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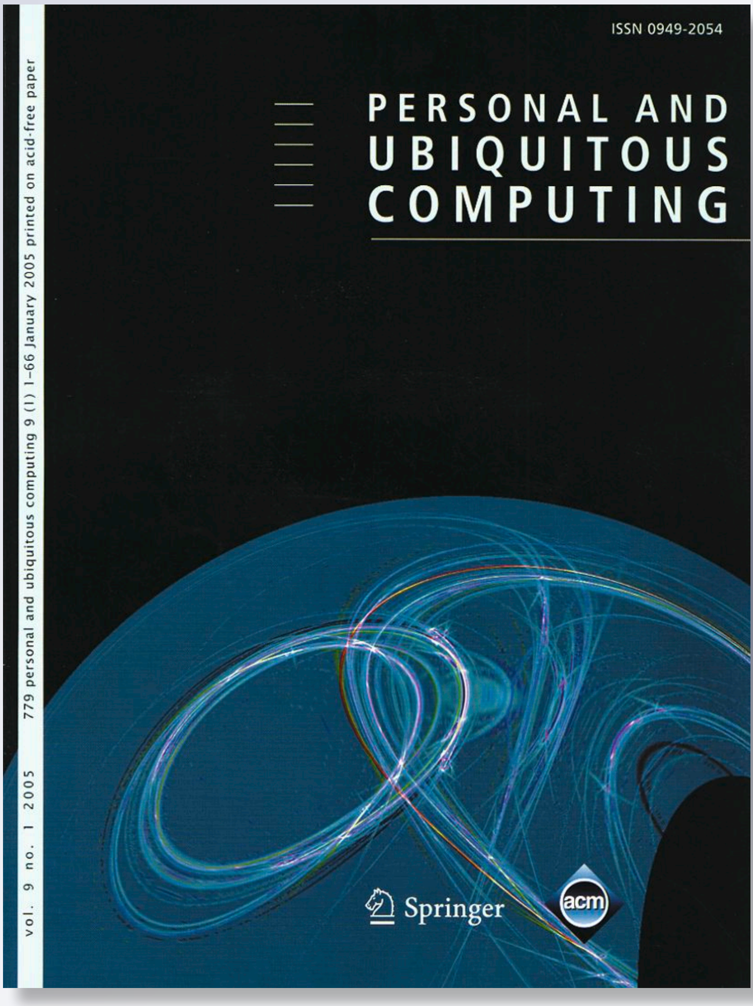

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ORIGINAL ARTICLE

You never call: Demoting unused contacts on mobile phones using *DMTR*

Ofer Bergman · Andreas Komninos · Dimitrios Liarokapis · James Clarke

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Abstract Throughout their lives, people gather contacts on their mobile phones. Some of these are *unused contacts*—contacts that have not been used for a long time and are less likely to be used in future calls. These contacts compete for the users' attention and the mobile phone's limited screen capacity. To address this problem, we developed a prototype contact list interface called *DMTR*, which automatically demotes *unused contacts* by presenting them in a smaller font at the bottom of the contact list. In phase I of this research, we asked 18 participants to assess for how long they had not used each of their mobile phone contacts. Results show that 47% of all their contacts had not been used for over 6 months or had never been used at all. In phase II, we demoted these *unused contacts* using *DMTR* and asked our participants to locate contacts that they had recently used, with and without the prototype. Results indicate that the use of *DMTR* reduced both the number of key strokes and the retrieval time significantly. The majority of participants indicated that it was easier for them to access their contacts using *DMTR* and that they would like to use it in their next mobile phone. The results provide strong evidence for the demotion principle suggested by the user-subjective approach.

Keywords Mobile phone · Contact list · Personal information management · User-subjective approach · Demotion

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1 Introduction

Personal information management (PIM) is an activity in which an individual stores his/her personal information items in order to retrieve and use them later. PIM has been studied in a physical office environment [1–3], on a computer relating to files [4–6], e-mails [7, 8], contacts [9], task lists [10–12], and across formats [13, 14]. With the recent growing interest in mobile phones (advances in technology, rise in usage, public attention, and research focus), there is also increased interest in mobile PIM research. However, these studies typically focus on the development and evaluation of new prototypes and little is known about the way people manage their personal information on mobile phones in general and in relation to their contact list in particular.

