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Abstract

Although knowledge about IS/IT adoption is very broad, it is fragmented, and we still do not understand well how users move dynamically from one stage to another during the adoption process, that is, from when a user knows a new technology until, if the process is successful, she/he incorporates it into her/his routine. One of the causes of this theoretical limitation relates to the lack of methodologies that help researchers analyze longitudinally collected data and distinguish changes that occur over time as participants experience the implementation of the new system. In this article, we present a method based on mind maps that allows researchers to graphically synthesize the mental processes experienced by individuals as they adopt a new system. The method allows comparing and measuring changes among mental models of an individual in different stages of the adoption. Findings show that this method better reflects user perceptions than others based on surveys and technical processing of textual data. Using mind maps is a novel contribution to researching and understanding technology adoption in a holistic way and with methods that include time as a contextual variable in the adoption process.

Keywords:

Mind maps; IS/IT adoption; Technological acceptance; Adoption process; Conceptual maps; UTAUT.

1. Introduction

The study of the adoption of information systems and technologies (IS/IT) is a very advanced and diverse field. Since the 1970s, researchers have studied the factors that motivate or affect the adoption of a new technology at an individual or organizational level. Various theories or models explain the enablers and inhibitors of adoption at different stages of the life cycle of system adoption. For example, the technological acceptance model (TAM) parsimoniously explains the factors that influence an individual's technological acceptance. At the organizational level, the Technology-organization-environment framework provides a solid understanding of an organization's adoption decision. In addition, diverse studies have identified the causes that lead users to use or reject a technology during or after implementation (Schwarz, Chin, Hirschheim, & Schwarz, 2014a; Tang & Chen, 2011).

Although the existing knowledge on IS/IT adoption is very broad, it is fragmented, and we still do not understand well how users move from one stage to another during the adoption

process (Correa Ospina & Diaz Pinzon, 2018; Schwarz et al., 2014a). Indeed, existing models and theories mostly explain only part of the adoption cycle, for example: acceptance, implementation, post-implementation, etc. This theoretical gap affects our understanding of why users abandon or persist in adopting a system since adoption is a dynamic process, in which the outcomes of a stage of the adoption are highly dependent on the previous stage (Correa Ospina & Diaz Pinzon, 2018; Dwivedi et al., 2015).

We developed a method of analysis based on mind maps to understand the changes in the experiences of the participants during the process of adopting an ERP-type system. This method helps to graphically represent the psychological perception that each participant has of the system being adopted and helps the researcher to visualize changes in these perceptions. The developed method also allows to compare and measure the changes between mental models as the participant progresses in the process of adopting the system.

This research is part of an ongoing project that uses action research and studies the process of adopting ERP-type systems in micro and small businesses. We present below a description of the method and a case study to illustrate its application.

2. Related works

The process of adopting an IS/IT can be defined as a dynamic activity that has multiple space/time dimensions and cannot be reduced to a binary state of accepted/rejected (Burton-Jones, Stein, & Mishra, 2017). Under this definition, a large amount of the knowledge we have about IS/IT adoption is limited because reduces this phenomenon to two forms: adoption is primarily an individual phenomenon (Saonee Sarker & Valacich, 2010; Suprateek Sarker, Valacich, & Sarker, 2005) and static (Correa Ospina & Diaz Pinzon, 2018).

In order to understand adoption as a process, methodological approaches different from those mostly used by researchers are needed. However, the problem with using other methodologies is that they must meet at least three criteria (Saldaña, 2003). First, they should be of a longitudinal type, such that the researcher can capture and analyze information from participants at different times in the adoption process. Secondly, these methodologies should involve time, either discretely or continuously, because time interacts and affects the collection and analysis of qualitative data. Third, these methodologies should allow for analysis or interpretation of when, how, how much, or why changes occur.

Langley (1999) suggests seven strategies for making sense in process analysis, among which she mentions: narrative, comparative cases, and visual mapping. On the latter, there are different types of mapping techniques, including concept maps, mind maps and argument maps, among others (Langley, 1999). A mind map seeks to represent the way in which subjects live their experiences, allowing the identification of psychological concepts and constructs and the connections between them (Wheeldon & Faubert, 2009).

