

Do you KnowDis? A User Study of a Knowledge Discovery Tool for Organizations

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ABSTRACT

Organisations today have no reliable way of ensuring that all employees are aware of information that may be relevant to their work. In this paper we report on a 2-year project in which we have iteratively designed, developed and tested a knowledge discovery system (KnowDis) for organizations. Early stages of our study revealed that, employees do not know what is available on the corporate intranet, or files and messages they have stored. KnowDis proactively fetches relevant information and displays it in an unobtrusive form; this increases employee awareness without disrupting their tasks. We discuss and characterize knowledge workers' email usage behavior. Our main study with 28 users of KnowDis-enhanced email showed it can improve the user experience and performance on information retrieval tasks for knowledge workers.

Author Keywords

Knowledge Management, Information Discovery, Personal Information Management, Sensemaking, Contextualization, Contextual User Interfaces.

ACM Classification Keywords

H.5.2 [Information Interfaces and Presentation]: User Interfaces - *Graphical user interfaces*.

General Terms

Design, Human Factors, Measurement, Performance

INTRODUCTION

"The mere existence of knowledge somewhere in the organization is of little benefit; it becomes a valuable corporate asset only if it is accessible, and its value increases with the level of accessibility." [5]

Most organizations heavily rely on email and instant messaging for asynchronous communications, and many employees organize their work around email and calendar tools [16, 27]. Organizations also make use of collaboration

and social networking tools for knowledge management and transfer [19, 21].

Nonetheless, opportunities for collaboration are frequently missed and efforts duplicated, due to relevant information not being known by the appropriate individuals. Knowledge workers often need to interrupt their tasks to search for additional information, and then switch back and resume the task. These interruptions decrease productivity, and search often produces a large number of hits the user has to sift through, increasing the sense of information overload [2, 4].

Consequently, employees often do not look for supplementary information. They don't expect to find relevant information within corporate knowledge repositories, don't know how to look for information using corporate search tools and data collections, or don't even know enough to ask a colleague.

In this paper, we examine the need for additional contextual information when reading or responding to email, and whether providing this information can reduce the sense of information overload. We report on a project in which we have iteratively designed, developed and tested a proactive knowledge discovery system (KnowDis) for large organizations.

The contributions reported in this paper are based on a seven-week field evaluation of KnowDis in a large enterprise. We demonstrate that our proactive knowledge discovery tool can improve the email experience and reduce the sense of information overload. We also provide a characterization of knowledge workers' email usage behavior during the field study, and how this behavior differs for employees with varying degrees of workload.

RELATED WORK

Knowledge is the key resource in today's knowledge society [9]. As Davenport & Prusak [5] have put it: "*a knowledge advantage is a sustainable advantage*". Knowledge management is not simply the amount or quality of information controlled by an organization, but rather how employees can create, share, access, maintain and act upon that information [20]. Adding knowledge within an organization through generation or acquisition isn't enough: the knowledge must be discoverable, comprehensible, and transferable at the appropriate times within the immediate workflow context [13].

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Unfortunately, the ideal is rarely met [24]. In a survey on Intranet usability, Nielsen found that *“poor search was the greatest single cause of reduced usability”* and *“accounted for an estimated 43% of the difference in employee productivity”* [23]. Recent interviews on knowledge management indicated that 39% of the statements about knowledge creating, sharing, accessing, using, maintaining and infrastructure were concerned with access [20, see also 15, 21]. The *“grasp of collective organizational knowledge”* decreases for companies larger than two to three hundred employees [5]; global enterprises are fighting an uphill battle for effective knowledge management [9]. The result is limited attention, information overload, vague or ambiguous communication, and misplaced attention on less relevant issues. This in turn forces knowledge workers to constantly compromise and somehow simply “muddle through” [14].

To alleviate the onslaught of information, a broad range of studies have explored ways to aid knowledge workers in large organizations. Those studies particularly focus on analyzing new tools that facilitate searching for expertise or experts [10, 11], automate and share how-to knowledge [19], enable social bookmarking [22], content aggregation [3] or social networking [6].

Recently, several researchers have explored the use of contextual search algorithms to develop proactive search capabilities [1, 17, and 18]. In these studies, keywords are extracted from a current document in a browser and these keywords are used to find other related documents. Links to the related documents are presented in an information tool bar. These studies examine the usefulness of proactive search, in the context of search activities (i.e. while the user is browsing).

However, searching for information is often an interruption of other work activities. The typical purpose of search is to close a knowledge gap that was discovered during another activity, e.g., reading an email, composing a document, coding or upgrading software, designing a user interface, etc. - switching from one application to another takes time and attention, and often leads to further interruptions.

In this study, we focus primarily on information overload in the context of email and concurrent search activities. For knowledge workers in large organizations, the one salient aspect of their work is dealing with email – reading, replying, creating, organizing, re-finding – typically for several hours per day, and interacting with dozens or even hundreds of people. Employees are flooded with email and other interruptions that distract their attention from important tasks [27]. Problems associated with email overload include stress, interruptions, lost productivity, and email obsession [13].

