O.W. Bertelsen, L. Ciolfi, M.A. Grasso and G.A. Papadopoulos, (eds.)
ECSCW 2013: Proceedings of the 13th European Conference on Computer Supported Cooperative Work,
21-25 September 2013, Cyprus

"Drops hollowing the Stone". Workarounds as resources for better task-artifact fit.

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Abstract. The paper reports on a systematic survey of the literature around the manifold theme of workarounds in CSCW and in so doing presents a range of definitions that focus on different aspects of this phenomenon. We also report a case study in a large hospital where we discussed with some key users the opportunity of a tool that could promote awareness of existing workarounds, as a way to provide feedback on the actual use of an IT application in a bottom-up fashion. This case study led to the design of a simple process annotation tool, where users could distinguish between different kinds of workarounds: either as misalignments with respect to the organization procedures, or circumventions of the technology supporting them, or both.

Background and Motivations

In December 2011, we began a research-oriented partnership with the IT department of a large hospital in Northern Italy that employs approximately 1,500 nurses and 600 doctors and that in 2011 admitted 45,000 inpatients, 8,000 outpatients and over four million ambulatory patients. The common idea shared by the research group and directly endorsed by the Chief Information Officer (CIO) of the hospital was to assess the impact of an articulated Electronic Patient Record (EPR), which had been awarded in 2004, 2009 and 2010 as the most innovative and impressive project of hospital digitization in Italy, on patient safety and the daily work of the so called *frontline users* (Tucker and Edmonson, 2007) of this application, that is nurses and doctors.

Everything was going well, until the CIO must have realized that we were go-

ing to involve frontline users *directly*, partly with a closed-ended questionnaire to administer to the whole clinical workforce, and partly through a series of focused semi-structured interviews on a convenience basis. This roadmap was never officially forbidden, but the initial enthusiasm began waning considerably, more and more perplexities were raised by the IT Department, and the research seemed to take out a new "one step forward, two steps back" policy. We even began thinking that in that hospital the level of acceptance of the EPR and related satisfaction could be epitomized by rephrasing a CSCW title from the 90s: "I love the system – THEY just don't use it" . Probably as an attempt to remove this increasing suspicion of ours, the CIO invited us to attend one of the periodic, approximately monthly, meetings that were organized between him and some nurse representatives to collect observations, issue reports and enhancement requests related to the EPR usage in their wards.

The meeting was informal and friendly, and nurses seemed glad to share their issues also with us, i.e., external persons that had been presented to them as *"consultants from the University who have come here to study how well our EPR has come to fit our work practices and routines"* in the CIO's words, *"also thanks to your great work of analysis, and continuous feedback!"*, as he was pleased to add before letting the nurses have the floor.

The main thing that struck our attention in this meeting was that several times the issues, misfits and shortcomings that were reported by the nurses (be these about either the graphical interface, functional aspects or the application workflow) were interpreted by the CIO as actually a *misuse* of the system: *"this is not a bug, the EPR* is *supposed to do that"*; or also *"yes, you get stuck, but it's because you haven't done this and that before, and the EPR is expecting you do that instead"*; or *"yes, probably this could have been made more clear, but you should have used the other command, and then opened the other dialog box . . . in this way, look, there you go!"*. In some cases, the CIO was genuinely surprised that certain ways to get things done with the EPR – like printing a report before completion, proceeding to the next available screen without a validation, or checking a medication without the related prescription – did even exist, i.e., that some unanticipated operation was possible *at all*, or that two alternative ways to complete a task were equally feasible, one being completely undocumented and much more error-prone than the other: *"I'll have this fixed soon, don't worry, and remember that you have to do like I've just told you now,* not *in the other way"* was a typical way he addressed those "discoveries". This left the nurses often in a state of bewilderment mixed to an ineffable feeling of having done something wrong, as well as with a slight touch of optimism that the IT supplier (i.e., the vendor of the EPR, probably the largest health IT company in Italy) could do something to improve their record, *sooner or later*.

As one of the nurses told us at the coffee machine after the meeting: *"we* know *that only a small portion of our reports are passed on to the vendor . . . "* (she said that so much alike a teenager would have said that she *knows* that Santa Claus does not exist) *". . . either because* we *are to change our habits [with the EPR], or we were doing something the wrong way, or because some things are really trifles with*

respect to other due updates and important improvements. Yet, we are happy that someone is listening to us, and that our efforts to systematically collect our troubles with the EPR and take part in the changes of the next releases of the system are acknowledged eventually; it's a way to mould *the system, if you will, so that it fits better our practices here. It's like the proverbial small drops that hollow the stone: our periodic reports are the drops. And of course the EPR is the Stone!"* While we were jotting down this evocative remark, another nurse abruptly threw in sarcastically: *"And yet, sometimes we would prefer having a good* pneumatic drill*!!"*. A general laughter ensued (but undoubtedly that remark was aimed at IT people and also at us...).

In this paper we report an informal *side* research with respect to the main project on the impact of the EPR on hospital work mentioned above; a study that stemmed from those meetings and small talks at the coffee machine about the nurses' inchoate quasi-bugs, imperfect issues, misbugs and miswarts and their *trans-lation* to the supplier through the IT Department. Taking our word that we would reconsider the methodological approach to assess the degree of user acceptance and satisfaction of the current EPR in the whole hospital (that is that we would give it up), the CIO organized a short series of individual meetings with some of the head nurses involved in the project where to address the patient safety dimension only. Thus, partly for contrived serendipity and partly for dogged resolution, in those interviews we also focused on those peculiar ways nurses and doctors achieve their tasks by coming to break, either intentionally or unintentionally, with intended or specified practices and technologies, i.e., on what in the specialist literature is usually denoted with the term *workaround* (Wimelius, 2011).

