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RESEARCH ESSAY

Using quantitative data in mixed-design grounded theory studies: an enhanced path to formal grounded theory in information systems

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Abstract
This article discusses a key development in the use of grounded theory (GT) in information systems (IS) – the use of quantitative data in mixed studies to build on and elaborate theories. We examine the design of one of our research projects and describe how this mixed-design GT project helped elaborate emerging theories using slices of qualitative and quantitative data. Our contributions are threefold: (i) we show that the use of mixed data and techniques can be leveraged to help build credible theories in IS because it allows researchers to build theories of greater abstraction and scope: it helps sense-making in the drive from substantive to parsimonious formal theories; (ii) in line with classic GT, we propose a mixed typological design to help build a pathway to formal grounded theories in rupture with existing literature; and (iii) we highlight GT as a meta-theory of research design and revisit some of its main principles in a mixed-design perspective.
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Introduction

In the information systems (IS) field of research, there have been regular calls for IS native theories (Watson, 2001; Weber, 2003; Markus & Saunders, 2006). Furthermore, mixing qualitative and quantitative data and methods within a single research project has been shown to provide a richer understanding of a given topic (e.g., Galliers, 1991, 1993, 1994; Lee, 1991; Landry & Banville, 1992; Mingers, 2003) for which neither a qualitative nor a quantitative approach in isolation would be sufficient (Ågerfalk, 2013), and to help draw inferences that are better and more accurate that is, 'meta-inferences', and an integrative perspective (Venkatesh *et al*, 2013, p. 26). More generally, mixing data and methods fosters theory building (Wu, 2012). Surprisingly in this context, one of the most widely accepted instruments to help theorizing with all kinds of data and within any chosen philosophical paradigm, grounded theory (GT), has been applied in a very restrictive manner in IS research. The use of GT to its full extent has been hindered by misunderstandings and the so-called 'paradigm war'.

GT has become the dominant qualitative approach since the late 1980s in many disciplines (Vryant & Charmaz, 2007). It has also been used in IS in some landmark qualitative studies (e.g., Orlikowski, 1993; Levina & Vaast, 2008), and its use in IS qualitative studies is increasing (Urquhart *et al*, 2009).

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However, GT's main purpose is, and has always been, theory building with any type of data. It was conceived for that purpose, rather than as a qualitative analysis method (Glaser & Strauss, 1967). In Glaser and Strauss' seminal 1967 work, as well as in Glaser's, 2008 full monograph on quantitative GT, it is stated that qualitative and quantitative data may be used separately or together while conducting a GT study. When developing a GT, it is therefore important to consider not only qualitative data, but also quantitative data, as these can help elaborate the theories. Yet, rarely do we see quantitative data used in a GT study and, to our knowledge, no research has attempted to show why it might actually be useful to mix qualitative and quantitative data, in order to develop, and elaborate on, a GT. This article investigates what we feel is an exciting route for theory building in IS – the use of quantitative data in mixed-design GT studies.

The present article uses a classic GT approach to investigate the design of one of our GT research projects. Thus, our object of research, the 'main concern' (Glaser, 2004), is the mixed design of this project. We briefly describe the phases of this longitudinal project about IT usage and the related theory-building journey using mixed data, methods and techniques. We do not give detailed empirical results as these are provided in other papers, which are already published and may be referred to. We describe the mixed typological GT design (GTD) that emerged from our investigations and helped us formalize the emerging theories. We summarize the results of this project and provide some methodological elements of our research only in sufficient detail to explain how our data and the emerging theories guided our research design, and how our research consequently evolved. We study how and why qualitative and quantitative data, methods and techniques were combined and mixed while respecting classic GT guiding principles and founding characteristics. Our work highlights how mixing data and techniques helped us make sense of the unfolding story towards parsimonious formal theorizing in rupture with existing literature.

The results of the present work lead us to propose a mixed typological GTD that may be applied to help and inspire other researchers in their theorizing efforts. Our results also lead us to reflect about what classic GT actually is. Our work illuminates the fact that, beyond being used as a method, technique, methodology or framework, GT is a metatheory of research design aimed at theory building, which can live in symbiosis with different philosophical assumptions. It may even be argued that GT is a research paradigm in itself (Glaser, 2005), which helps to do what it was originally proposed for, that is, to develop theories. When using this research paradigm, it is important not to hinder the researcher's creativity: beyond the general guidelines that we propose, researchers may, to some extent, adapt and reinvent the techniques they apply in order to nurture their own creativity.

The article is organized as follows. In the first section, we investigate theory building in IS research. Then, after discussing some terminological and paradigmatic issues, we go back to GT's genesis and founding principles. In the next section, we review the mainstream IS literature for mixed studies that use at least some elements of GT in their design. In the following sections, after summarizing the design of the present article, we describe one of our own substantive journeys to the land of theories. Finally, and before concluding, we discuss the GT of research design and the true status of classic GT that emerged from our work.

Theory building in IS

In order to investigate what mixed-design GT may bring to theory building in IS research, we first study in this section, the theories developed and used in the IS field.

Gregor (2006) argues that 'developing theory is what we are meant to do as academic researchers and it sets us apart from practitioners and consultants' (p. 613). After the turn of the century, attention was, however, brought to the fact that the IS research field was lacking in the area of theorizing (Watson, 2001; Weber, 2003). More recently, it has been further highlighted that IS research needs a plurality of theories and methods in order to make sense of the complex and dynamic world that surrounds us (Junglas *et al*, 2010).

In their 2006 call for IS theories, Markus & Saunders used the site http://www.istheory.yorku.ca/, which described the theories used in IS research, to find that only four of the 52 listed there originated predominantly in the IS field. In 2013, a wiki page appears to have replaced this site. Even though we could not find on the wiki page a definition for what is designated by the term 'theory', the site appears reliable as it provides in most instances the IS works that have used the proposed theories. It is supposed to take into account 'theories widely used in information systems (IS) research', with 87 such theories now listed. The originating area of 17 of these theories is indicated as being IS, together with other fields in four instances. If we remove these four instances – and another that contains no information except for the name of the theory (International Information Systems Theory) – these findings show that a greater number of theories are now used in IS and that the number of theories used originating predominantly in IS has risen from 7.6% in 2007 to 14.94% in 2013. This seems to show that, even though the situation has improved, IS research still lacks theories beyond those originating in other research fields.

Many different views of what a theory is have been given in the literature from etic (nomothetic) or emic (idiographic) perspectives. For instance, Bacharach (1989) views a theory 'as a system of constructs and variables in which the constructs are related to each other by propositions and the variables are related to each other by hypotheses' (p. 498), whereas Weick (1995) views theories as 'approximations' of a complex reality that one has to make sense of. In the present article, we will retain the all-encompassing definition provided by Gregor (2006), which is as a-paradigmatic as possible, and views 'theories

as abstract entities that aim to describe, explain, and enhance understanding of the world and, in some cases, to provide predictions of what will happen in the future and to give a basis for intervention and action' (Gregor, 2006, p. 616). Gregor investigates the structure and form of theories in IS research. She argues that the four primary goals of theory are analysis and description, explanation, prediction, and prescription (Gregor, 2006). She shows that combinations of these goals lead to five types of theories that are interrelated and should be combined: *analytic* (type I: what is), *explanatory* (type II: what is, how, why, when and where), *predictive* (type III: what is and what will be), *explanatory and predictive* (type IV: what is, how, why, when, where and what will be), and *theory for design and action* (type V: how to do). Usually, one must analyse before one can explain, predict or act. And preferably one must attempt to explain and predict, if at all possible, before one actually acts.

When theorizing, researchers produce theories at different levels of generalization; these are sometimes linked to the theory's level of abstraction: a meta-theory is at a high level of abstraction and provides 'a way of thinking about other theories' (Gregor, 2006, p. 616); a grand theory is abstract, scarce in observational details and 'unbounded in space and/or time', whereas some empirical generalizations are rich in observational details but often 'bounded in space and time' (Bacharach, 1989, p. 500). There are, however, different conceptions of generalizability, which 'refers to the validity of a theory in a setting different from the one where it was empirically tested and confirmed' (Lee & Baskerville, 2003, p. 221). Lee & Baskerville (2003) identify different types of generalizability and generalizing beyond statistical, sampling-based generalizability: generalizing from empirical statement to empirical statement (EE), that is, from data to description; from empirical statement to theoretical statement (ET), that is, from description to theory; from theoretical statement to empirical statement (TE), that is, from theory to description; and finally from theoretical statement to theoretical statement (TT), that is, from concepts to theory.

Beyond the various classifications aimed at describing theories proposed by different authors and summarized above, we would add a further consideration. When researchers theorize, they can do so through what we term *incremental theorizing*, that is, theorizing while using existing concepts/constructs or *rupture theorizing*, that is, theorizing while using new concepts/constructs. Incremental theorizing, although essential to help a research field mature and grow, represents additional information and gradual developments on existing concepts/constructs. Rupture theorizing uses nascent concepts/constructs, which were previously unrevealed and unstudied in the literature, or which were previously applied in, and adapted to, completely different domains. Rupture theorizing may involve defining and specifying these new concepts/constructs and/or investigating relationships between these and other, previously established and studied, concepts/constructs. The researcher's philosophical stance does influence the theorizing process and will, more or less, ease the path towards rupture theorizing, which is particularly essential in a 'young' field of research in search of legitimacy such as IS (De Vaujany *et al*, 2011). For instance, in a hypothetical-deductive stance, the literature is usually first investigated for clues to lay down hypotheses in a linear research approach (Cresswell, 2003; Zachariadis *et al*, 2013). Due to what has been termed the 'paradigm war', which is discussed in the next section, the predominance of quantitative studies in IS has led to mostly hypothetico-deductive research and to data poverty (as data collected are used for theory testing and not for theory building: Lyytinen, 2009; Evermann & Tate, 2011) and, consequently, to incremental theorizing. In the case of rupture theorizing, if a concept/construct has never been previously studied in a field, the literature will be of little help to describe or explain it or to develop propositions/hypotheses involving this new construct. Hence, alternative options with an exploratory stance have to be found.

As all preconceptions are to be set aside when doing GT (Glaser, 2013), adopting a GT stance often leads to theorizing in rupture with existing literature. We show in the present article why and how mixed-design GT may facilitate formal rupture theorizing, with strong generalizability of results. Before doing so, we need to address some terminological and paradigmatic issues.

Terminological issues and the paradigm war

In this section, we deal with the terminological and paradigmatic issues related to mixed design in research. In line with Johnson & Onwuegbuzie (2004), but with different philosophical assumptions, we challenge the ideas that using quantitative data automatically places the researcher within a positivist paradigm or qualitative data within an interpretive paradigm and that using both quantitative and qualitative data results in pluri-paradigmatic positioning (Mingers, 2001) or philosophical incommensurability (Kuhn, 1970). We propose (i) some definitions for constitutive elements that may be found in the design of any research project, (ii) our own simple classification for mixed-design studies, and (iii) we investigate some paradigmatic issues related to mixed-design research.

Some definitions

As highlighted by Mingers (2001), certain words may be interpreted in many different ways by different researchers; this sometimes leads to misunderstandings. In order to avoid this it is important to define terms for the present study. We do not claim these definitions to be correct across domains, but they will be used consistently throughout this article.

(1) *Methods* are the *data-collection methods* used in the research project, such as interviews, observation, filming or surveys. Contrary to commonly accepted beliefs, we do not consider that specific methods will produce

specific data: methods traditionally understood as quantitative may produce qualitative data (e.g., one may include open-ended questions in a survey that will yield qualitative data), and methods traditionally understood as qualitative may produce data that may subsequently be quantitized (Sandelowski *et al*, 2009).

(2) *Techniques* are the *instruments* used in the research project to help analyse and make sense of the collected data, such as text analysis, cluster analysis or structural equation modelling (SEM). Here again, we depart from traditional beliefs considering qualitative and quantitative instruments as completely distinct. Some techniques traditionally believed to belong to the qualitative realm may be perceived to be extremely close to the quantitative realm. For instance Glaser's (1978) selective and theoretical coding may be realized through text analysis but also through factor/cluster analyses and 'soft' SEM – traditionally considered as quantitative techniques and often used in quantitative studies.

(3) *Methodology* is *the specific combination of research methods and techniques* used in a research project; each research project may be considered as having a specific methodology, as we understand researchers as important stakeholders in their own research who may adapt the methods and techniques they adopt.

(4) *Framework* is the *general set of guidelines* proposed by some authors that a researcher may choose to follow in a given project, such as action research (Baskerville & Pries-Heje, 1999) or case-study research (Eisenhardt, 1989).

(5) *Paradigm* is the *system of 'beliefs and practices* that influence how researchers select both the questions they study and methods that they use to study them' (Morgan, 2007, p. 49). The term 'paradigm' has been understood and used in social sciences at different levels of generality (Morgan, 2007). In IS research, the tendency has been to apply it at the all-encompassing level of a world view, which includes the researchers' philosophical assumptions that traditionally impact their ontological (what exists), epistemological (what is knowledge), methodological (what set of methods/techniques may be used to obtain knowledge) and axiological (what is valuable) beliefs/choices.