Buzan and Buzan (1996) describe mind maps as a simple technique of arranging ideas, with which thoughts are reflected orderly and concisely in the form of an organigram. Likewise, Meier (2007) defines mind maps as a way to represent the experiential knowledge of an individual, constituting the most important base to represent the knowledge structure of a person and his perception of the World (Chournazidis, 2013).

A mind map is a set of ideas represented by key words, and/or drawings interconnected by links. A mind map has a star-shaped structure, in the center of which the main idea or theme

is written or drawn. Each arm or branch represents an idea subordinated to the central theme and each branching implies a hierarchical order of ideas. The most extrema branches will be the most tangible aspects or ideas related to the central theme (Azema & Jafari, 2016). Brinkmann (2003) argues that from the primary branches arise subbranches, where the principle is that ideas should move from the abstract and general to the complex and specific. Each main branch builds a unit with its subbranches and no connections are made between subbranches belong to different main branches. Most maps use colors, images, and symbols.

2.1 Use of mind maps as a research method

Mind mapping is a visual-spatial method of representing information applicable to a range of research activities, including information management, project development, and data analysis (Mammen & Mammen, 2018). Mind maps offer researchers a particular way to better synthesize and understand qualitative data collected from research. In addition, mind maps provide an economic and innovative means of combining qualitative data with the nuance and perspective of the researcher's reflections (Wheeldon, 2010).

Wheeldon and Faubert (2009) presents a qualitative analysis method based on mind maps. He used "concept counting" to design each participant's- mind maps. The concept counting begins when the researcher identifies which concepts were described by the participants during the research. Then, the researcher uses the frequency count of the concepts in order to place them on the map according to their importance. Later, this same author developed and tested a technique of mixed methods called "prominence scoring" to use mind maps in longitudinal research (Wheeldon, 2010). The method begins with the identification of the concepts, elements, and activities that participants mention in interviews conducted at different times in the research. These concepts, elements, and activities are then converted into variables that can be quantified through frequency counting. The variables can be drawn on one or several mind maps, depending on whether they were mentioned in one, several or all of the interviews. This strategy allows the researcher to assign the variables to each of the participants depending on the phase of the research in which they were recorded. The frequency count is used to assign a score to the variables and compare the results according to when the data were collected. This author tested his method to analyze the change experienced by 19 subjects while participating in a technical assistance project (Wheeldon, 2011). Meier (2007) used mind maps in his research. Two particular features of his method are noteworthy. Firstly, group mind maps were obtained from focus-group. Secondly, the mind maps were partially elaborated during the focus groups and refined later by analyzing the transcripts of the interviews.

3. Mapping the technology adoption process

Although individualistic IS/IT adoption models have been widely researched in the literature, in recent times, one of their limitations has begun to be questioned by the scientific community. These models and theories assume that technology adoption is primarily an individual and static phenomenon, hiding the dynamics and interactions behind the implementation of a system (Bayerl, Lauche, & Carolyn, 2016; Correa Ospina & Diaz Pinzon, 2018; Schwarz, Chin, Hirschheim, & Schwarz, 2014b). This restricts the understanding of the phenomenon of technology adoption because the incorporation of a new technology is not only a set of atemporal causal factors but also a process that evolves over time. Although researchers have sought to study adoption as a dynamic process and in a more holistic way, such research is still incipient and much remains to be done (Correa Ospina & Diaz Pinzon, 2018).

A particular aspect of IS/IT research that remains little addressed is understanding how users change their perceptions about a new technology as it is adopted in an organization. Researchers assert that while people interact with technology, they make sense about that technology, i.e., they develop assumptions, expectations, and learnings that will be used later to generate actions (Orlikowski & Gash, 1994). Then, when participants begin to use technology, they relate signals from the outside with previous experiences, mental models, identity and the institutional framework, elaborating assumptions about the technology (Elbanna & Linderoth, 2015). These assumptions are influenced by exogenous information and by the cognitive construction of users (endogenous information), such that they will reject technologies that contradict their institutional routines or rules related to their individual or professional identity (Elbanna & Linderoth, 2015). Therefore, these assumptions are dynamic and may evolve as new information from the outside appears or initial conditions change, causing users to substitute their initial disposition for or against using the system (Elbanna & Linderoth, 2015).