This paper focuses on unused contacts that compete for the users' attention and the mobile phone's limited screen capacity. To address this problem, we developed the *DMTR* prototype. *DMTR* automatically demotes unused contacts by presenting them in a smaller font at the bottom of the contact list (see Fig. 1). After the introduction, we will first present the *DMTR* prototype design and then our research, which aimed to study the unused contacts problem and to evaluate our prototype's success in addressing this problem.

1.1 Previous work

Calling occurs not only after accessing and searching contact lists (also referred to as address books). The task of calling a mobile contact can also be accomplished through the recent and missed calls list or the quick-dial feature of the phone. Why do users use multiple tools on their phone? There is no literature that we could find to explain this.

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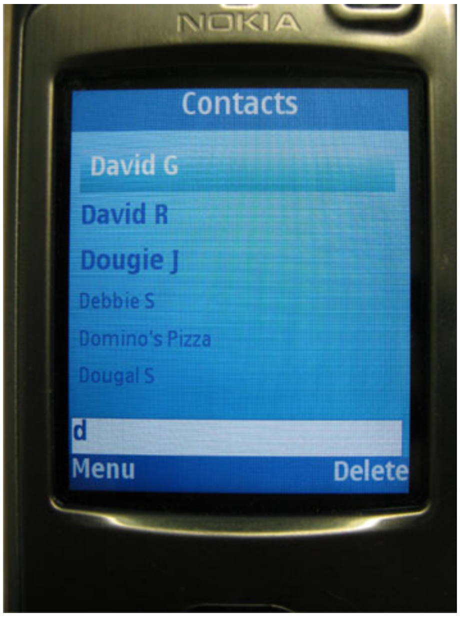

Fig. 1 *DMTR* interface

However, in our initial conversations with users, they indicated that in order to avoid searching for a contact to call or text, they would look first in the (recent or missed) call list. This was particularly true when it was someone they remembered having talked to recently, as it was deemed to be "faster" than searching for a contact in the contact list. The use of a call list as a primary retrieval tool was also found among semi-literate users [15], albeit driven by reasons other than convenience. Although using a recent call list to find a contact might offer significant speed advantages over searching a contact list, it might not always be the best strategy to adopt in terms of effectiveness [15, 16]. Böcker and Suwita [16], who examined the usability of a C10 phone, found that although almost all users had no problem finding and calling a given contact from the contact list (94% success), this rate dropped significantly to 73% when asked to find and call the same contact from a call list. Klockar et al. [17] also investigated the usability of several mobile phone models and found that while users typically had almost no problem calling a contact from the contact list (i.e., the number of key strokes over the optimal path was near zero), there were more problems (significantly more key strokes) when asked to check their missed call list. Some devices go to some length to support this naturally occurring phenomenon of mixed tool use for calling; e.g., Nokia S40 devices offer a choice of recently called contacts when looking to add a recipient to a text message and Sony Ericsson's P1i keeps track of recently messaged contacts that can be viewed before going to the contact list.

Gaur [18] recommends two interesting ways to enhance the usability of a contact list: marking a contact with a Bluetooth signature to later aid the exchange of data, or notifying on their vicinity and using geo-tagging to remind people where they met a particular contact. Rhee et al. [19] recommended an altogether different approach, where a "life diary" that monitors all of a user's activities becomes a communication gateway. The user is able to respond in any manner from any event, e.g., send an e-mail prompted after a phone call, return a call from sms. This negates the need to search for contacts when answering a person in a different format. However, the authors do not present any evaluation of their design.

In a key paper, Oulasvirta et al. [20] examined using context awareness to improve the contact list. In their work, the researchers recommended the augmentation of a user's contact list applications through the addition of contextual cues about themselves that can be shared among contacts (e.g., user location, time spent in location, availability of different communication modes) and contextual information about their own contacts, such as whether a number has been used recently and the number of contacts' Bluetooth phones that happen to be nearby. The researchers found that augmenting the application enabled groups to obtain a greater awareness of each member's context and as such, their design was found to be useful in a number of situations during field trials. Their work highlights the under-exploitation of platforms such as contact lists and their potential when augmented through context awareness. With regard to designing how context awareness should drive applications such as contact lists, perhaps the most significant finding in the research was the fact that ultimately, and in line with [21], in situations where social factors are likely to be the key to the adoption of an application, context awareness should be used to present information to users while leaving ultimate control over the course of action to them, rather than fully automating it. Oulasvirta et al. also recommend adopting unremarkable computing as a design principle that makes computing transparent and supportive of the natural flow of activity, something that they attribute to [22], but which possibly emerges from the initial theories of Weiser on the nature of ubiquitous computing.