Working *Around* and Working *Through*

We consulted a number of literature contributions to get a picture of the concept of workaround in order to better focus on the subject during our field study[1]. Workarounds are mentioned in many research papers from several different research areas, especially those related to health information technology and organizations. Most of the recent contributions, especially from the workflow-related literature, declare to be motivated in trying to understand how to minimize the risk of workaround occurrence, as a symptom of workflow inadequacy (e.g. Kobayashi et al., 2005), while others (a large minority, but yet the most interesting ones to our aims) focus on this subject to exploit their existence as signs of appropriation and drivers for change (VV.AA., 2005; Vassilakopoulou et al., 2012).

Irrespective of their motivations, the number of research contributions that use this expression is growing at a steady rate: in 2002, PubMed indexed approximately 20 papers containing this word, while in 2011 they were more than 180. Despite this increasingly broader interest, few researches have been so far explicitly aimed

[1] We report some of the definitions we collected in our survey in the shared resource that is available on ResearchGate at http://goo.gl/BUKDJ

at studying this phenomenon thoroughly (e.g., Gasser, 1986; Ferneley and Sobreperez, 2006; Wilkerson, 2009; Wimelius, 2011). This can be traced back to at least two main criticalities: first, workarounds must be observed "in vivo", that is in the situated unfolding of work practices and technology use, which requires direct and expensive observational studies (e.g., Bowers et al., 1995; Obradovich and Woods, 1996; Phillips and Berner, 2004; Patterson et al., 2006; Koppel et al., 2008); moreover, as we also can report from direct experience, workarounds regard a kind of "invisible work" that users could not have any interest in making explicit in interviews, nor other IT project stakeholders be willing to acknowledge: it is a sort of dark side of the IT deployment, or open secret, that the involved stakeholders could like to keep a lid on, for almost the same reasons IT researchers would like to peek below that lid, i.e., because "finding device deficiencies and exposing error traps is a politically, legally, and financially charged enterprise" (Obradovich and Woods, 1996). Focusing on workarounds as a first-class concept could also clash with the pervasive custom to evaluate the acceptance of a technology, and the success of the related digitization project, in terms of whether an important number of people use it regularly or not: for instance, the fact that the electronic medical record was used in almost all the departments of the hospital that hosted our field study was, for the CIO of that hospital, a sufficient reason not to "waste precious resources" in deploying a user satisfaction questionnaire for such application. Yet, when coping with collaborative, and more specifically workflow-based, applications, usage is not always an option and other dimensions should be considered, such as reluctance and satisfaction of end-users, the degree of "distributed viscosity"(Rogers, 1994) that is perceived by end-users (i.e., the extra efforts introduced by the computer-based support that they do not feel contributing to their goals), and their level of compliance with the intended use of the system and the related procedures, and hence whether workarounds are applied, and which ones (Poelmans, 1999).

The main difficulty in unravelling the true nature of workarounds lies in the truism that such a true nature does not exist, as what a workaround is arises from the concurrence of particular "characteristics of the material artifact, the charateristics of the human agents who use it, and the nature of the context in which it is used" (Wimelius, 2011, p. 48). In other words, workarounds are to be discovered (or, better yet, uncovered) at the meeting point, so to say, of technology and users, that is where the technological component of a socio-technical setting meets the social and human side of such setting, when the "technological artifact" is put "in use" and becomes a "technology-in-practice" (Orlikowski, 2000). This point of intersection of different trajectories, i.e., the product life cycle trajectory of the technological artifact on one hand, and the continuous evolution of the social context on the other, is difficult to frame and pinpoint in a detailed manner and it has been the object of appropriation analysis, which is aimed at studying how technologies "are used, misused, or not used by people in various contexts" (Orlikowski, 2000, p. 407), and of other analyses aimed at understanding how users interpret technology in use, i.e., what meanings users assign to the artifacts embedded in their situated lives, and to what extent these meanings are consistent with the design-

ers' intended interpretative scheme (Pipek, 2005); in other words, the extent these technologies provide the necessary "slack" or leeway for a workaround. In one of these analyses, Koopman and Hoffman (2003) make the interesting point that workarounds should be clearly distinguished from kludges, that is any awkward or clumsy fix that are temporarily effective, because workarounds rather concern procedural variations or adaptations in the use of some system, i.e., a behavior, rather than a physical hacking and tweaking of a system. In the same vein, Halbesleben et al. (2008) propose to differentiate workarounds from errors ("occasions where one fails to achieve the intended outcome"), mistakes (deficiencies or failures in cognitive processes), and especially from deviations, as the former ones "have a very specific motive (to complete a task by getting around a block), whereas deviance tends to have a wider variety of motives [...and most of the times] the goal of the workaround is to get the work done, with the self-serving benefit a secondary gain" [p.5].