Despite the theoretical wealth that this theory opens up, Davidson (2006) argued that the IS/IT research approach is depriving the field of accumulating substantial knowledge on the subject. Therefore, we made the following proposition to address this exploratory research on the IS/IT adoption process and the use of mind maps:

> **P1:** *During the process of adopting a new system in an organization, users change their perception about the system being adopted.*

Then, the use of mind maps became a method aligned with the need to understand the changes in the mental processes of the users (participants). Next, we describe the three steps we follow to build these mind maps.

3.1 Step 1: To divide the adoption process into discrete stages (temporal bracketing)

The adoption of technologies as a temporary process is a dynamic continuum (Bayerl et al., 2016; Langley, 1999). The first step then was to divide this continuum into discrete temporal phases (temporal bracketing) in order to able to evaluate changes in perceptions produced in individuals from a previous stage to a later one.

Researchers have proposed different models and numbers of stages to divide the process of technological adoption (Eze, Duan, & Chen, 2014; Haddara & Zach, 2012; Rogers, 2003; Schwarz et al., 2014b). Recently, Cataldo, Almuna, Briones, Bustos, and McQueen (2018) suggested that models of three or fewer stages may hide valuable information from participants produced between stages, and models of five or more stages may become confusing to analyze the process of adoption. Consequently, they proposed a four-stages model of adoption: acceptance, diffusion, implementation, and routinization or post-implementation. We adopted this model to discretize IS/IT adoption.

3.2 Step 2: Elaboration of mind maps

Similar to Wheeldon (2011), we build a mind map of each participant for each stage of adoption. For this purpose, two researchers, one with a background in MIS and the other in psychology, coded separately the interviews of the participants using relevant thematic criteria (the details of these interviews are presented in the following section). Then, for each interview, the researchers grouped the codes into categories and, in some cases, subcategories. The categories represented the highest level of classification of the codes, while the subcategories group intermediate levels. In some cases, no subcategories appeared.

To design each mind map, we follow Buzan, Buzan, and Harrison (2010)'s instructions, i.e., a map must begin to be drawn radially with the title or main idea in the center (which in our study refers to the system). Then the branches are assigned sorted according to their relevance, such that branches closer to the center have greater relevance and those farther away have less relevance. The central lines are thicker and radiate from the center becoming thinner as they move away from it. In addition, each branch and subbranch is located clockwise, so that each map is read from its top right (the most relevant topics or subtopics) down and to the left (less relevant topics and subtopics).

Similar to Wheeldon (2010), in each map, the primary branches were made up of categories and the ends of each branch corresponded to each of the codes created and included in the map. When subcategories existed, they were drawn as intermediate branches.

Wheeldon and Faubert (2009) state that the variables most often are the most relevant, so they should go first. We followed these recommendations and established as a measure of relevance, the frequency of citations that each code had in the interviews. The same criterion was used to quantify the relevance of the categories (and subcategories if they existed), with the frequency of a category being the total sum of the frequencies of the codes and, where they existed, the frequency of the categories was the sum of the frequency of the subcategories. We consider as a criterion of exclusion of codes, those that did not represent the current experience of the subject of study and codes that did not have relevance in the topic. Fig. 1 graphically illustrates the steps to elaborate the mind maps.

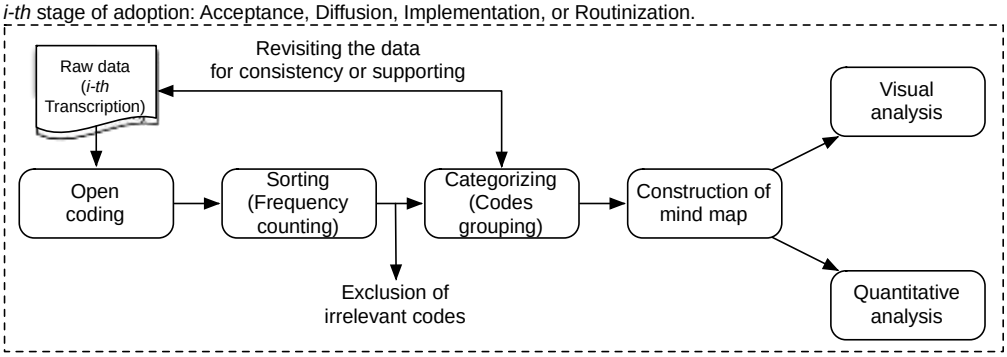

Fig. 1: Steps to elaborate the mind maps.

