "*System Quality*" using the D&M dimensions.
- Gable et al. (2003) used 15 items (see fig. 10, p. 42 of this thesis work) on the basis of a "*System Quality*" literature review[112].
- Sedera et al. (2004) used 9 validated measures: ease of use: ease of learning, user requirements, system features, system accuracy, flexibility, sophistication, integration and customization.

Every measure item must potentially reflect the point of view of different stakeholders, if possible. I prefer to exclude every "*System Quality*" factor expressed in terms of "ease to/of ..." for the reasons exposed above about "understandability" and "user friendliness", and every other item which explicitly refers to users' requirements because all the measures within this construct must reflect how the ERP system technically is and not how users desire it through their requirements. This doesn't mean that users' requirements must be neglected: "*System Quality*" measure items must provide an objective measurement about the state of the ERP system under a technical perspective and only after doing this it's possible to compare obtained measures to users' requirements. The latter observation suggests the importance of time in doing such measures, in fact they should be repeated in different points in time, according to the nature of the goal that has to be achieved (hopefully). Besides the fact that a quality factor has a different weight if assessed during the transitional period or after normal operations have been achieved, some objectives can't

[112] See Gable et al. (2003), p. 50, Appendix B for a brief description.

be accomplished immediately after go-live and this is consistent with what I quoted by Markus, Axline et al. (2000) in p. 138 about some achievement conditions related to net benefits.

Users' requirements and system objectives can express needs in terms of functionalities (i.e. "I want a system which includes ATP/CTP functionalities managing stocks across n of m sites of mine", with obviously n < m) that can be more or less complex: under this perspective, an ERP project can result in different outcomes. The most desirable one is having all the ERP functionalities the stakeholders asked for in each desired module, thus there should be both a goal achieving on one side and a satisfaction of multiple stakeholders' explicit expectations on the other side. Unfortunately, this kind of correspondence isn't totally exhaustive in a wide meaning, in fact satisfying ERP system goals in terms of required functionalities is fundamental for avoiding a correspondence failure but it doesn't assure that these functionalities are truly useful, that they will be effectively used and that they perfectly fit with the functionalities set which is desired on an operational/practical level. Like in every design, even in an ERP one, implicit or unexpressed requirements exist and, if neglected in the early project phase, they could arise when someone interacts with the system, with all the pertinent consequences. This issue is, then, multiple:

1. It's possible to have a system that doesn't include all the functionalities which have been expressed in terms of system objectives or user's explicit requirements. If this occurs, it's a typical (and I want to add "pure") correspondence failure and it's pertinent to this paragraph.
2. If the ERP system doesn't include functionalities which are desired by some stakeholders but that haven't been identified explicitly in the early project phases (i.e. they are implicit requirements/needs or expectations that lasted as such because, for example, there was a bad communication in the planning phase between operational managers and steering committee/project team), in my opinion this is an expectation failure[113].
3. If the ERP system includes all the functionalities, both explicit and implicit (including possible expectations), desired by the stakeholders but some of them aren't used or they are underutilized, i.e. because they are judged to be not job relevant, even if initially they were included in the "want" list, then this isn't a

[113] This is deepened in the pertinent section, p. 159.

matter of correspondence failure or expectation failure but I consider it as an interaction failure[114].

Thus, issue #1 has to be considered within the "*Negation of Correspondence Failure*", mostly referring to "*System Quality*". Anyhow, according to fig. 47, it's necessary to consider the semantic level through the "*Information Quality*" construct, as stated in p. 140. It's the same construct introduced by D&M (1992) in p. 6 of this thesis work and it concerns the information yielded by the system, namely its output, and not to the information in input which is processed through some logics. "*Information Quality*" is, then, the set of "*the desirable characteristics of the system outputs; that is, management reports and web pages* [for example]" (Petter et al., 2008, p. 239). Information in input isn't considered because its quality, expressed through the needed characteristics like forma, appropriateness and so on, is a tie for using the ERP system itself: if the information in input doesn't respect these characteristics, the desired output can't be obtained. This concept is linked to the prescriptivity of the ERP systems and it's a kind of constraint which doesn't refer to the quality in processing the information.

"*Information Quality*" is often measured as a component of "*User Satisfaction*" (Petter et al., 2008) but, in the context of this quality construct, the term "user" refers to all those using the yielded information and not to system users[115] in a wide meaning, i.e. one using a report which may have been processed by someone else through the ERP system. This consideration recalls the existing links among different kinds of failure[116] (p. 132): why to include "*Information Quality*" if it's often measured as a component of "*User Satisfaction*", which will be necessarily considered in the model?. My idea is that the answer is in the declension of the term "user". Given that it will be important to exclude from "*User Satisfaction*" measures every item that refers to "*Information Quality*" in order to avoid overlapping measures, each measure item can have a different meaning within the negation of different failures. "Users" in "*User Satisfaction*" concerns every stakeholder using the ERP system while in "*Information Quality*" it concerns everyone using the information in output from the system and this means that can also be someone which doesn't interact with the system but that can be satisfied by its output. Then, this kind of user satisfaction is

[114] This is deepened in the pertinent section, pp. 153-154.

[115] Namely who interacts with the system without necessarily using the information in output. Within the "*Information Quality*" construct, only who uses the information can be considered as an user. See p. 2 of this work.

[116] I want to remind that I chose to neglect these relationships in the model for the reasons in p. 132.

a consequence of an adequate "*Information Quality*" but this reasoning should be valid for "*System Quality*" too: the main difference between quality dimensions and "*User Satisfaction*" is that their objective is different as they concern two different kinds of failure. Every influence between them should be avoided in order to respect the theoretical basis of the framework I'm proposing.

Measure items of "*Information Quality*" and "*System Quality*" experienced a similar development. Some researchers developed a generic measurement scale of "*Information Quality*" (i.e. Fraser and Salter, 1995), others developed their own scales using the literature relevant to the type of the investigated IS (i.e. Coombs et al., 2001; Wixom and Watson, 2001). Other useful references are the following:

- Sedera et al. (2004) suggested six "*Information Quality*" factors: availability, usability, understandability, relevance, format, conciseness.
- Gable et al. (2003) used 10 items (fig. 10, p. 42 of this thesis work), discarding 8 other ones on the basis of an "*Information Quality*" literature review[117].

Considering both the quality dimensions, other useful hints in selecting measure items can come from the questionnaire used by Ifinedo (2006), with the advantage that it's ERP specific (see table 23 in Appendix C of this thesis work[118], items 1÷11 for "*System Quality*" and 12÷19 for "*Information Quality*"). Again, every other useful measure item/factor which adequately fits with theoretical foundations (i.e. the four kinds of failure by Lyytinen and Hirschheim, 1987) is well accepted.

"*Net Benefits*" in fig. 47 isn't the same construct which has been drawn in fig. 46, in fact the latter considers all the net benefits from the points of view of all the pertinent stakeholders, as described in pp. 137-138, while within the "*Negation of Correspondence Failure*" we have to consider only those net benefits that are achievable through the correspondence success, namely accomplishing ERP system objectives, requirements and specifications. Thus, for example a benefit like "continuous improvement of users' IT skills" isn't relevant in this context and it has not to be considered. One can argue that a correspondence failure is much more detrimental than a process failure, and this is true as I already stated in p. 123, because its occurrence can deny every kind of benefit. Given that

[117] See Gable et al., 2003, p. 50, Appendix B for a brief description.

[118] In my opinion, item #9 must be supported by the considerations about system functionalities in pp. 142-143. Moreover, assessing the item #11 I recommend to consider the statements about users' requirements in p. 142.

this isn't totally true, since also a complete failure can yield useful information on weak points in challenging further possible ERP projects (and this is a benefit), this context isn't dual. If on one side a correspondence failure can deny almost the whole body of net benefits, on the other side its negation doesn't mean that all the net benefits will be achieved: it will imply the achievement of some benefits strictly linked to the success in terms of both "*Information Quality*" and "*System Quality*" and it will enable the possible, not sure, achievement of further benefits. If the negation of correspondence failure occurs but users[119] reject the system, a lot of net benefits will be potentially lost. On the basis of this reasoning, I consider as correct to distinguish the "*Net Benefits*" construct within the negation of each kind of failure. The "*Net Benefits*" box in fig. 46 isn't the same one as that in fig. 47, exactly like both them are different from those within "*Negation of Interaction Failure*" (fig. 48) and "*Negation of Expectation Failure*" (fig. 49): they are the same about the meaning of net benefits but they are different from each other, for example in terms of the way in which they can be achieved. Anyway, I want to underline that the "*Net Benefits*" construct in fig. 47, 48 and 49 are three subsets of "*Net Benefits*" belonging to "*Negation of Process Failure*". In fact, as stated in p. 139, a process failure could lead to limitations of system benefits, potentially on all the levels (it depends from the specific ERP project/context), then it considers all the achievable benefits and this is consistent with the process failure definition in pp. 115-116. Instead, the other three "*Net Benefits*" boxes are failure-specific. It's also possible to hypothesize a partial, quite limited, overlap among these three construct but I don't consider it as relevant, given the reasons in p. 132 about neglecting links among the negations of different kinds of failure.

