Workload and Perceived Usefulness when an Electronic Checklist with Sound is Used for Aeroplane Landing

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SUMMARY

This study explored whether there were differences in workload and perceived usefulness between people who used an electronic checklist with sound for aeroplane landing and those who used a paper checklist. Two groups of University students were assigned to one of two conditions (A. paper checklist and B. electronic checklist with sound). Each group read their checklist (paper – group A, electronic checklist – group B) and selected cockpit areas on a screen to indicate completion of landing sub-tasks on an A320 aircraft. Workload and perceived usefulness were assessed subjectively. Those who used the electronic checklist stated lower levels of workload and found their checklist more useful than those who used the paper checklist. These findings suggest that electronic checklists with sound are a promising alternative to paper checklists used for landing, but further research is needed to fully understand their benefits for pilots.

KEYWORDS

Electronic Checklist, Sound, Paper checklist, Workload, Performance, Blue Colour, Cue

Introduction

Paper checklists have been in use for many years in different settings. They are used to guide, provide information and overcome the limitations of short-term and long-term memory. One of the tasks that paper checklists have traditionally been used for by pilots is to help them with landing, with one of the pilots reading the items on the checklist aloud and the other completing the required tasks. This may change in the future with the 'single-pilot' concept, whereby there will only be one pilot in the cockpit (Liu et al., (2016). This could have a detrimental impact on workload during landing because all the information would need to be processed and tasks completed by one person instead of two.

A shift towards integrating electronic checklists in the cockpit has recently been observed on some types of aircrafts (e.g. the Boeing 777 and the Airbus A220). Pilots can use those checklists to complete the landing tasks in a way similar to the paper checklists. Using electronic checklists for landing is a promising method because, in contrast to paper checklists, they can provide feedback to pilots about the read and completed actions. This can reduce the likelihood of omitting procedures, thus help pilots to avoid mental overload during the already mentally demanding stage of landing, and improve their user experience (Boorman, 2001a/b, as cited in Hales & Pronovost, 2006). This study explored if workload in single-pilot operations can be lower and perceived usefulness higher when an electronic checklist with sound is used to complete landing tasks than a paper one.

Method

A between-subject study design was used with 30 Cranfield University students being assigned to one of two conditions (paper – group A, electronic checklist – group B). For the purposes of the study, a PowerPoint presentation was developed to simulate the parts of a A320 cockpit that pilots would be expected to interact with to land the aeroplane. Both groups were requested to read each of the items on their landing checklist and then use the mouse to click on the correct part of the screen to simulate completing the landing sub-tasks. Before using the mouse to click on the laptop screen, Group B also had to select each of the items on their checklist. When an item was correctly selected on the electronic checklist, a sound was heard to reinforce the participants to use the mouse to make a selection on the laptop and the last item that was selected on the checklist was highlighted in blue to reduce search time. The NASA-TLX Scale (workload) and an 8-point Likert item and an open-type question (perceived usefulness) were used.

Results

A series of Mann-Whitney U tests were conducted to compare the NASA-TLX ratings on each of the six subscales between the two groups. The analysis showed that the group who used the electronic checklist with sound reported significantly lower levels of mental demand ($p=.02$), frustration ($p=.02$), and effort ($p=.04$) and better performance ($p=.02$) than the group that used the paper checklist. There were no statistically significant between-group differences in the reported physical ($p< .299$) and temporal demand ($p< .281$).

An independent sample t-test analysis was performed to determine whether there was any difference between the groups in how useful they found their checklists. The mean reported Usefulness score was significantly higher in the group that used the electronic checklist, ($t(29)=-3.163$, $p< .004$, $d=-1.137$). Subjective feedback revealed that the electronic checklist helped the participants track their progress with tasks and provided them with real-time feedback. In contrast, according to the participants, there is a risk that landing tasks/checks are omitted when using a paper checklist.

Discussion

The findings of this research are consistent with past research, arguing that human-centred design of augmented visualisation and auditory aids human-machine interaction performance (Li et al., 2020). This is arguably because the sound should compensate for the attention required for each individual task to be completed. Therefore, reducing the time glancing to the checklist items. This is mainly because attention is a stimuli-driven and is goal-directed that works simultaneously to complete the task (Eysenck & Keane, 2015; Baker et al., 2004).

Several confounding variables could have affected the results of the experiment, this includes usage of naïve participants, that were not pilots; low fidelity replication of A320 interface and checklist, which was designed in a PowerPoint MS; and did not employ eye tracking equipment to assess the level of attention switching between the two groups. Therefore, future research with more complex control might be more suitable to create a realistic interaction and use of eye tracking equipment to measure time required to glaze at each item might reveal whether sound brings any benefits.

Conclusion

In conclusion, this thesis has endeavoured to provide some light on whether there were differences in workload and perceived usefulness between paper checklist and electronic checklist with sound . Electronic checklist with sound has proven to show low levels of workload and it was found more useful than the paper checklist.

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