Setting aside time to develop personal information management (PIM) strategies through reflection [2] or well-defined training interventions [25] can reduce feelings of information overload. However, Gupta et al [13] argue that email overload is more dependent on the complexity of tasks

linked to the processing of particular emails, rather than the number of emails being processed, and that a more task-centric approach to email management is needed. A number of researchers [13, 26, and 27] highlight the need for better (automatic) categorization and prioritization of email to cope with email overload.

The proactive search techniques described above offer another approach to reducing the information overload associated with email. This approach is not focused on organizing email or associating email with particular tasks. The aim instead is to facilitate comprehension by providing additional context (related emails and documents). As noted by Billsus et al [1], *“when we are unaware of relevant information and human resources, the quality, efficiency, and satisfaction of our work suffers”*. Automatically generated recommendations are one way to assist people in discovering relevant information.” Search engine providers (e.g., Google) and retailers (e.g., Amazon) use this technique frequently to display targeted advertisements that are related to the user’s search query or the shopper’s product selections.

However, most of the studies of proactive search [1, 17, and 18] focus on the usability of the information toolbar *per se*; using metrics such as how often the recommendations are selected. Our research contributes new knowledge by examining the impact of proactive search tools on work quality and information overload. In the context of email, proactive search tools are not meant to be the focus of the user’s attention, but to “come in handy” in the course of their daily email tasks.

OUR RESEARCH

The overall goal of our research is to support knowledge workers by providing them proactively with information relevant to their current task. Since reading and responding to email is a substantial part of the daily work experience, we focused on providing email users with information that is relevant to the email message they are reading, but that they might not be aware of. Contextually relevant knowledge is discovered automatically, in a proactive manner, from the web, intranet, or desktop, without requiring explicit attention or instruction from the user.

The risk of providing contextual information in this way is that it might distract users’ attention from their focused activity, so information must be displayed in an unobtrusive way. At the same time, it should be easily noticed when the user requires it. In order to develop a system that meets these needs, and to assess the overall value of the system, we combined an investigation of email and search work habits with the development of a prototype tool, called *KnowDis*.

Research Questions

Do users find having a proactive search tool embedded in their email application helpful or not? If not, why not? If yes, how is it helpful and how does it integrate with their day-to-day work?

Do users find proactive search features distracting? If yes, how is it distracting? What can be done differently to make it less distracting?

Do users think their work-related tasks that depend upon information search become more efficient and more effective when proactive search tools are available?

Method

Over the course of two years, we have iteratively designed, developed and field-tested a proactive knowledge discovery system (KnowDis) for the enterprise. As part of the evaluation process, we conducted 46 semi-structured interviews with key knowledge workers of a large IT organization.

We started by collecting user requirements for such a tool through semi-structured interviews with 7 employees of a large IT organization in Phase 1. Based on those findings, we built a first functioning prototype, which we pilot-tested with 16 employees in the organization. The prototype was an add-in to Microsoft Outlook that extracted keywords from the active email and displayed links to relevant documents within corporate knowledge repositories. After participants used the prototype in their day-to-day work for some days (some participants used it considerably longer), we conducted a further fourteen semi-structured interviews.

In Phase 2, we re-designed the prototype to address the issues raised in Phase 1. This includes improved keyword generation algorithms, additional search domains (the ability to receive recommendations from the Web or from the desktop), and a range of other aspects, such as a more customizable user interface.

The second KnowDis prototype was made available to knowledge workers within a large IT organization. Employees wishing to integrate KnowDis into their day-to-day work had to fill in a detailed pre-study questionnaire before being provided with a user guide and video demos explaining the key features of KnowDis. After 7 weeks of use, we asked users to fill in a post-study questionnaire and conducted an additional 25 interviews.

PHASE 1

Requirements Gathering

We conducted in-depth interviews with 7 knowledge workers to understand how they manage corporate information in the context of their daily tasks. Four of our interviewees worked in sales, two in development, and one in back-office support. In the first part of the interview, we specifically asked about what types of information they needed for their daily tasks, and how they used tools such as email, corporate knowledge repositories, and collaboration tools such as wikis and SharePoint. In the second part of the interview, we introduced the concept of KnowDis and asked about its potential relevance to the participant's email activities.

The interviews revealed that employees develop their understanding of how the company operates through

exchanges – by email, phone or face-to-face - with their colleagues. This social network is a crucial backbone for employees with information needs. Employees try to find their way around the company's knowledge repositories - spread across internal sites, databases, Wikis, SharePoint. But they often end up asking members of their social network where to find the information. Most admitted to habitually turning to the social network as a first resort. Participant P1 argued to be highly dependent on help by a colleague he described as his *"power user"*.