A classification of mixed-design studies

Another area that requires terminological clarification relates to the terms 'mixed method' and 'multi method'.

Research that mixes data/methods/techniques has received increased attention in the last 20 or so years, and it has been used for different purposes, for example, complementarity (the purpose being to gain complementary perspectives on the same phenomenon), completeness (to obtain a complete picture of a studied phenomenon), developmental (to answer questions resulting from previous inferences), expansion (to expand understanding), corroboration/confirmation (to assess credibility), compensation (to compensate for weaknesses of each set of methods) and diversity (to obtain divergent views) (Venkatesh *et al*, 2013). These authors propose an extensive review of the various interpretations of the two terms 'mixed method' and 'multi method', which have been used to designate a variety of types of research. We do not claim to reconcile all divergent views, but note that much is said about methods/techniques – and little about data – in the mixed-methods/multi-methods literature. It is, however, important to stress that methods/techniques do not mean much without data, since 'data is a necessary basis on which to build theories' (Evermann & Tate, 2011, p. 634) and, in most cases, you need good data to produce good theory (Lyytinen, 2009). Cresswell (2009) mentions that 'qualitative data consists of text and images and quantitative data, numbers' (p. 207). The term 'quantitative data' is mostly used to describe a type of information that may be counted or expressed numerically and is amenable to statistical analysis (Monette *et al*, 2011), whereas 'qualitative data' provides explanation for and information about something in the form of words and involves in-depth description (ibid.). However, a researcher may choose to 'quantitize' qualitative data (Sandelowski *et al*, 2009) or to 'qualify' (Cresswell, 2007) – or 'qualitize' (Sandelowski, 2000) – quantitative data. A researcher may also use secondary data in various ways, with different techniques, regardless of the methods used to collect these data. Hence, the situation is far from clear. Also, the different definitions given by various authors about the terms 'mixed methods' and 'multi methods' (see Venkatesh *et al*, 2013) are often, in our own reading, epistemologically biased, as they link methods and world views. Therefore, we would rather consider in our work a different classification of research in terms of design: quantitative design, qualitative design and mixed design, this classification being close to the one adopted by Cresswell (2009).

In a quantitative design, the researcher uses quantitative data, collected with 'traditional' quantitative methods (e.g., surveys) and analysed with the help of 'traditional' quantitative techniques (e.g., principal-component analysis). In a qualitative design, the researcher uses qualitative data, collected with 'traditional' qualitative methods (e.g., interviews) and analysed with the help of 'traditional' qualitative techniques (e.g., text analysis). In a mixed design, the researcher includes and combines quantitative and qualitative data, methods, techniques, concepts and/or language (Johnson & Onwuegbuzie, 2004); data collection and data analysis may be conducted using a parallel, concurrent or sequential approach; and data can be integrated at the collection or analysis stage (Ostlund *et al*, 2011). In some works in the literature, the time ordering of the quantitative and qualitative phases – as well as the degree of dominance of either qualitative or quantitative methods – has been investigated, leading to various possible combinations, but the integration of all data is mostly envisaged only as a

final stage of the analysis (Johnson & Onwuegbuzie, 2004), when all the data have been collected and analysed.

We propose to broadly classify mixed-design studies in two types: *type 1, differentiated mixed-design (MD1) studies* and *type 2, embedded mixed-design (MD2) studies*. As it is not the object of the present work, this classification is intentionally very broad for simplification purposes. In an MD1 study, the researcher conducts in one single project what may be understood as two separate studies: a quantitatively designed study and a qualitatively designed study; each study is complete in itself. For example, one may choose to do some interviews and collect qualitative data, which are then analysed; one may then use these data and the results of the analysis to develop and lay down hypotheses. One may then collect quantitative data and verify the hypotheses using statistical methods (e.g., Spears & Barki, 2010). Or one may conduct separate quantitative and qualitative studies investigating the same phenomenon, and eventually compare the results of the two studies (e.g., Kaplan & Duchon, 1988). Even though an MD1 study does not always explicitly underline the paradigmatic dichotomy between interpretivism/qualitative methods and positivism/quantitative methods, it often implicitly does so through its research design: exploring through qualitative design and verifying through quantitative design.

Finally, in an MD2 study, the researcher uses quantitative and qualitative data and analyses them as one set with the help of those quantitative and/or qualitative techniques that the researcher thinks will best serve the purpose of her/his research and are congruent with her/his philosophical assumptions. The different quantitative and qualitative data, methods and techniques are mixed and supplement each other within a single project. Neither qualitative nor quantitative data are sufficient in themselves to theorize or verify: *all are necessary*. The researcher may need to qualify quantitative data (e.g., make sense of the results of the factor analysis of quantitative data with the help of collected qualitative data) or quantitize qualitative data as a compromise between numerical precision and narrative complexity (Sandelowski *et al*, 2009). An MD2 project may be qualitatively or quantitatively driven, depending on the 'core' method (Morse, 2003); the other 'imported' methods serve to enlighten and are supplemental to the 'core' method. The theoretical drive of an MD2 study may be overall inductive, with description, discovery and/or exploration as purposes of the research (as is the case for GT studies). Or the drive may be deductive, if confirmation is the purpose. Finally, an MD2 research adopts explicitly or implicitly one single paradigm or world view.

In the present work, we are more specifically interested in MD2 research projects. As Mingers (2003) suggests, we detach the research methods, techniques, methodology and framework from the researcher's philosophical assumptions, as we believe it is essential to break the dichotomy that still appears to exist in IS research. We think neither that using quantitative data, methods and/or techniques forcibly confers a confirmatory, hypothesis-testing positivist stance nor that using qualitative data, methods and/or techniques forcibly confers an exploratory interpretive stance. From the perspective taken in this article, qualitative and/or quantitative techniques, methods, and data can suit different existing paradigms and, when mixed, 'have the potential to foster theory building' (Wu, 2012, p. 175).

Paradigmatic issues

Over the past 20 years, as mixed design was attracting growing interest in many fields, there has been an important debate about the rationale for combining methods previously considered as incompatible due to the paradigms presumed to be linked to these methods (Bryman, 1998; Hall, 2012). This dispute has led to philosophical 'caricatures' (Bryman, 1998) at each end of a continuum. In IS research, at one end, quantitative purists espouse a positivist philosophy and adopt the 'natural science model' (Bryman, 1998) with independent and dependent variables, and quantitative data (Lee & Hubona, 2009): the observer is separate from the object of study; science is objective and aims to uncover laws that are time- and context-free; and the focus is on deduction, confirmation, hypothesis-testing and quantitative analysis (Johnson & Onwuegbuzie, 2004). Causality is understood from a Humean perspective ('A causes B'). At the other end of the continuum, qualitative purists espouse an interpretive philosophy associated with ethnography, hermeneutics and some forms of case research, interpreting settings and contexts to take the 'natives' point of view' (Lee & Hubona, 2009, p. 238): realities are multiple and socially constructed, so that knower and known cannot be separated; research is subjective and value-bound; causes and effects cannot be differentiated; and the focus is on induction, exploration, discovery and qualitative analysis (Johnson & Onwuegbuzie, 2004).

Hall (2012) shows that, in order to solve this issue, researchers who mix data, methods and/or techniques have adopted three alternative approaches: a-paradigmatic (which simply ignores the paradigm issue), multiple paradigm (which draws on several paradigms) and single paradigm (which draws on one paradigm). We take the third approach. While paradigms are incommensurable (Kuhn, 1970), data, methods and techniques need not be so (Van Maanen, 1979): mixed design can be accommodated within different single paradigms. The logic of justification must not be confused with the methods/techniques; this logic dictates neither the type of data collection nor the techniques a researcher should use (Onwuegbuzie & Teddlie, 2003). As these authors remind us, 'although many research procedures or methods typically have been linked to certain paradigms, this linkage between research paradigm and research methods is neither sacrosanct nor necessary' (Johnson & Onwuegbuzie, 2004, p. 15).

Many qualitative and quantitative researchers have now reached an agreement on some major issues (Johnson & Onwuegbuzie, 2004): reasoning is relative and varies among people; observation is an approximation of reality; a single set of empirical data can yield different befitting theories; hypotheses are linked to assumptions; probabilistic evidence is not final proof; and researchers' beliefs are embedded in their communities' assumptions. Both quantitative and qualitative methods and data are important and may be useful in a research project, irrelevant of the researcher's philosophical positioning, which will, however, influence the way methods and data are used/mixed and results analytically treated (Sandelowski, 2000).

Having addressed some terminological and paradigmatic issues related to mixed design, and as there have been calls in IS to leverage GT for its original and main purpose – theory building (Urquhart *et al*, 2009) – we revisit in the next section GT and its founding principles.

Revisiting GT

Even though Denzin & Lincoln (1994) labelled GT as post-positivist, GT was described by Glaser & Strauss (1967) as accommodating any epistemological perspective. It is so much the case that the authors of the 1967 book come from different epistemological academic backgrounds: positivism for Glaser, and symbolic interactionism for Strauss. However, Glaser was often critical of his original academic background, which inspired him to create the term 'theoretical capitalism' to describe the natural science model, whereas Strauss remained close to his own (Simmons, 2011). These elements might explain why GT research has been conducted using a variety of underlying philosophies, from neo-positivist to constructivist (Annells, 1996; Sandelowski, 2000), and it has been witnessed that many different epistemological and ontological stances can live in symbiosis with GT (Gummesson, 2011). Various authors have proposed different GT frameworks; beyond Glaser's all-encompassing classic vision, the main frameworks are those proposed by Strauss & Corbin (1990), and by Charmaz (2008), mostly linked to differing underlying philosophical assumptions, and applied using qualitative data and methods.

Many researchers in different research fields currently apply GT as a coding technique, as a 'toolbox' (Seidel & Urquhart, 2013) combined with qualitative techniques, or as a framework: during the past decades, 'GT has become a whole range of applications from orthodox and classic GT to GT light … to one-calorie-only GT' (Gummesson, 2011, p. 232). In IS research, Matavire & Brown (2011) find that GT has been used with four different approaches. First is the 'classic' (or Glaserian), and second the 'evolved' (or Straussian) approach. Some of our Glaserian grounded-theorist friends find the term 'evolved' biased and even offensive, but we have kept it here to relate to Matavire & Brown's (2011) work. Matavire and Brown consider that these first two approaches apply the full set of GT guidelines, with two main differences: the use of the 'paradigm model' in the 'evolved' approach, and the role of the *a priori* theory and literature review, about which the 'evolved' approach is more lenient (the 'classic' approach preferring not to investigate the literature until some data has been collected and analysed, and the resulting theory has started to emerge). Third, the data-analysis approach uses only some of the techniques and/or coding procedures of classic or evolved GT; this approach neither uses a full GT framework nor, in most cases, develops theory. Fourth is the approach that mixes GT with other frameworks, such as grounded action research (Baskerville and Pries-Heje) or the grounded case-study approach (Eisenhardt, 1989).

The roots of GT lay in Paul Lazarsfeld's inductive quantitative methodology (Christiansen, 2008). To develop GT, Glaser used Lazarsfeld's elaboration analysis of quantitative data, together with his own method of consistency analysis. Since its inception by Glaser during his doctoral dissertation and its detailed description by Glaser & Strauss in their seminal 1967 book, GT has been constantly 'in flux' (Mills *et al*, 2006). Using Glaser's term, it has been 'remodelled' (Simmons, 2011) and applied from different perspectives (Holton, 2011), and thus has different meanings for different people (Somekh & Lewin, 2011). In the 1967 book, GT was proposed to attempt closing 'the gap between theory and empirical research' (Glaser & Strauss, 1967, p. vii), to 'develop canons more suited to the discovery of theory' rather than to the testing of existing theories and, finally, to 'ground theory in social research itself for generating it from the data' (ibid, p. viii). GT's main thrust is, thus, generating theories about social phenomena grounded in data, any type of data, and derived from a systematic analysis of these data. (Lingard *et al*, 2008, p. 459).

Hence, to sum up, GT first emerged with quantitative data; Glaser then extended it with Strauss to qualitative data. A GT may thus be generated using qualitative and/or quantitative data, methods and techniques. A GT is derived inductively from any data (quantitative and/or qualitative), used in any way and in any combination: this has been stated by Glaser a number of times as he says himself (Glaser, 2008). However, GT is still mostly used as a qualitative methodology (Fernandez *et al*, 2007; Jones & Noble, 2007; Holton, 2008).

The original 1967 book provided no detailed methods or methodology as such, but rather founding principles and guidelines. These main principles include theory building (the end purpose of a GT study), exploration and emergence (concepts and relationships come from the data and are not preconceived or imposed on data), theoretical sampling (sampling is directed by the emerging theory and continues until theoretical saturation), and constant comparative analysis (data are continuously compared with previously collected and analysed data, looking for similarities and differences to help towards conceptualization and theorization). These principles have been highlighted, commented upon and summarized in the IS research field by various authors (see for

instance Birks *et al*, 2013; Urquhart *et al*, 2009). As a complement to this we propose a graphical summary of their integration in Figure 1.