Beyond Good and Evil

Taken all together, these proposals, from one hand provide a rich conceptual background for any research interested in this topic; on the other hand they also lead researchers confronting a fuzzy and fragmented picture, which can undermine any attempt to extract precise requirements for the computational support of the emergence of this phenomenon with a coherent set of tools or practices. Notably, these many contributions, although they agree upon the pervasiveness and almost unavoidability of this phenomenon, do not converge on a quite basic element, i.e., whether workarounds should be considered as a positive, neutral or negative phenomenon, and therefore whether they should be computationally supported or prevented.

On a common sense level, workarounds are perceived as positive whenever the intentions lying behind are recognized aimed at overcoming the (perceived) shortcomings of a technology (Joshi, 1991; Bain and Taylor, 2000; Button et al., 2003), or at pragmatically managing unusual circumstances and problem situations that always occur even in the most accurate workflow (Kobayashi et al., 2005); conversely, workarounds are perceived as negative, when they seem to be motivated by an ungrounded intention to resist the technology (or "inertia" as called in Boudreau and Robey, 2005), or as resulting from underrating the potential negative consequences deriving from the misuse, non use or even sabotage (Ferneley and Sobreperez, 2006) of the supportive technology (e.g., Marakas and Hornik, 1996; Bain and Taylor, 2000; Lapointe and Rivard, 2005). Obviously, this approach focuses on causes (e.g., perceived inadequacies, blocks, inefficiencies) and motivations (e.g., appropriation, resistance, opportunism) and disregards the criterion to assess the impact and effect of workarounds, on collaboration, data quality, task completion, business unit performance, and the like, as this is much more difficult (e.g., for the cascading effect by which a workaround may raise the need to perform other patching workarounds and so on, cf. Kobayashi et al., 2005), and controversial (Obradovich and

Woods, 1996; Martin and Koopman, 2004; Petrides, 2004; Patterson et al., 2006; Vogelsmeier et al., 2007).

Ferneley and Sobreperez (2006) propose to go beyond the mere positive-negative dichotomy mentioned above: they follow the notion submitted by Kobayashi et al. (2005); Petrides (2004), which relates workarounds to either an "action ensuing from resistance" for both "good" or "bad" organizational reasons , or to an engagement with the system that yet fails to conform to the prescribed "rules of engagement"; yet, they also distinguish between: "hindrance workarounds", which are undertaken to circumvent system procedures or processes that are perceived to be too time consuming ("viscous" in the sense hinted above), onerous or difficult (Prasad and Prasad, 2000); harmless workarounds, which do not significantly affect the flow of work or the quality of the involved information (Button et al., 2003; Lapointe and Rivard, 2005); and lastly, essential workarounds, that is actions that are necessary to complete a task or reach a goal (Kobayashi et al., 2005). Similarly, Wilkin and Davern (2012) have recently proposed to distinguish between all system usages that are unfaith with respect to the design's spirit denoting as "circumventions" any potentially harmful actions with respect to both collaboration and information quality; and as "user innovation" those workarounds that, although produce outcomes that are inconsistent with system design, nevertheless "meet common goals", possibly even more efficiently than the system.

While those taxonomies (and any other effort in this direction) can be useful for analytical purposes, caution should be adopted in applying them too rigidly: indeed, the positive and negative nature of a workaround is inextricably bound to the observer's perspective and judgement (the same idea is conveyed in the attribute *distributed* in the expression "distributed viscosity" mentioned above); for instance, the same behavior can be traced back either to an hindrance or to an advantage according to the users' idea of what is necessary to achieve their goals; to their familiarity with the structures that are inscribed in the technology (Orlikowski, 2000); or to their capability to imagine and foresee at least some of all the possible consequences deriving from such a behavior.

These behaviors can originate from multiple causes: a steep learning curve requested to users to master the system complexity; users' ignorance of the system's proper use (Boudreau and Robey, 2005); either grounded or ungrounded (namely false) perception of limitations of the technology by users (Wilkin and Davern, 2012); poor user interfaces leading to unproper use by users (intentionally or unintentionally) (Kushniruk et al., 2005); discrepancies between the application workflow and existing operating procedures or cooperative conventions, be them either intentional, e.g., related to some process redesign initiative (Halbesleben et al., 2008), or unintentional, i.e., due to poorly conducted business analysis, requirement elicitation or process modelling activities (Pan et al., 2008); user hostility and resistance towards tools that are imposed from above or that disrupt existing power relations (Ferneley and Sobreperez, 2006); their will to react to a perceived lack of responsibility and identity, or to a perceived reduction of their skills and competencies caused by digitization within their organization (Alvarez, 2008).