In 2002, Nielsen [23] reported that company intranets that are not well designed significantly reduce productivity. Our interviews indicate that this has not changed. Interviewees reported struggling with the structure of knowledge repositories in the organization - identifying which information is useful is the biggest problem. P1 illustrates the problem, saying *"people want a path [to information] to get their thoughts right"* and that employees cannot find the information using search *"because they don't get their plan right"*. P2 heavily depends on distribution lists to find *"a lot of useful information"* as *"[Internal] search never brings up the right documents"*.

Participants generally acknowledged that integrating a tool which provides work-related information into Outlook was a sensible choice, as *"everything goes through email"* (P3). Participants generally understood the concept behind KnowDis - *"reminds me of Google Mail"* (P2 – referring to contextual ads being displayed). Participants saw KnowDis' potential benefits - *"save time, rather than having to search for 20-30 minutes"* (P6), and expressed the dormant need for such a tool: *"I would rather want to have such a tool sooner than later. Even if it did not work perfectly, give me version 1 now, and make an improved version 2 available later"* (P1).

Pilot study

Our choice of participants focused on individuals that qualify as knowledge workers within the organization. Although information retrieval and management practices are very unique and bound to individuals' experiences and work responsibilities, we found a number of patterns.

Participants agreed on email being their central hub of communication throughout the day. Although mobile usage of email (via blackberries typically) seems to be increasing and is quite significant for some individuals, Outlook, within this corporation acts as the main means to manage email and the large number of meetings and teleconferences.

Participants reported receiving 100 to 500 emails a day. Employees said that for 50% of replies, they needed to retrieve additional information, so improving this process seems particularly important. For most participants, email was the main information source: *"That's one of my largest pools of information, really, is my e-mail system"* (P3).

However, needed information may not just reside locally in other email, but also in their personal files, on the corporate intranet, or somewhere on the Web. Accordingly, some of

our participants had an ‘escalation strategy’: own memory → desktop search → web search → ask a colleague. Contacting colleagues is the most common fall-back method used to obtain required information. This has significant implications for productivity because domain experts are often overwhelmed with requests.

PHASE 2

Based on the findings in Phase 1, we re-designed the initial prototype. In its second iteration, KnowDis is a fully functional prototype add-in for Microsoft Outlook that uses keyword extraction to make sense of the active email message, and proactively displays without any user intervention, links to information on the local machine, a company’s intranet resources, and the Web (see Figure 1).

Search domain buttons

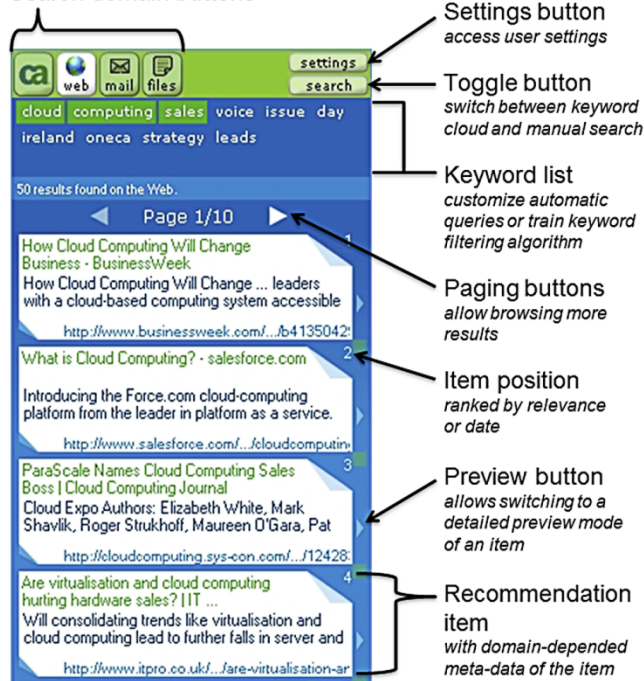


Figure 1: User Interface of the KnowDis Prototype

KnowDis Prototype

As an Outlook add-in, KnowDis becomes part of the Outlook User Interface (see Figure 2), its location, size and other aspects of the KnowDis UI being customizable. The second iteration of KnowDis utilizes background threading for improved performance, Add-in Express¹ for improved deployability across Windows environments, and a more flexible UI for greater customizability.

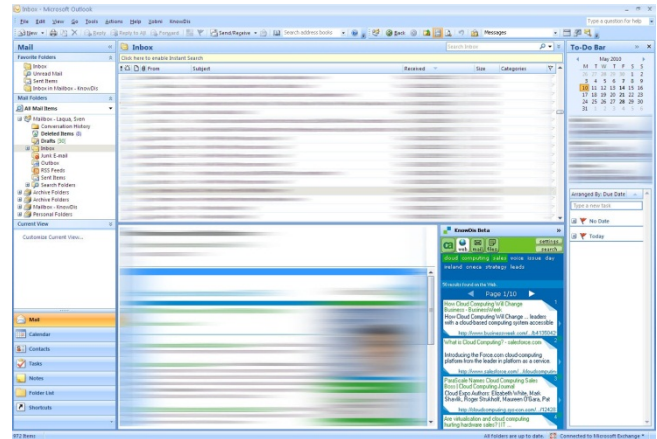


Figure 2: Integration of KnowDis in Outlook

Without having to switch the focus of attention away from reading email, relevant documents are made available, such as prior presentations, journal articles, competitor news, etc.