The double arrows in Figure 1 illustrate the constant comparative analysis and 'inextricable link between data collection and analysis' (Birks *et al*, 2013, p. 3) leading to the discovery of patterns, which in turn guide further theoretical sampling until theoretical saturation is reached.

In order to understand the results of the present research, and how mixing data, methods and techniques may help a researcher's theorization efforts, we found that one has to delve further into Glaser's work, subsequent to the 1967 seminal book. Some important clues may be found in Glaser's (1978) broad coding proposal (substantive and theoretical) and in his work about formal GT (Glaser, 2007).

Substantive coding includes both open coding (that is coding data into categories that are not preconceived *ex ante*, and continuing until a core variable is identified), and selective coding (that is coding those variables that relate to the core variable). One essential element in GT is the emergence of the core category/variable, which recurs frequently in the data and accounts for much of the variation in the pattern of behaviour or phenomenon of interest, and around which the theory is being built. Glaser (1978) stresses that GT is based on a 'concept- indicator model' (p. 62) and that one should not stop at first-order concepts/constructs. This concept-indicator approach, described by Glaser in 1978, has been illustrated for qualitative research in *Management Science* by Gioia *et al* (2013). Hence, once the core category/variable has emerged, one of the purposes of selective coding is to identify the indicators for the properties and/or dimensions of this main concept/construct and Glaser (1978) shows that this can be done through a typological effort. The differentiating criteria of a GT typology must, however, be 'earned distinctions, not received distinctions' (p. 65), and each type must make a difference in the theory as otherwise they can be collapsed with other types. This highlights the importance of *parsimony* while one aims at theoretical saturation and more particularly when one uses a typological approach.

Once substantive coding has been effected, theoretical coding may then be conducted, that is coding for relationships between substantive codes to be integrated as propositions/hypotheses into a theory. Theoretical coding is carried out to help conceptualize how substantive codes might relate to each other and 'weave the fractured story back together again' (p. 72). Glaser (1978) stresses that confusions between covariance, causality and anticipated consequence should be avoided. To generate theory, it is therefore essential to have 'the fullest range of theoretical coding possibilities' (p. 73) to help towards *sense-making*.

The ultimate aim of GT is substantive or *formal theory building*. A substantive theory reaches beyond analysed data and observed incidents but applies to the substantive area of enquiry (Urquhart *et al*, 2009). A formal theory is abstract in terms of time, place and people until it is applied (Glaser, 2007); it has been defined by Glaser (2007) as 'a theory of SGT [substantive GT] core category's general implications, using, as widely as possible other data and studies in the same substantive area and in other substantive areas' (p. 99). A formal GT has no predetermined level of abstraction, as this will be determined by the theoretical sampling and the data used. It allows generalizing on a core category from different substantive areas 'with more multivariate conceptual complexity' (Glaser, 2007, p. 100). The formalization of a substantive GT involves starting with an existing substantive theory; its aim is, however, to 'enhance the theory, widen its scope or in other ways improve it – but not to verify or falsify it' (Urquhart *et al*, 2009, p. 4). The formalization of a substantive GT will therefore always involve the full GT process. To sum up, theorizing is a continuum (Runkel & Runkel, 1984; Weick, 1995): a substantive theory can be understood as what Weick (1995) terms an 'interim struggle', an early stage of formal theoretical development leading towards further development and stronger formal theory at a 'higher gradation of abstractness and generality' (p. 385).

Even though our full understanding of classic GT only emerged as a result of the present work and will be further discussed in subsequent sections, we provide here a theoretical preview and state some of our findings in order to facilitate reading the present article (Suddaby, 2006).

For this article, and in a grounded fashion, we took the design of one of our mixed GT research projects as an object of research. We investigated more specifically how and why we were driven to use this specific design. We found that we mixed data, methods and techniques to help *sense-making as we worked towards parsimonious formalization of the substantive rupture theories* that were emerging through our work. We also found that GT, as described in Glaser & Strauss (1967) and elaborated on by Glaser in subsequent publications, is a meta-theory of research design aimed at theory building. This meta-theory is adapted and extended by researchers as they apply it (Glaser, 2005) and has thus been 'remodelled'

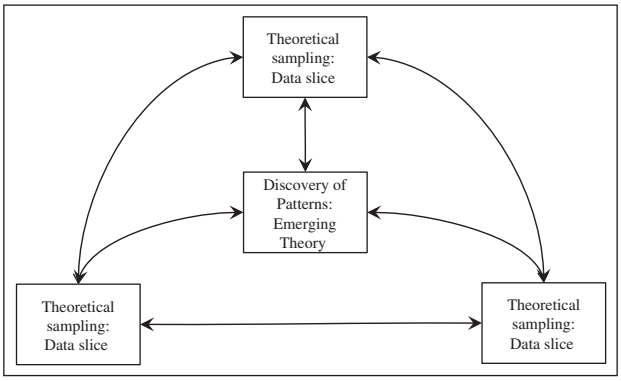

Figure 1 The emergence of a theory grounded in data.

numerous times (Glaser, 2003). This remodelling often leads to substantive GTDs, developed by researchers for specific research projects. Some of these substantive GTDs have been formalized into frameworks, for example those of Strauss & Corbin (1990), of Charmaz (2009) or even of Glaser himself in his 2008 monograph that provides a framework for quantitative GT.

Before detailing our findings and how they were obtained, we first investigate mixed GTD studies in IS research.

Mixed GTD in IS research

Previous sections shows how IS research begs for new theories, which might be richer if they use mixed data, and that GT's main purpose is theory building with any kind of data, even though it appears to have mostly been applied with qualitative data. We therefore decided to verify whether IS research has availed of GT's full affordances and whether we could identify some mixed-design GT studies in the literature. In this section, we investigate in the mainstream IS literature which studies used mixed GTDs, and how they went about this. We search for mixed-design studies that use qualitative and quantitative data and methods, with any one of the four GT approaches described by Matavire & Brown (2011) as having been applied in IS research.

For our preliminary search, we used the Publish or Perish (POP) software (Harzing, 2007), which uses Google Scholar as its database. We searched for the following terms anywhere in the text of articles: 'grounded theory' + ('mixed method', 'mixed-method', 'multimethod', 'multi method' or 'multi-method') + 'quantitative' + 'qualitative'. Our preliminary search was carried out using the terms 'mixed method' and 'multi method' as there is no consensus on the definition of these terms. However, we kept our subsequent analysis of the resulting articles within the terminological boundaries defined in a previous section. As the search was made anywhere in the text of articles, this includes (in POP) the references quoted in the articles; thus, even if authors choose not to mention GT in the article itself, they usually have to at least mention the use of GT coding techniques, in which case they would have to cite a work, which most probably has 'grounded theory' in the title (e.g., Glaser & Strauss, 1967, or Strauss & Corbin, 1990).

We investigated articles published in the Senior Scholars' Basket of Journals, shared by the Association for Information Systems (December, 2011): the *European Journal of Information Systems*, the *Information Systems Journal, Information Systems Research*, the *Journal of the Association for Information Systems*, the *Journal of Information Technology*, the *Journal of Management Information Systems*, the *Journal of Strategic Information Systems*, and *Management Information Systems Quarterly*. We then double-checked our results on the site of each of the investigated journals more specifically for recent 2012–2013 publications, as we feared that recently published articles might not yet be indexed in Google Scholar: We identified several articles this way. Our search yielded a total of 44 articles. All articles were read and analysed. Non-empirical and/or conceptual studies concentrating on research methods and/or design were eliminated. Those empirical papers that did not fit our research objectives (use of both qualitative and quantitative data and/or quantitative and qualitative research methods/techniques in a GT approach) were also eliminated. Besides one of our own recently published works, we were left with only 13 studies that possibly fitted our enquiry (see Table 1).

Using the classification we proposed in a previous section for mixed method studies, we found that the 13 studies were split between two main groups: MD1 GT studies and MD2 GT studies.

In the first group (MD1 GT studies: see Figure 2), all studies appear only to use a GT approach during their

Table 1 Mixed-design GT studies published in IS main stream research outlets

Citations	*Multiple paradigms with explicit dichotomy*	*Multiple paradigms with implicit dichotomy*	*A-paradigmatic*	*Single paradigm (Critical realism)*	*Design Type*
Kaplan & Duchon, 1988	√				MD1 GT Differentiated mixed-design studies
Soffer & Hadar, 2007	√				
Trauth & Jessup, 2000	√				
Wu, 2012	√				
Gable, 1994		√			
Spears & Barki, 2010		√			
Wong *et al*, 2011		√			
Zahedi & Bansal, 2011		√			
Ågerfalk & Fitzgerald, 2008			√		MD2 GT Embedded mixed-design studies
Bajaj, 2000			√		
Dennis & Garfield, 2003			√		
Feldman & Horan, 2011			√		
Larsen, 2003			√		
Walsh, 2014				√	

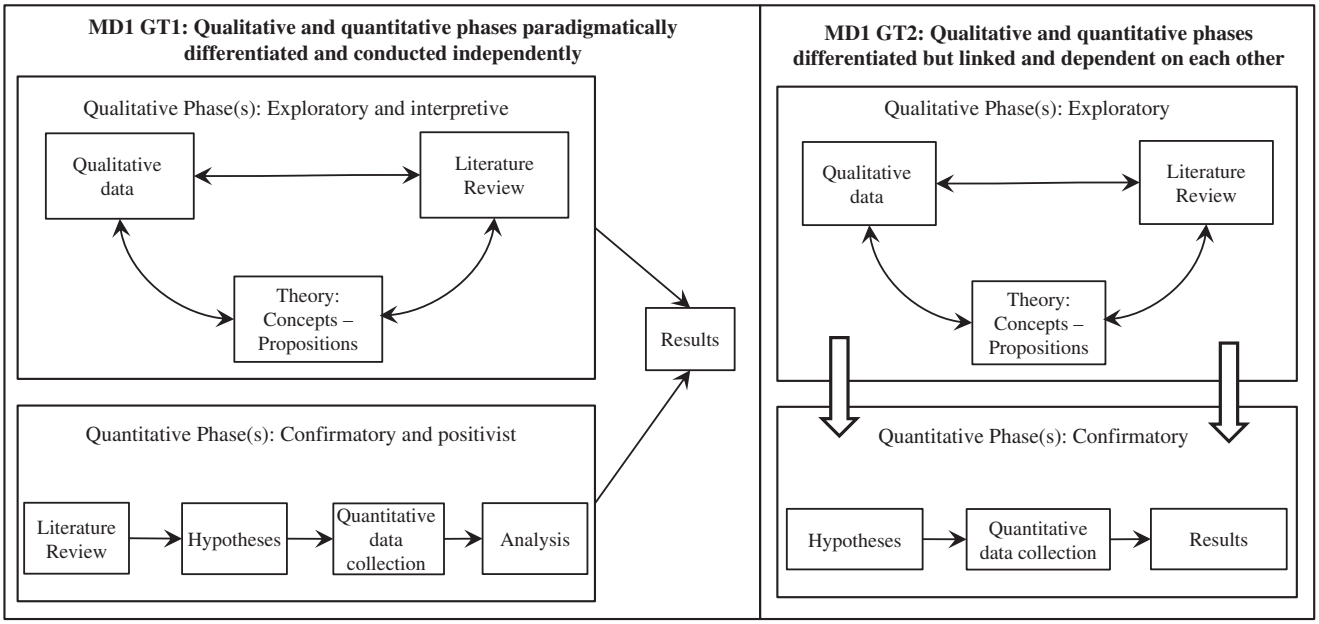

Figure 2 Designs of MD1 GT studies published in IS mainstream research outlets.

qualitative phases. We identified two subgroups in MD1 GT studies. Four of the studies (whose design is named here 'MD1 GT1': Kaplan & Duchon, 1988; Trauth & Jessup, 2000; Soffer & Hadar, 2007; Wu, 2012) maintain what we consider an explicit *paradigmatic dichotomy*. They paradigmatically differentiate the qualitative and quantitative phases (interpretivism for exploratory phases *vs* positivism for confirmatory phases) and conduct them independently of each other. They integrate and discuss the results of the qualitative and quantitative analyses as a last stage of the research.

Four other studies (whose design is named here 'MD1 GT2': Gable, 1994; Spears & Barki, 2010; Wong *et al*, 2011; Zahedi & Bansal, 2011) start to break the dichotomy as, though clearly differentiated (exploratory versus confirmatory), the qualitative and quantitative phases are linked and depend on each other. These studies appear first to use qualitative methods, data and techniques in a GT approach to propose hypotheses, and then to use quantitative methods, data and techniques to test these hypotheses. This is summarized in Figure 2.