3.3.3 Negation of Interaction Failure

It occurs when the ERP system isn't rejected by its users and when it's used as intended, thus users' attitude towards the system is positive. As it's clear that behavioral aspects have to be considered, I structured this negations on two levels, both converging to "*Net Benefits*" (see fig. 48):

- TTF level: it refers to the TPC model by G&T (1995) in fig. 5

[119] In this statement a "user" is everyone interacting with the system and not only who uses information in output from the system. The former meaning is typical of a direct interaction context (use, perception about the system etc., see the "*Negation of Interaction Failure*" in p. 148), the latter is exclusive of the "*Information Quality*" construct.

- TAM level: it refers to the TAM by Davis (1985) in fig. 23

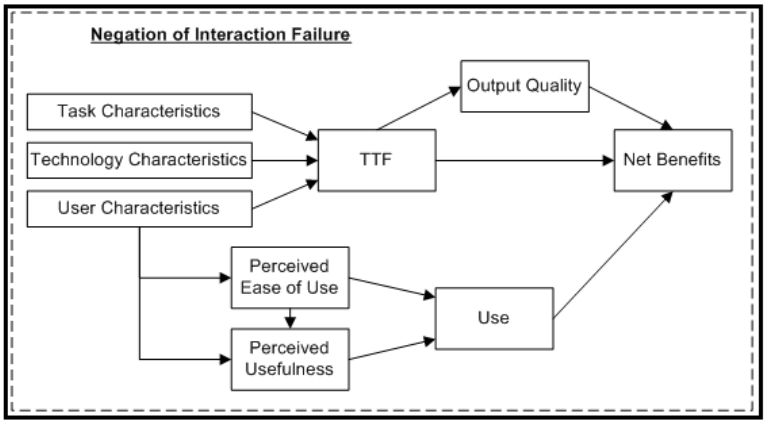


Figure 48: Negation of Interaction Failure

These two levels don't reproduce exactly the original works which they refer to but I hypothesized modifications in constructs and relationships following both other works, analyzed in Chapter 1, and personal considerations about the interaction failure. According to G&T (1995) and to the Theories of Fit[120], the task-technology fit is affected by the characteristics of the actions that transform inputs in outputs ("*Task Characteristics*") on one side and by characteristics of hw/sw/data[121] on the other side ("*Technology Characteristics*"). Moreover "*User Characteristics*", understood on individual level, come within the relationships net and this is consistent with the interaction failure definition (p. 116). In fact, within an ERP project each change management strategy connected to a necessary BPR, which can be more or less extensive, can't leave out of consideration people characteristics, that are fundamental in aiming to a maximum fit between the ERP system and the tasks it's called to support. Then, Theories of Fit include individual user characteristics and this reduces drastically the chance of a system rejected by users. Furthermore, as already stated in p. 107, within an ERP project a good manager should challenge a negotiation phase in which organizational and technological changes are re-discussed for considering people needs, characteristics and requirements. Then, in order to avoid the feeling of lack of involvement, "*User Characteristics*" are quite important in the ERP context, much more than in other IS projects. A good "*TTF*" is an excellent way to summarize a lot of important aspects which are connected to both BPR and system-processes coherence and that are significant within the "*Negation of Interaction Failure*": "*TTF*" and its three antecedents (see fig. 5 and fig. 48) are quite shared and accepted among researchers and they provide a sound structure to this modeling step.

[120] See some details about Theories of Fit in p. 26.
[121] They include the characteristics of user support services, like training, help line etc. (G&T, 1995, p. 216) as already quoted in p. 28. See pp. 25-36 of this thesis work for details on the TPC model.

Thus, it's possible to use the same measure items that G&T (1995, pp. 121-122) selected for their work:

- Task Characteristics: this construct has been analyzed and measured through two items, namely "non-routineness" (lack of analyzable search behavior) and "interdependence" (with other organizational units). G&T (1995) chose five measures of task characteristics: three questions on "non-routineness" and two on "interdependence" (see p. 190 in Appendix D). Being in an ERP implementation context, the "*Task Characteristics*" construct must refers to the re-engineered processes (theoretical to-be, see p. 105) and to their tasks: considering the as-is situation, either the theoretical one or the real one, makes no sense as a BPR will be performed.
- Technology Characteristics: G&T (1995) suggested "particular system used" and "department" (the department of the respondent) but I don't consider them as totally adequate. My doubt doesn't lie on the latter factor, which can be useful anyway (maybe not here but within another construct), but on the former because it refers to a general context in which several different ISs can be used within the same company while I'm trying to contextualize measures in a pure ERP environment, namely with only one system. "*Technology Characteristics*" should refer to what the ERP system can offer in terms of automation, support and processes coverage but without comparing these characteristics to the needs related to the tasks (this will comparison will be assessed in the "*TTF*" construct) and without overlaps with "*System Quality*" measures. The approach by G&T (1995) is quite smart: they defined a dummy variable for each system, attributing "1" if the system was used by the respondent and "0" otherwise, and weighting it when respondents used more than one system[122]. In this way, the use of a specific system (value "1") brings with itself all the pertinent characteristics of that system and "*this allowed us to capture inherent differences between technologies without having to explicitly define those differences*" (D&T, 1995, p. 223). A good solution can be to contextualize this approach, which would avoid the creation of wide questionnaires that should include sections for each ERP system characteristic in an endless list. Within an ERP implementation, the package selection usually considers a lot of variables and the one that maybe is the most important is the fit between the best practices

[122] See G&T (1995), pp. 222-223 for further details.

incorporated in the package and the company's processes in their to-be version (theoretical to-be). Including "*User Characteristics*" too, this fit becomes exactly the "*TTF*" construct and, obviously, it will be different according to the considered package. Then, in order to assess it, "*Technology Characteristics*" should allow to compare different kinds of package and that's why G&T's approach can be quite useful: instead of considering different ISs, we can consider different ERP packages using a dummy variable for each of them, with value "1" if the specific package will be used and "0" otherwise. It's clear that, in a same site, we can't use more than one ERP system then there's no need of considering weights because a variable assuming value "1" forces the others to be "0". As a matter of fact, a weight sophistication is possible anyway because, quoting what stated in p. 108, "*ERP packages usually cover about 90% of all the business requirements and processes and it's licit to support the remaining 10% with best of breed applications, legacy systems or ERP modules belonging to suites different from the principal one*". This implies that a modest coexistence of different system can occur within the ERP context also in a same site of the adopting company and appropriate weights should be chosen on the basis of the coverage percentages[123] but, as already stated, this is a sophistication and, actually, I prefer to ignore it.

- User Characteristics: even if it's included in the TPC model (fig. 5), G&T (1995) excluded this construct from the simplified model (fig. 6) they tested, then they didn't suggest useful measure items about it. In order to satisfy requirement #4 (p. 120), an user isn't only someone directly belonging to the adopting company but everyone that uses system functionalities and, in a wide meaning, also one using data yielded through the ERP system, i.e. a particular report. Furthermore, the TPC model analyzes how an individual believes that using a new technology (the ERP system, in our case) can enhance his/her performance in doing his/her job, then we can't consider stakeholders in an aggregated perspective but a decomposition on the individual level is necessary. The willingness of aiming to individual characteristics is consistent with the necessary change management strategies[124] and with the concept of interaction failure, which lies on a direct relationship between user and system. Examples of measure items can be:

[123] The relationship $\sum_{i=1}^{n} w_i = 1$, with n = number of coexisting systems, w_i = weight of the system i, must be always valid.

[124] For example, in the negotiation phase described in p.107 and quoted in p. 146.

- Age: this factor has been analyzed in the UTAUT model (fig. 36) by Venkatesh et al. (2003), even if in a different context.
- Gender: see "Age".
- Experience with IS: see "Age".
- Managerial level: typically, one performing a clerical work, or however a job with low decisional power, queries the system with specific needs, priority, required waiting times and so on which are different from those associated with a manager[125], they have different kinds of knowledge and skills and this has repercussions on "*TTF*" because they will manage/refer to different tasks/processes and they will need different kinds of support by the ERP system. This factor has been considered by G&T (1995, p. 222) too, expecting that "*differences in job title would affect user evaluations on TTF*" but without making specific hypotheses. They included it within "*Task Characteristics*" but I consider it as more appropriate in "*User Characteristics*". G&F (1995) operationalized it through a dummy variable.
- Department of the user: as already quoted in p. 147, G&T (1995, p. 223) considered the department of the user as another "*proxy measure for the characteristics of information systems*" in "*Technology Characteristics*", stating that the IT/IS department itself may have differentiated user departments in terms of attention, emphasis, priority and relationship management and then affecting the level of service experienced by users in the different departments, moreover they captured these differences through a set of departmental dummy variables. My opinion is that this factor fits better with "*User Characteristics*" than with "*Technology Characteristics*", furthermore other dummy variables can be used to identify internal users, i.e. suppliers, customers, partners etc. , which use the system through remote access.

