**Introduction**

Good example to motivate focus on IAC in data entry:

*“As an essential component for providing seamless continuity of patient care, clinical handover can be conceptualized as a three-phase process, consisting of prehandover, handover communication, and posthandover (Kerr, 2002). The majority of existing literature on clinical handovers has focused on the communication phase. Although focusing on the communication phase is extremely valuable, there is a necessity to broaden the research attention to the pre- and posthandover phases, as the extension helps to pinpoint more accurately the stages responsible for the problems observed in handover transition (Raduma-Tomàs, Flin, Yule, & Close, 2012).”*

*A data entry task is typically characterised as following the stages of retrieving data, perceiving it, entering data and the option to check it for errors.* As the main part of data entry is the ‘entry’ part, the majority of literature has focused on the entry phase and assumes the data is given. In these studies, data is either presented to the participant or already well encoded in their mind. Although this focus is valuable and has shown that the design of different entry interfaces have an effect on errors, it is necessary to broaden the scope of the task and pay attention to the retrieval phase, as it helps reveal new problems.

Gap in previous IAC research

*“Memory-intensive strategies can be dangerous. However, there is a lack of empirical research that addresses the underlying reasons and quantifies the potential negative impacts. This study, therefore, aims to examine the factors influencing medical residents’ information retrieval strategy and performance.”*

Examples how IAC is manifested in data entry

*“Studies in human–computer interaction (HCI) have consistently shown that the effort or cost to retrieve a particular piece of information from either KIH or KIW affects one’s retrieval strategy and performance: an increasing IAC from the world encourages a more memory-intensive strategy to access KIH, and discourages access to better information in the world. In hospitals, IAC from the world could be manifested via various means. For example, …”*

People have to retrieve it from other physical locations, it is hidden in emails, it has to be looked up in databases, online, it is one code in a large spreadsheet.

**Background**

Definition of terms

Information item: a tangible representation of a package of information, such as a paper document or an email message (Jones, 2007); distinction made between documents and other information items such as webpages, but lines are blurring

Information source

artefacts

Data

Information

Information is used in different ways; to further understanding, or used to transcribe verbatim.

Study 4

through analysis of artefacts, several issues were found to be causing issues: lack of established coordination mechanisms (centralised information sources difficult to understand; people create and work with local copies of information and keep using this even when it is updated); limitations in communication bandwidth (people are not aware of activities in other departments, explicit action is needed for information exchange), design of the expenses system (not suitable for multitasking as they get locked out, no overview of all information which makes it difficult to check, inter-dependent information not linked).

* What was done: this study presents a laboratory simulation to investigate the relationship between information access and performance. Participants are given claim sheets to process. The information has to be retrieved from three tabs, with differing levels of access. Some of the information is already on the form, others have to be looked up. It is a 3x3 within-subjects design with IAC (low, medium, high) and number of sources as independent variables. Dependent variables are completion time, errors, number of visits, duration of visits to source, timing of switches (look at T-pattern analysis for routines).
* What was found: duration of T-pattern (i.e. the time between two actions) influences
* Why does this matter: this can inform the design of cognitive artefacts. Electronic expenses sheets need to not only focus on the administrator as the single user, but on the multiple people involved and in providing easy access to the same information, to prevent errors from happening.

Analysis. For each trial, the order of events was considered and the trial was either grouped under an existing strategy group, or a new strategy group was created. For the first iteration of categorising the trials, it was considered in which order items were entered. The different strategy groups were then grouped into two larger groups: a *sequential* group, where items were entered in sequential order, and a *cost* group, in which items were grouped and entered according to their information access cost. For the second iteration, it was considered whether participants visited multiple data items before entering them, or whether they viewed and entered data items one by one

Interleaving strategy. A post-hoc comparison showed that people interleaved significantly more often in the High-Amount condition compared with the Control condition (p = 0.007). There was no significant difference between the High-Amount and High-Account conditions (p = 0.2), or between the High-Account and Control conditions (p = 0.1).