Perhaps the most relevant work in this area is that of Jung Anttila and Blom [23], who investigated the improvement of a mobile contact list focusing on the need to differentiate important contacts from other contacts. They found that users responded very positively to being able to access the top 10 contacts quickly in terms of communication frequency, those whose birthday was nearing, and those contacts that were recently added, as three special category views that helped differentiate potentially important contacts from the rest of the repository.

1.2 Unused contacts

Throughout their lives, people gather contacts on their mobile phones. These contacts include the name and phone number/s of friends and acquaintances, family members, work-related contacts, household contacts, child-raising-related contacts, casual contacts (e.g., the number of a pizza restaurants where they worked for a few days), and various others. Some of these contacts are *frequently used* (e.g., spouse, close friends and relatives, and daily contacted work associates); others are *occasionally used* (e.g., less close friends and relatives, occasionally called work associates, the dentist, a child's teacher). There is another group of contacts that users have not called in a long time and are unsure whether they will ever call again. We will call this group *unused contacts*. Some of these *unused contacts* are contacts that lost their relevance (that pizza restaurant where they no longer work), others are contacts that have never been used (for example, when bumping into an old school friend, taking each other's numbers can be an act of politeness rather than a practical matter). Some contacts may even be so old that the user is not sure whether their phone numbers are still correct. These numbers were transferred from device to device as users upgraded their phones, either because it is more practical to transfer entire contact lists by selecting all elements rather than copying individual ones, or because users were concerned that they might not have them in the future when they needed them.

What do people do with these unused contacts? Judging from personal information management (PIM) literature, not much. PIM literature indicates that when encountering the old "to keep or not to keep?" question [24], users typically prefer the keep option. This behavior can be attributed to several factors: First, one can always think of a situation when the information may be needed [3]. Second, keeping is the default option (what happens if the users do nothing) and users are known to take the default option [25]. Third, there is a "deletion paradox" phenomenon [26]: while unimportant information items distract attention and increase retrieval time for the target item, it also takes time and attention to review items to decide whether to keep or delete them, and users may want to avoid this. Finally, there are various psychological reasons why people avoid deletion, many of which can be attributed to the decision-making process described in *Prospect Theory* [27]. These psychological reasons for avoiding the deletion of PIM items are described in [28].

As a result, numerous PIM studies indicate that users' information repositories are often cluttered with unimportant information items [8, 14, 24, 29, 30]. As one of Boardman and Sasse's [14] participants commented: "*Stuff goes in but doesn't come back out—it just builds up*" (p. 585). These information items compete for the user's attention, obscuring important information relevant to the current task. It is well known in the field of cognitive psychology that when performing a visual search, the number of irrelevant distracters increases the time it takes people to identify a target object [31, 32]. Specifically in PIM, research has shown a positive correlation between the number of files in folders and the retrieval time of the target file [5]. Based on this body of knowledge, it can be expected that unused contacts will slow down the retrieval of the target contact (i.e., the time it takes users to find the contact they are looking for and call this person).

Mobile phone interfaces have an additional problem: their visual presentation abilities are necessarily limited due to small screen size [33]. This intrinsic problem is caused by the fact that mobile devices need to be small, since users carry them everywhere, often in their pockets. As a result, unused contacts compete with target contacts not only for the users' limited attention resources but also for the limited mobile phone screen display. In computer displays, collections of information items, such as files in a folder, are often displayed in a two-dimensional array (with more than one column) allowing to present up to 200 files on the same screen depending on screen size, resolution, and font size. Therefore, in a computer display, the amount of visual space is typically sufficient for users to reach the target file in the target folder within a single click (or with unusually large collections, within one or two presses of the folders' scroll bar). However, as the mobile phone display is typically limited to one dimension (i.e., contacts are presented linearly in a single column), its screen displays an average of 4–10 contacts at a time (again depending on screen size, resolution, and font size). As all contacts occupy display space, we also expect the *unused contacts* to increase the number of user actions (either button presses or display clicks) needed to reach the target contact.

To conclude the introduction, we expect mobile phone contact lists to contain a substantial number of *unused contacts*, which increase the number of key strokes and the amount of time needed to reach the target contact in order to make the designated phone call.

2 DMTR

In this section, we will report on the design approach that addresses the *unused contacts* problem and on *DMTR* design heuristics and the development process.