These factors are only an example and, maybe, they aren't exhaustive in describing "*User Characteristics*" then further suggestions are well accepted, but paying attention to a particular aspect. According to fig. 48, the "*User Characteristics*"

[125] As a matter of fact, ERP systems work in an OLTP environment while high-level managers typically, even if not always, use business intelligence tools in an OLAP environment. However, the one above is only an example to address the differences linked to different organizational levels in approaching the system under a "*TTF*" perspective.

construct is an antecedent of "*TTF*" on one side and of both "*Perceived Ease of Use*" and "*Perceived Usefulness*" on the other side: it represents a link between the TTF level and the TAM one. For a matter of compactness and coherence, each factor of "*User Characteristics*" should affect simultaneously the three constructs quoted above, then factors influencing, for example, only one or two of these constructs in my opinion can't be accepted. Efforts should be made for identifying factors that can be considered as global, i.e. "Age" (see above) is a good choice as it likely exerts an influence on all the three constructs, while examples of factors which I consider as ineffective are "computer anxiety" or "computer playfulness" from TAM 3 (fig. 32) by Venkatesh and Bala (2008) because they are PEOU specific[126].

- TTF: this construct has been already described within the TPC model (pp. 26-28) and its formalization is adequate even in the ERP context, given all the considerations stated above about its determinants. G&T (1995), after a skimming process through a factor analysis[127], defined eight factors of "*TTF*", articulated in 16 items (see table 21)[128]. Analyzing the questionnaire (table 24, p. 190-191, Appendix E of this thesis work), some factors (Quality, Systems Reliability, Production Timeliness) have been already considered in the "*Negation of Correspondence Failure*" and this is true also for single item like "Responsiveness". Moreover, as stated in p. 141, I prefer to exclude "Ease of Use" too, moving it to its pertinent construct ("*Perceived Ease of Use*", see fig. 48). At this point in time, I'm not able to express an objective opinion on the goodness of the other factors/items because it will be possible when some numbers will be available, but actually they seem adequate on a theoretical level. Further efforts can be done in detailing some factors/items which should reflect the perspectives of

[126] "Computer anxiety" is the degree of "*an individual's apprehension, or even fear, when she/he is faced with the possibility of using computers*" (Venkatesh, 2000, p. 349). "Computed playfulness" is defined as "[…] *the degree of cognitive spontaneity in microcomputer interactions*" (Webster and Martocchio, 1992, p. 204). Their specificity is due to the fact that, as showed in fig. 32, they have been theorized by Venkatesh (2000) as "*anchors related to individuals' general beliefs regarding computer and computer use*" through which "*individuals will form early perceptions of Perceived Ease of Use of a system*" (Venkatesh and Bala, 2008, p. 278).

[127] See further details in G&T (1995), p. 221.

[128] Cronbach's Alpha is satisfactory on average, even if at least a 0.7 value is recommended. Cronbach's Alpha values refer to the factors within the questionnaire in pp. 190-191 in Appendix E of this thesis work, which includes the discarded items too. The 0.7 threshold indicates a "good" internal consistency (George and Mallery, 2003; Kline, 2000) but, as a matter of fact, a 0.8 threshold is much more reliable. Anyway, although values in table 21 aren't really high, it doesn't matter: I'm only suggesting those factors as a not exhaustive example and further suggestions are obviously well accepted.

different stakeholders, i.e. differentiating the meaning of the term "user" within "relationship with users" (see table 21) but trying to avoid any kind of overlapping measures: I can conceptually accept an item measuring more than one factor but not more items measuring the same aspect of a factor.

Table 1. Results of Factor Analysis:
16 Original Task-Technology Fit Dimensions*
And 8 Final Task-Technology Fit Factors

8 Final TTF Factors	16 Original TTF Dimensions (After poor questions dropped)	Cronbach's Alpha
Quality	Currency of the data Right data is maintained Right level of detail	.84
Locatability	Locatability Meaning of data is easy to find out	.75
Authorization	Authorization for access to data	.60
Compatibility	Data compatibility	.70
Ease of Use/Training	Ease of Use Training	.74
Production Timeliness	Production Timeliness	.69
Systems Reliability	Systems Reliability	.71
Relationship With Users	IS understanding of business IS interest and dedication Responsiveness Delivering agreed-upon solutions Technical and business planning assistance	.88

* After 5 of the original 21 TTF dimensions were dropped as unsuccessfully measured.

Table 21: "*TTF*" final factors and measure items (from G&T, 1995, p. 222)

Besides the four constructs described above ("*TTF*" and its three determinants), I have added another one in the TTF level: "*Output Quality*". In fig. 26 there is a construct labeled as "*Perceived Output Quality*" but its name is really misleading because it concerns a measure of the benefit of using the system (see p. 69): this construct by Davis (1985) has nothing to do with the one I included in fig. 48. Instead, the "*Output Quality*" construct suggested by Venkatesh and Davis (2000) in fig. 31 is more appropriate, although some considerations are necessary. Venkatesh and Davis (2000, p. 191) stated that "[...] *over and above considerations of what tasks a system is capable of performing and the degree those tasks match their job goals* [...], *people will take into consideration how well the system performs those tasks, which we refer to as perceptions of output quality*", moreover "*judgements of output quality* [...] *are less likely to be used for excluding options from considerations. Instead, they are more apt to take the form of a profitability test in which, given a choice set containing multiple relevant systems, one would be inclined to choose a system that delivers the highest output quality*" (Venkatesh and Davis, 2000, pp. 191-192). Given these premises, my goal is to structure an "*Output Quality*" construct using some of the aspects suggested by Venkatesh and Davis (2000) but discarding part of them, adding further ones and without overlaps between this conceptualization and those belonging to other constructs:

- Venkatesh and Davis (2000) hypothesized "*Output Quality*" as an antecedent of "*USEF*" (see fig. 31). The way I'm structuring this construct is independent from "*Perceived Usefulness*" then the pertinent relationship is neglected.
- The nature of "*Output Quality*" is that of a perception and I want to keep this characteristic.

- According to what quoted above by Venkatesh and Davis (2000), judgments on "*Output Quality*" are apt to express a preference, based on a perception on how well the system performs tasks, without excluding options from consideration. This is conceptually in contrast with another antecedent of "*USEF*", namely "*Job Relevance*"[129] (see fig. 31), because judgments about "*Job Relevance*" express the degree of compatibility: if a system is considered to be non job relevant it will be eliminated from the choice set for further considerations. My opinion is that "*Job Relevance*" is a sub-dimension of "*TTF*" and this implies a substantial difference. In fact, while in TAM 2 (fig. 31) "*Output Quality*" and "*Job Relevance*" are on the same level (both antecedents of "*USEF*"), according to fig. 48 within the model I'm building "*TTF*" precedes "*Output Quality*" and this highlights the process sense of this relationship: "*TTF*" evaluation occurs on paper or through specific users in a controlled environment while *"Output Quality*" is a perception riped through a physical interaction between users (which can be external to the implementing company) and the system before and after its go live, then the system exists in the adopting company and both internal and external users are experiencing it. I want to underline that, at the moment, I haven't defined yet "*Output Quality*" because I'm building it through these steps.
- One can argue that "*Use*" should be an antecedent of "*Output Quality*": an user matures a perception about output quality after using the system. If this is undoubtedly true on one side, on the other side the "*Use*" construct, as I'll deepen in pp. 155-157, isn't conceptualized as a dichotomous condition of use/no use and it's inflected according to other factors. The condition of using the system at least one time is simply a prerequisite because we're in an interaction context. Rejecting a priori the system is a decision that should be avoided through the determinants of IS success (i.e. creating awareness by "*Organizational readiness*") but it's out of the scope of this model and it's hypothesized that such decision is bypassed through a good upstream management, while the choices of not using the system anymore or to underutilize it are then a consequence of a first (or some first ones) use(s), achieving an interaction failure.

[129] It's defined as "*individual's perception regarding the degree to which the target system is applicable to his or her job*" (Venkatesh and Davis, 2000, p. 191).

Given these considerations, "*Output Quality*" can be defined as an user perception, matured after at least one interaction with the system, about its effective quality but it's necessary to define which quality I'm referring to. Avoiding overlaps is fundamental, thus it's necessary to distinguish this quality from the one in the "*Negation of Correspondence Failure*" construct. "*System Quality*" is something objective because it's part of the ERP system evaluation and it's considered within the "*Negation of Correspondence Failure*" for a comparison with system objectives, requirements and specifications. Instead, "*Output Quality*" is less objective because it's a perception that, basically, can be different in each internal or external user and it has no references: there isn't a comparison list, like the one which contains system specifications, and its operationalization should reflect this aspect. Factors describing "*Output Quality*" can be the following:

- Number and kind of ERP system functionalities that are underutilized or not used by users, both internal and external. I already introduced this factor as the part #3 of the functionalities' issue described in pp. 142-143. Functionalities which potentially are part of this set are all those that have been successfully implemented and that were desired by the stakeholders, both implicitly and explicitly, and correctly identified in the planning phase. The fact that some of these identified and desired functionalities haven't been successfully implemented isn't relevant for an interaction context while it's important for correspondence and/or expectation issues, according to the particular situation (see pp. 142-143). This factor requires a double set of measures: one for identifying through dummy variables those functionalities which are not utilized (an user interacts with the system but exploits only some of them) and another for understanding if they are underutilized. The latter aspect can be operationalized through the number of times each single functionality is being used within a temporal range or for a specific number of operations[130]. one can argue that this is a pure measure of the "*Use*" construct: this would be true if "*Use*" is described only by the utilization frequency and if it's functionality specific. As a matter of fact, "*Use*" refers to the utilization of the system as a whole, then to an aggregated information, and its conceptualization includes much more aspects as I'll describe afterwards.
- Other aspects of pure interaction, i.e. hard learning. Some researchers (i.e. Rivard et al., 1997) suggested "user friendliness" as a factor of "*System Quality*" but in p. 141

[130] How much times a functionality is used, i.e. for every hundred operations.