Study 5

Why previous tools are not appropriate for data entry work

Lastly, information is not only needed from the same type of documents which are easily grouped in one application, but include a variety of sources such as emails, websites, and paper.

An advantage of paper sources is that they can be easily regrouped and collected when needed for work. For digital information, this is much harder. When comparing paper to digital documents,

all documents must be organised and stored within a dedicated folder beforehand, for the TAP feature to be able to access them and display them in the task pane. As Study 2 showed, people do not always know they need certain information until they have started a task. Even if they do, they may not want to spend time organising this, as digital sources are still less intuitive to group and categorise than paper sources (Cangiano & Hollan, 2009).

a time-consuming activity people are not willing to invest time in. Furthermore, while having documents at hand has shown to help the user be focused on the task, not all required information is known in advance, neither by the user or the system. Lastly, information has to be retrieved from different applications, devices, and media.

Most information management tools support research tasks, where documents are needed for longer periods of time, but not administrative tasks, which is characterised by rapidly going in and out of documents. Administrative tasks such as data entry are presumed to have pre-defined steps with no variation, and exemplary tasks to be automated (). However, as Study 1 and 2 showed, this is not always the case and there are often exceptions. People do not know what information they need in advance, and where from.

Chan (2011) studied the use of checklists in a routine data entry task, and found no effect of a checklist on resuming a routine data entry task. However, there were a number of limitations. The task was always the same and relatively simple, so people were able to easily learn and remember the steps throughout the experiment. The checklist was printed on A4 paper, not integrated in the digital interface, and not constructed by the participant. Lastly, the checklist was used for a slightly different purpose: it was not to defer interruptions, but to resume the steps in a task after an interruption.

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| --- | --- |
| **Data entry task** | **Other tasks** |
| Many documents needed for short time | Few documents for longer time |
| Structured task | Unstructured task |
| Documents are repeatedly needed | Documents are needed once |
| Not all documents known in advance | - |

|  |  |  |
| --- | --- | --- |
| * Task pane | Removes the need to go out of interface for this function | TAP |

*Open frequently used information*. If there are documents that the user repeatedly uses whilst working on this task, these could automatically be grouped, so that upon opening a task the user is surrounded by task-relevant information. Even though some sources such as websites and documents were repeatedly needed, participants in Study 2 did not make use of available shortcuts.

*Pin frequently used information*. The user should be able to include documents they want to use and ‘pin’, save these shortcuts. They can also include documents they only need this time.

*Variety of sources.* The user should be able to look up information from a variety of sources, such as webpages, documents and emails.

*To do list*. User should be able to make a note to look something up later, and defer interruptions. If they all do it in one go and only interrupt themselves once, they may switch to a second screen because they only have to pay the initiation time cost once.

*Minimise interruptions.* People may be able to more easily defer interruptions to look up information, if they have a tool to keep track of information they need.

*Restore resumption after task switching.* People often interrupt a task before it is completed. In Study 2, it also occurred people postponed a task if they could not complete it at the time. Having context information at hand helps them resume it later (Bondarenko, 2010).

The user should be able to enter new information when it arises.

*Things we did not know before*. In some studies people do plan ahead, in others not. We found that people do not always know what they need, and where from, even for a structured data entry task and therefore cannot be easily automated, and address it immediately. If they know the cost to retrieve information, they know to leave it until later.

While information retrieval tools allow the user to search, it does not solve the issue that the user still has to interrupt the main task to retrieve information.

The proposed tool makes it possible to manage information retrieval needs.

*Information pane*

Look up literature on use of task pane (TAP, Mendeley)

If they write it down in the pane, when they switch they still see the pane with the written things, can pin it to that screen, and when switching back to data entry interface it will be (and stay) in that pane.

Study 6 (old designs)

In each condition, the participant was initially presented with three window tabs: one with the data entry interface, a second window with a price and a project code, and a third window with the other price and project code (see Figure 1). In the IP and SSP conditions, the participant had the option to either place information, or write down what information they needed. They could do this by dragging the window to the pane. In the IP condition, the information pane was shown on the same screen.

In the SSP condition, the information pane was always visible on the second screen.