2.1 The user-subjective approach and the demotion principle

The *user-subjective approach* is the first approach designated specifically for PIM systems design [26]. Several design schemes for the computer environment have been derived from the user-subjective approach [13]. In this paper, we present the first user-subjective design for mobile phone environments. The user-subjective approach suggests design principles under which PIM systems can make use of subjective attributes of information systems in order to better facilitate their retrieval. One of these principles is the *demotion principle*, which directly addresses the *unused contacts* problem as specified previously. The demotion principle proposes that information items of lower importance should be demoted (i.e., making them less visible) so as not to distract the user, but (unlike in deletion and archiving) kept in their original context, in case users want to retrieve them in the future.

The user-subjective approach is deliberately abstract, and the demotion principle does not directly specify whether the user or the system identifies the information items as unimportant or how the information item would be made less visible. In a previous paper [28], we developed and positively evaluated a prototype called *GrayArea* with a direct manipulation interface: users can identify files as unimportant and demote them by dragging them to a gray area at the bottom of their folders. When designing *DMTR*, we assumed that users would not bother to demote *unused contacts*, just as they do not delete them. We therefore decided on a design based on automation: contacts that had not been used for a long time will be considered unimportant (note that the system interprets the users' actions) and be automatically demoted. Concerning the way these contacts are demoted, we first thought of an interface where *unused contacts* would not appear on the default contact list and would appear there only when the users requested them (e.g., by pressing the "view all" key). However, this interface archives the *unused contacts* rather than demoting them, because they completely disappear from the default contact list. This can be alarming for users, at least in the beginning. Under mobile HCI guidelines, interfaces have to be made as intuitive and easy to learn as possible. As such, we had to think of a way to make unused contacts less visible and accessible, while keeping them on the users' contact list in order to avoid confusion and panic.

2.2 DMTR interface

The diversity of mobile phone manufacturers (many of whom employ more than one operating system for their devices) has given the mobile device market various contact list interaction designs. When designing the *DMTR* prototype, we examined several designs and chose Nokia's interaction design as a template, which we extended to include the demotion interface, because of its simplicity, intuitiveness, and the familiarity of a great majority of users with this type of interface. (Nokia is still the global market leader in mobile phone devices). However, similar demotion interfaces can be applied to all other mobile phone interaction designs.

In Nokia's interaction design, contacts are always listed in alphabetical order and only the contacts beginning with the pressed letters are presented. The contacts are retrieved as follows: When entering the contact list, the user receives a list of all the contacts, which typically extends far below the limits of the screen (see Fig. 2a). If the user wants to call his friend Dougie, for example, he would press the first letter of Dougie's name ("d") and then the list would filter

Fig. 2 The retrieval process on a standard Nokia UI (*left*) and the DMTR interface (*right*)

itself to contain only those contacts beginning with a "d" (Fig. 2b). Now the user has the choice of either using the directional keys to scroll the selection indicator to the desired contact or pressing another letter of the name to further narrow down the contacts on the filtered list. As such, assuming in our example that the user has made the second choice and presses the letter "o", he would then see all the contacts starting with "do" (Fig. 2c).

The *DMTR* interface adds the demotion aspect to this interaction design. All demoted contacts appear in a smaller font and are listed in alphabetical order below the regular contacts alphabetical list. The interaction design is as follows: when the users enter the contact list, they receive *all* regular contacts (see Fig. 2d) and below this list, *all* the demoted *unused contacts* listed (which do not usually appear on the screen). When users type in the first letter of the target contact's name, they receive all the regular contacts beginning with that letter, followed by the list of unused demoted contacts beginning with that letter. For example, when users press "d", they receive the regular contacts beginning with "d" followed by the demoted contacts starting with "d" (see Fig. 2e). The user has the choice of either scrolling to the target contact or typing in another letter. Assuming that enough letters have been added, our user receives the only regular contact starting with "do" (his friend Dougie), followed by the demoted contacts starting with this letter combination (Fig. 2f). As this example shows, the *DMTR* interface makes the regularly used contacts more visible (because they do not have to compete with the demoted contacts for screen space) and as such, they can be retrieved in fewer steps than in the traditional Nokia interaction design.