I discarded it stating that I conceptualized "*System Quality*" as focused only on technical aspects: this is a good opportunity to place "user friendliness" within the "*Negation of Interaction Failure*" and a questionnaire with a Likert scale can be used to operationalize it. Someone can argue that these latter factors concern the "*Perceived Ease of Use*" construct but this isn't true because "*Perceived Ease of Use*", as theorized by Davis (1985), indirectly influences "*Actual System Use*" through "*Attitude towards using*" (fig. 24) and, also in further models developed starting from the TAM, it's always an antecedent of "*Actual System Use*" (see Chapter 1) then, according to its definition in p. 61, it's a perception matured before interacting with the system while the factors above are yielded after the interaction.

Fig. 48 shows a direct effect of "*TTF*" on "*Net Benefits*". These net benefits are all and only those achievable through a successful interaction between users and system and they constitute the greater part of the net benefits contained in the corresponding box in fig. 46[131]: if the system is "good" in terms of both specifications and "*TTF*", if it's used correctly and if it isn't rejected or underutilized, the successful interaction can yield, during time, a great part of both the tangible and intangible benefits partially listed in p. 137-138. Moreover, I hypothesized that "*TTF*" influences "*Net Benefits*" indirectly too, through a mediating role of "*Output Quality*": my idea is that the latter construct catches a part of the interaction experience that "*TTF*" ignores, according to the way I structured these constructs. "*TTF*" influences "*Output Quality*" because it's a perception of the user on the extent to which the fit between tasks and system can improve the performance on the individual level and this perception affects user's perceptions about interaction represented by "*Output Quality*". According to the Theories of Fit within the TPC model (pp. 26-30), it's opportune to underline that one of the most important net benefits resulting from a positive "*TTF*" (and then, in my model, from a positive "*Output Quality*" and from a positive interaction experience as a whole) is a positive impact on the individual performance of the user, either internal or external (i.e. a customer, a partner, a supplier etc.): this consideration again confirms how this *work in progress* model considers the perspectives of different stakeholders and that it's based on sound streams from literature.
The TAM level (see fig. 48) is constituted by the classical triptych "*Perceived Ease of Use*", "*Perceived Usefulness*" and "*Use*" that is the foundation of the TAM by Davis (1985), besides attitudes and behavioral intentions (see 1.6.1). Concerning the first two

[131] See pp. 144-145 for considerations about the composition of the "*Net Benefits*" boxes.

constructs, whose definitions are in p. 61, they are exactly the same proposed by Davis while "*Use*" deserves a wider description: as the latter construct is more structured than the other two, I prefer to analyze now the operationalization of "*Perceived Ease of Use*" and "*Perceived Usefulness*", thus I can deepen "*Use*" afterwards.

- Perceived Usefulness: Davis (1985) operationalized this construct through 14 items, which have been reduced to 10 after a further semantic analysis (see tables 25 and 27 in Appendix F of this thesis work, p. 192). They are contextualized on an electronic mail system but they can be adapted for an ERP system. Venkatesh and Davis (2000) used only four items (table 29, p. 193 in Appendix G of this thesis work) but they are exactly four of the 10 items used by Davis (1985) fifteen years before their work. A further example is in Venkatesh et al. (2003)[132]: six items with a wording that is, in my opinion, much more adequate than the one in the other examples. In fact, according to its definition and to its relationship with "*Use*", "*Perceived Usefulness*" is a perception matured before using the system[133] in its final operating environment, then the term "would" (i.e. "would improve", "would increase" etc.) makes the wording much more appropriate.
- Perceived Ease of Use: Davis (1985) operationalized this construct through 14 items, which have been reduced to 10 after a further semantic analysis (see tables 26 and 28 in Appendix F of this thesis work, pp. 192-193) but, like for "*Perceived Usefulness*", they should be adapted for the ERP context. Venkatesh and Davis (2000) used only four items (table 29, p. 193 in Appendix G of this thesis work). As for "*Perceived Usefulness*", the example by Venkatesh et al. (2003)[134] is decidedly more appropriate and I strongly recommend its wording style. Further considerations are the same suggested for "*Perceived Usefulness*" above.

Constructs like "*Use*" or similar have been widely described in Chapter 1. According to p. 29, the "*Utilization*" construct within the TPC model by G&T (1995) and the "*Use*" construct within the IS success model by D&M (2003) are different for several aspects and my intention is to structure a construct which is a hybrid between them:

[132] See table 30, p. 193 in Appendix H of this thesis work.
[133] It's an antecedent of the "*Use*" construct in every TAM version (see Chapter 1) even if, sometimes, they are mediated by "*Behavioral Intention to Use*" and/or "*Attitude toward using*".
[134] See table 31, p. 193 in Appendix H of this thesis work.

- Utilization: I want to keep its aspect concerning the perceived dependence from the ERP system (see p. 31). Given that an user can belong to whatever organizational level (from a high-level manager to the clerical staff) and also to an external company (i.e. a customer, a supplier, a partner etc.), it can be useful to operationalize the "*Use*" construct as described in p. 31, namely by asking users to rate how dependent they are on the ERP system for performing their tasks, i.e. using a Likert scale like the one in the note 17, p. 31. I recommend to hold an aggregated approach, considering the dependence on the system (and its use for the other factors) as a whole and not as decomposed in its single functionalities: the latter aspect has been already addressed and deepened within the "*Output Quality*" construct.
- Use: the most interesting part of the construct suggested by D&M (2003) is its declension in several aspects, as described in pp. 13-14. Petter et al. (2008, p. 239) defined it as "*the degree and manner in which staff and customers utilize the capabilities of an information system. For example: amount of use, frequency of use, nature of use, appropriateness of use, purpose of use*". Further considerations are needed:

    - The model I'm proposing doesn't distinguish between mandatory and voluntary use. This choice doesn't mean that I don't consider this topic as important but, as a matter of fact, I preferred to bypass the issue as discussed in pp. 152, namely hypothesizing a good upstream management in terms of ERP success determinants (i.e. persuading users about the need of change and the necessity of using the ERP system).
    - A factor similar to "extent of use" (see p. 14) has been already introduced and discussed within the "*Output Quality*" construct (p. 153).
    - "Nature of use" (see p. 14) has been considered within the "*TTF*" construct, even if on a perception level.
    - Self reported use data aren't reliable[135], in fact "*typically, heavy users tend to underestimate use, while light users tended to overestimate use*" (Petter et al., 2008, p. 241). Efforts in measuring use data through an automatic tool would be appreciated.

[135] I already quoted this issue, see table 12 in the "Limitations in the methodologies used for testing the TAM" section.

- As described in Chapter 1, "frequency of use" is a controversial factor because for Doll and Torkzadeh (1998) more use isn't always better, then they developed an use measurement tool "*based on the effects of use, rather than by frequency or duration*" (Petter et al., 2008, p. 241). Another useful measure could be the number of times the system is used divided by the number of tasks accomplished through it, like in the TPC model (p. 29): this method has been neglected by G&T (1995) in favor of the one quoted above in "*Utilization*" due to practical difficulties (see p. 31) but it would be really useful if someone is able to effectively perform it.

Relationships in fig. 48 among "*Perceived Ease of Use*", "*Perceived Usefulness*", "*Use*" and "*Net Benefits*" have been already discussed in literature (see Chapter 1). I hypothesized a direct relationship between "*User Characteristics*" and both "*Perceived Usefulness*" and "*Perceived Ease of Use*", as briefly stated in p. 31, because characteristics like age, experience and so on[136] affect perceptions of a potential user about the ERP system.