3.3 Step 3: Analysis of mind maps

Our assumption is that each mind map reflects users' experiences with the system. For the analysis of the changes of these experiences, then, it is necessary to develop a technique that allows to compare and evaluate the changes in the mind maps of the subjects. To do this, we built a summary table of categories by stage of adoption. This table is similar to the one developed by Wheeldon (2010), who also uses a frequency count to generate a ranking of topics in his mind maps. With the table of ranked categories by stage, it is possible to measure and compare the changes in the participants about their experience with the use of the system. A better way to analyze these changes is to create a state-by-state category chart. Then, two types of comparisons can be made between stages of adoption: a qualitative-visual one, directly comparing each map, and a quantitative one.

A requirement for maps to be longitudinally comparable is that there is a guarantee that common categories will emerge among them, i.e. that subjects will persistently express some issues throughout the adoption process. Kelly's theory of personal constructs (Kelly, 2003)

allows us to infer that at least there will always be two stable categories on maps. Kelly argues that subjects transform the evaluation of their experiences into mental constructs, which serve as guides and elements of discrimination from reality and human behavior, giving meaning to their actions and feelings. He postulates that at least two bipolar or dichotomous personal constructs arise from the experience of a subject. In other words, when a subject experience a phenomenon, she/he attributes to the situation a construct that describes it and, simultaneously, she/he create another antagonistic construct. To one of them she/he confers a character of desirability and to the other of undesirability (Kelly, 2003). Given that mind maps represent the evaluation that users make of their experience with the system, then, we can infer that in the elaboration of the maps will appear, at least, two opposite categories and that will last throughout the process, which gives meaning to the experience of the subject.

4. Application of the method to the study of IT/IS adoption

Our goal was to apply the proposed method to help us understand the adoption process in individuals. Following the criteria of Saldaña (2003), the method should consider that the information collected is qualitative-longitudinal, dynamic (time), and that it should help us to identify the change in perceptions about the system that occur in the mentality of the participants.

In this case, we present the mind maps of a woman who participated in the implementation of an ERP-type software in a small restaurant in the city of Talca (Chile). The data collection was done in the context of a research-action project consisting of helping small local restaurants to improve their management by implementing a specialized software in restaurants. The software is composed of two main modules: one for sales management and the other for inventory.

A group of researchers and implementers worked full time for a month in the restaurant, they assisted in the implementation of the software and, at the same time, collected qualitative information mainly from interviews (semi-structured and spontaneous), and participant observation.

Discretization of the adoption process into four stages (Step 1) involved implementing data collection activities at specific times of adoption. Table 1 summarizes these activities and the participants.

Next, we will present the application of the proposed method to the process of adopting the system in the restaurant. The following sub-section summarizes the context of the case of one of the participants and then we present the results of the analysis.

4.1 Case description

The case study is Mary (pseudonym), a 47-year-old woman with high school education, and co-owner with her husband of the restaurant that has 27 years of operation and 10 employees. Her main tasks are to be at the cash register, receiving payments from clients, paying tips to waiters, and accounting for daily income and expenses (opening and tonnage). She is also in charge of the daily inventory of the warehouse.

The decision to adopt the system (acceptance) was made individually by Mary's husband (co-owner), so she did not participate in the first meetings. Mary begins to participate in the

research from the diffusion stage (see Table 1). Thus, we can construct mental models of her in three of the four stages: diffusion, implementation, and post-implementation.

Stage	**Activity**	**Participants**
Acceptance	Two semi-structured interviews	Owner
Diffusion	Two focus-groups and individual questionnaires after training	A focus-group with the Owner and the Cashier (co-owner) Another focus-group with the rest of the employees
Implementation (one month)	Participant observation (one month) Semi-structured and spontaneous interviews	Owner Cashier (co-owner) Employees
Routinization (post-implementation)	Semi-structured interviews	Owner Cashier (co-owner) Key employees

Table 1: Data collection activities and participants by research stages.