Moreover, two further interesting aspects of workarounds are worth being isolated, at least to the aims of our research: their *collective*, almost collaborative, nature, and their *evolutionary* characteristics, a sort of "regional metamorphism" that can transform their status from reproachful deeds to even ordinary features of a next release of a system. In regard to the former dimension, it is clear that any single worker can perform a workaround on the basis of her autonomy and power; yet, as also noted by Wilkin and Davern (2012), it would be improper to define the extempore single action of an individual working around an official application as an "innovative workaround": speaking of "innovation" requires that a group of "users at the worksite have agreed that system functionality is unsatisfactory and have *implemented* an alternative usage that *meets* the defined needs of *at least some* key users" (emphasis added). This does not mean that such workarounds are necessarily planned, devised or even designed "on paper", but rather that they can emerge from the spontaneous agreement of peers (instead of been given from above as a standard operating procedure) and "stabilize" into socially acceptable conventions of use (Cabitza et al., 2009a); or into something even further. This brings us to the latter aspect: their metamorphism; this regards how the temporary and informal nature of a workaround can evolve into a persistent structure and flank the solutions devised in the traditional approach (i.e., analysis-design-development cycle). To this regard, Tyre and Orlikowski (1994) have pointed out how extempore, but to some extent, appreciated workarounds conceived as a temporary adjustement to technology misfit (cf. Gasser) can become, incrementally or by simple repetition, a permanent solution and accepted practice over time, and even persist and outlive the system shortcoming or perceived block that originated them. This phenomenon has been observed frequently (most recently also by Zhou et al., 2011) and can be suggestively depicted in terms of the natural phenomenon known as "social trails" , i.e., in terms of those traces of collective and repeated crossing that wear down unpaved paths over time, e.g., in public meadows between regular paved paths (which would represent the intended workflows, in a way)[2]. These "social trails", once carried to the IT domain can bring both risks and opportunities. From the negative side, consolidated but unanticipated usages can jeopardise the full capacity of the IT system, which most of the times evolves from the interventions of people that are fully unaware of these local and yet effective workarounds (e.g., CIOs, IT designers, developers): what develops over time and in bottom-up manner as an "essential workaround" (see above) can become a harmful one, when the system has been changed and thus the surrounding conditions that let the former thrive. On the other hand, it is known that harmless workarounds have sometimes evolved in extremely popular features (e.g., hashtags in Twitter[3]), and that similar concepts developed in ethnoclassification and psychogeography have recently been absorbed also in the Web page design principle of "paving the cowpaths"[4]. Workarounds, as

[2] Some nice examples are available at http://goo.gl/X42TW

[3] See e.g., the discussion at http://goo.gl/HPkno

[4] "2.4. When a practice is already widespread among authors, consider adopting it rather than forbidding it or inventing something new", from the HTML Design Principles issued by the W3C

expressions of unanticipated and situated use, are in these cases a powerful source for the meliorative change of artifacts, in terms of their "better fit" with the tasks at hand (Carroll et al., 1991).

A Matter of Perspective

Thus, for summary's sake, most of literature contributions can be put along two main perspectives: first, those authors that see workarounds as mainly *deviations* that go astray from an ideal path or course of action, and that metaphorically "move around" a system that is supposed to support that course of action in a cooperative setting (and which, conversely, is perceived as a block or obstacle by the involved agents): in this mold, Azad and King (2008) describe workarounds as "[...] non-compliant user behaviors vis-à-vis the intended system design".

On the other hand, a complementary way to see workarounds is to conceive them as alternative, ad-hoc, creative ways by which practitioners reach a goal, *irrespective* and *in spite of* any perceived inadequacy or shortcoming of the means that should support them in their tasks (Ash et al., 2004; Tucker and Edmonson, 2007); this stance sees those phenomena more like *work-through* than work-*around*, as users involved therein could be said to *go straight to their goal*, by more or less metaphorically overriding the system and its embedded policies. In this latter line, the first and probably most influential contribution is by Gasser (1986). Gasser defines workarounds as one of the specific strategies that users adopt "for accommodating to the misfit" of their computational resource "to the work it is intended to support": it's a sort of adaptation or accommodation (Bowers et al., 1995) where both users and the system is likely to change. Gasser starts from the consideration that all organizations are open systems subjected to unpredictable contingencies, to which users have to respond in extempore manners and *readjust* their work activities to accommodate the "qualitative misalignment of resources needed or expected for carrying out a task". To this aim, he enumerates the strategies of *fitting*, i.e., either making changes to the "computing arrangement" or, the other way round, "adjusting work schedules and commitments"; *augmenting*, i.e., undertaking additional work to make up for misfits (e.g., by additional training); and *working around*. This activity is defined as "intentionally using computing in ways for which it was not designed or avoiding its use and relying on an alternative means of accomplishing work" (p. 216). Moreover, Gasser distinguishes between different types of workarounds: "data adjustment" regards making up input data to get the system produce the desired response or, in other terms, gaming the system with wrong data to get the right response: for instance, filling in an input field of a form with some nonsensical character just to avoid a mandatory check for complete forms that blocks the application; "procedural adjustment", or hacking the procedure by knowing how to get the same results faster: for instance, asking the right person to do something, bypassing some necessary steps or verifications, or gaming the system by post hoc corrections; lastly, backup systems, i.e., the use of alternative, also paper-based or

Working Draft (2007).

"pretechnology" ones (Vogelsmeier et al., 2007), systems, which are also called "duplicate systems" (Wimelius, 2011), or "shadow tools" (Boudreau and Robey, 2005; Handel and Poltrock, 2011), that coexist in tension with the legitimate and formally sanctioned system.

The two perspectives mentioned above, namely the *work-around* and the *work-through* oriented ones, stress each a different, but not necessarily exclusive, idea of the inherent main reason behind this phenomenon, i.e., either the existence of "flaws in the technological solutions" or the will of "users not adhering to procedures defined by the technology" (Wimelius, 2011, p. 186) (or by its designer, cf. Pipek, 2005), respectively. Consequently, discourses on workarounds and workthroughs also reflect two different stances on the role of technology in managing cooperative organizational work and on the capability of users to cope with contingencies and breakdowns (Tyre and Orlikowski, 1994), possibly generated by an inadequate, or so perceived, technology. Yet, both views in some way subscribe the general idea that workarounds are a kind of unintended consequence of digitization (Ash et al., 2004; Boudreau and Robey, 2005), and one of its inescapable "side effects" (Pipek, 2005; Wilkin and Davern, 2012): as noted by Azad and King (2008), automating for sake of better standardization, reduction of process variation and hence better quality can lead to the paradoxical consequence of having more variability, that is introduced by "user behaviors [...] which may go so far as to bypass the formal system entirely" (p. 264).