The six studies of the second group (MD2 GT studies, see Figure 3: Bajaj, 2000; Dennis & Garfield, 2003; Larsen, 2003; Ågerfalk & Fitzgerald, 2008; Feldman & Horan, 2011; and Walsh, 2014) do mix qualitative and quantitative methods, data and techniques without any explicit or inferred paradigmatic dichotomy. However, all of them but one (Walsh, 2014) take an 'a-paradigmatic' stance (Hall, 2012), or at least they do not express their underlying philosophical assumptions in a precise way. Regardless of the time ordering of the qualitative and quantitative phases, all studies remain in an exploratory stance while using both qualitative and quantitative data, and highlight the emergence of theory from all collected data:

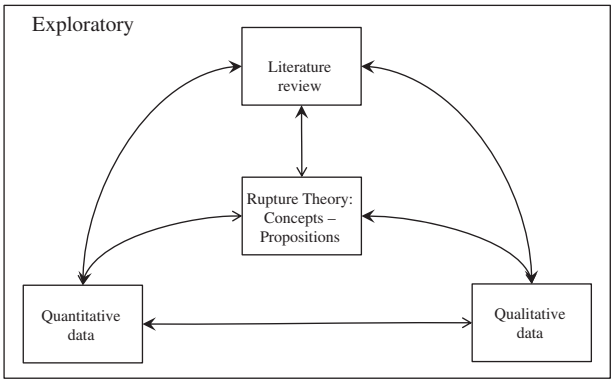

Figure 3 The design of MD2 GT studies published in IS mainstream research outlets.

qualitative and quantitative phases and analyses are embedded as the research moves towards what may be considered as *rupture theorizing*.

In the next sections, we first describe the methodology applied in the present research to investigate the GTD we used in one of our research projects. We describe this project and summarize its different phases. We investigate what drove us to develop and apply an embedded mixed (MD2) GTD to this project and discuss our findings.

Design of the present research

The present work uses a classic GT approach to investigate the design of one of our research projects. In this section we elaborate on our philosophical stance as well as on the data collection and the coding applied in the present work.

A critical realist stance

Our underlying philosophical assumptions adopt a critical realist world view (Bhaskar, 1978, 1979, 1989, 1998, 2002). A debate about critical realist precepts is beyond the scope of the present article, and the reader could refer to Mingers (2004) for a summary of the main features of this philosophical stream of thought and to Zachariadis *et al* (2013) for the resulting interpretations concerning the validity and quality of inferences in mixed method research.

It is, however, necessary to indicate here that, for a critical realist, reality is multi-faceted and may be perceived differently by different individuals, and in different contexts. Critical realists consider, however, that an 'intransitive domain' exists independently of our perceptions. In the ontological domain, critical realism holds a realist view and, in the epistemological domain, it accepts the 'relativism of knowledge as socially and historically conditioned' (Mingers, 2004, p. 91). Through retroduction, critical realism aims to discover the underlying structures that generate specific patterns of events or non-events, and welcomes quantitative and/or qualitative data, methods and techniques. The critical realist retroductive approach to knowledge creation, very well elaborated on by Zachariadis *et al* (2013), is fully congruent with the necessary emerging quality of grounded theories.

It is also essential to clarify what causality means for a critical realist, as theories are often conceived as centred on causality, that is, the relationship between a cause and an event (Gregor, 2006). The notion of causality as a 'generative mechanism' is a core and defining feature of critical realism (Bhaskar, 2002). Generative mechanisms are best understood as 'tendencies', as their activation is highly context-dependent (Bhaskar, 2002). In contrast with the Humean vision of causality ('A causes B') commonly accepted in traditional positivist quantitative circles in IS, a generative mechanism can be reformulated as 'A generates B in context C' (Cartwright, 2003; Smith, 2010). For a critical realist, causality is, thus, a process of how causal powers are actualized in some particular context, a process in which the generative mechanisms of that context shape (modulate, dampen, etc.) the particular outcomes. For instance, wood in a camp fire (A) will have a tendency to generate heat (B) if somebody has put together the right elements for the fire to burn adequately and has put a light to it, and if it does not rain on the fire (C). Thus, even though some regularity in events may be empirically derived, critical realism does not look for universal laws and recognizes the significant role of context, social structures and individual agencies in causal explanations.

Data collection and coding

Glaser (1978) and Strauss (1987) both suggest the use of theoretical memos, where the researcher breaks off from analysing the data to theorize about it. These memos play a vital role in helping the researcher build the theory; they are the witnesses of her/his 'interim struggles' (Weick, 1995). Beyond the many unpublished memos that punctuated the research project that we are investigating, we consider that published conference papers and journal articles are also memos, as they informed our on-going theorization. The data we used for this article are extracted from these published memos (Walsh & Kefi, 2008a, b; Walsh, 2009; Walsh & Gettler Summa, 2010; Walsh *et al*, 2010; Walsh, 2014).

The data used for the present article were coded and recoded several times and led to various memos, which were submitted to reviewers during the different rounds of review for the present article. Through substantive coding, different categories emerged from the data, such as *parsimony, sense-making, formalizing, reflective*. The 'main concern' (Glaser, 2004) is the mixed GTD of our research project. The core category that emerged from our work as largely explaining this main concern is *Formalizing* and its properties, *Parsimony* and *Rupture*. Another important category that emerged as related to our core category is *Sense-making*. Once the core category had emerged, we used Nvivo 10 software to help us code the other categories around it, and mainly to help us write the present article, that is, to help us with the theoretical coding of our data (see Appendix A for details of the nodes used). Descriptions of the emerging categories and the resulting theories related to mixed GTDs are provided in the next sections.

A mixed-design GT study

On the basis of the definition of mixed design we proposed in a previous section of the present work, a mixed design is a design that uses mixed methods (of data collection) and/or mixed data and/or mixed techniques. To develop the present GT about mixed GTDs, we used some of our articles published in journals or conferences as memos and sources of data. Some of these memos use qualitative methods, data and techniques and some use mixed methods, data and techniques. Therefore, we do not use in the present work mixed methods (of data collection) or mixed techniques, but we do use mixed data as some of our memos include quantitative data. Hence, following our own definition of mixed design, we do use a mixed design in the present GT study to investigate the mixed design of one of our GT research projects.

A journey to the land of theories using mixed-design GT

In this section, we first briefly summarize the different phases of the project whose design we investigated, and the empirical results of each phase. We investigate what we did in each phase in terms of design, how we remained reflectively in a GT stance while mixing data, methods and techniques, and the elements that emerged as the reasons why we had been driven to develop and apply the mixed design that we used.

Summary of our mixed-design project

The overall purpose of the investigated project, which included four phases, was to investigate, from a new

perspective, IT usage, which is a central construct in IS research. This project adopted a GTD because GT is particularly helpful in developing new perspectives on well-established theoretical research areas (Sousa & Hendriks, 2006). The four different phases of our research project together with the methods used to collect data, the techniques applied, as well as the various categories, relationships between categories and theories emerging from each phase are summarized in Table 2 and briefly described in this section. The published memos, which described the emerging theories of the investigated project, and were the sources of the data used for the present work, are summarized in Figure 4. As we were within a GT approach, looking for theories grounded in data, the type of generalizability we aimed at during all phases of the project was from data to description, concepts and theory that is, EE and ET generalizability (Lee & Baskerville, 2003).

The qualitative phases – a user profile typology explained by users' IT culture During the first two phases of our research project, we used the 'evolved' GT framework with qualitative data collected in a focus group and interviews and that we analysed and coded (open, axial and substantive coding: Strauss & Corbin, 1990) through text analysis and with the help of NVIVO software. The focus group and 13 interviews conducted during the first phase led us to a type I analytic theory (Gregor, 2006) through which our core category (IT culture: the set of IT-related values espoused by individuals) started emerging; at this stage, we investigated the literature, started theorizing about this emerging concept (Walsh & Kefi, 2008a) and identified some user ideal types from our data (Walsh & Kefi, 2008b). However, none of our emerging categories were saturated. We therefore conducted 41 further interviews during the second phase, which led us to a type II explanatory theory (Gregor, 2006).

We identified 18 dimensions of the IT culture construct, related to user needs and motivations, as well as three attitudinal user groups (refusal, passive and pro-active). We proposed a user typology with nine IT culture ideal types explained through user needs and motivations (Walsh *et al*, 2010). The users' IT culture and IT values were found to evolve simultaneously with the emergence and development of their IT needs and through various types of motivation. We showed that evolving IT culture user profiles are influenced by the socio-organizational context and can be guided towards other types of profiles that might help fulfil organizational IT needs. These elements summarize the theory of IT culture creep (Walsh *et al*, 2010) that emerged from the qualitative phases.

Table 2 The design of our journey to the land of theories

Design	*Phases*	*GT stance*	*Data collection methods*	*Techniques used to code the data*	*Emerging categories*	*Emerging relationships between categories*	*Resulting theory and published memos*
Qualitative	1	Evolved framework	Focus group and 13 interviews	Text analysis	IT culture at the individual level (core category) User profiles	Attitudinal groups	Theorization about the concept of IT culture Description of some user profiles (Conference Papers: Walsh & Kefi, 2008a, b)
	2	Evolved framework	41 interviews	Text analysis	18 dimensions related to users' needs and motivations IT culture user ideal types	IT culture user ideal types	Typology of user profiles explained through their needs and motivations. Dynamics between profiles. IT culture creep (Journal article: Walsh *et al*, 2010)
MD2 GT2	3	Classic GT	Survey (95+247 respondents for pre-test and pilot test) Interviews with some of the respondents	Text analysis (quali data). Exploratory factor analysis and cluster analysis (quanti data)	Two new user ideal types. Reduction from 18 to 8 concepts/ constructs to differentiate users	Amended user ideal types	Amended typology of user profiles explained through their needs and motivations (Conference Papers: Walsh, 2009- Walsh & Gettler Summa, 2010)
	4	Classic GT	Survey (282 respondents) Multiple interviews with 7 participants	Text analysis (quali data) Exploratory factor analysis, PLS SEM (quanti data)	Global IT needs Contextual IT needs Situational IT needs	Expressed through various propositions	A new path to explain and predict IT usage (Journal article: Walsh, 2014)

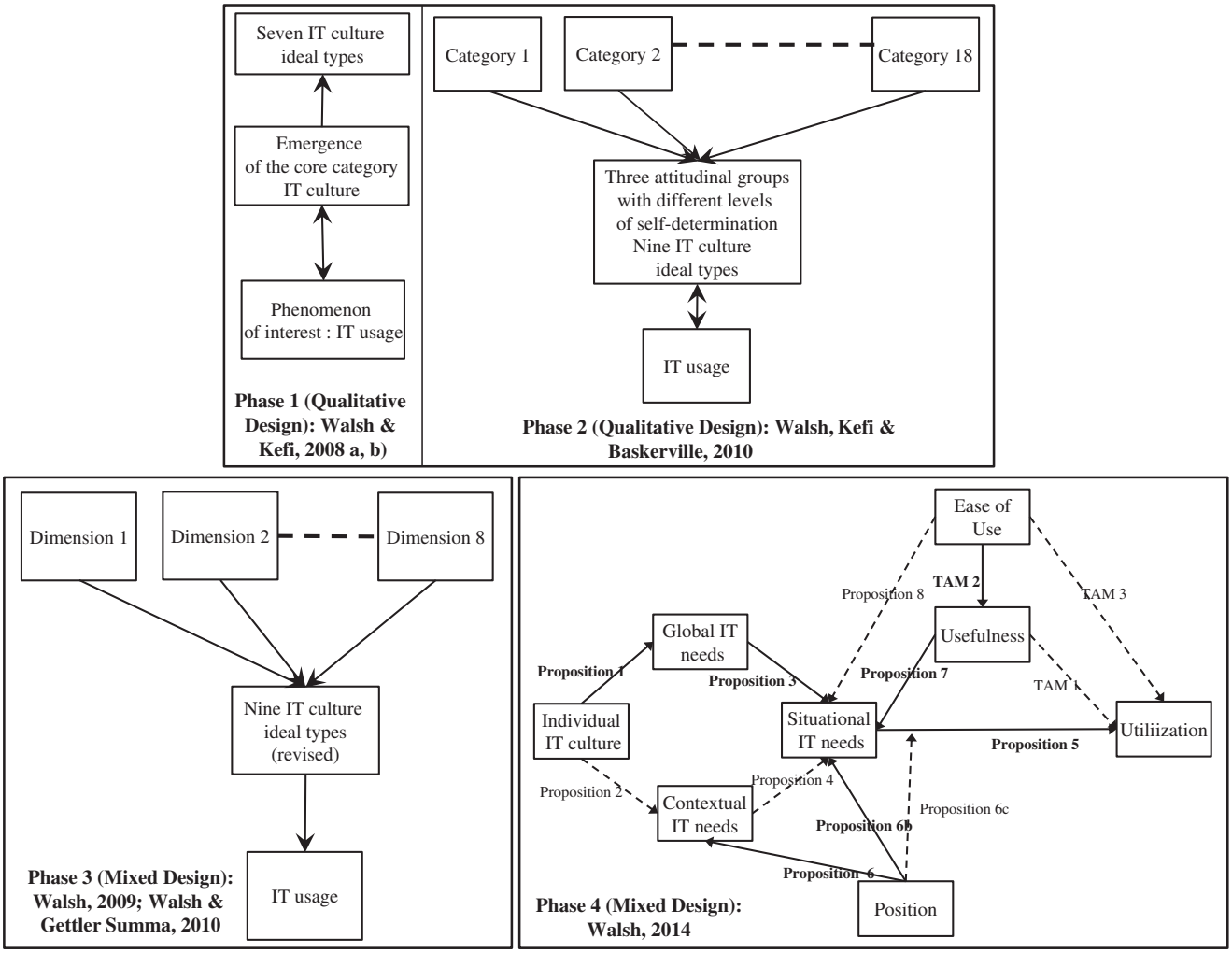

Figure 4 Our published memos: The different ports of call during our journey.