The diffusion phase interview was conducted after a training session in which she and her husband participated together. In the interview, Mary showed an ambivalent mood, with difficulties prevailing over expectations. On the one hand, she expressed high expectations about the outcome of the implementation of the system, making positive comments about the benefits it would bring to the restaurant. On the other hand, she also repeatedly expressed insecurities about learning to use the system, which are mainly based on negative self-references (caused by a low self-esteem) and the fact that she had never used a computer.

> Mary: *Yeah, yeah, yeah. I mean, it's just a matter of getting used to* [learn how to use the system]. *But since I had never taken a computer... you'll understand that for me it is more difficult than for mine workmates.*

The implementation stage interview was conducted five days after the system began operating. At that time, Mary showed a clear rejection of the system and her expressions were more negative than in the previous stage. During the interview, she makes more references to her lack of knowledge in technologies, using as an example the fact that she had never had a mobile phone before. She is also stressed due to the criticism of the employees and her husband for their difficulty in learning to use the system. It is worth mentioning that during the entire interview, there were contradictions regarding her opinion on the benefits of using the system.

> Mary: [The system] *is neither good nor bad. But it costs me a lot. For example, it's difficult for me to see the bill of a table and close it.* [Then] *I forget it, and it remains open and later I check-out another table with that bill* (...) *Then, those things to me complicate me.*

Despite her initial negative state, Mary finally learns how to use the system and also increases her confidence in the use of technologies. This positive opinion was also common among the rest of the participants. Given this successful implementation, the owner decided to run a second implementation phase, in this case, he wanted to enable the system inventory module. Then, he convinces Mary to adopt this module. She is convinced mainly for two reasons: because of the success of the previous implementation and because she expected to be able to stop using the notebook in which she was writing the daily inventory. However, the results

were not as successful as in the first phase of implementation. Mary was upset with the inventory system because now she has to enter the inventory data into the computer and, duplicate them in the notebook. This situation caused a rejection of the second module of the system, but a successful adoption of the first one.

In the post-implementation interview, conducted two months after the system was installed, Mary positively evaluated the first module of the system, repeatedly mentioning the benefits of using it. But the displeasure with the inventory module influenced the negative opinions she expressed in the interview. This meant that the interview had two parts: one positive, when she was talking about the first module, and another negative, when she was talking about the second module.

> Mary: *What would change* [the system]*? You know what I dislike? having to make the write down the list every day yet, because I write the list* [in the notebook] *and I* [also] *have to go every day to the system and check the system.*

> Mary: *Yes, because I know what was sold* [and] *what was not sold* (...) *and I know how much money they have to have for me and* [now I know] *everything. I don't need to be here* [at the restaurant]. *And that has made the system a lot easier for me.*

4.2 Elaboration of mind maps

Consequently, we produced three mind maps, corresponding to each of the stages of adoption in which Mary participated. An excerpt from these three maps can be seen in Fig. *2* (Due to space constraints, a full version of the maps may be requested from the authors.). The number in the middle of each branch indicates the frequency of the category.

Table 2 shows the evolution of the categories by adoption stage. Fig. *3* is a graph constructed from the table and visually shows the changes in Mary's mind maps.

The proposed method based on mind maps confirms the initial proposition of this research. As can be seen in Table 2 and, more particularly, Fig. *3*, Mary, as a user of a new system, changed her perception of it as she experienced its use.

In general, it can be said that she always perceived difficulties in the use of the system, even after routinization. The first map shows that Mary mostly visualized difficulties and almost no benefits. In addition, it could be seen that there were two types of difficulties at this stage: those related to the system and those of a personal type. The latter were the majority of difficulties perceived by Mary.

In the implementation process, the difficulties increased due to direct use with the system, pressure from other peers and low self-esteem. In the post-implementation stage, the difficulties decreased but remained high. Our explanation is that the difficulties perceived by Mary at this stage are related to the inventory module that did not meet her expectations.