3.3.4 Negation of Expectation Failure

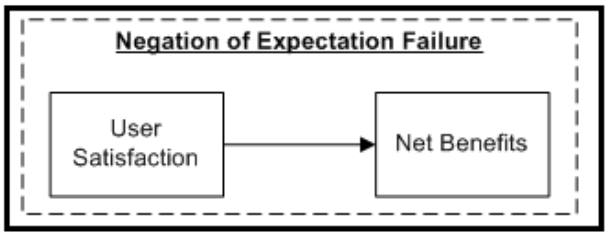


Figure 49: Negation of Expectation Failure

It occurs when the ERP meets requirements, expectations or values of all the stakeholders' groups, namely when all these groups[137] don't perceive a gap between the situation in which the implemented ERP system "lives" and the situation they desire. According to fig. 49, I structured this negation in a compact way with only two constructs. On a conceptual level, "*User Satisfaction*"[138] is the same construct by D&M (1992). Petter et al. (2008, p. 239) suggested a definition which can be useful for the next operationalization: "*users' level of satisfaction with reports, Web sites and support services*". Maybe it's reductive within the context of the "*Negation of Expectation Failure*" since it doesn't distinguish between what an user will obtain, because correctly defined in a planning phase, and what he/she desired in terms of personal expectations, which are not always included within the requirements

[136] See further examples in p. 149.
[137] Obviously "all" means all the most relevant ones for the ERP project.
[138] I described it in p. 7 as "*users' reaction to the use of IS output, namely the information, on condition that the information is required and then necessary*".

(both implicit and explicit), but anyway I consider it as adequate. A stakeholder experiencing an expectation failure isn't necessarily someone that interacts with the system because an user can be also someone that, for example, utilizes a report which has been produced by someone else through the system[139]. Moreover, stakeholders that have expectations about the ERP system but don't interact with it at all (i.e. a shareholder of the adopting company) aren't ignored, in fact that's why I introduced the "*Net Benefits*" construct too, in order to obtain a wide covering of stakeholders' groups and of their expectations. Examples of measures of "*User Satisfaction*" are the following:

- D&M (1992) suggested several measures (table 32, p. 194 in Appendix I of this thesis work), including one concerning the overall satisfaction.
- Gable et al. (2003) proposed four "*User Satisfaction*" measures in their *a priori* model (fig. 10), which are quite similar to those suggested by D&M (1992).
- Several "*User Satisfaction*" measurement instruments have been developed in literature. Petter et al. (2008) suggested the EUCS (End-User Computing Support) instrument by Doll et al. (1994) and the UIS (User Information Satisfaction) instrument by Ives et al. (1983). Seddon and Yip (1992) empirically found that EUCS outperformed UIS in the context of accounting IS. Unfortunately, according to Petter et al. (2008, pp. 214-242) "*both the EUCS and UIS instruments contain items related to system quality, information quality, and service quality, rather than only measuring overall user satisfaction with the system. Because of this, some researchers have chosen to parse out the various quality dimensions from these instruments and either use a single item to measure overall satisfaction with an information system (Rai et al., 2002) or use a semantic differential scale (Seddon & Yip, 1992)*": on this basis, I strongly recommend to exclude every item that could lead to overlapping measures. Other "*User Satisfaction*" measurement tools, for which the same considerations are valid, are those proposed by Swanson (1974) and Bailey and Pearson (1983), as stated in p. 7.
- According to observation #2 in p. 142, another aspect should be measured in "*User Satisfaction*", namely the lack in the ERP system of one or more functionalities which are desired by one or more relevant stakeholders but that haven't been expressed explicitly and haven't been identified as implicit requirements in the

[139] See note 119, p. 145.

early phases of the project[140]. This measure can be performed through a questionnaire structured with a Likert scale.

About "*Net Benefits*", what stated in pp. 144-145 about differences among their boxes is still valid. Within the "*Negation of Expectation Failure*" it represents all the net benefits achievable only through stakeholders satisfied in terms of expectations about the ERP system, then benefits which are more general, i.e. those linked to the whole ERP project and not strictly to the system, must be excluded. As for the other "*Net Benefits*" constructs, I don't want to suggest particular factors besides the general, although incomplete, list in pp. 137-138 because some specific benefits are linked to which ERP modules an adopting company wants to install and to the reasons of the system adoption. The relationship between "*User Satisfaction*" and "*Net Benefits*" is one of the basic links in the IS success model by D&M (1992), then it doesn't require further details.

[140] See p. 142 for further details.

4. Conclusions: what have I done?

The ERP failure negation model I created is in fig. 50. Red lines denote new relationships and constructs I structured and hypothesized while black ones indicate what I took from the existing literature, even if some of them have been modified, as described in Chapter 3. The four negations are in black for a matter of aesthetics although no one in literature defined them explicitly. The four "*Net Benefits*" boxes have been enclosed in a single transversal construct but this doesn't mean I merged them on a theoretical level: what stated in pp. 144-145 and in the whole previous chapter about their differences is still valid, their fusion is only a matter of graphical compactness. Table 22 summarizes literature sources for both constructs and relationships and it shows, in a more orderly way, the innovative elements I introduced. My opinion is that the most innovative one is the whole approach to the ERP success, namely the idea of defining an ERP (full) success model through the negation of the four kinds of IS failure by Lyytinen and Hirschheim (1987), appropriately contextualized within the ERP environment.
My work can be summarized as follows:

- Chapter 1 is a literature analysis on the most relevant models concerning IS/IT. Some of them describe IS success, other the acceptance of the IS as a technology and the fit between processes and technology. I also analyzed several measurement models and, although they constitute a minority due to a shortage in literature, further ERP specific frameworks too. This chapter allowed me to identify all the important bricks needed for a sound theoretical foundation for the next modeling phase.
- Chapter 2 is a contextualization within the ERP reality in which I highlighted how much ERP projects are risky, quoting examples from real facts, peculiarities that make them a specific topic in IS research, all the elements which make an ERP project much more risky and complex than an IS generic one. Then, I conducted a brief literature analysis on the concept of success in ERP implementations and on the meaning of failure within the IS context privileging[141], about failure, the approach by Lyytinen and Hirschheim (1987) in order to set up a starting point for the third chapter.

[141] Reasons that led to this choice are in pp. 121-122.

- Chapter 3 is the modeling phase. I defined the "*ERP full success*" construct negating all the kinds of failure suggested by Lyytinen and Hirschheim (1987), explaining step by step how I moved from a generic IS context to an ERP specific one. Afterwards, I filled each negation box with constructs and relationships both new and taken from the existing literature, mostly analyzed in Chapter 1. On the basis of Chapter 2, I ulteriorly improved the contextualization within the ERP reality and I integrated each set of measures with further appropriate items, suggesting useful application hints for practitioners, researchers or everyone else that wants to use this ERP failure negation model.

I consider the result as satisfactory because it meets the whole requirements list I defined in p. 120:

1. *It should be based on elements widely shared and accepted in literature*: see table 22.
2. *It must suggest a new approach*: on the basis of my literature analysis, the failure negation approach is definitely new.
3. *It has to be ERP specific, considering organizational, technological and project dimensions*: I considered all the three dimensions and I contextualized the model within the ERP implementation through a deep literature analysis.
4. *Points of view of different stakeholders have to be taken into account*: both constructs and relationships, including the pertinent measure items, have been structured for considering, where it's possible, all the relevant stakeholders.
5. *It must not be too much complicated in his building and application*: model's building has been quite linear and I suggested several hints and recommendations for its application and measurement (see Chapter 3).
6. *Its success meaning has to be univocal*: I univocally defined the "*ERP full success*" concept, describing all the theoretical steps I followed in doing this, starting from the generic (and not univocal) meaning of IS success.
7. *It should not directly include neither CSFs/CFFs nor ERP implementation models*: the modeling phase partially considered CSFs/CFFs and ERP implementation models but creating something different and, potentially, independent from them.

The ERP failure negation model I created is, obviously, perfectible. My goal, hoping to have achieved it, is to propose a new approach in explaining the ERP success, given the

shortage of ERP success specific framework in literature. Further works are needed in order to measure the validity of the proposed model, collecting adequate samples. Criticisms and improvement suggestions are welcome, although I want to state that increasing the number of constructs and/or relationships isn't, in my opinion, advisable: literature doesn't need for models which are so complicated as to be too hard to use for practical applications. The conclusion I drew through this work is that new approaches to the ERP success topic are needed. Often, new frameworks are a partial merge of previous existing frameworks, without adding new relevant elements but only proposing variants using a little innovative (or not innovative) approach. It's my opinion that the ERP success context needs and deserves effective practical applications: theoretical sophistications are useless if they don't add value to practitioners. For becoming potentially useful in terms of comparison of different ERP implementation under the same perspective, success measurement of completed or ongoing ERP projects and identification/definition of a pattern addressing ERP projects to success through a comprehensive and univocal meaning, my ERP failure negation model needs for field research, wishing it will give practical contribution and support to this theoretical work.