The KnowDis User Interface

The recommendation items are the central component of the KnowDis UI. When the user selects a new email message and the email remains active beyond a short interval, the selected search domain is queried using keywords generated from the active email. The search results are displayed as recommended items.

Through experimentation, we have chosen 1.5sec as a reasonable interval, to compensate for quick continuous email selections, e.g. when browsing/navigating using a keyboard, before a query is being sent. If the user selects another email message before the search results have been displayed, a new query is launched and the recommended items from the first query are not displayed.

The number of visible recommendation items is adjusted automatically based on the visual height available for KnowDis in Outlook and selected size of recommendation items (adjustable from 0-8 lines of description).

The preview button allows switching to a more detailed view of a particular recommendation item. The preview mode uses the entire height available within KnowDis.

Search domain buttons in the top-left of the KnowDis UI allow the user to switch between Intranet, web, email, and file search (see Figure 1).

A search/keywords toggle button further allows switching between the display of a keyword list and the display of a search field for manual searches (using self-chosen keywords).

A settings button in the top-right provides access to user settings that allow customizing:

- Stop-lists for automatic keyword generation (adding new stop-words, or removing existing ones),

¹ Add-in Express is an extension for Visual Studio to facilitate the development of Microsoft Office add-ins.

- Knowledge repositories to be included in Intranet search (e.g. SharePoint, Wikis, etc.),
- File-types to be used for desktop file searches (e.g. Word, Excel, PowerPoint, PDF, HTML, etc.),
- Sites to be used in custom site searches on the Web (e.g. acm.org, sigchi.org, bbc.co.uk, etc.).

The keyword list displays the ten most relevant keywords extracted from the active email message. Based on experimentation and results from the pilot study in Phase 1, the first three keywords are used to automatically query the active search domain, and thus are highlighted in the keyword list. The user can select/deselect keywords as desired and re-query the desired domain, or train the keyword generation algorithm by adding undesired keywords to the existing stop-word list, in situ through a context menu.

Recommendations through Proactive Search

The KnowDis client processes a selected email, generates keywords from that email and then automatically initiates a call to one of the search providers for related information (see Figure 2). Although we are aware of potential concerns with regards to proactively providing recommendations (such as potentially being distractive), within this study we wanted to understand employees' perception of such an intervention, if done in an unobtrusive manner.

The key benefits of displaying the results of the proactive search in this manner are:

- No articulation of keywords is required.
- No decision is required on whether to run a search for additional information or not – user can simply glance at initial results.

In a production version of KnowDis, employees would very likely be given the ability to switch between a pull and push-type recommendation mechanism. Although it needs to be noted that opting for a pull-type mechanism, will impact the user's ability to "stumble upon" good-to-know information [cf. 1].

Utilization of Existing Search Providers

The idea of KnowDis is to utilize existing search technologies. There are marginal disadvantages to this approach, mostly in the form of less flexibility in adjusting/configuring the search technologies. But those are easily outweighed considering the huge gains achieved by simply plugging existing search providers into the KnowDis architecture.

The search providers available in the current prototype are:

- Coveo Enterprise Search web service to enable querying corporate knowledge repositories
- Microsoft Bing web service to enable querying the entire web, a specific website, or a group of websites
- Google Desktop Search service to enable querying local files and email (implemented as separate search domains)

A KnowDis server component provides centralized activity logging of users' interactions with KnowDis and basic interaction activity within Outlook (see Figure 3).

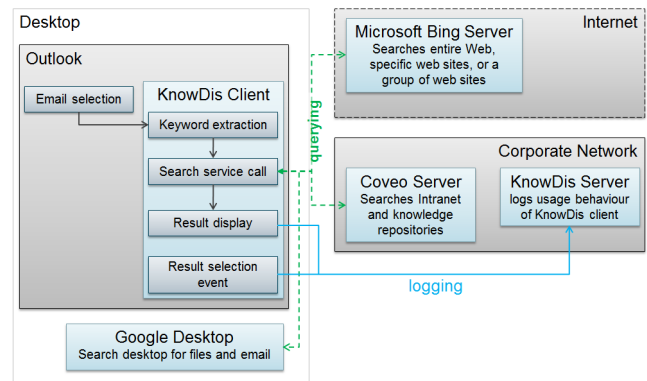


Figure 3: KnowDis Architecture Overview

Field Study

Phase 2 was conducted over a seven week period. During that time, according to the company's IT department, no major upgrades of search engine or content taxonomies occurred.

Participants

47 employees filled in the initial pre-study questionnaire. 36 of those employees installed and used KnowDis to some degree. Twenty-eight out of those 36 were classified as active users (more than one week of usage), with around thirty days of average active usage in a seven week period. After the official completion of the user study, we asked users to fill in a second post-study questionnaire, which was completed by 24 out of those 28 active users. All reported analyses of usage logs and questionnaire responses are based on those 24 active users – henceforth referred to as the study participants. The study participants were from different technology groups in the company, some from development, some from support and some from services functions.