The mixed phases – amending the qualitative typology and theorizing in rupture with existing literature We adopted a 'classic' GT stance for the last two phases of our project (the reasons for this are discussed in a subsequent section), mixing data (qualitative and quantitative), methods (interviews and surveys) and techniques (text analysis for qualitative data; exploratory factor analysis, cluster analysis, and partial least squares (PLS) structural equation modelling for quantitative data). Data were coded with the help of software but also, in some instances, hand-coded on a table (see Walsh, 2014). The third phase led us again to a type II explanatory theory (Gregor, 2006). With our extended data set, we reduced the dimensions of the IT culture construct from 18 to 8. We also identified two further ideal types and found that two other previously identified ideal types were subgroups of several others, thus leading to an amended typology of user profiles (Walsh, 2009; Walsh & Gettler Summa, 2010). These results extended, refined and formalized the theory developed during phase 2. The fourth phase led us to a type IV explanatory and predictive theory (Gregor, 2006) in rupture with existing literature. During this last phase, we proposed a new path to explain and predict IT use, expressed through various propositions linking users' IT culture and IT needs to their IT usage (Walsh, 2014).

Mixing data reflectively within a GTD

We do not describe here how we mixed data in detail during the last two phases of the investigated project, as this may be found in the articles already published about this project. However, we highlight some main elements that, more specifically, necessitated a reflective approach when we mixed qualitative and quantitative data and we provide illustrative information.

Remaining in an exploratory stance while using mixed data During all phases, we remained in an exploratory stance, in line with our GT approach; we let ourselves be guided by our diverse data, and by the story and theories

that unfolded. We avoided laying down any hypotheses even while using quantitative data and techniques. This was delicate as even those quantitative instruments originally intended for exploratory purposes can be used more or less so and some software algorithms could drive the 'unaware' researcher using them to make hypotheses at certain stages during application of the relevant procedures; however, we were very careful not to do so. We remembered Glaser's (2008) advice and did not apply the various quantitative techniques we used in a mechanical fashion. We aimed at understanding the meaning behind the techniques and, when we used specific software to apply these techniques, the meaning behind the algorithms used by the software. We made sure that the way we used and adapted these techniques allowed us to remain in an exploratory stance while coding data as per Glaser's substantive and theoretical coding procedures summarized in a previous section. We give some examples of this below.

During the last two phases of our project, we used exploratory factor analyses, whose purpose is 'to examine the underlying patterns or relationships for a large number of variables and to determine whether the information can be condensed or summarized in a smaller set of factors or components' (Hair *et al*, 2006, p. 101). This quantitative technique helped us with the selective and theoretical coding of our quantitative data by sorting our data 'into the appropriate pile' (Glaser, 2004, p. 19). When applying this technique while using SPSS software, we made sure not to inform the software with the number of factors we could have expected (based on previous qualitative phases and results), and let the new slices of quantitative data inform us of the emerging number of factors.

During phase 3 of the project, we used cluster analysis, a statistical data analytic method viewed mainly as an exploratory technique (Hair & Black, 1998) and whose main purpose is 'to group [in clusters] objects [or people] based on the characteristics they possess' (Hair *et al,* 1995, p. 423). High within-cluster homogeneity and between-cluster heterogeneity is aimed at. Cluster analysis is very close to the GT comparative method (Glaser & Strauss, 1967) and has been highlighted as such in the literature (Larsen, 2003). It searches for non-obvious patterns and relationships between important sets of data. However, the way one uses cluster analysis (or any other multidimensional scaling instrument) will, of course, determine whether theory is allowed to emerge from the data, or is forced upon those data. Having read and attempted to understand all we could find on this technique, and followed an academic course about it, we did not stop at the partial results of three main clusters provided by the software that we had used (SPSS). The software algorithm obviously considered that the most statistically significant clustering was provided by these three main clusters differentiated by user IT needs (this was congruent with what we had found during qualitative phases 1 and 2), but we still did not eliminate the possibility that each of these main clusters might still be further clustered significantly using all other available variables. We therefore proceeded to further cluster-analyse and investigate in an exploratory fashion each of the three clusters provided by the software. We designed a specific three-stage clustering procedure (Walsh & Gettler Summa, 2010), the first of these stages having been provided by the software that we used. The last two stages of our clustering design followed the two-stage clustering approach suggested by Hartigan (1975), Milligan (1980), and Punj & Stewart (1983) as we found that, contrary to other quantitative clustering approaches, this allowed us to avoid laying down any hypotheses during the various stages of the procedure.

During phase 4, even though we used SEM, traditionally considered as a confirmatory technique, we chose PLS path modelling. This approach is generally viewed more as an exploratory, soft modelling approach than as a confirmatory one (Vinzi *et al,* 2010; Gefen *et al,* 2011; Hair *et al,* 2012; Ringle *et al,* 2012). We investigated all possible paths between the various constructs under scrutiny before deciding which paths were the most probable when considering our quantitative and qualitative data together as one set: 'the discovery strategy, which is an unbelievable sin in verification studies, virtually discovers theory for the analyst by providing associations to be compared and conceptualized' (Glaser, 2008, p. 51).

Hence, even when we used quantitative data and techniques we remained in an exploratory stance, which is an essential aspect of a GT approach.

Theoretical sampling of mixed data We collected data (quantitative and qualitative) as we needed them to move the emerging theories towards the saturation of concepts/categories/relationships and the formalization of the emerging theories. Hence, our sampling of mixed data was theoretically driven that is, it was guided by theoretical relevance (Glaser & Strauss, 1967).

When collecting qualitative data during phases 1 and 2, we had used different settings (corporate and societal) with various participants. Our theoretical sampling had aimed at maximum diversification in order to capture all possible user profiles. We wished to formalize our theory, hence to further extend the scope of the research to other contexts and different social strata in order for our results to be more likely to be valid across diverse organizations and strata of populations using any type of information technologies. Therefore, when we collected quantitative data for phase 3, our sampling was not statistical and random. It was very close to a 'strata' (students *vs* corporate) and 'quota' (different genders, ages and academic levels) approach. This diversification design was even applied within the 'strata': in corporate populations, we included diversified hierarchical levels (top management, middle management and employees), diversified occupations (accountancy, engineering, teaching, etc.), and active and unemployed/retired people; in the student population we included foreign students.

During phase 4, we collected quantitative data to saturate the category IT needs theoretically into three different constructs (situational IT needs, contextual IT needs and global IT needs) but we were not able to theorize relationships between these and other constructs until we had collected further qualitative data. Thus, after we started to explore our quantitative data, together with the qualitative data previously collected, we more specifically theoretically sampled seven participants, conducting further interviews with them. These participants were selected to help us formalize our theory because of their very different IT culture profiles, which were fairly representative (but not statistically so) of many different profiles one would expect to meet in an overall population.

Hence, we theoretically sampled qualitative data more specifically when we needed rich description of emerging concepts or relationships between concepts; we theoretically sampled quantitative data more specifically when we needed to move back from details and obtain a synthetic perspective.

Embedding constant comparative analyses of qualitative and quantitative data During the last two, mixed, phases of our project, and in order to theorize, it was particularly important not to separate qualitative and quantitative analyses, each technique yielding information that helped us understand the 'whole' picture.

Through the qualitative data collected during phases 1 and 2, we identified indicators for each of the 18 dimensions of the construct IT culture that allowed us to differentiate between user ideal types; these indicators were turned into items for the survey administered during phase 3. During the pre-tests, we streamlined the items of the survey and the various dimensions/constructs with the help of exploratory quantitative factor analysis but also of the qualitative analysis of text collected in interviews conducted with some of the respondents as neither techniques were sufficient on their own to saturate our coding categories.

During phase 4, we investigated and confirmed some relationships between constructs through quantitative techniques with our substantive quantitative data set, but we did not retain them as they did not make sense in our complete data set, or within the substantive contexts investigated. Conversely, some other relationships that were not completely confirmed through our quantitative data were nonetheless discussed, as – from information obtained through our qualitative data set – they could have been important for further research in other substantive areas with different and less specific/targeted sampling.

The open and selective coding, searching for categories (variables), had been effected during the first three phases. To effect the theoretical coding during phase 4, that is, investigate the relationships between each pair of variables, we investigated results obtained from the previous phases and from the literature (if available) but we did not find sufficient elements to allow us to highlight theoretical codes (propositions): IT culture had been identified as core category explaining IT usage and the various types of IT needs had been identified as related categories. However, the path from IT culture to IT usage was not clear, nor the relationships between IT culture and IT needs. Therefore, we collected further data and searched for qualitative and quantitative clues. The qualitative clues were obtained from verbatim collected during new interviews. The quantitative clues were obtained from various quantitative analyses done on quantitative data collected during this phase through the administration of a new survey. This survey included some items validated during phase 3 as well as other items added specifically for this phase, and which were grounded in previously collected verbatim. We investigated the quantitative paths between each pair of variables with the help of (i) their standardized coefficients β, which indicate the strength of the relationships between the two variables, (ii) the significance of these paths, obtained through the bootstrapping procedure and expressed by the probability P that the hypothesis underlying this path might not be verified, and (iii) the R^2 value for each variable, which inform us how much of its variance is explained by its antecedent(s).

Qualitative and quantitative data collection and analyses were embedded: theoretical codes, that is, propositions, emerged through constant iterations between quantitative and qualitative data as they were collected and through the analysis of all our data as one set. For generalizability purposes, some of these propositions were qualified as 'formal' (full lines in Figure 4 – Phase 4) when, based on the data we had collected, they appeared to extend to other substantive areas and other contexts beyond those researched for that specific study. Other propositions were qualified as 'substantive' (dotted lines in Figure 4 –Phase 4) because, based on our whole data set, we had some indications that they may hold true only within the substantive area and investigated context. To illustrate the theoretical coding that was effected during phase 4 of our project, we provide some examples of it, in a tabular format, in Appendix B.

Parsimoniously formalizing theories in rupture with the literature

In this section, we highlight the core category (*Formalizing*) and its properties (*Parsimony* and *Rupture*) as well as its necessary pre-condition (*Sense-Making*) that emerged as guiding the mixed MD2 GT research design used as research object of the present work. In the investigated research project, the emerging theories guided our theoretical sampling of qualitative and quantitative data. We added quantitative data to our data set during the last two phases for various purposes highlighted in past literature, for example, 'expansion', 'compensation', 'completeness' and 'complementarity' (Venkatesh *et al*, 2013). However, within our GT framework, we also found that we felt driven to mix data because it enhanced sense-making and

allowed parsimonious theoretical saturation towards the formalization of our substantive theories in rupture with existing literature.

Making sense of the 'whole' story One of the characteristics that is essential for GT researchers to develop is their theoretical sensitivity, that is, 'the ability to develop theoretical insight combined with the ability to make something of these insights … [i.e.,] … the ability to conceptualize and organize, make abstract connections, visualize and think multivariately' (Glaser, 2004, p. 11). In our work, mixing qualitative and quantitative data and techniques helped improve our theoretical sensitivity and make sense of the collected data.

We used 247 questionnaires during phase 3 as an additional part of our whole data set. Our purpose during phase 3 was to theoretically code the quantitative data through a statistical clustering of cases in groups based on the respondents' needs and motivations, then to interpret and investigate any resulting quantitatively obtained clustering together with our qualitative typology. The results from the quantitative clustering design had insufficient meaning and could not be interpreted if considered on their own; they had to be analysed together with previously collected qualitative data and results. We did this, and it guided us towards amending the typology grounded in users' IT culture profiles previously proposed at the end of phase 2. This amended typology made sense when we used both qualitative and quantitative data as one set and it also made sense within each subset of data; it has since also been verified several times with various sets of data.