With regard to the benefits perceived by Mary, in the first stage, Mary hardly mentions them. They emerge quickly in the implementation stage and remain stable in the routine stage. The benefits were twofold: those that benefit her in her work and those that she perceives her peers have obtained. Among the former, the most mentioned by Mary were time savings, access to instant and reliable information to improve business control, simplification of tasks and easiness. On the other hand, she mentioned that she perceived that the system had

increased staff tips, improved the work climate, and clarified everyone's roles and responsibilities.

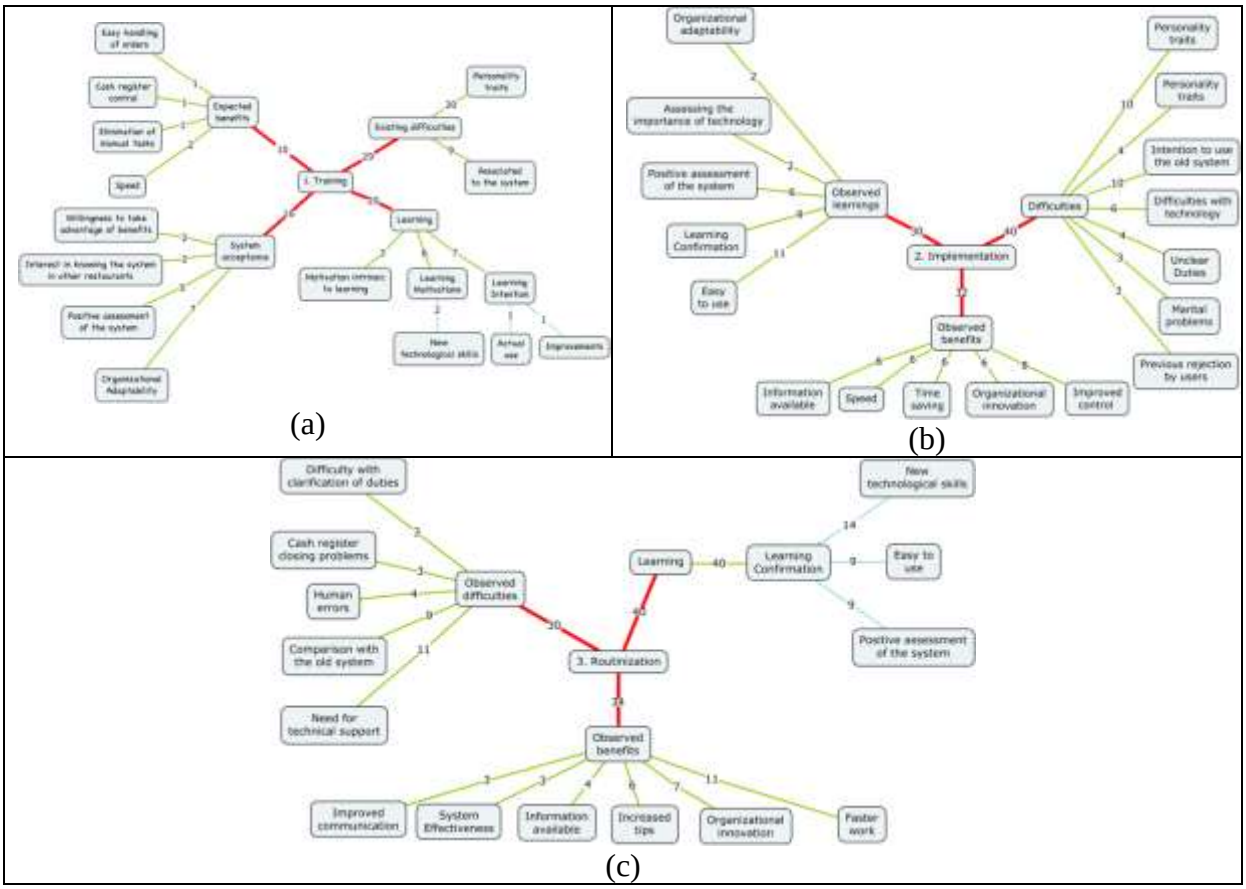

Fig. 2: Mary's mind maps by adoption stage (a) Diffusion; (b) Implementation; and (c) Post-implementation.