A further 13 users who installed the prototype didn't complete the study. They showed little usage (less than a week), didn't fill in the post-study questionnaire, or left the company during the study.

We also conducted 25 semi-structured interviews (most active KnowDis users, plus some less active) to understand employees' experience of KnowDis in more detail.

Results

Overall, participants kept KnowDis visible in Outlook 74% of the time (calculated based on a participant's interactions with email messages). This number varied vastly between participants, with some having KnowDis visible all the time, while others would hide KnowDis 99% of time, and make it visible when they wanted to use it.

The search domain by default was the corporate knowledge repository and this domain was used 78% of the time; the public web was used as the search domain 21% of the time.

Email and the local file system were rarely chosen as the search domain (combined usage was 1%). Two factors may have contributed to this distribution: 1) Corporate search was the default search domain, and 2) email and file search required the presence of Google Desktop on the participant's machine, which contrary to our findings in Phase 1 was not the case for most participants.

Although KnowDis usage is largely passive because it provides recommendations unobtrusively, interaction with KnowDis was high in the first week, when participants familiarized themselves with KnowDis, and dropped to low levels in subsequent weeks. This is not surprising because click-through rates tend to be low for unobtrusive advertisements [7].

A workload construct was developed by combining a variety of factors: The level of human interaction (with co-workers, or customers), email handling (reading, writing, archiving, re-finding, etc.) and information handling (creation, retrieval, sharing). Based on a total of 34 measures, workload was calculated for each participant. On a 0-1 scale, the average workload was 0.65 (min = 0.53, max = 0.92).

Participants were split into a high workload (10 participants with above average load) and a low workload group (14 participants with below average load). We then analyzed interactions with email and KnowDis separately for the two groups.

A breakdown by week (Figure 4) illustrates that high KnowDis usage in the first week was caused primarily by participants from the high workload group (red bars). Usage for that group drops off sharply from the second week. For participants of the low workload group (green bars) usage of KnowDis continuously increases until week 5, when it drops to a lower level. This drop is positively correlated with a drop in email usage (0.43) for the low workload group (green line). The drop in KnowDis usage for the high workload group is marginally negatively correlated with a rise in email usage (-0.18, red line).

A breakdown by hour of day (Figure 5) illustrates the pattern of email usage for the high workload group (red line) and low workload group (green line) and the contrasting styles of use for KnowDis. Whereas the low workload group makes use of KnowDis more consistently throughout the day (green bars) with a peak in the morning and another one in the afternoon, the high workload group shows significant peaks of use just before and after lunchtime (red bars).

Notably, email usage within the high workload group is split evenly between morning (50% before 12pm) and afternoon (50% after 12pm), while email usage within the low workload group is more concentrated in the afternoon (36% before 12pm, 64% after 12pm).

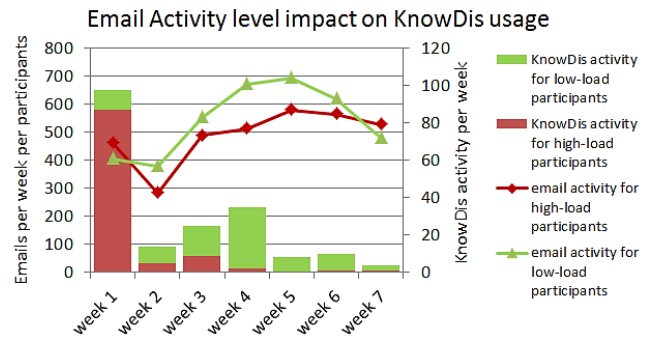


Figure 4. Email vs. KnowDis interactions for average participants of high vs. low load group

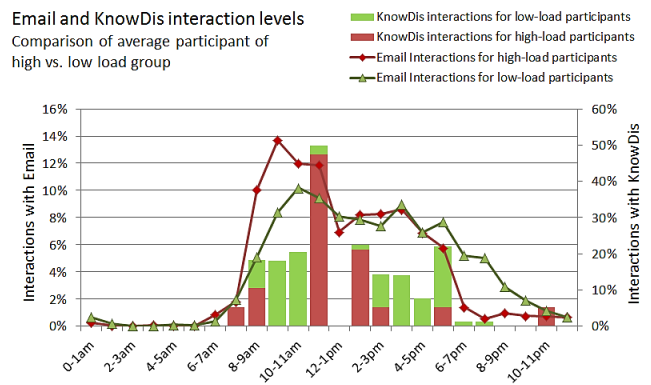


Figure 5. Email vs. KnowDis interactions for average participants of high vs. low load group (percentages relate to a day's use)

Questionnaires

As part of the study design, pre- and post-study questionnaires were used to evaluate the impact of KnowDis (as a Microsoft Outlook add-in). The statistical analysis is based on the 24 out of 28 active participants who filled in both pre- and post-study questionnaires. Significance is evaluated through repeated measures t-tests.