In light of all these considerations, for the rest of the paper we restrain from giving yet another original definition of workaround; we rather adopt the essential elements of the Gasserian perspective to denote as workaround *any behavior end-users of a technology, or the members of an organization, intentionally exhibit, also on a regular basis, to reach a legitimate and agreed goal (such as completing a work item or task), in spite of* either *the technology* or *an organizational procedure*; in the former case we speak of *system workaround*, while in the latter we speak of *process workaround*.

The Case Study

As anticipated in the Introduction, we had the opportunity to discuss with some key users of a complex EPR of the idiosyncratic behaviors that they and their colleagues adopt to have their work done even *in spite of* formal procedures and dedicated applications. More specifically, we report here on the interviews we had with: a head nurse (HN) who was responsible of several groups of nurses in four different units; a nurse working in the inpatient ward (IWN); a nurse working in the Day Hospital Unit (DHN); and a Head Physician (HP) who worked in both wards. These roles covered different kinds of work experiences that were anyway strongly correlated, and possessed complementary perspectives on the impact of the EPR on daily care, and yet all equally grounded, as all the practitioners involved were using the system since its first deployment, years before. More precisely, the EPR had been in standard use for three years to the date of the interviews: this allowed us to col-

lect experiences of usage and opinions well after the initial phase of appropriation, which usually affects the stability and validity of users' perceptions.

In those interviews the word "workaround", or any close phrasing, was never used, as we did not want to bias the discussion by hinting at any shrewd way to game or circumvent the system; yet, we often sided with end-users in assenting to little "stretches" or tricks that they could perform in spite of official procedures to convey a sort of complicity and make those little admissions, if any, easier. We purposely adopted a low profile and avoided direct questions to understand how *deep* in situated practice these little "detours" were; how practitioners perceived these liberties (e.g., awareness, guilt, satisfaction, overindulgence), and their impact on preexisting work practices. The interviews were all tape recorded, but recording was stopped whenever the interviewees asked for a more confidential observation (that happened twice); one of us participated as silent observer with the task to take notes during the talk to facilitate later keyword analysis, thematic analysis and passage retrieval (Seidman, 2006). The average length of the interviews was 44 minutes; the total recording was of 176 minutes. In the next section we will outline the main relevant behaviors our interviewees described to us.

Chronicles from the Frontline

All key actors agreed that the introduction of the EPR had been useful, especially for its potential role in improving patient safety and reducing errors in drug management. They also agreed that the system was not difficult to appropriate, after the necessary initial period of training and adaptation (which lasted approximately 2-3 months). Yet, quite surprisingly, we were told that while the order entry feature of the system was used regularly (also because highly pushed by the Hospital Pharmacy for legal and inventory reasons), the system was scarcely or not at all used to support the phase of drug administration at the patients' bed. The main reason for this *system workaround* (see above) was simply that the disposition of the beds and armchairs both in the ordinary admission ward and in the Day Hospital rooms did not allow the drug cart, on which to put a PC connected to the hospital network, to move among the patient's beds or chairs: EPR-supported drug administration would require nurses (and sometimes doctors) to move back and forth from the bed/chair to the cart, a condition that was shortly rejected, as impracticable and leading to even more potential risks and errors. DHN said that *"the distance is not a problem* per se*, as it is approximately five meters or so, but we have to cover that short way many many times everyday. [...] Some patients lie in beds, while others are seated in special armchairs and attached to an infusion pump in different rooms [...] when they sound their little alarm to notify us that the their infusion is finished, we have to run to them, then to the cart, and then back again to them: we would have little time to log in the EPR and use it in this frantic activity as we were told to do, to check every administered medication"*. DHN was aware that the EPR was supposed to be used to check that the right drug would be administered to the right person by means of a barcode scanner, as well in the right order according

to a detailed drug protocol defined by the physician for that particular patient; that notwithstanding, the physical (although relatively short) distance between the PC and the actual "point of care" prevented Day Hospital nurses from using the system: *"we ask our patients first name and family name twice, and then administer the drug; indeed some of them respond quite absent minded, or weary for the medication, but that's the kind of control we can afford right now, at our current work rates"*. She added: *" I would like to use the EPR, I would feel safer, or comforted that everything is all right. Indeed, we used it for about six months at the beginning and it was fine, although quite cumbersome [...] but then we had to increase our pace and serve more outpatients per day, I suppose for economic reasons [...]"*.

The system workaround described above can also generate correlated process workarounds. For instance, in the inpatient ward, also the IWN told us to systematically bypass the patient-drug-patient check, but for an opposite reason with respect to the Day Hospital case: *"every day we come to handle few patients, the same ones for quite long stays [...] we come to know our patients very well, it would be weird and alienating to double check everything with the EPR: [...] just imagine the worst case: even in a case of bone marrow transplantation between twins, I would administer the right drugs to the right person even without really looking at the person [...] I'd go straight to the right person, as we really come to know them, they are not just bed numbers, if you get what I mean [...]"*. Also the HN raised a similar concern *"we cannot ask to the same patient her name and family name for each drug in the drug protocol [...], paradoxically, this would give her a bad impression and make her think we don't know what we're doing there"*.