Mixing quantitative with qualitative data also yielded findings and relationships that took us into ideas that we could not preconceive but that could only be discovered (Glaser, 2008) and also unexpected relationships between some newly defined constructs. Another researcher with sharper cognitive abilities and greater 'skills at conceptualizing by comparisons' (Glaser, 2011, p. 257) might perhaps have achieved the same results using only qualitative data. However, with our own cognitive abilities and personal dispositions, we tried and found that we could not. For instance, in phase 4 one path (the negative path between global and situational IT needs, illustrating the 'Ambassador *vs* Nemesis' debate: see Walsh, 2014 and proposition 3, Figure 4) was particularly difficult to analyse, describe, understand and explain thoroughly. We needed the quantitative data to highlight this surprising overall negative path and give us its average statistical values for different groups of participants. When nothing or little is known about a phenomenon, no proposition or hypothesis can be laid down: we need description of the phenomenon in order to theorize (Fawcett & Downs, 1992). 'The imagination cannot work *in vacuo*: there must be something to be imaginative about, a background of observation' (Medawar, 1969, pp. 44–45). Description was first obtained through the qualitative data collected during the first two phases that led to our conceptualizing a positive path between global IT needs and situational IT needs. But it was only when we collected quantitative data during phase 4 that a surprising globally negative path between global and situational IT needs emerged within our substantive area and context, although this path also proved positive for some sub-groups. And it was only when we collected further qualitative data in the substantive area investigated that our whole data set finally made sense and we were able to explain it. In this instance, mixing data and techniques helped us discover how and why highly IT-acculturated users may hinder, rather than facilitate, new-IT acceptance if their situational IT needs are ignored.

We needed the 'rich knowledge that only qualitative methods can provide' (Shah & Corley, 2006, p. 1821) as well as the framing of our ideas in statistics to sharpen them and lead to 'new, unanticipated issues' (Lee & Hubona, 2009, p. 238) that finally made sense when considering our whole data set and substantive contexts. Thus, both 'meaning' and 'counting' were essential (i.e., putting 'qualitative flesh on quantitative bones': Tarrow, 1995) to help us make sense and 'provide the conceptual overview with grounded interpretation' (Glaser, 2003, p. 118).

Formalizing substantive theories Not limiting ourselves to qualitative design helped us challenge our cognitive limitations towards the formalization of the various theories that were emerging, and to pave the way from substantive to formal GT as we multiplied types and sources of data.

Mixing qualitative and quantitative data helped us move away from our substantive area of investigation and along the path towards formal theory – that is, towards finding a theory that reaches beyond any substantive area (Glaser, 2007). Glaser (2011) stresses that the procedures required to generate formal GT are the same as those to generate substantive GT. The multiple differences between the two are in the theoretical sampling: 'In SGT [substantive GT] one samples within a substantive chosen site or population. In doing FGT [formal GT], one samples widely in other substantive sites and populations both within and outside the substantive area in order to make the theory more general, as one constantly compares, adding new properties and categories to the core category being generalized' (p. 257).

In our work, during phase 3, sampling quantitative data from settings as diversified as possible, together with qualitative data, helped us achieve this. During phases 1 and 2, we had reached theoretical saturation – or at least what we believed to be theoretical saturation. Adding more qualitative data did not seem to add any new theoretical elements, but this was because of our own limitations and insufficient theoretical sensitivity, that is, our limited ability to conceptualize and formulate the emerging theory. However, in a reflective approach, we still wished to extend our results in order for them to be

applied in further research in other substantive areas and contexts. Adding on quantitative slices of data during phase 3 helped us formalize the user typology and increase the scope of our research to broader contexts. During phase 4, mixing data led us to highlight that, based on all data collected, some of our propositions appeared to extend to other substantive areas and contexts beyond those researched (formal theory: illustrated by the continuous lines in Figure 4, phase 4) while others might hold true only within certain substantive areas and contexts (substantive theory: illustrated by the discontinuous lines in Figure 4, phase 4). Using mixed methods during this phase, and being clear about our research design, helped us to theorize in rupture with established literature and question the Technology Acceptance Model (Davis, 1989; Davis *et al,* 1989), which is the most commonly used model in IS research. It also allowed us to avoid 'HARKing' (hypothesizing after the results are known: Garst *et al,* 2002), leading to the 'Texas sharpshooter approach' bias that plagues many quantitative studies and usually results from their authors' quest for publication: 'the fabled "Texas sharpshooter" fires a shotgun at a barn and then paints the target around the most significant cluster of bullet holes in the wall. Accordingly, the Texas sharpshooter fallacy describes a false conclusion that occurs whenever *ex post* explanations are presented to interpret a random cluster in some data' (Biemann, 2012, p. 2).

When developing emerging concepts/constructs that had not been extensively investigated in past literature, it appeared to us important to start the investigation with qualitative data (phases 1 and 2 of our project). However, and in order to ensure proper theoretical saturation, we found that additional slices of quantitative data were needed and appeared to us almost essential for generalizability and formal-theory generation (phases 3 and 4 of our project). Mixing data, methods and techniques, thus, allowed us to broaden the scope of the emerging theories and improve the transferability (design validity) and confirmability (inferential validity) of our results. We believe that we could not have reached the type IV formal theory proposed at the end of phase 4 if we had not 'listened' to the emerging embedded mixed GTD and corresponding theoretical sampling of mixed data, which were guided by the theories that were gradually unfolding from the data already collected. This was, however, perhaps due to our cognitive abilities, dispositions and philosophical assumptions.

Parsimonious formal theoretical saturation Our purpose during mixed phase 3 was not to verify the qualitative typological results previously obtained during phases 1 and 2. Rather, we wished to densify and expand the theory by adding further 'slices of data' (Glaser & Strauss, 1967).

The qualitative data collected during phases 1 and 2 of our project helped provide rich descriptions of the user ideal types and the 18 possible dimensions of the explanatory second-order IT culture construct as these emerged from constant comparative analysis. The conceptual analysis of these dimensions represents what Glaser (2008) terms 'substruction' (p. 42); we scrutinized the data in order to find indicators for each of these emerging dimensions. However, some of the 18 dimensions we had qualitatively identified for the IT culture construct appeared redundant, as many items from our qualitative data were double-coded within two subcategories (this was highlighted in the online appendix of Walsh *et al*, 2010). With our qualitative data, we had not been able to eliminate the redundant dimensions among the 18 identified qualitatively. We therefore decided to collect quantitative data and use quantitative techniques to help us solve this issue: Glaser (2008) states that the aim of quantitative GT is a 'flexible search for relationships … and underlying dimensions which feed into the development of typologies' (p. 4). During phase 3, with a diversified population, we thus investigated further our core category, the users' IT culture, while linking it to user ideal types; we also investigated the core category's properties, user needs and motivations, while comparing these to ideal types' attributes. We mixed qualitative and quantitative data, methods and techniques during this phase to guide us in our theoretical coding towards identifying the dimensions of the second-order core category (IT culture) and eliminating correlated redundant dimensions. At the same time we aimed to assess the relative importance of each first-order construct (the IT culture dimensions) used to describe the ideal types. To sum up, mixing data and methods allowed us to densify the IT culture concept through dimension reduction (from 18 to 8) and resulted in a parsimonious, though more formally saturated, theory.

After we had reduced the IT culture dimensions from 18 to 8, and ensured with the help of our whole data set that these dimensions were saturated and sufficiently refined to differentiate all user profiles, we then had the (quantitative) means to accumulate and analyse large quantities of data. We therefore decided to address another issue we had with the original qualitative user typology that we had not been able to solve using only qualitative data and techniques. Some of the user ideal types that had emerged through the qualitative phases of our project (Walsh *et al*, 2010) appeared blurred, and we had an intuition that a larger data set might yield interesting additional results. Consequently we decided to multiply the data sources and increase our database using the available quantitative data and to attempt quantitative profiling of users with the available data from the 247 respondents of the final test. This allowed us to saturate the IT culture user profile ideal types parsimoniously.

Jane Hood (2007) argues that what she terms the 'troublesome trinity' – that is, theoretical sampling, constant comparison of data to theoretical categories and focus on theory development via theoretical saturation – distinguishes GTD from any other research design. The first two may be equally well achieved through the use of either qualitative or quantitative data, although we have yet to see widespread and sole use of quantitative data in

GTD studies. However, when one considers the concept of 'theoretical saturation' in the last of the three features illuminated by Hood (2007), and more specifically formal theoretical saturation, we would propose that the use of a mix of quantitative and qualitative data and techniques might, in some instances and for some researchers, prove essential. When no additional relevant data are found with which the researcher can enhance the emerging theory, saturation is considered to have been achieved; this allows the researcher to judge when sampling should stop (Glaser & Strauss, 1967). However, this process is limited by the researcher's interpretation of the data and capacity to synthesize parsimoniously all the data obtained. We found that, for us, this drawback was considerably lessened when using quantitative data and techniques towards achieving formal theoretical saturation.

Our journey to the land of formal theories is summarized in Figure 5. The different 'slices' of data, numbered from 1 to 4, in this diagram represent the data added during each of the four phases of the investigated project, and include both qualitative and quantitative data for slices 3 and 4. All data were used as one set as data slices were added. All data slices were used to build the new path to IT use proposed during phase 4.

Investigating, with a classic GT approach, the mixed research design of one our research project allowed a GT of research design to emerge, which we discuss in the next section.

A GT of research design

The mixed typological GTD that we used in the investigated research project helped achieve 'meta-inferences' (Tashakkori & Teddlie, 2008; Venkatesh *et al*, 2013) with enhanced 'integrative efficacy' and 'inference transferability' (Venkatesh *et al*, 2013). The emergence of this design also served the purpose of highlighting the true status of classic GT as a meta-theory of research design. In this section, we discuss these two elements that emerged from our work.

The emergence of a mixed typological GTD

Driven by our data, we used a typological approach in the project investigated for the present research, before even knowing such an approach existed; it was only subsequently that we put a name to it and reflected on what we had done, realizing that it was but one possible application of classic GT.

Although frequently overlooked, typologies have been considered as constituting the first and last method employed by science (Wolf, 1926; Punj & Stewart, 1983), and organizational research is filled with examples of ground-breaking research that started with a typological effort, for example, Miles & Snow, 1978, and Mintzberg, 1979, 1983. Typologies are much more than classification systems (Doty & Glick, 1994). A classification system provides rules for assigning cases to groups, whereas a typology is a conceptually derived interrelated set of 'ideal types' (Weber, 1904) (e.g., in our research, IT culture ideal types), each of which represents a unique combination of attributes (e.g., in our research, each IT culture ideal type represents a unique combination of the user's needs and motivations) that explains an outcome of interest (e.g., in our research, the outcome of interest is IT usage). Typologies thus include two types of constructs: second-order ideal types and first-order dimensions that are used to describe the ideal types (Weber, 1904; McKinney, 1966). Each ideal type helps towards the construction of hypotheses (Weber, 1904) because a typology illuminates the relationships between the similarity of a case to an ideal type and the dependent variable(s) of interest.

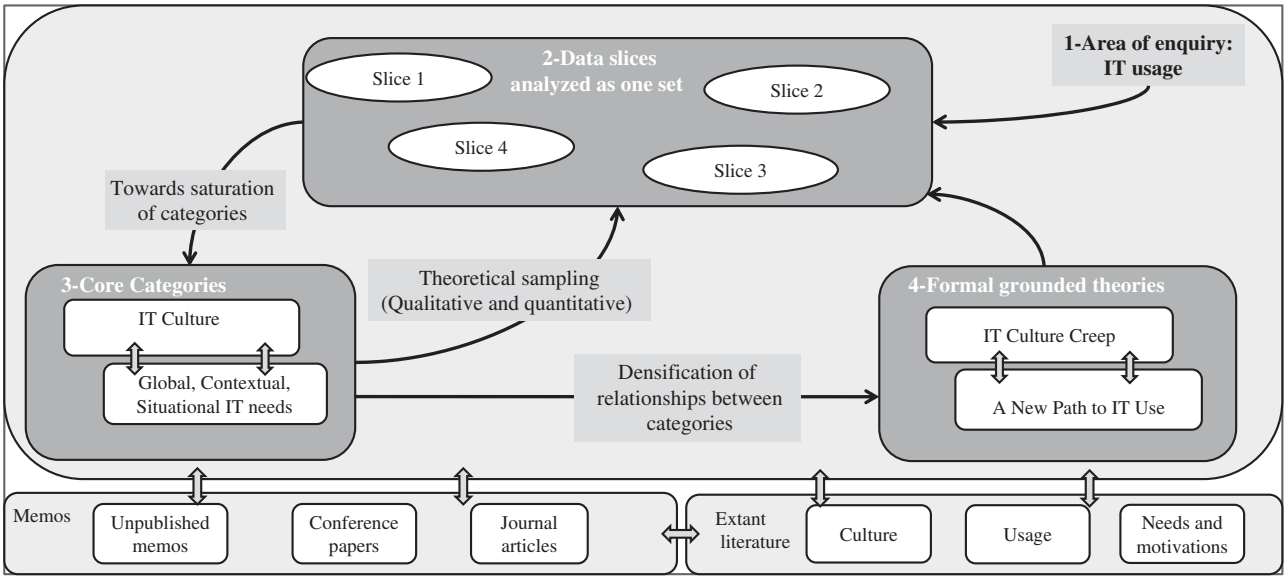

Figure 5 A summary of our grounded journey to the land of formal theories.