The questionnaires used a combination of open-response and closed-response questions. The Likert scales had either five or six alternatives, e.g., strongly disagree, disagree, somewhat disagree, somewhat agree, agree, and strongly agree. To facilitate comparisons across the different scales, all responses were normalized to a 0 to 1 range.

Both before and after using KnowDis, participants considered email essential to their work environment. Prior to using KnowDis, the average rating of the importance of email among active participants was 0.83 (on 0 to 1 range; s.d. = 0.18), and after using KnowDis the average was 0.79 (s.d. = 0.22). The difference between the two scores is not significant. Likewise, no statistical differences were found between pre- and post-study questions regarding their efficiency in using mail (0.54 and 0.51), nor in their agreement that they spend a lot of time trying to figure out where (i.e., wikis, blogs, public web, internal collections, previous email, etc.) to find relevant information when responding to emails (0.56 and 0.53). Thus, the overall use

of email, its efficiency or the need for finding related information while reading email did not vary significantly between the pre- and post-questionnaires.

The most commonly used feature of KnowDis has been the automatic recommendation of related corporate information. Participants used this feature 78% of the time. There was not enough activity using the web, email or desktop search functions of KnowDis to warrant separate statistical analyses for those domains. Most of the KnowDis users agreed that email responses depending on information search are completed more efficiently and more effectively when related information is automatically available.

- a) Participants found searching for information within the corporate knowledge repositories significantly more efficient, when having KnowDis available within Outlook. Prior to using KnowDis, the mean efficiency rating for search for corporate information while acting upon an email was 0.27. However, when asked in the context of their KnowDis experience, the rated efficiency increased to 0.40. This difference was significant in a paired t-test ($t_{23} = -2.145, p < 0.05$). This question made explicit reference to KnowDis and Outlook, and clearly suggests a benefit of KnowDis. Nonetheless the low values suggest much room for improvement beyond the current prototype. This topic will be further explored in the qualitative section below.

Two additional questions examined the impact of KnowDis on more general attitudes toward information searching, without explicit reference to KnowDis or email.

- b) Participants found it significantly easier to find relevant information from another business unit, as the rating on an agreement scale decreased significantly from 0.79 to 0.72 for the statement: *"Relevant information is often difficult to find when it is created in another business unit in [the large IT organization]"* (t-test: $t_{23} = 2.23, p < 0.05$).
- c) Participants felt less overwhelmed by the amount of information they needed to search to do their work, when having KnowDis available within Outlook. Ratings on an agreement scale decreased from 0.56 to 0.49 for the statement: *"I feel overwhelmed by the amount of information I need to search for in order to perform my job"*, but this difference was not significant. However, a post-hoc exploration of the data revealed an age effect. The eight participants that were under 35, showed no improvement in self-ratings of feeling overwhelmed, with the mean scores for this group increasing from 0.50 to 0.53. However, the 16 participants who were over 35, showed a significant decrease in feelings of being overwhelmed, from 0.575 to 0.475 ($t_{15} = 2.52, p < 0.05$).

A re-examination of the responses to the two previous questions showed a similar but far less dramatic difference.

In those responses both young and old showed the same predicted change in behavior.

Finally, we asked whether participants would like to continue using KnowDis after the study, 14 of 24 strongly or weakly agreed (weighted agreement score is 0.56). 16 of 24 participants strongly or weakly agreed with the statement: *"I would recommend KnowDis to a colleague"* (weighted agreement score is 0.58). Of the participants who would not like to continue using KnowDis (in its current state), 9 of 14 strongly or weakly agreed that they would use KnowDis more, if it were easier to use (weighted agreement score is 0.63). Notably, high ratings of KnowDis were uncorrelated with the increases in perceived efficiency noted above. This discrepancy is explained by some of the negative comments regarding the KnowDis design, in particular the decision to use Google desktop search to support the desktop and email search, by concerns about the internal search engine, and by whether or not training materials were used.

The post-questionnaire also revealed that a large proportion of participants (13 of 24) did not look at any of the supporting material for KnowDis— a user guide wiki and video demos of key features. We analyzed the impact of the study material on participants' wish to continue using KnowDis and found a significant difference ($t_{21} = 2.34, p < 0.05$) between the 2 groups:

- 8 of 11 participants who used at least some of the supporting material would like to continue using KnowDis (weighted agreement score is 0.67), vs.
- 6 of 13 participants who did not look at any of the materials would like to continue using KnowDis (weighted agreement score is 0.46)

Those numbers suggest that making use of at least some supporting material significantly increased the perceived usefulness of KnowDis. Considering that KnowDis is a prototype, we also asked whether participants would use KnowDis more, under certain conditions:

- 23 of 24 participants would use KnowDis more if search worked better (weighted agreement score is 0.96)
- 20 of 24 participants would use KnowDis more if results from various search domains were presented in a combined view (weighted agreement score is 0.83) (*out of participants who would like to continue using KnowDis, 100% said they would use it more to some degree, if it provided a combined view of results*)
- 16 of 24 participants would use KnowDis more if they could break their (information retrieval) habits (weighted agreement score is 0.67)

Interviews

We conducted 25 post-study interviews (~ 40min each) focused on participants' experience with KnowDis – things that either worked well or not, if and how they integrated KnowDis into their daily work routine, and how to improve future versions of KnowDis.