The situation described above and the obligation to keep both the electronic and paper based information up to date required nurses to duplicate their work, a situation that have been described several times (e.g., Cabitza et al., 2005; Munkvold et al., 2006). This redundancy of data and effort was mentioned by all the interviewees as time consuming and error-prone. Some of them recognized the necessity of this additional effort as a consequence of not using the EPR as prescribed, while the IWN emphasized that she would prefer to work only on the EPR, but the others would do differently and this leads to nasty situations: the best tool is the one chosen by the majority of the colleagues, not the best one "in se": *"they [the management] do not fully support the system adoption, or just do not consider whether it is used at the 100% of its capabilities or not [...] the data in the EPR are always correct in my experience, but in regard to currency, I would have some doubt [...]"* he said.

Another workaround was reported when the drugs are delivered from the Hospital Pharmacy to the ward where they are to be administered to the patients. The procedure and the EPR require nurses to check if all the drugs that had been prescribed are delivered as expected. This should be made through the system, by ticking off the items shown in a drug list one by one with a barcode scanner that yet was seldom employed for technical problems of hardware compatibility; therefore, since this check would require the time to compare the barcode of each drug with a corresponding item in the drug list "by hand", this operation was generally

performed later at the end of the shift, and not exactly when the drugs arrive at the ward. Yet, in order to cope with this process workaround at the ward side, the hospital pharmacy pushed for a corresponding system workaround, that is requiring the nurse on duty to sign a paper-based delivery note to acknowledge receipt of the drugs, whatever the shipment. Obviously, this might cause a potential mismatch between the current step in the EPR workflow and the actual task, until the ticking off is performed, as well as more serious data-related misalignments whenever nurses realize at the end of their shift that some drug had not been dispatched (a rare event, though). These workarounds are considered harmless, at least from the perspective of the pharmacy, as they have a regular receipt (although on paper) and this can enable them to trigger the stock depletion and replenishment procedures; yet, all the interviewees agreed upon the fact that if administration were supported by the EPR, as it should, everything would be stuck irremediable, as the system would not allow for the administration of drugs that have not yet been officially dispatched from the pharmacy.

The lack of investments that is due to current economic restrictions and that our interviewees recognized as the main reason behind some misuses of the system (e.g., the cumbersome cart and the faulty barcode scanner) has an impact also on the phase of drug prescription. As the HP told us *"the lack of a digital signature system forces us to keep and sign a paper copy of each drug prescription [...] this has to be faxed to the pharmacy as soon as possible so that they can allocate the materials and prepare the necessary drugs [...] this of course does not exempt us from filling in all the details also on the EPR, because in short what we sign and fax is a printed screenshot of one of its pages."*. This system workaround is the source of another process workaround. When doctors complete the prescription of a protocol for a given patient, the EPR makes this information immediately available to the pharmacists; these latter start the preparation of the drugs before receiving the fax with the handwritten signature of the doctor (that comes after that a specific page of the application has been printed by a nurse, usually checked and signed by a doctor and finally faxed by a nurse again to the Pharmacy). This lapse of time can rarely generate a mismatch between what has been prepared and the actual formal prescription, as this latter can be modified before the paper-based prescription has been signed. The modification of a prescription is not an arbitrary and meaningless action, but rather is something that allows doctors to cope with exceptional cases (e.g., patient's allergies, rare adverse reactions, drug shortage): however, the above mentioned workaround can generate mismatches also in those rare cases where the due modifications occur during the "grey zone interval" between these two events. It is easy to understand that any mismatch consumes time to be caught and properly handled by either the nurses at the ward or the pharmacists, either separately or within an interaction between these two roles that is usually mediated by phone.

The HP mentioned another situation where a system workaround occurred for what could be related to an analysis or design mistake. In case of protocols containing expensive drugs, it is necessary to associate each of those drugs with a specific document, that contains information about the drug administration sequence;

this information is monthly delivered to the regional health authority that uses it to monitor drug usage across the territory and allow for its reimbursement. In some protocols, one of the drugs might be not very expensive and could be used in other protocols: in these second contexts *"the document does not make any sense [...] but it has to be produced the same, otherwise the EPR would prevent us from any other action [...Thus] we tell the system to create a copy of it, we even* have *to open it, and then throw it away and forget about it [...] so the EPR will allow us to proceed and do our work"*. On the one hand, the EPR considers the simple fact that users have opened the file as a validation of its content; on the other hand, the EPR designers did not consider that what makes sense in a department (e.g., in haematology where the cheap drug is used within a crucial and expensive protocol) generates a useless redundancy in another department.

The definition of the therapy protocols is problematic since, to prevent unwanted modifications, any change generates a new protocol that has to be filled in from scratch. For this reason the definition of complex protocols requires time and concentration, two scarce resources for doctors. This fact generated an odd form of workaround, a role-based workaround in-between the system and the official procedure: the doctors proposed to the hospital management that they would still be in charge of defining and validating the protocol on paper, also to exploit the natural flexibility of this medium; but also that later someone else would have to put all the paper-based protocols into the system, someone "*who does not need to be a doctor [...] as they have only to copy our files into the system, one character after one character*". Doctors experimented this solution for a certain period of time, but their protest led only to multiple typos in the protocols imputed into the system, to the suspicion that some typo could also lead to some serious misnomer, and hence to wrong drug administrations, and they had to choke down their protest for silly data entry duties and work again *with* the system.