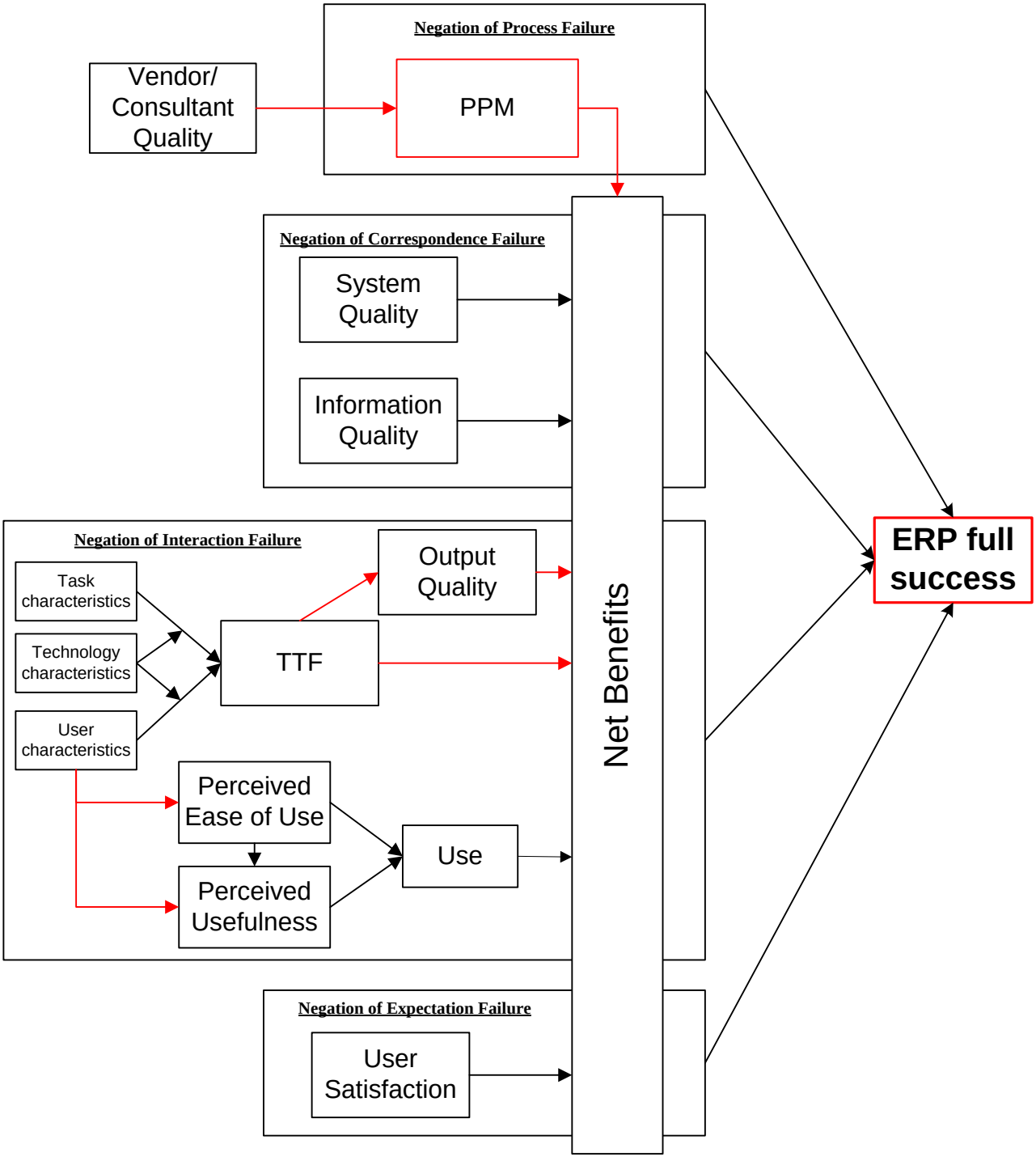


Figure 50: the ERP failure negation model

INNOVATIVE ELEMENTS

Approach

ERP (full) success defined through the negation of the four kinds of IS failure by Lyytinen and Hirschheim (1987), appropriately contextualized within the ERP environment.

Constructs

- Project Planning and Management (PPM)
- ERP full success
- Negation of Process Failure
- Negation of Correspondence Failure
- Negation of Interaction Failure
- Negation of Expectation Failure

Relationships

- Vendor/Consultant Quality → PPM
- PPM → Net Benefits
- TTF → Output Quality
- TTF → Net Benefits[2]
- Output Quality → Net Benefits
- User Characteristics → Perceived Ease of Use
- User Characteristics → Perceived Usefulness

NOT INNOVATIVE ELEMENTS

Constructs

- Vendor/Consultant Quality (Ifinedo, 2006)
- Net Benefits (Seddon 1997; D&M, 2003)
- System Quality (D&M, 1992, 2003; Gable et al., 2003, 2008; Ifinedo, 2006)
- Information Quality (D&M, 1992, 2003; Gable et al., 2003, 2008; Ifinedo, 2006)
- Task Characteristics (G&T, 1995; Smyth, 2001; Dishaw et al. 1999, 2002)
- Technology Characteristics (G&T, 1995; Smyth, 2001)
- User Characteristics (G&T, 1995; Smyth, 2001)
- TTF (G&T, 1995; Smyth, 2001; Dishaw et al., 1999, 2002)
- Output Quality[1] (Venkatesh and Davis, 2000)
- Perceived Ease of Use (Davis 1985, 1989; Venkatesh and Davis, 1996, 2000; Legris et al., 2003; Venkatesh and Bala, 2008)
- Perceived Usefulness (Davis 1985, 1989; Venkatesh and Davis, 1996, 2000; Smyth, 2001; Legris et al., 2003; Venkatesh and Bala, 2008)
- Use[1] (D&M, 1992, 2003; G&T, 1995; Davis 1985, 1989; Venkatesh and Davis, 1996; Legris et al., 2003; Dishaw et al., 1999, 2002)
- User Satisfaction (D&M, 1992, 2003; Smyth, 2001)

Relationships

- System Quality → Net Benefits (see Petter et al., 2008, p. 250 for a meta analysis with 22 references)
- Information Quality → Net Benefits (see Petter et al., 2008, p. 251 for a meta analysis with 11 references)
- Task Characteristics → TTF (G&T, 1995; Smyth, 2001; Dishaw et al., 1999, 2002)
- Technology Characteristics → TTF (G&T, 1995; Smyth, 2001)
- User Characteristics → TTF (G&T, 1995; Smyth, 2001)
- Perceived Ease of Use → Perceived Usefulness (Davis 1985, 1989; Venkatesh and Davis, 1996; Legris et al., 2003; Venkatesh and Davis, 2000; Venkatesh and Bala, 2008; Dishaw et al., 1999, 2002)
- Perceived Ease of Use → Use (see Legris et al., 2003, for a meta analysis, whose results are in table 13, with 28 references)

• Perceived Usefulness → Use (Davis, 1985, 1989; see Legris et al., 2003, for a meta analysis, whose results are in table 13, with 28 references) • Use → Net Benefits (D&M, 2003; see Petter et al., 2008, pp. 251-252 for a meta analysis with 22 references) • User Satisfaction → Net Benefits (D&M, 2003; see Petter et al., 2008, p. 252 for a meta analysis with 14 references)

Table 22: innovative and not innovative elements within the ERP failure negation model

[1] = the original structure of this construct has been modified, see Chapter 3.
[2] = relationships between "*TTF*" and "*Performance Impacts*" already exist (i.e. see G&T, 1985) but the "*Net Benefits*" construct is much more wide than the "*Performance Impacts*" one.

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Appendix

Appendix A: summary of ERP Business Benefits from Shang and Seddon (2000), Appendix 1, pp. 1011-1013

I. Operational benefit summary

1.1 Cost reduction.

- **Labor cost reduction**: the automation and removal of redundant processes or redesign of processes led to full time staff reduction in tasks in each business areas including: customer services, production, order fulfillment, administrative processes, purchasing, financial, training and human resources.
- **Inventory cost reduction** in management, relocation, warehousing, and improved turns.
- **Administrative expenses reduction** in printing papers and supplies.

1.2 Cycle time reduction. Measurable cycle time reductions were found in three kinds of activities that support customers, employees and suppliers.

- **Customer support activities** in order fulfillment, billing, production, delivery and customer services.
- **Employee support activities** in reporting, month-end closing, purchasing, or expense requisition, HR and payroll and business learning.
- **Supplier support activities** in speed payments and combined multiple orders with discount gained.

1.3 Productivity improvement. Products produced per employee or labor cost, customer served per employee or labor cost, or mission accomplished per employee in non-profit organization.

1.4 Quality improvement. Error rate reduction, duplicates reduction, accuracy rate or reliability rate improvement.

1.5 Customer services improvement. Ease of customer data access and customer inquiries.

II. Managerial benefit

2.1 Better resource management.

- Better asset management for improved cost, depreciation, location, custodian, physical inventory and maintenance records control.
- Better inventory management for improved inventory turns, stock allocation, quick and accurate inventory information, just-in-time replacement and having a variety of options dealing with various requests.
- Better production management for optimized supplying chain and production schedules.
- Better workforce management for improved manpower allocation, and better utilization of skills and experiences.

2.2 Better decision making.

- Improved strategic decisions for improved market responsiveness, better profit and cost control, and effective strategic planning.
- Improved operational decisions for flexible resource management, efficient processes, and quick response to work changes.
- Improved customer decisions with flexible customer services, rapid response to customer demands and quick service adjustments.

2.3 Better performance control in a variety way in all levels of the organizations.

- Financial performance control by lines of business, by product, by customers, by geographies or by different combinations.
- Manufacturing performance monitoring, change prediction and quick adjustments.

Overall operation efficiency and effectiveness management.