Overall, participants' feedback on the perceived usefulness of KnowDis varied from *"isn't useful for me"* (P8) to *"changes the way I will work in the future"* (P3), with a number of participants somewhere in between those two extremes. From the feedback participants provided, we identified two main groups:

- The first group (14/25) – we call them **adopters** – embraces KnowDis to varying degrees. For some, KnowDis worked well, the way it was provided: *"this is great [...] it really saved me time."* (P25). Others embraced the concept of proactive recommendations, but thought that *"algorithms need to be better"* (P11).
- The second group (11/25) – we call them **skeptics** – was more or less cautious about the benefits KnowDis could provide them with. P5 and P8 expressed that KnowDis isn't useful for them. P17 argued KnowDis is a *"wonderful tool, didn't adopt it, because used to work in a different way"*.

Skeptics raised a number of reasons why KnowDis didn't work well enough for them. In line with the results from the post-questionnaire, the largest proportion of skepticism derived from the perceived quality of recommendations, attributed to the search engines used. P9 said recommendations are *"not good enough"*, and P7 argued that the *"idea is great, but search too bad because of [corporate search engine used]"*. P8 thought too many keywords were used for the proactive search, and P17 suggested generating keywords from email subjects only. P21 summed up his impression, saying that the *"concept of KnowDis is a really good idea"*, but that for KnowDis to work, a *"decent search engine is needed, which doesn't exist within [the organization]"*. P7 and P25 thought web search wasn't good enough because of KnowDis' reliance on Microsoft Bing, rather than Google search.

Proactive retrieval of recommendations caused some skepticism, as P7 perceived KnowDis *"a bit distracting"*. P7 described his general work strategy as: *"I'm in research mode, design mode, analysis mode"*, and perceived KnowDis proactive recommendations intrusive, trying to *"push him"* into research mode. P20 was rather torn, saying KnowDis has been *"helpful AND distracting"*, and that it *"requires a learning curve to not click too often on information"*. P3 also preferred working in blocks (dealing with email, doing some 'actual' work, then dealing with more email), explicitly mentioning that he *"tries to avoid context switching"*. Nevertheless he acknowledged that KnowDis provides *"useful hints"* – such as *"Wiki pages with interesting information"*, and argued that KnowDis helped *"complete [his] understanding [of a matter]"*.

Sometimes, mundane reasons – such as an old, slow machine with a very small screen (P18) – made KnowDis distracting, due to performance problems and too much occupied screen real-estate. When asked how to change KnowDis, both P7 and P18 said they preferred getting related information not

within Outlook but on a separate web site. P6 suggested displaying recommendations in a separate tab in Outlook, but not as a side bar.

Adopters generally appreciated receiving proactive recommendations within Outlook, integrating this functionality into their process of email handling. P1 used KnowDis' contextual information as means to better understand an email: *"gist of content in a small space"* (P1). P14 in particular *"liked the preview mode with more detailed information"*, although he *"had to mess a lot with the keywords to make it more useful"*, P14 argued that he now *"always go to [KnowDis] first [to look for relevant information]"*. P24 *"definitely wants to continue using [KnowDis]"*, arguing that the *"nice thing about it [is], it's just there"* and he *"doesn't need to start up browser first"*.

Despite concerns about the search algorithm, P15 acknowledged that *"sometimes irrelevant things [were shown], but that's how search works"* and that he was *"very impressed with what [KnowDis] does"*.

Supporting New Employees and Staying in the loop

One participant (P19) in particular made heavy use of KnowDis to get a better understanding of the inner workings of the organization she joined less than a year ago. Before her participation in this study, she struggled to make sense of organizational structures in general, and the way knowledge repositories are organized. She said that she *"couldn't find information needed"* and that KnowDis *"has made search [within the organization] easier"*. She found the keywords generated by KnowDis *"better than the ones I created"* and that recommendations helped her *"understand what's going on in the organization"*. She also used the URL's in the recommendation items to find out which knowledge repository a particular recommendation came from.

DISCUSSION

KnowDis was developed as an add-in to Outlook, proactively recommending documents related to the current context as defined by the email being read. These documents were primarily available via a corporate intranet; however the capability for both desktop and web search was also incorporated in the tool. The impact of this tool was evaluated via usage monitoring and pre- and post-study questionnaires and interviews.

Our results demonstrate that the majority of participants preferred having information provided in the context of their work (as opposed to having to stop reading their email in order to search for information) – the biggest challenge being quality of search and keyword generation.