The second-order construct (i.e., the core category) that helps to differentiate the ideal types is a 'theoretical formulation[s] fashioned by the observing scientist' (Lee & Baskerville, 2003, p. 230). It helps to explain the patterning of first-order data and represents the observing researcher's perspective, whereas its dimensions or first-order constructs represent the perspective of the observed people (Van Maanen, 1983; Lee & Baskerville, 2003). This new second-order construct may possibly enrich new models and may help to theorize further in a rupture fashion (e.g., in our research, the new path to IT use through users' IT culture and IT needs).

Doty & Glick (1994) highlight the fact that a fully developed typology includes two levels of theory: a *middle-range theory* restricted to ideal types, that is, 'formed by the set of causal arguments explaining the internal consistency of the underlying processes within each ideal type' (p. 235) and a *grand theory* between the ideal types and the dependent variable. These authors also find that this second level of theory is rarely made explicit in typologies that one finds in the literature, for example, Miles & Snow,1978; Mintzberg, 1979; Weber, 1946. We found that the embedded mixed typological GTD that we used in the investigated project considerably helped us to make this second level theory explicit.

Furthermore, Gregor (2006) considers that a typological approach may eventually lead to a 'type III or IV' (p. 623) theory – that is, a theory for predicting, or for explaining and predicting. However, she does not investigate the level of generality of the resulting theory, or whether theorizing is of an incremental or rupture nature. We found that an embedded mixed GTD (MD2 GT), coupled with a typological approach and applied in a critical realist stance, helped us widen the scope and level of generality of our GT, and drive from a substantive to a formal, explanatory and predictive, rupture theory.

In the project investigated for the present work, we thus found that mixing data/methods/techniques was particularly suited to a typological GT framework; we found that a typology finds its place between the story and the model, between the emergence of hypotheses and the verification of these hypotheses, and between the cognitive and performative aspects of research, leading to rupture explanatory and predictive theorizing. The design of our project, briefly summarized in Figure 6, is a critical realist interpretation and application of GT as described by Glaser & Strauss in their 1967 book and further clarified by Glaser in what came to be known as 'classic' GT. The double arrows in Figure 6 result from the constant comparative analysis of all data and highlight the necessity to embed qualitative and quantitative designs and analyses. This mixed GTD that we used helped us with sense-making and allowed us to formalize parsimoniously the various theories that emerged along this project.

This proposed typological GTD is still only a substantive GTD. Its formalization into a mixed typological GT framework is beyond the scope of the present article. It is, however, on its way to being achieved through the analysis of one of our own empirical works described in the present article (i.e., a substantive GT of research design) but also through those of doctoral and research master students (i.e., other substantive GTs of research design) that we have observed, and from the specialized methodological literature that we investigated *ex post*. It may for instance be noted that, although the theory-building approaches of the various MD2 studies identified in the literature in a previous section are very different from our own, one study (Larsen, 2003, which we discovered only when the present work was close to completion) takes what seems to be a mixed typological approach similar in some aspects to the one we adopted in our research project.

Two of Glaser's proposed coding families, the 'dimension family' and the 'type family', clearly highlight the typological effort for theory building as an interesting possibility for GT studies: 'while dimensions divide up the whole, types indicate a variation in the whole based on a combination of categories' (Glaser, 1978, p. 75). Discovering these coding families after we had instinctively and unknowingly applied them, helped us realize and understand the true status of classic GT.

The true status of classic GT

This work helps to highlight the true status of what has been named in the literature 'classic GT', and which emerges from our work as a meta-theory of research

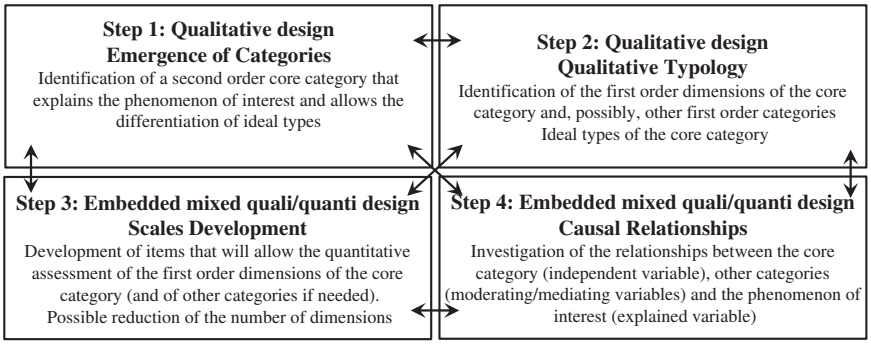

Figure 6 A summary of our mixed typological GT design towards parsimonious theory formalization.

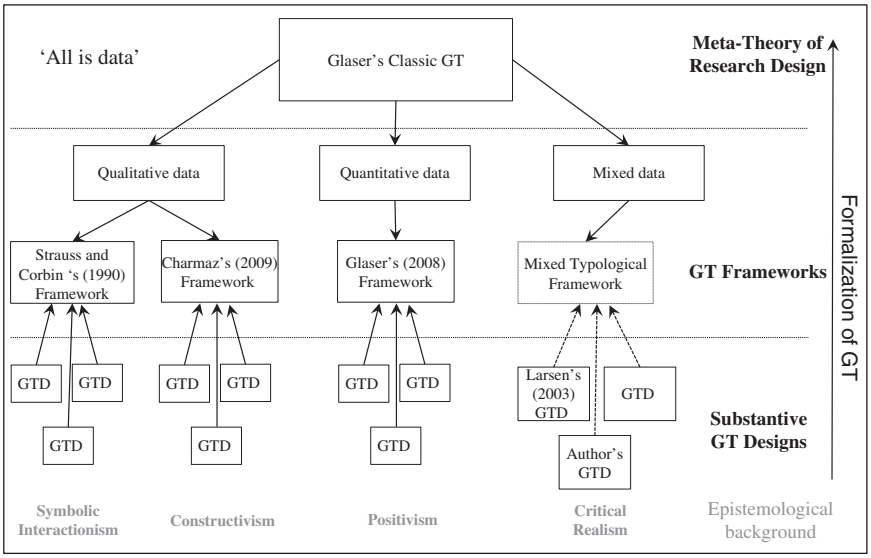

Figure 7 Classic GT as a formal grounded theory of research design.

design aimed at theory building. Just like our own mixed typological GTD, which is biased by our critical realist philosophical positioning and our cognitive dispositions, the frameworks proposed by Strauss & Corbin (1990), Charmaz (2009) or Glaser (2008) are epistemologically and methodologically biased interpretations and applications of classic GT. We do not call for a reconsideration of the intrinsic worth of these works: Strauss & Corbin (1990) and Charmaz (2009) filled an important methodological gap in qualitative research; Glaser (2008) addressed many issues related to doing GT with quantitative data. However, in terms of design, it has to be highlighted that these frameworks have emerged through our work as being at a lesser level of formalization than that of 'classic' GT, which is often misunderstood, and which Glaser has been defending for many years. Our findings, which are summarized in Figure 7 and elaborated on below, are congruent with Glaser's recurring argument that 'GT *is* a grounded theory'.

In the project that we investigated for the present research, like many new or would-be grounded theorists, we started our work (phases 1 and 2) with so-called 'evolved' GT (Strauss & Corbin, 1990) because, since initially we used only qualitative data, everything was spelled out for us in that particular framework; it appeared simpler just to follow what we were told to do. However, we soon had to move on to classic GT (phases 3 and 4) as we felt our creativity and theory-building capacity were being hindered by limited methodological and epistemological choices imposed on us by the 'evolved' framework. We now believe it is important to free young researchers' minds, showing them that classic GT does not bind them within arbitrarily set limits; on the contrary, it allows the creative component of the act of research (Suddaby, 2006) to express itself: 'I wish more scholars would feel free to let a bit of their persona out and stop hiding behind an established elite. One should of course learn from others, but one should not be cloned by them. After all, the personality of the scientist is his/her most important research instrument' (Gummesson, 2011, pp. 234–235).

Thus, our own journey to the land of formal theories highlighted for us that classic GT goes far beyond any techniques, methods or frameworks. It emerged from our work as a meta-theory of research design aimed at theory building: while respecting GT's guiding principles, researchers may develop their own design to fit their data and their own philosophical assumptions, aiming perhaps eventually to propose (as we did in the present work) a substantive design not for other researchers to apply, but to inspire them.

We provide below some guidelines for researchers who envisage conducting a meaningful GT study within any paradigm that is congruent with their own philosophical assumptions, but who do not wish to be limited by any single type of data. These guidelines build upon those provided by Glaser & Strauss in their seminal 1967 book; we expand and clarify them in a mixed-method perspective.

(i) All is data: Any data (qualitative and/or quantitative), films, photographs, literature etc. may be used. They may be collected by methods, and analysed with the help of techniques that appear suitable to the researcher to facilitate theory emergence, while congruent with her/his philosophical stance.

Even if a researcher chooses to use quantitative data and/or techniques traditionally considered by some as confirmatory, it is not the technique in itself that is important but how it is used and applied with an exploratory purpose. As early as 1979, Tukey highlighted that 'exploratory (quantitative) data analysis is an attitude and a flexibility' (p. 24). We found through our work that factor analysis that helps to group emerging variables,

and/or cluster analysis that helps to classify objects/people/concepts based on their similarities and differences, could fruitfully be used in an exploratory fashion. We also found that SEM in the soft exploratory version of the PLS approach also helped us theorize. Researchers could most probably also use many other techniques, if they always take care not to impose hypotheses on the data. Our purpose in the present work was not to give a catalogue of techniques to be applied as 'no catalog of techniques can convey a willingness to look for what can be seen, whether or not anticipated. Yet this is at the heart of exploratory data analysis' (Tukey, 1979, p. 24). When one uses quantitative data, it may be useful to remember that the numbers themselves are not what matters in social sciences: it is the meaning behind the numbers that is important. Hence, quantitative techniques should never be used in a mechanical fashion without fully understanding the meaning behind the techniques (Glaser, 2008). While doing GT, concepts come from the data; they are not preconceived or imposed on data. This is particularly important when data, methods and techniques are mixed – the quantitative and qualitative components are not used for verification or testing, but for further elaboration of the theory. There should be no 'forcing', where it is assumed that particular constructs will occur in the data. Thus, and whatever the data that are being used, exploration and emergence of the theory from the data have to remain central.

(ii) The purpose is theory building: Discovering patterns (induction), testing theories (deduction) and relying on the best explanation to understand obtained results (abduction) are components of the scientific process, leading to modifiable, self-correcting theories (Holton, 2011). *Where researchers begin, or how they begin, should not be considered an issue*.

'Science … does not begin with a tidy question. Nor does it end with a tidy answer' and 'neither exploratory nor confirmatory is sufficient alone' (Tukey, 1979, p. 24). If the researcher is driven by the emerging theory to mix data, methods and techniques, the time ordering of quantitative and qualitative phases is not important as such. There is no specific purpose to mixing data other than theoretical sampling towards theoretical saturation. From the perspective of GTD, whether the next 'slice of data' is quantitative or qualitative does not matter, as long as understanding is enhanced and the emerging theory is densified and/or formalized by sampling that slice of data.

When using quantitative data, Glaser (2008) mostly envisaged the use of secondary data. However, we found through our work that, if one collects one's own specific primary data related to new constructs, it can be difficult and even improbable to launch the large-scale quantitative investigation of a phenomenon before some kind of solid, thorough understanding of this phenomenon has been acquired through qualitative enquiry to ensure scholars are asking the 'right' questions in their surveys. Therefore, if one is rupture theorizing and investigating a new construct, it appears necessary first to assess the rich phenomena that emerge from people's interactions qualitatively in order to gain an initial understanding of these phenomena (Klein & Myers, 1999). One may then use further slices of qualitative or quantitative data to enhance understanding as well as densify and/or formalize the emerging theory.

(iii) Constant comparative analysis of all data: Quantitative and qualitative slices of data feed information into each other. If one uses mixed data, one should not analyse or interpret qualitative and quantitative data in isolation but as data are collected, and together with all previously collected data,

If and as one theoretically samples quantitative data to supplement qualitative data (or vice versa), one should not wait until all quantitative data are collected, but keep analysing the data set as new data are collected in order to systematically check for possible emerging new patterns and/or categories. Theoretical sampling is directed by the emerging theory and continues until saturation of concepts, categories, properties and relationships. During data collection, one should follow Glaser & Strauss's (1967) advice on theoretical sampling, based on maximizing or minimizing group differences and similar/diverse concepts, in order to decide on analytical grounds where to sample from next. If the need to mix different types of data emerges during the research process, the purpose is not to test or correct what has been found previously, but to extend understanding of the phenomena under scrutiny, and the scope of the emerging theory, as well as to densify the concepts towards theoretical saturation: 'different kinds of data give the analyst different views or vantage points from which to understand a category and to develop its properties' (Glaser & Strauss, 1967, p. 65).

(iv) Emergence of design: Researchers should not start a GT study having decided to conduct a mixed-design study but rather let the design emerge in congruence with the theoretical sampling guided by the emerging theory.