III. Strategic benefits

3.1 Support current and future business growth plan in:

- Business growth in transaction volume, processing capacity and capability.
- Business growth with new business products or services, new divisions, or new functions in different regions.
- Business growth with increased employees, new policies and procedures.
- Business growth in new markets.
- Business growth with industry's rapid changes in competition, regulation and markets.

3.2 Support business alliance by efficiently and effectively consolidate newly acquired companies into standard business practice.

3.3 Build business innovation by:

- Enable new market strategy
- Build new process chain
- Create new business

3.4 Build cost leadership by achieving economies of scale through streamlined processes or shared services.

3.5 Generate or enhance product differentiation by:

- Providing customized product or services for instance: early preparation for the new EMU currency policy and provide customized billing, provides individualized project services to different customer requirements, provides different levels of service

appropriate for the varying size of customer companies.
- Providing lean production with make-to-order capabilities.

3.6 Build external linkage with suppliers, distributors and related business parties.

3.7 Enable Worldwide expansion with:
- Centralized world operation
- Global resource management
- Multi-currency capability
- Global market penetration
- Deploy solution quickly and cost effectively across worldwide

3.8 Enabling E-business by attracting new or getting closer to customers through the web integration capability. The web-enabled ERP system provide benefits in business to business and business to individual in:
- Interactive customer service
- Improved product design through customer direct feedback
- Expanding to new E-market
- Building virtual corporation with virtual supply and demand consortium
- Deliver customized service
- Provide real time and reliable data enquiries

IV. IT infrastructure benefits

4.1 Increased business flexibility by response to internal and external changes quickly at lower costs and provide range of options in react to the change requirements.

4.2 IT costs reduction in:
- Legacy system integration and maintenance
- Mainframe or hardware replacing
- IT expense and staff for developing and maintaining the system
- Year 2000 compliance upgrade
- System architecture design and development
- System modification and maintenance
- Disparate information reconciliation and consolidation
- Technology R&D

4.3 Increased IT infrastructure capability: stable and flexible for the current and future business changes

Stability:
- Streamlined and standardized platform
- Global platform with global knowledge pipeline
- Database performance and integrity
- IS management transformation and increased IS resource capability
- Continuous improvement in system process and technology
- Global maintenance support

Flexibility:
- Modern technology adaptability
- Extendable to external parties
- Expendable to a range of applications
- Comparable with different systems
- Customizable and configurability

V. Organizational benefits

5.1 Support business organizational changes in structure, and processes

5.2 Facilitate business learning and broaden employ skills
- Learned by entire workforce
- Shorten leaning time
- Broaden employees' skill

5.3 Empowerment
- Accountability, more value-added responsibility
- More pro-active users in problem solving
- Work autonomously
- Users have ownership of this system
- Middle management are no longer doers but planners
- Greater employee involvement in business management

5.4 Changed culture with common visions
- Efficient interpersonal communication
- Interdisciplinary thinking, coordinate and harmonize differences, and interdepartmental processes
- Consistent vision across different levels of organization

5.5 Changed employee behavior with shifted focus
- More critical managing and planning matters
- More concentration on core work
- Customer and market focus
- Move from back office to front office

5.6 Better employee morale and satisfaction
- Increased employee satisfaction with better decision making tools
- Increased employee efficiency of field operations and services
- Satisfied users for solving problems efficiently
- Built morale with better system performance
- Satisfied employees for better employee service

Appendix B: the Enterprise System Experience Cycle by M&T (2000)

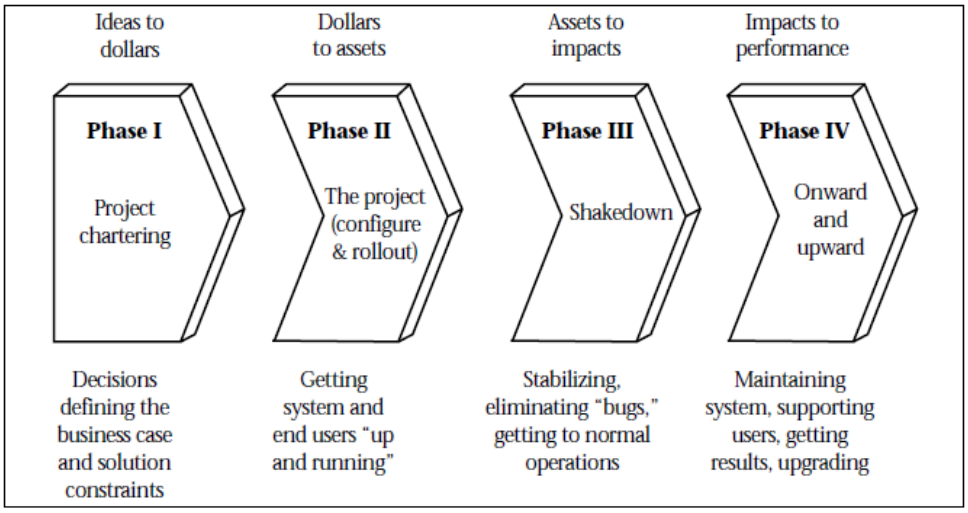

Figure 51: the Enterprise System Experience Cycle by M&T (2000, p. 189)

Appendix C: measure items from the questionnaire by Ifinedo (2006)

	Measures
1	Our ERP has accurate data
2	Our ERP is flexible
3	Our ERP is easy to use
4	Our ERP is easy to learn
5	Our ERP is reliable
6	Our ERP allows data integration
7	Our ERP allows for customization
8	Our ERP is efficient
9	Our ERP has good features
10	Our ERP allows for integration with other IT systems
11	Our ERP meets users' requirements
12	Our ERP database contents is up-to-date
13	Our ERP has timely information
14	The information on our ERP is understandable
15	The information on our ERP is important
16	The information on our ERP is brief
17	The information on our ERP is relevant
18	The information on our ERP is usable
19	The information on our ERP is available
20	Our ERP vendor/consultant provides adequate technical support
21	Our ERP vendor/consultant is credible and trustworthy
22	Our ERP vendor/consultant has good relationships with my organization
23	Our ERP vendor/consultant is experienced and provides quality training and services
24	Our ERP vendor/consultant communicates well with my organization

Notes: (1) Assessed on a Likert scale (1=strongly disagree, 2=disagree, 3=somewhat disagree, 4=neutral, 5=somewhat agree, 6= agree, and 7=strongly agree). (2) [Our ERP] refers to the type(s) of ERP system in use in the participating firms.

Table 23: extract from the questionnaire by Ifinedo (2006), p. 33. Items 1÷11 concern "*System Quality*", items 12÷19 concern "*Information Quality*", items 20÷24 concern "*Vendor/Consultant Quality*"

Appendix D: measure items of "*Task Characteristics*". Three items measure "non-routineness" (labeled as "task equivocability"), two items measure "interdependence" (from G&T, 1995, Appendix part B, pp. 235-236).

TASK EQUIVOCABILITY

ADHC1 --- I frequently deal with ill-defined business problems.
ADHC2 --- I frequently deal with ad-hoc , non-routine business problems.
ADHC3 --- Frequently the business problems I work on involve answering questions that have never been asked in quite that form before.

TASK INTERDEPENDENCE

INTR1 --- The business problems I deal with frequently involve more than one business function.
INTR2 --- The problems I deal with frequently involve more than one business function.

Appendix E: questionnaire for measuring "*TTF*" by G&T (1995)

PART A. TASK-TECHNOLOGY FIT MEASURES

8 Final Factors of TTF
21 Original Dimensions of TTF
Questions

Quality

CURRENCY: (Data that I use or would like to use is current enough to meet my needs.)
CURR1 — I can't get data that is current enough to meet my business needs.
CURR2 — The data is up to date enough for my purposes.

RIGHT DATA: (Maintaining the necessary fields or elements of data.)
RDAT1 — The data maintained by the corporation or division is pretty much what I need to carry out my tasks.
RDAT2 — The computer systems available to me are missing critical data that would be very useful to me in my job.

RIGHT LEVEL OF DETAIL: (Maintaining the data at the right level or levels of detail.)
RLEV1 — The company maintains data at an appropriate level of detail for my group's tasks.
RLEV2 — Sufficiently detailed data is maintained by the corporation.

Locatability

LOCATABILITY: (Ease of determining what data is available and where.)
LOCT1 — It is easy to find out what data the corporation maintains on a given subject.
LOCT3 — It is easy to locate corporate or divisional data on a particular issue, even if I haven't used that data before.

MEANING: (Ease of determining what a data element on a report or file means, or what is excluded or included in calculating it.)
MEAN1 — The exact definition of data fields relating to my tasks is easy to find out.
MEAN2 — On the reports or systems I deal with, the exact meaning of the data elements is either obvious, or easy to find out.

Authorization

AUTHORIZATION: (Obtaining authorization to access data necessary to do my job.)
AUTH1 — Data that would be useful to me is unavailable because I don't have the right authorization.
AUTH2 — Getting authorization to access data that would be useful in my job is time consuming and difficult.