Reflections on experience

The interviewed key actors emphasized several times that they would like to use the EPR more, and in all its capabilities, "*provided that [...] some contextual conditions are satisfied*". This recalls a similar argumentation proposed by Bowers et al. (1995): a system is never good or bad *per se*, rather it has to be evaluated in relation to its context of use. This issue emerged during the interviews as a side effect of the main theme related to the workarounds, nevertheless it was discussed with high ardour by the interviewees as they felt that they could contribute in a factual way to the establishment of these enabling conditions. For example, the HP mentioned that the EPR requires him to perform the modification of any protocol modification by hand, for example when the same therapy is administered during two or more days or when the pharmacy substitutes an equivalent drug for another. Doctors have often reported this problem to the Hospital CIO "*from the very beginning*" and asked for a modification that from the programming point of view has always seemed almost trivial, "*[...] but then they [the vendor's developers] must have forgotten*

to make the modification we asked for, or something went wrong in the passing on...". Paradoxically, then, the few doctors that are able to perform these manual changes have never taught the others doctors how to perform this operation, in order to avoid that *"too many doctors change the protocols ... they could introduce errors and misalignments"*: thus doctors were complaining for a cumbersome and difficult procedure but, at the same time, they were also happy of these hurdles, and jealous of their capability to modify the protocol, although extremely time consuming.

The study shows that also in the case in which the technology is welcome for its positive effects on some aspects of the work practices, e.g., an increased patient safety in some phases of their caring process, the practitioners can feel necessary to adopt workarounds to reach their primary goal, i.e., the patient care and recovery, irrespective of the limits of the technology involved, or of the general policies and procedures that such technology enacts and enforces. Our study confirms the findings reported also elsewhere, and notably in (Zhou et al., 2011) that workarounds might concern problems that could be (and sometimes are) solved by either a stronger adaptation of users to their computational system, or by usually small adjustments of the system's functionalities by its developers, or of the related organizational procedures; or they might concern problems that are related to more complex situations that require more demanding efforts to be dealt with. However, in both cases the voice of the frontline users of the system deployed in an organization, in this case doctors and nurses in a hospital, does not easily reach the people that can actually solve the problems detected at the shop floor: i.e., either the organization top management (including the CIO), or the system developers (usually a third-party vendor). The reasons for that can be diverse and range from time pressure, to more political or strategic concerns, often related to the relationships between the IT Department, the other departments and (external) IT suppliers. Our interviewees admitted that *"often the IT Department is a useful filter, that is a* refiner *which sifts improper reports from real bugs, and that prioritizes multiple internal reports into a single, coherent set of evolutionary requests, also in light of precise and urgent budget constraints [...] but other times it also acts as a* deafening barrier*, which provides external stakeholders with a simplistic picture of the internal process of technology appropriation and acceptance, [...] also because they want the digitization project be a success at any price"* and this prevents the end-users' voice to reach both the top management and the supplier timely, systematically, or just faithfully.

Unlike the findings reported by Tucker and Edmonson (2007), the practitioners involved in our study were in favour of letting a persistent record of their problems, proposals and partial solutions – among which those essential workarounds that they had devised to reach their goals better – be preserved by some computational tool, and promoted, so that their contributions could be taken in consideration more likely than being forgot, disregarded or underestimated. This tool, the "pneumatic drill" hinted at by the nurses in front of the coffee machine, would not substitute already established occasions in which "due feedback is collected", nor let end-users bypass the IT Department in making sense of their troubles with the system. Far

from it, such a recording tool was envisioned to help collect feedback also by whom has little time to organize her interactions with the system in a systematic report, or that does not have any particular inclination in analysing the intended behavior of the system and comparing it with her working habits; such a tool should provide a lightweight communication channel between stakeholders, by creating new opportunities for confrontation and discussion, both in an inter-department context, and when the whole organization has to negotiate maintenance contracts and change requests with the IT supplier. Lightweight in this case would mean that such a tool should not be either demanding nor binding in terms of use, but also contextual with respect to the work practices, and flexible in the amount of information that it manages so as to be usable (and possibly useful) in different working contexts. On the basis of these informal requirements, we developed a prototype that is described in the next section.

The ProAnnoto Prototype

On the basis of the findings of the field study and inspired by the idea to let workarounds emerge in an almost stigmergically manner from work practice, we conceived a functionality, that we called ProAnnoto (Process Annotation), as a supportive means for end-users to visually represent upon an official workflow (possibly enacted by a computational system) the limitations and blocks they encounter in the use of such a workflow: to this aim, users are asked to leave a sign on the process maps that could evoke in their mind the workarounds they adopt to circumvent or avoid those shortcomings.