2.3 Heuristics

The *DMTR* design interface was presented to two groups of HCI experts for heuristics. One group at Sheffield University included 7 HCI experts of various nationalities, and the other group consisted of 3 HCI experts at Glasgow Caledonian. The experts expressed positive opinions about *DMTR* and made the following suggestions: (1) to allow users to reverse the demotion by *manually* un-demoting a contact (needless to say, if a demoted contact is used, it is *automatically* promoted to the regular contact list). This allows users to keep important numbers that are rarely used (such as emergency calls) handy. (2) To allow users to turn off the *DMTR* functionality and by doing so un-demote all demoted contacts and stop demoting *unused contacts*. Both suggestions allow for reversibility and return the locus of control to the user, as suggested by [25], and were implemented in the *DMTR* prototype. In addition, we had to decide on the time frame in which the system would regard a contact as unused and demote it. Some experts suggested automatic demotion after 3 months of no use, and others preferred 6 months. In order to be "on the safe side" and avoid demoting contacts that are occasionally used, we decided on the 6-month option. Our choice was also backed by further evidence gathered through the examination of actual users' contact lists, which showed that almost half of contacts had not been used for more than 6 months or had never been used at all (see Sect. 5.1).

2.4 Development

The DMTR prototype was implemented in J2ME, using the "J2ME Polish" UI framework.[1] Technically, the prototype's interface consists of an extended FilteredList class for the main display, which is populated by an internal RecordStore, responsible for holding all the user's contacts and meta-data concerning them (e.g., frequency of use, timestamp of last use). By using the JSR-15 PIM API for J2ME, we were able to import all the user's actual contacts easily from the device's standard contact list application into the DMTR prototype. The prototype also contained several functions specific to the research that we planned on carrying out with it, namely the following: a transparent keylogger function that monitors use of the prototype and saves data in an exportable XML data file; a function that imports contacts and contact meta-data from an external source in order to help us set up experimental conditions quickly and accurately on multiple devices; and a function to allow experimental parameters such as participant ID and demotion parameters to be set up on the test device prior to experiments. We also developed custom software to help parse the XML usage data and analyze it on a desktop computer for the purpose of evaluating our prototype using quantitative data.

3 Research question

Our research questions related to two topics: the *unused contacts* problem and the effect of *DMTR* in addressing it.

Questions regarding *unused contacts*:

1. What is the percentage of *unused contacts* of all contacts?
2. Do participants delete *unused contacts*?
3. What is the size of the collection and how does it affect the percentage of *unused contacts*?

[1] http://www.j2mepolish.org.

Questions regarding the effect of *DMTR*:

4. Does the use of *DMTR* reduce the number of key strokes used for a call?
5. Does the use of *DMTR* reduce retrieval time?
6. Does the percentage of demoted *unused contacts* affect the reduction in key strokes and retrieval time in *DMTR* use?
7. What are the correlations between key strokes, duration, and collection size?
8. What is the participant's attitude toward *DMTR*?

4 Method

The optimal *DMTR* evaluation design would be to install it on the participants' mobile phones and ask them to use it instead of their mobile phone's default address book for a few months (preferably more than 6, in order to gather enough information about unused contacts to demote them), and then for an additional time for the experiment, while logging their actions. However, this was not possible because it was not realistic to assume that participants would commit to using our prototype exclusively rather than their mobile phone's original contact list for such a long time. Instead, we conducted a laboratory experiment in two phases. In phase I, participants reported on when they last used each of their contacts. Using *DMTR*, we demoted contacts that had not been used for over 6 months. Then, in phase II, we gave participants retrieval tasks with and without the use of *DMTR*.

4.1 Participants

Participants were 18 students at Glasgow Caledonian University, Scotland (non-random selection). Of the participants, 16 were men and 2 women. Their ages ranged from 20 to 47 ($M = 24.86$, $SD = 7.47$). All participants used mobile phones. Participants were randomly divided into 2 groups of equal size, the *A–M group* and *N–Z group*. The rationale behind the division into groups is explained in the next section.

4.2 Procedure

The evaluation procedure included two phases with an appropriate time gap between them, in order to remove any effects from recent calls, as explained later.

4.2.1 Phase I

In phase I, participants were asked to give the tester their mobile phone. The tester extracted their mobile phone contact list to a spreadsheet on the laboratory computer. Then, for each of the contacts, the participants were asked to assess when it was last used. For each contact on the sheet, participants could choose among the following options: "at least once a week," "past month," "1–6 months ago," "over 6 months ago," or "never."

4.2.2 Time gap

Between phase I and phase II, there was a two-month gap so that the recent calls in phase II would not necessarily relate to the estimations in phase I.