Designs are guided by ideas that come from the exploration of data (Tukey, 1979). The decisions to mix data and methods, and when to do so, are not set at the start of the research project but emerge as the research proceeds. However, emergence of design does not mean either lack of clarity in the design, or mislabelling or misrepresentation of it. In our investigation of mainstream IS literature, we found that the designs of MD2 GT studies were often blurred. Except for Walsh (2014), these studies appear to 'conceal' the GT framework in their work or to discover it by chance: while they cite some seminal GT reference or use only some of the GT main guidelines and/or coding techniques, they do not openly enrol in a full GT approach for their work, mentioning GT in passing if at all. Consequently their design is somewhat blurred. Furthermore, we discovered recently through an informal interview with an upcoming scholar, who has won prizes for the significance of his work (published in a number of top-tier journals), and who has given us permission to cite him, that some top researchers do use mixed GTD but are careful not to mention this, as otherwise 'their work would not get published' or at least would meet great difficulty doing so. This worrying issue of mislabelling/misrepresentation has been highlighted by Birks *et al* (2013).

Both issues (lack of clarity and mislabelling) summarized above may be addressed, and solved, by openly enrolling in a classic GT stance as was done in Walsh, 2014.

(v) Philosophical neutrality: If the emerging theory leads a researcher to sample through quantitative methods and collect quantitative data, this should not raise any issue other than for this researcher to fully master techniques, which may appear appropriate for the analysis and coding of collected data and are in congruence with their philosophical assumptions.

When theoretically sampling quantitative data, statistical validity may be set aside as data collection should be guided only by the emerging theory. All cases, including deviant minority cases, can be taken into account, as they are all potentially important, and might require further qualitative analysis in order to discover unobserved variables and causal statements (Glaser, 2008). When software are used for some of the analyses, researchers can reflectively ensure that the mathematical algorithms in the software do not eliminate these 'statistically insignificant' cases or groups of cases without investigating them, with the help of qualitative data previously collected or specifically collected for this purpose. Mixing quantitative and qualitative data whenever needed, and analysing and interpreting them in an embedded manner, will allow researchers to identify whether or not so-called statistically insignificant results should in fact be taken into account.

The guidelines proposed above are not linked to any specific ontology, epistemology, framework, methodology or techniques. They are only linked to classic GT and the elements related to mixed research design that emerged from our work. While following these guidelines, researchers may develop their own substantive GTD and methodology grounded in their chosen philosophical assumptions. This will help free their creativity and theory-building abilities towards rupture formal GT.

Conclusion

This research shows the importance for grounded theorists not to limit themselves to qualitative data, as doing so might hinder the emergence of the resulting theory. In line with Glaser & Strauss's (1967) original clear intention for GT to be applied with both quantitative and qualitative data, this article shows how one can go about it through the mixed typological GTD proposed here. It is, however, just one possible design, with a critical realist perspective: our philosophical stance influenced the way we developed our own substantive design and applied the GT principles.

When starting a research project, one should ask oneself some questions. Are we trying to discover and operationalize new concepts and theories, are we trying to build upon existing theories with established concepts, or, still, are we trying to validate or invalidate existing theories? If the answer is the first of these three options, then we argue that researchers should be open to the possibility that a mixed GTD might be suitable and useful in helping to do so. GT helps build theories; mixed data help mathematicians to bring context into their abstract world and sociologists to accept help from mathematicians to decipher existing patterns in their data. We do believe that this is irrelevant to any paradigmatic positioning. Furthermore, if researchers are able to combine these two schizophrenic aspects within themselves, without letting paradigmatic issues blur their vision, then the path from substantive to formal theory may be eased.

If we had not used a GTD with both qualitative and quantitative data, we believe that the research project investigated in the present work could not have been completed satisfactorily. Charmaz (2008) underlined the revolutionary impact that GT had on qualitative enquiry. We believe that its impact on quantitative enquiry, and more particularly on mixed enquiry, may be even more revolutionary if properly illuminated. Furthermore, and although most published quantitative research work is presented with a positivist (hypothetical deductive) stance, we do believe (see Bedeian *et al,* 2010) that the most innovative quantitative studies result from first letting the data talk, and then laying down hypotheses. Openly applying a GT framework with quantitative data might free quantitative researchers to be more open about the way they write up their research, and bring out the creative, theory-building aspect of their work. As for mixed design, GT might be the path to enhanced formal theoretical development. We hope that in this work we have contributed to open up this path.

Theories produced by researchers in IS research and proposed to practitioners are rarely prescriptive (Gregor, 2006). However, *Management Science* and IS aspire to 'actionability' (Schön, 1983; De Vaujany *et al,* 2011). Hence, if not prescriptive, IS theories and related concepts should aim to be actionable. This meets with GT and its emphasis on empirical research as a basis for theory development and practical value (Holton, 2011). We believe that by showing that GT can profitably be used in mixed-method studies, and by providing some guidelines to do so, many more researchers may be able to call on this mode of theory building – it is our hope in the future that GT will not be seen purely as the province of qualitative research, which in truth it never was: it just happened to help fill a gap in qualitative enquiry. It can, however, fill much more significant gaps in research. From our perspective, classic GT is more than a method (even a 'method in movement': Charmaz, 2009; Østerlie, 2012), set of methods, methodology (albeit 'unstable': Østerlie, 2012) or framework. Classic GT emerged through our work as a meta-theory of research design: it appears very close to an integrative research 'paradigm for discovery' (Glaser, 2005, p. 145) that fits Klee's (1997) definition of the term 'paradigm': that is, a model to be imitated, adapted, extended 'that defines practice for a community of researchers' (p. 135). Such a paradigm does not need a specific ontology or epistemology to justify it (Glaser, 2005); it does not hinder the researchers' creativity and may guide them in their quest for 'middle range' and 'grand' theory in Merton's (1967) sense.

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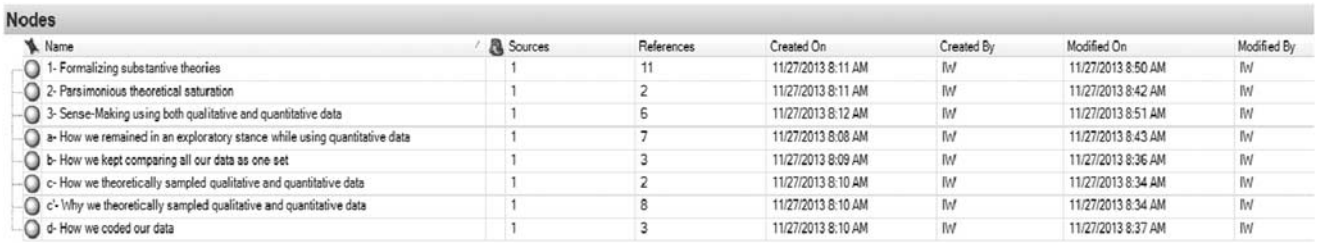
Appendix A

Coding the mixed GT design of our research project



Nodes

Name	Sources	References	Created On	Created By	Modified On	Modified By
1- Formalizing substantive theories	1	11	11/27/2013 8:11 AM	IW	11/27/2013 8:50 AM	IW
2- Parsimonious theoretical saturation	1	2	11/27/2013 8:11 AM	IW	11/27/2013 8:42 AM	IW
3- Sense-Making using both qualitative and quantitative data	1	6	11/27/2013 8:12 AM	IW	11/27/2013 8:51 AM	IW
a- How we remained in an exploratory stance while using quantitative data	1	7	11/27/2013 8:08 AM	IW	11/27/2013 8:43 AM	IW
b- How we kept comparing all our data as one set	1	3	11/27/2013 8:09 AM	IW	11/27/2013 8:36 AM	IW
c- How we theoretically sampled qualitative and quantitative data	1	2	11/27/2013 8:10 AM	IW	11/27/2013 8:34 AM	IW
c'- Why we theoretically sampled qualitative and quantitative data	1	8	11/27/2013 8:10 AM	IW	11/27/2013 8:34 AM	IW
d- How we coded our data	1	3	11/27/2013 8:10 AM	IW	11/27/2013 8:37 AM	IW

Appendix B

Table B1 Theoretical coding effected during phase 4

Theoretical codes	*Generalizability*	*Constant comparative analysis of all data as one set*		
		Secondary data (from previous phases and from the literature)	*Primary qualitative data*	*Primary quantitative data*
Proposition 1: Individual IT culture has a positive influence on the individual's global IT needs.	Formal	We found during phases 1 & 2, three main attitudinal user groups (proactive, passive and refusal). These groups include different user profiles, with differing degrees of IT acculturation. We also found that the most IT-acculturated users are proactive. They are perceived by managers as having a facilitating influence during the implementation of new IT in organizations. They are also those users with high levels of global IT needs, whereas passive users have lower levels of global IT needs and refusal users have none.	'For me, there is a clear link between an individual's level of IT acculturation and the need they perceive for IT in their life'. (CEO of an IT firm)	IITC→GLOBITNEE: $\beta = 0.598$, $P<0.001$ R^2 for GLOBITNEE = 35.8%
Proposition 2: Individual IT culture has a positive influence on contextual IT needs	Substantive	We found during phases 1 & 2 that the users who were highly IT-acculturated also had high levels of contextual IT needs.	'I certainly could not do my job in X school without IT. This was not the case in my previous institution, although I personally feel I need IT to do my job as a professor […] for instance, it's the first time I have been asked to use PowerPoint slides to teach. In my old school, nobody ever used PowerPoint'. (Young assistant professor with a couple of previous teaching experiences and who has started a new job in X school; she grew up in a computerized home environment with a father who is an IT engineer)	IITC→CONITNEE: $\beta = 0.400$, $P<0.001$

Table B1: (*Continued*)

Theoretical codes	*Generalizability*	*Constant comparative analysis of all data as one set*		
		Secondary data (from previous phases and from the literature)	*Primary qualitative data*	*Primary quantitative data*
Proposition 3: Global IT needs influence situational IT needs, positively or negatively	Formal	Vallerand (1997, 2001) showed that motivation at the situational-level results from the effects of both global motivation and 'social factors at the appropriate level of generality' (Vallerand, 1997, p. 275).	'I have fairly important IT needs; for example, I have several computers and I always need to be connected through the web. When I travel abroad, I remain connected even if it costs me a lot of money […]. You evaluate the platform and how it helps you fulfill needs linked with your responsibilities. I found that Moodle helped only with uploading the files that I wanted the students to have, and I found other functionalities inadequate, so I use the platform only minimally'. (Young IS assistant professor)	POSITION→SITITNEE: $\beta = -0.138$, $P<0.001$
Proposition 4: Contextual IT needs have a positive influence on situational IT needs	Substantive	N/A	The link between the need for IT that I perceived as related to the school where I did my EMBA, and the need for the specific tool that was proposed to help us in our tasks as students is significant […]. It was made clear to us, from the beginning of the course that we were supposed to be IT-proficient. (Mature EMBA student)	CONITNEE→SITITNEE: $\beta = 0.280$, $P<0.001$
Proposition 5: Situational IT needs, related to some specific system or software, have a positive influence on the use of this specific system or software.	Formal	If users perceive needs for some specific IT in order to fulfil given tasks, they will be driven to fulfill these needs (Maslow, 1954) and hence use this specific IT.	N/A	SITITNEE→UTILIZATION: $\beta = 0.676$, $P > 0.001$
Proposition 6a: The position held by an individual within a given organization affects the individual's contextual IT needs.	Formal	Post *et al* (1999) show that organization size and users' academic education influence the level of users' contextual IT needs.	'I have done several summer jobs during my studies – from stable work with horses, through factory work, to helping candidates in local elections; obviously, I did not have the same needs for IT in all these jobs. It is probably in my current teaching position that I need IT the most'. (Young assistant professor)	POSITION→CONITNEE: $\beta = 0.277$, $P > 0.001$ R^2 for CONITNEE explained by IITC and POSITION = 27.7%
Proposition 6b: The position held by an individual within an organization affects their situational IT needs.	Formal	N/A	N/A	POSITION→SITITNEE: $\beta = 0.454$, $P<0.001$ R^2 for SITITNEE explained by CONITNEE, GLOBITNEE and POSITION = 35.8%
Proposition 6c: Position has a moderating influence between	Substantive	N/A	'I teach in several schools and I am not very much into IT. If I were to get used to all the	Quantitative analyses with and without the moderating effect.

Table B1: (*Continued*)

Theoretical codes	*Generalizability*	*Constant comparative analysis of all data as one set*		
		Secondary data (from previous phases and from the literature)	*Primary qualitative data*	*Primary quantitative data*
situational IT needs and utilization.			different IT tools in the different schools where I teach, it would take me hours that I don't have. Unless I am 'officially' obliged to utilize a platform, I will not do it even if I need it […] even if it would make my exchange with the students somehow easier'. (Professor who shares his time between consulting and teaching in business schools, and who feels, as he says so himself, 'constrained to utilize IT')	