Theme	Diffusion	Implementation	Routinization	Total
Difficulties	29	40	30	99
Learning	20	30	40	90
Acceptance	16	-	-	16
Benefits	10	32	34	71

Table 2: Table of categories identified in the mind maps according to their stage of adoption.

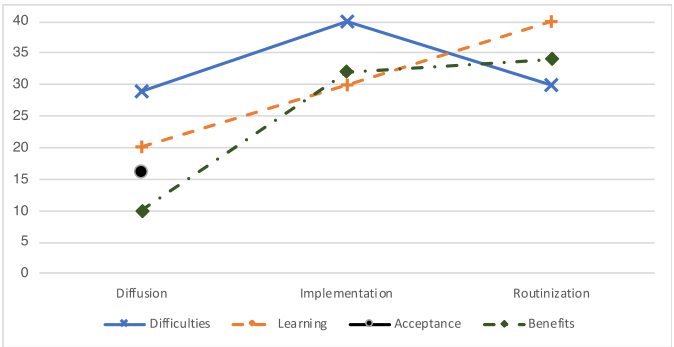

Fig. 3: Changes in Mary's mind maps.

5. Discussion on the proposed method

An important conclusion from the use of mind maps is that they reflected Mary's moods about the system at each stage. In fact, all three mind maps show that she always had a high level of rejecting to using the system and also reveal that she currently is not satisfied with the results of the implementation. But they also show that Mary appreciates meaningfully the part of the system that helps her simplify and make her job easier.

These conclusions about Mary are consistent with the observations made by the team of researchers who implemented the system. It is important to mention that the interviews were coded by two researchers who did not participate in the implementation process; in fact, one of them did not have direct contact with any of the participants.

We compared the results of the proposed method with those obtained with some kind of qualitative-visual analysis. In this case, we build concept maps based on semantic networks using Leximancer software. Similar to the case of mind maps, we generated with the software a map for each interview with Mary (Due to space constraints, we present only one of the concept maps in Figure xxxxxxx, a full version of the concepts maps and tables created by Leximancer may be requested from the authors). Our analysis showed some advantages of the proposed method over concept maps. The main one is that the themes that arose in the concept maps were not consistent among them, that is, the concept maps generated by Leximancer did not guarantee that one or more themes appeared in two or more maps to make comparisons between maps (for reasons of space we cannot give more details of these results, but more information may be required if it is desired).

Fig. 4: Mary's conceptual map created with Leximancer (Implementation stage).

Finally, the constructed mind maps and their analysis reflect the elements Mary placed most importance on when adopting the system. Another advantage of mind maps is that their use helps us understand how personal and environmental variables affect changes in the adoption process (analysis that was outside the scope of this article and therefore is not mostly detailed).

6. Conclusions

In this paper, our aim was to propose a research method to understand the IS/IT adoption process. In that sense, the proposed method based on mind maps allows to know the perceptions of the users as they experience the implementation of an ERP-type system in a small business. This method incorporates the temporal dimension into the analysis and helps to understand and compare the changes that occur in the subjects. The researcher can do two types of analysis: one qualitative by visually comparing changes in participants' mental models, and another quantitative by calculating differences in the frequency of categories that arise at each stage of adoption.

Although not the objective of this research, the proposed method would also allow for distinguishing between individual or group factors that affect adoption and how these change as users experience system implementation.

Comparatively, the method described generates analysis results that better reflect the experiences expressed by users than others based on questionnaires. Also the generated categories are consistent between maps to differences of the case of techniques of automatic visualization of conceptual maps.

Several limitations can be identified in this study. One of the main limitations is that this method needs to be validated in more cases in order to assess its usefulness in contexts other than the one described in this study. Another limitation is methodological. For the construction of any mind map, it is fundamental to distinguish the relevance of each of the theme. In our proposal, thematic relevance is measured by means of the frequency of codes; in this sense, there may be other ways of measuring the relevance of a category (theme) different from the proposal by us. That is ultimately based on the interpretation of the coders.

As future work remains to test this method with more subjects and in different contexts, this would help to compare the effectiveness of mind maps to understand the adoption process and to validate the method in more general scenarios. It also remains to be able to use the method to understand how individual and social factors affect, interact and evolve during the adoption process.

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