4.2.3 Phase II

In phase II, we uploaded each participant's contact list to a laboratory mobile phone (Sony Ericsson W910i) with the *DMTR* prototype installed on it. The uploaded contact lists contained all the necessary meta-data to allow a simulation of *DMTR*, as if the prototype had already been in use for more than 6 months. This meant that we demoted contacts which the participants reported as not used for over 6 months (or never), depending on the group to which they belonged: For participants in the *A–M group*, we demoted *unused contacts* that began with the letters A to M and left the contacts beginning with other letters untouched, as the control condition. For participants in the *N–Z group*, we demoted *unused contacts* starting with N to Z, leaving the contacts beginning with the rest of the letters untouched. Participants were tested individually. Participants gave their mobile phone to a tester who then manually updated the contact list on the laboratory phone with names the participant had added during the time gap. Then, the tester gave the laboratory phone to the participant and held the participant's actual phone. The tester then read a name listed in the participant's mobile phone *Recent Calls* list. The participant was asked to "call" this person on the laboratory phone (however, the calling function in our prototype was disabled, so that the participants would not bother these people). Key strokes and retrieval time (the time it took the participant from first action, which was getting into *DMTR,* until they pressed the call button) were automatically logged by the prototype. As contacts in the *Recent Calls* list could start with letters in the A–M range or with letters in the N–Z range, each participant was engaged in both the experimental condition using *DMTR* and the control condition, which was the same retrieval method without the demotion. We also voice recorded the procedure and then tested participants for possible mistakes (i.e., "calling" the wrong contact instead of the one specified by the tester), but found none. At the end of phase II, participants answered a short questionnaire.

5 Results

5.1 Phase I: unused contacts results

5.1.1 *What is the percentage of unused contacts of all contacts?*

Figure 3 shows the participants' contact usage distribution using the data collected in phase I.

Figure 3 shows that almost half of the participants' contacts (754 contacts, constituting 47% of all contacts) are *unused contacts*, i.e., contacts that have not been used for over 6 months or never been used at all. Another 15% of the contacts are *frequently used* contacts that participants use at least once a week. Between these two groups of contacts, there is a mid-range group of *occasionally used* contacts (last used in the past month and up to 6 months ago), which constitutes 38% of all contacts.

When testing the percentage of *unused contacts* across participants, we found that the percentage of *unused contacts* varied among participants and ranged from 0% for one of the participants (who had a very small contact list consisting only of the contacts she actually used) to 77% of *unused contacts* for another. The average *unused contacts* across participants was 39% (SD = 17%).

5.1.2 *Do participants delete unused contacts?*

Of the 18 participants, only one reported on actively deleting *unused contacts*. This participant had only 24 contacts, none of which had not been used for over 6 months or never. We excluded her from participating in phase II because none of the participants' contacts would have been demoted, and therefore, we could not test *DMTR* effect in this case. However, as we believe that this case represents a small part of the mobile user population, we will relate to it in the discussion section.

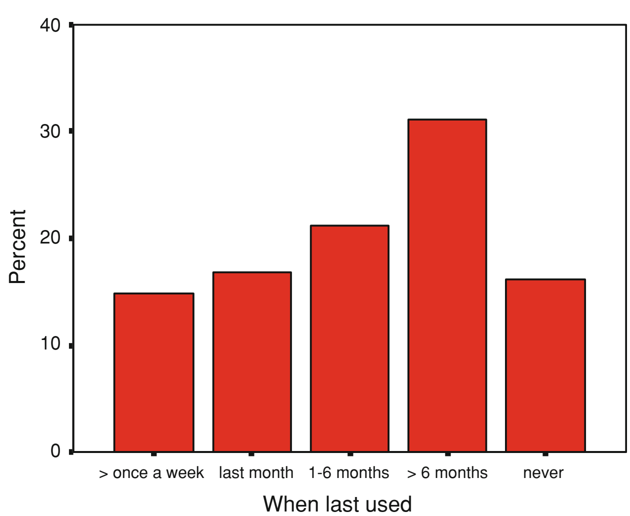

Fig. 3 Distribution of time that passed from last use for all contacts ($N = 1{,}596$)

5.1.3 *What is the size of the collection? Does collection size affect the percentage of unused contacts?*

Collection size (i.e., number of contacts in the contact list) varied considerably among users, from a minimum of 17 contacts to a maximum of 202 contacts. The average contact list size was 92.47 (SD = 56.93). As expected, we found a high positive Pearson correlation between number of contacts and percentage of *unused contacts* $r(17) = 0.81$, $p < 0.01$.