Compatibility

COMPATIBILITY: (Data from different sources can be consolidated or compared without inconsistencies.)
COMP1 —There are times when I find that supposedly equivalent data from two different sources is inconsistent.
COMP2 —Sometimes it is difficult for me to compare or consolidate data from two different sources because the data is defined differently.

COMP3 — When it's necessary to compare or consolidate data from different sources, I find that there may be unexpected or difficult inconsistencies.

Production Timeliness

TIMELINESS: (IS meets pre-defined production turnaround schedules.)

PROD1 — IS, to my knowledge, meets its production schedules such as report delivery and running scheduled jobs.

PROD2 — Regular IS activities (such as printed report delivery or running scheduled jobs) are completed on time.

Systems Reliability

SYSTEMS RELIABILITY: (Dependability and consistency of access and uptime of systems.)

RELY1 — I can count on the system to be "up" and available when I need it.

RELY2 — The computer systems I use are subject to unexpected or inconvenient down times which makes it harder to do my work.

RELY3 — The computer systems I use are subject to frequent problems and crashes.

Ease of Use / Training

EASE OF USE OF HARDWARE & SOFTWARE: (Ease of doing what I want to do using the system hardware and software for submitting, accessing, analyzing data.

EASE1 — It is easy to learn how to use the computer systems I need.

EASE2 — The computer systems I use are convenient and easy to use.

TRAINING: (Can I get the kind of quality computer-related training when I need it?)

TRNG1 — There is not enough training for me or my staff on how to find, understand, access or use the company computer systems.

TRNG2 — I am getting the training I need to be able to use company computer systems, languages, procedures and data effectively.

Relationship with Users

IS UNDERSTANDING OF BUSINESS: (How well does IS understand my unit's business mission and its relation to corporate objectives?)

UNBS1 — The IS people we deal with understand the day-to-day objectives of my work group and its mission within our company.

UNBS2 — My work group feels that IS personnel can communicate with us in familiar business terms that are consistent.

IS INTEREST AND DEDICATION: (to supporting customer business needs.)

INDN1 — IS takes my business group's business problems seriously.

INDN2 — IS takes a real interest in helping me solve my business problems.

RESPONSIVENESS: (Turnaround time for a request submitted for IS service.)

RESP1 — It often takes too long for IS to communicate with me on my requests.

RESP2 — I generally know what happens to my request for IS services or assistance or whether it is being acted upon.

RESP3 — When I make a request for service or assistance, IS normally responds to my request in a timely manner.

CONSULTING: (Availability and quality of technical and business planning assistance for systems)

CONS1 — Based on my previous experience I would use IS technical and business planning consulting services in the future if I had a need.

CONS2 — I am satisfied with the level of technical and business planning consulting expertise I receive from IS.

IS PERFORMANCE: (How well does IS keep its agreements?)

PERF2 — IS delivers agreed-upon solutions to support my business needs.

Table 24: questionnaire with items measuring "*TTF*" (from G&T, 1995, Appendix part A, pp. 234-235)

Appendix F: measure items for "*Perceived Usefulness*" and "*Perceived Ease of Use*" in their initial scale (14 items per construct) and after a skimming process through a further semantic analysis (10 items per construct)

Initial scale items for "*Perceived Usefulness*"	
Item Number	***Measuring item***
1	My job would be difficult to perform without electronic mail
2	Using electronic mail gives me greater control over my work
3	Using electronic mail improves my job performance
4	The electronic mail system addresses my job-related needs
5	Using electronic mail saves me time
6	Electronic mail enables me to accomplish tasks more quickly
7	Electronic mail supports critical aspects of my job
8	Using electronic mail allows me to accomplish more work than would otherwise be possible
9	Using electronic mail reduces the time I spend on unproductive activities
10	Using electronic mail enhances my effectiveness on the job
11	Using electronic mail improves the quality of the work I do
12	Using electronic mail increases my productivity
13	Using electronic mail makes it easier to do my job
14	Overall, I find the electronic mail system useful in my job

Table 25: "*Perceived Usefulness*" initial items pool (readapted from Davis, 1985, p. 84)

Initial scale items for "*Perceived Ease of Use*"	
Item Number	***Measuring item***
1	I often become confused when I use the electronic mail system
2	I make errors frequently when using electronic mail
3	Interacting with the electronic mail system is often frustrating
4	I need to consult the user manual often when using electronic mail
5	Interacting with the electronic mail system requires a lot of my mental effort
6	I find it easy to recover from errors encountered while using electronic mail
7	The electronic mail system is rigid and inflexible to interact with
8	I find it easy to get the electronic mail system to do what I want it to do
9	The electronic mail system often behaves in unexpected ways
10	I find it cumbersome to use the electronic mail system
11	My interaction with the electronic mail system is easy for me to understand
12	It is easy for me to remember how to perform tasks using the electronic mail system
13	The electronic mail system provides helpful guidance in performing tasks
14	Overall, I find the electronic mail system easy to use

Table 26: "*Perceived Ease of Use*" initial items pool (readapted from Davis, 1985, p. 85)

Revised scale items for "*Perceived Usefulness*"	
Item Number	***Measuring item***
1	Using electronic mail improves the quality of the work I do
2	Using electronic mail gives me greater control over my work
3	Electronic mail enables me to accomplish tasks more quickly
4	Electronic mail supports critical aspects of my job
5	Using electronic mail increases my productivity
6	Using electronic mail improves my job performance
7	Using electronic mail allows me to accomplish more work than would otherwise be possible
8	Using electronic mail enhances my effectiveness on the job
9	Using electronic mail makes it easier to do my job
10	Overall, I find the electronic mail system useful in my job

Table 27: "*Perceived Usefulness*" revised items pool (readapted from Davis, 1985, p. 90)

Revised scale items for "*Perceived Ease of Use*"	
Item Number	***Measuring item***
1	I find it cumbersome to use the electronic mail system
2	Learning to operate the electronic mail system is easy for me
3	Interacting with the electronic mail system is often frustrating
4	I find it easy to get the electronic mail system to do what I want it to do
5	The electronic mail system is rigid and inflexible to interact with
6	It is easy for me to remember how to perform tasks using the electronic mail system
7	Interacting with the electronic mail system requires a lot of my mental effort
8	My interaction with the electronic mail system is clear and understandable
9	I find it takes a lot of effort to become skillful at using electronic mail
10	Overall, I find the electronic mail system easy to use

Table 28: "*Perceived Ease of Use*" revised items pool (readapted from Davis, 1985, p. 91)

Appendix G: measure items for "*Perceived Usefulness*" and "*Perceived Ease of Use*" from Venkatesh and Davis (2000)

Perceived Usefulness	(Cronbach's α ranged from 0.87 to 0.98 across studies and time periods)
Using the system improves my performance in my job.	
Using the system in my job increases my productivity.	
Using the system enhances my effectiveness in my job.	
I find the system to be useful in my job.	
Perceived Ease of Use	(Cronbach's α ranged from 0.86 to 0.98 across studies and time periods)
My interaction with the system is clear and understandable.	
Interacting with the system does not require a lot of my mental effort.	
I find the system to be easy to use.	
I find it easy to get the system to do what I want it to do.	

Note. All items were measured on a 7-point Likert scale, where 1 = *strongly disagree*, 2 = *moderately disagree*, 3 = *somewhat disagree*, 4 = *neutral* (neither disagree nor agree), 5 = *somewhat agree*, 6 = *moderately agree*, and 7 = *strongly agree*.

Table 29: measure items for "*Perceived Usefulness*" and "*Perceived Ease of Use*" (extract from Venkatesh and Davis, 2000, Appendix 1, p. 201)

Appendix H: measure items for "*Perceived Usefulness*" and "*Perceived Ease of Use*" from Venkatesh et al. (2003)

Measure items for "*Perceived Usefulness*"	
Item Number	***Measuring item***
1	Using the system in my job would enable me to accomplish tasks more quickly
2	Using the system would improve my job performance
3	Using the system in my job would increase my productivity
4	Using the system would enhance my effectiveness on the job
5	Using the system would make it easier to do my job
6	I would find the system useful in my job

Table 30: measure items for "*Perceived Usefulness*" (extract from Venkatesh et al., 2003, table 9, p. 448)

Measure items for "*Perceived Ease of Use*"	
Item Number	***Measuring item***
1	Learning to operate the system would be easy for me
2	I would find it easy to get the system to do what I want it to do
3	My interaction with the system would be clear and understandable
4	I would find the system to be flexible to interact with
5	It would be easy for me to become skillful at using the system
6	I would find the system easy to use.

Table 31: measure items for "*Perceived Ease of Use*" (extract from Venkatesh et al., 2003, table 10, p. 451)

Appendix I: *"User Satisfaction"* measure items from D&M (1992)

Measure items for "*User Satisfaction*"	
Item Number	***Measuring item***
1	Satisfaction with specifics
2	Overall satisfaction
3	Single-item measure
4	Multi-item measure
5	Information satisfaction: difference between information needed and received
6	Enjoyment
7	Software satisfaction
8	Decision-making satisfaction

Table 32: measure items for "*User Satisfaction*" (extract from D&M, 1992, table 7, p. 84)