Based on all interviewees' feedback on work-style (e.g. dealing with email, and information search), we observed that a rather large proportion of skeptics seems to prefer working in a more structured and well-planned way. For this group, proactive search might not be a useful feature; rather an optional *"button to trigger search manually"* might be the default option. This group is reminiscent of the *non-*

encounterers identified by Erdelez [12]. Non-*encounterers* are people who report that they seldom acquire important information through accidental or incidental counters.

In contrast, participants demonstrating a more flexible work-style, constantly switching between tasks, email and information search fell mostly in the group of adopters. Those participants in particular embraced the serendipitous nature of KnowDis, as it “*reminds that there is more information than what’s in the email*” (P15) and one “*can already see list of what’s out there*” (P25). These participants are reminiscent of the *encounterers* or *super-encounterers* identified by Erdelez [12]. *Encounterers* recognize that they often “bump” into information. *Super-encounterers* recognize these accidental encounters as an important form of information acquisition.

Some adopters utilized the related information provided by KnowDis to evaluate the context and relevance of an email before actually shifting their attention to the actual content of that email. Those participants used KnowDis to aid them in categorizing and prioritizing email, and even preferred KnowDis centrally within Outlook in-between the email list and the actual email message preview.

Search-related Problems

Perceived ability of search providers

Participants experience with corporate search engines, and familiarity with using Google on a daily basis created preconceptions that impeded a neutral assessment in many cases. Participants’ reliance on Google for much of their information search shaped their expectation for ease of search, relevance, number of results, etc. In their experience, internal search engines perform poorly compared to Google; because KnowDis used an internal search engine, these participants did not expect KnowDis to perform well.

For example, the web search functionality integrated into KnowDis using Bing allowed manually searching or retrieving recommendations from a range of web sites simultaneously (e.g. using a list of favorite web sites). Although this type of search is potentially very useful, its concept was unfamiliar to participants, presumably because such searches aren’t supported in Google. After explaining this functionality to interviewees after the study, a number of them wanted more time with KnowDis to try out this feature.

Perceived usefulness of keywords

On the one hand, some participants didn’t expect automatically generated keywords to be useful. P2 explained KnowDis’ perceived failure to generate useful keywords with his email, because his email is “not keyword rich”. P5 perceived much of received email to be ‘junk’, thus he did not expect KnowDis to provide much useful information.

On the other hand, effective keyword generation from email is challenging. A large amount of corporate email is rather process focused, general communications or work coordination, and not information rich. Future keyword

extraction algorithms used in KnowDis might need to firstly categorize an incoming email to apply the best keyword extraction strategy. This goes in hand with the need to better understand the task an email is related to. In contrast, P19’s very positive perception of KnowDis’ automatically generated keywords is probably rooted in her being new to the company and not having adopted corporate terminology yet.

Ability of personalization

To make personalization in a tool such as KnowDis useful, it needs to support dynamic adjustment of search domains and provide federated search results. It will further require vast connectivity to an array of search providers that capture the essence of employees work environment. For example, P5 expressed the need for KnowDis to integrate more tightly with “his tools” to make it more useful – such as Outlook’s to-do list, Eclipse IDE, and Windows Desktop Search. Participants also argued that the display of combined results (from more than one search provider) would be highly desirable.

Information Overload

The interviews indicated that information overload is a barrier to adopting new tools that might help reduce their overload. This is a vicious cycle, where employees continue to be overwhelmed, yet cannot take the time to learn new tools or techniques that would help improve their situation. Some participants found the tool useful to their work, selecting the recommended links. However some participants were so overloaded with work, that they found it challenging to adapt a new tool into their workflow. Future versions of KnowDis and other tools intended to knowledge management must address this challenge.

Participants mentioned other uses of KnowDis during the interviews, e.g., using KnowDis to proactively monitor an organizations competition. One participant highlighted potential benefits of KnowDis to developers by “*allowing easy access to product information from competitors*” and to “*enable designers to be a step ahead of competition, e.g. come up with better features*” (P18).

Finally, some participants showed genuine concern about losing the benefits provided to them through KnowDis after the study, which demonstrates some real-life impact on employees’ work-strategies.

CONCLUSION

Our research confirms and extends the conclusion reached in Gupta et al. [13] and Billsus et al. [1]: email overload and resulting work stress is more dependent on the complexity of tasks linked to the processing of particular emails, rather than the number of email being processed. KnowDis, and proactive search in general, provides an approach to lessening feelings of overload by enriching email with local, enterprise and internet context.

Differences in work styles across knowledge workers suggest that real-world deployments of proactive search features should be user-controllable – e.g. offering an on/off switch.

Implications for Field Studies

Workload of participants should be considered for an effective evaluation of work-related tools in the field. Furthermore, it is essential to ensure all participants have the necessary understanding of the tool to be evaluated. The provision of user guides (PDF/Wiki), or video demos might not be enough, and the use of 1 to 1 live meeting or similar technologies might be advisable.

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