5.2 Phase II: DMTR results

In phase II, participants made 365 "calls". Of these "calls", 164 (45%) were made in the *DMTR* condition (i.e., in the letter group that contained demoted contacts), and 201 (55%) were made in the control condition.

5.2.1 *Does the use of DMTR reduce the number of key strokes used for a call?*

The number of key strokes used in the *DMTR* condition ($M = 5.12$, SD = 3.03) was significantly smaller than in the control condition ($M = 7.21$, SD = 6.25), $t(363) = 3.92$, $p < 0.01$. We also measured the average reduction in button presses for each participant, subtracting the average number of button presses per participant in the *DMTR* condition from the average number of steps in the control condition for the same participant. The average reduction in button presses across participants was 1.96 button presses (SD = 3.56).

5.2.2 *Does the use of DMTR reduce retrieval time?*

The time it took the users to perform a "call" under the DMTR condition ($M = 4{,}424$ ms, SD = 1,872 ms) was significantly shorter than the time it took in the control condition ($M = 5{,}204$ ms, SD = 2,829 ms), $t(363) = 3.03$, $p < 0.01$. We also measured the average reduction in retrieval time for each participant by subtracting the average retrieval time per participant in the *DMTR* condition from the average retrieval time in the control condition for the same participant. The average reduction in retrieval time across participants was 340 ms (SD = 1023 ms).

5.2.3 Does the percentage of demoted unused contacts affect the reduction in key strokes and retrieval time in DMTR use?

We found no significant correlation between the percentage of demoted items and reduction in key strokes: $r(16) = 0.18$, $p > 0.05$. However, we did find a significant correlation between the percentage of demoted contacts and reduction in retrieval time: $r(16) = 0.45$, $p < 0.05$. In other words, the higher the percentage of demoted contacts, the more time *DMTR* saves when retrieving the target contact.

5.2.4 What are the correlations between key strokes, retrieval time, and collection size?

There was a positive correlation between the number of key strokes and retrieval time: $r(373) = 0.62$, $p < 0.01$. This could be expected as each key stroke takes time (on average, a key stroke took about a second—$M = 932$ ms, SD = 407 ms). There was also a significant correlation between the contact list size and the number of steps required to make a "call": $r(373) = 0.13$, $p < 0.05$. However, the correlation between size and retrieval time did not reach significance: $r(373) = 0.07$, $p > 0.05$.

5.2.5 What is the participant's attitude toward DMTR?

At the end of phase II, participants were asked to answer two questions using a three-point Likert scale and to write their comments and suggestions regarding *DMTR*. Fifteen of the 17 participants engaged in phase II, and 14 responded to the questionnaire. When asked whether they agree with the statement "*It was easier for me to access the contacts using DMTR*," 12 participants (86%) answered "yes," one (7%) answered "don't know," and one participant (7%) answered "no." When asked *"Would you like to use DMTR in your next phone?,"* 9 participants (64%) answered "yes," 4 (29%) answered "don't know," and one participant (7%) answered "no." When asked to give their comments and suggestions regarding *DMTR,* eight of the comments were clearly positive (e.g., *"I Have an iPhone and would like it as an iPhone app."* and *"It helped me get to the people I call quicker"*); two comments reflected a mixed attitude (*"Need some time to get used to it, but more interesting and easier to use"* and *"Easier but I prefer my phone's contact list. I'm more used to it"*); two comments were negative (*"Wouldn't install it in my phone"* and *"Didn't like the colour of the app."*), and; two were suggestions for improvements (*"Perhaps the DMTR should also be ordered by the most recently called"* and *"I would maybe cut down the length of time before a contact moves to the bottom of the list to 3 months rather than 6"*).

6 Discussion

Results indicate that *unused contacts* comprise a substantial part of the participants' contact list: nearly half of it (47% of all collections and an average of 40% across participants). This result seems reasonable considering the fact that only one participant reported on deleting contacts. Moreover, our participants were young students, most in their early 20s, with a relatively small contact collection size ($M = 92.47$, SD = 56.93). As participants refrain from deleting their contacts, their collection is expected to grow in time. Our results also show a high positive correlation between collection size and percentage of *unused contacts* ($r = 0.81$). We can then expect the percentage of *unused contacts* to grow over the years with the size of their collection and dominate it when they are in their 30s and 40s.