Since the Business Process Modeling Notation (BPMN[5]) is considered as sufficiently powerful to express ideal models of work processes (and workflows), as well as relatively easy to appropriate by end-users (Wohed et al., 2006), we decided to build the ProAnnoto functionality on the basis of a BPMN(-like) description of the work protocols that are enacted in the considered setting

In order to have an agile tool that could be discussed with prospective users in terms of potential usefulness and applicability irrespective of the real existence of an automated workflow, ProAnnoto has been developed with the collaboration of Davide Saronni as a stencil of Oryx; Oryx is a common Web platform for process modelling (Decker et al., 2008) that allows for the collaborative editing of process models and that stores those protocols in an online repository that can be shared within a group of users.

This means that each user can generate its own copy of the protocol (e.g., a different copy for each patient) or, likewise, on the basis of a simple parametrization and access rights, the same copy of a protocol can be shared within a group of users (e.g., an hospital unit, that shares the same model to treat a specific disease, without differentiating according to the patient). More specifically, the basic BPMN editor of Oryx has been extended with a symbol stencil that users can use to annotate their

[5] http://www.omg.org/spec/BPMN

protocols with three specific icons: one denoting what we called *system workaround* occurring during the execution of the protocol; one denoting what we called *process workaround* (see above); and a third icon to denote those cases where it is not easy to distinguish between system or process workarounds (or there is no reason to), but yet the user wants to convey the idea that a workaround *is* in place. In this way, the users can use a process model as a simple report form to record extempore anomalies and inadequacies that they detected in a real situation. When the protocol is shared and at a certain point in the process a single user experiences a workaround that has been already signaled by another users, she can access a dialog box associated with the related existing icon and increment the number of occurrences of the detected workaround, as it were a sort of "I agree" counter. Users can also leave an anonymous comment where to characterize their annotation with some further details related to the situation in which the workaround occurred.

The functionality is purposely left as simple as it looks: ProAnnoto does not ask users to appropriate a complex taxonomy to annotate critically a workflow instance, but rather it offers them the opportunity to record and report that the intended process (or enacting system) was found inadequate (in a particular point) and that some action had to be done to move on. On the other hand, ProAnnoto allows for the extraction of simple statistics from the accumulation of several reports: this information can be accessed by the interested people (e.g., the CIO of an organization or the project manager of the supplier) who can understand that some further inquiry is necessary and that something (that usually is irremediably) "off the record" is going on.

Some years ago, we prototyped an innovative EPR, called ProDoc (Cabitza et al., 2009b), whose main feature was offering, for each patient record, a contextual BPMN representation of the current clinical pathway associated with the patient at hand in terms of a "process map", which affords next due activities, as well as provides a process-aware access to the whole medical documentation. The future development of ProDoc will encompass the logical and technical integration of the ProAnnoto functionality: this activity will be scheduled after that (and if) the initial positive reactions, which we collected from the key users when we showed them the Oryx editor augmented with ProAnnoto on a tablet, will be confirmed in some more thorough validation sessions.

Conclusions

The paper reports on a systematic survey of the literature concerning the general concept of workaround, and in so doing it presents a range of definitions that focus on different aspects of this phenomenon. In particular, we shed light on the idea that workarounds are not always considered as harmful anomalies but *also* as resources for a better task-artifact fit, as well as for the evolution of the computational system *itself*, especially when they regard what we called "system workarounds". Yet, these insights have not yet been translated into any computational tool aimed at helping end-users let their workarounds emerge as a way to "put pressure" on whom it may

concern to improve their digital tools.

To close this gap, in this paper we envision the utility of a lightweight tool called ProAnnoto by which practitioners can collaboratively annotate visual representations, or "maps", of their processes, and in doing so indicate either any deviation from the official organization procedure ("process workaround"), or any circumvention of the technology that enacts those procedures ("system workaround"), or both, with specific iconic symbols (whose shape or characteristics are of secondary importance at best). Notwithstanding its computational simplicity, this solution is the first one to address the problem of involving frontline users in reporting their own workarounds at the degree of detail they deem as useful in a possible communication with the IT department of an organization and/or the provider of its IT solution as a means in their full control to prompt evolutionary maintenance of their appropriated artifacts towards a better fit of these with their situated work practices.

As anticipated in the Introduction, we are aware that the theme of workaround is a delicate one as their elicitation could raise conflicts among different stakeholders, like the users, the management and the IT providers, who might have different goals and perspectives with respect to the IT; we are also aware that the users themselves could prefer not to make visible those workarounds that make their daily professional life easier as outing them could make the system become just more difficult to game, not better. However, the voluntary (and anonymous) elicitation that is allowed by our system is only one of the means that users could exploit to break the barrier between them and those who do not perceive that the process of IT adoption is problematic and that an intervention is needed.

After decades of speculations about the need to have users participate in the conception and introduction of the technologies they are going to use, the most recurrent situation is still characterized by their *de facto* exclusion from this process for the inability of management and IT professionals to leverage the work experience of frontline users. The research efforts that aim to change these situations (e.g., Hartswood et al., 2008) sometimes look for complex solutions that encompass methodologies, methods, tools and technologies aimed at taking all aspects of these problematic situations into account (e.g., Fischer and Giaccardi, 2006; Stevens et al., 2009) On the other hand, we observed that users put to work simple strategies to take an active role in the development/refinement process of the IT they use and in the improvement of the task-artifact fit, and probably they only need more friendly environments to make these strategies more effective and "visible". The prototype proposed in this paper goes in this second direction, as it facilitates the user-driven and bottom-up definition of those strategies towards a better fit, and allows multiple stakeholders to find situated ways to support the users' workflow "from within" (Bowers et al., 1995).

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