These *unused contacts* represent visual stimuli that compete for the users' attention [31, 32] and for the limited mobile phone screen capacity, and as a result, our participants needed to press more buttons and spend more time when retrieving the target contact. Again, this problem is expected to grow over time with the growth in the participants' contact list.

Our results indicated that *DMTR* helped to address the *unused contacts* problem. When using it, retrieval was significantly faster and involved significantly fewer key strokes than when not using *DMTR*. The majority of the participants indicated that it was easier for them to access their contacts using *DMTR* and that they would like to use it in their next mobile phone. A positive attitude from the participants toward the prototype was also expressed when answering our open question. These results may suggest that mobile phone manufacturers should consider adding it to their next mobile phone systems.

The implementation of our approach in a modern mobile OS is possible, as the requirements of additional storage for the meta-data concerning contact usage are reasonable, given the ample storage space available in many devices today. Processing power in terms of calculating the importance of contacts could be a concern: if this service was to be offered in real-time, a "usage daemon" running continuously on the device to infer importance could decrease its performance and consume the battery more quickly. However, we feel that this "daemon" could perform adequately if run only occasionally (e.g., once a day). *DMTR* can also be used in cloud-based contact lists that are updated across multiple platforms (e.g., Google contacts running on an iPhone, or Skype mobile) by synchronizing the use of contacts across them.

Like the majority of interfaces, *DMTR* is not good for all users. One of our participants (with a small collection of only 24 contacts) explained that she consistently deleted her *unused contacts* and therefore had no use for *DMTR*. Were *DMTR* installed on this participant's next mobile phone, none of her contacts would be demoted, so it would neither help nor disturb her (she would not even need to turn off the option). Other participants might want to keep some of their unused contacts handy (e.g., emergency numbers). These users could do so either by un-demoting the contacts (once un-demoted, the system will not demote these contacts regardless of the time that they are not used), or by placing them in their quick-dial list.

Our results indicate that *DMTR* and quick-dial (or a recent call list) are complementary solutions, rather than competitive ones, because they relate to two different problems. Figure 3 shows that 15% of the contacts are used at least once a week. Users can use quick-dial (or the *Recent Calls* feature) in order to distinguish these *frequently used* contacts from all other contacts. However, 38% of the contacts are used occasionally (last used in the past month, up to 6 months ago), and current solutions do not separate these contacts from the 47% of *unused contacts*. *DMTR* is the first prototype to make this distinction and makes *occasionally used* contacts more accessible.

We now re-examine our design approach in the light of feedback from our experiment. *DMTR* is just one possible way to implement the demotion principle, and the demotion principle is only one principle advocated by the user-subjective approach. The user-subjective approach exploits a unique requirement of PIM systems [26]. In other systems, information is stored and organized by information professionals (e.g., Web site developers) for users who retrieve information according to their needs. To cater to the needs of different users and facilitate information retrieval, information professionals use general and objective attributes of the information for its organization. PIM systems are unique in that the person who stores the information and decides on its organization is the same person who later retrieves it. The user-subjective approach takes advantage of this unique feature and suggests that PIM systems should make systematic use of subjective, user-dependent attributes to facilitate the organization of personal information and its retrieval. This could be done either automatically by the system or manually by the user, using direct manipulation.

One such subjective attribute is the importance of an information item. Importance is a subjective attribute because it is user dependent: the same information item can be of the highest importance to one person and completely unimportant to another. The demotion principle suggests how PIM system design could help the user make use of the low-importance attribute. A different implementation of the demotion principle was developed and positively evaluated in [28]. The user-subjective design approach presents many subjective attributes, design principles, and user-subjective design schemes, yet to be explored [13]. The positive results regarding *DMTR* obtained here provide evidence in favor of the user-subjective approach as a whole and should encourage the development and evaluation of additional user-subjective designs.

7 Conclusions

This paper is the first to examine the *unused contacts* problem. Almost half of our participants' contacts were not used for over 6 months or had never been used at all. These contacts compete for the users' attention and the mobile phone's limited screen capacity. As a result, they slow down retrieval of the target contacts. Our results show that the use of the *DMTR* prototype significantly decreased key strokes and retrieval time and was given positive feedback by our participants. We deliberately did not attempt to patent *DMTR*, because we wanted users of all mobile phone manufacturers to benefit from it. It is our hope that the next generation of Nokia, Samsung, iPhone, and other mobile phones will contain *DMTR* or similar demoting features, addressing an important but commonly overlooked aspect of everyday mobile phone use.

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