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Checklists for the Evaluation of Computer Workplaces – Practical Requirements and Current Design Concepts

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Initiated by the European Community, most organizations are now confronted with the task to evaluate the ergonomic design of their computer workplaces. To clarify the practical demands of assisting checklists, an expert poll was performed. In this poll, the following requirements turned out to be essential: (a) The evaluation should be concise. 63% of the experts voted for a checklist with 20 to 39 items, to fit the efficiency demands of practice. (b) The assistance should be concrete. 97% called for prototypical cases illustrating the application of the checklist. (c) The tool is expected to support problem solving. 92% suggested that the checklist provides redesign suggestions. (d) The tool should be adapted to the user. 76% voted to provide different checklists for experts and novices. On the other hand, 67% of the experts could not specify a checklist that comes close to these requirements. Thus, it seems that the practical needs are still rarely matched and the realization of the computer workplace legislation is yet not well supported. As an alternative, a more systematic and user centered design approach in the development of corresponding checklists is proposed.

1. INTRODUCTION

Due to European law, organizations are now forced to evaluate the ergonomic design of their workplaces, in order to determine the hazards associated with the job (EU, 1989). Inter alia, this refers to computer workplaces. But because of the fact that the law does not prescribe the methods to be applied in such an evaluation, the management of concerned organizations is frequently unsure about how to satisfy the legal requirements.

As an assistance, a considerable number of evaluation tools has been developed, which are generally based on a checklist concept. In a review of such checklists for the German region, for example, Seidel-Fabian and Argyropoylos (1998) discuss 26 instruments. According to this review, the design of the checklists varies on several dimensions. As an example, the number of items ranges from 29 to well beyond 150, with the majority of checklists containing 70 or more items. A second source of variation is the design of the evaluation tools, ranging from classical paper-and-pencil questionnaires to multimedia assistance systems. And finally, some of the checklists presuppose substantial ergonomic background knowledge, while others can be applied even by non-experts. This variance implies that the authors of the tools have rather divergent conceptions regarding the practical requirements in computer workplace evaluations.

There are also indications that currently available checklists ignore or negate essential demands of practice. In larger organizations with a considerable number of computer workplaces, for example, the management frequently expects that an evaluation takes between 15 and 30 minutes. Moreover, the evaluation is commonly performed by safety attorneys, which are not ergonomics experts in a strict sense but rather ordinary employees performing this task on a honorary basis, after a corresponding vocational training. Thus, a checklist adapted to

such an organizational context would allow a concise evaluation of computer workplaces, even if the evaluation is carried out by non-experts.

In sum, there seems to be striking discrepancy between the requirements of currently available checklists and the organizational framework within which the evaluation is frequently performed. To determine whether this impression can be validated empirically, an expert poll was organized, investigating the requirements of checklists for the evaluation of computer workplaces. The following two sections describe how this poll was carried out and what the ergonomics experts replied. The final section provides a short discussion of the findings and outlines their implications for the future development and application of the checklists.

2. METHOD

2.1. Subjects

100 ergonomics experts were emailed and asked to participate in the poll. Of these, 81 experts filled the corresponding questionnaire with the necessary accuracy to include their data in the analysis. The experts came mainly from research organizations (51%), followed by the service sector (25%), industry (9%), administration (6%), development (6%), and freelance (4%). Based on this information, each subject was assigned to one of two groups, Research (n = 41) and Practice (n = 40).

2.2. Material

The experts filled the questionnaire on the Internet (Seidel-Fabian & Gude, 1997) or a paper and pencil version, if no Internet access was available. In sum, the questionnaire contained 22 items, of which only the first eight items will be discussed in the present context. Two items were concerned with the legal background of a computer workplace evaluation:

- Do you need information about the Occupational Safety Act? (Alternatives *Yes, No*)
  If Yes: What information do you need? (Options *General, Field of application, Practical use, Other*)
- Do you need information about the Computer Workplace Ordinance? (Alternatives *Yes, No*)
  If Yes: What information do you need? (Options *General, Field of application, Practical use, Other*)

The following six items referred to the content of the checklist:

- What is the maximum number of questions the checklist should contain? (*Number field*)
- Should the application of the checklist be illustrated by prototypical cases? (Alternatives *Yes, No*)
  If Yes: Which cases are of interest? (Options *Office, Industry, Home, Other*)
- What graphical elements should illustrate the checklist items? (Options *Pictures, Animations, Videos, Other*)
- Should the checklist provide design recommendations for each of its questions? (Alternatives *Yes, No*)
- Should different checklists be supplied for experts and novices? (Alternatives *Yes, No*)
- Are there one or more checklists which you already applied successfully and which we should use as a model? (Alternatives *Yes, No*)
  If Yes: Please specify these checklists: (*Text field*)

2.3. Hypotheses

For some of the above items specific hypotheses were formulated, in order to guide the subsequent analyses. Generally, the need for legal background information was predicted to be more pronounced in the Practice group than in the Research group, especially regarding the practical use of the laws. Moreover, the Practice group was expected to focus on the efficiency of the evaluation while the Research group would emphasize its completeness. Consequently, it was hypothesized that the maximum number of checklist items should be smaller in the

Practice group, as compared with the Research category. With regard to the other content aspects of the checklist no pronounced differences between the two expert groups were predicted.

3. RESULTS

3.1. Legal background

The data for the two legal background items were analyzed in two log-linear models. The first model analyzed the yes/no-responses to both items and contained the two independent variables Group (Research vs. Practice) and Item (Information about Workplace Safety Act vs. Information about Computer Workplace Ordinance). In this model, the main effect of Group turned out to be significant ($\chi^2 = 3.04$, $df = 1$, 1-tailed $p < 0.05$). As expected, a larger proportion of the Practice group needed information about the legal background, as compared with the Research category (73 vs. 56%). The main effect of Item and the interaction between Group and Item could not be confirmed ($\chi^2 < 1$, in both cases). That is, the need for information regarding the Workplace Safety Act and the Computer Workplace Ordinance was similar in size (63 vs. 66%) and not moderated by the Group factor.

The second model was concerned with the requested information domain, with the three independent variables Group (Research vs. Practice), Item (Information about Workplace Safety Act vs. Information about Computer Workplace Ordinance), and Domain (General, Field of Application, Practical Use, Other). The two expert groups did not differ in their responses, neither as a main effect ($\chi^2 < 1$), nor in interaction with Item ($\chi^2 < 1$), Domain ($\chi^2 = 2.50$, $df = 3$, $p > 0.40$), or Item and Domain ($\chi^2 = 3.64$, $df = 3$, $p > 0.30$). This implies that the initially hypothesized more pronounced need of the Practice group for information regarding Practical use could not be confirmed, although on a descriptive level the corresponding values were in the correct direction (Research = 42%, Practice = 50%).

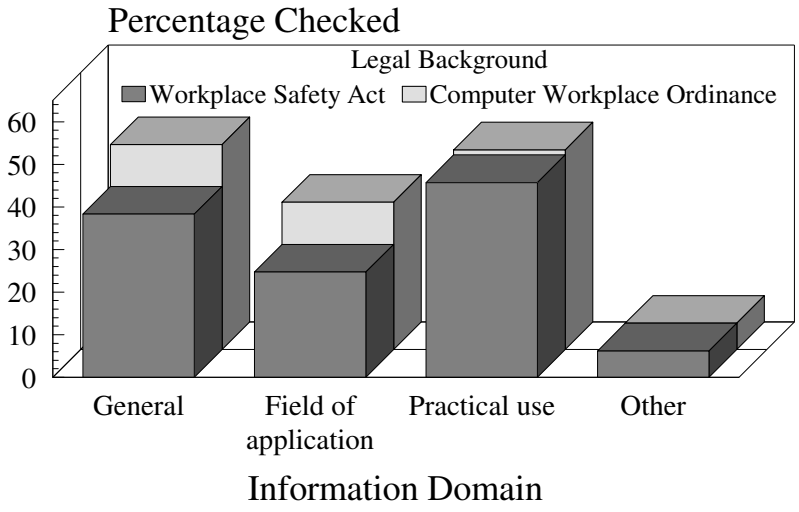

Figure 1. Percentage of checked information domain options regarding legal background.

As the group factor turned out to be of no significance, Figure 1 shows the descriptive values for information domain without this differentiation. In the statistical analysis, the main effect of Domain was significant ($\chi^2 = 84.62$, $df = 3$, $p < 0.001$). That is, the importance of the differentiated domains varied, especially general information and information regarding the practical use of the laws were requested, followed by Field of Application and Other. The main effect of Item and the interaction between Domain and Item were non-significant ($\chi^2 = 3.39$, $df = 1$, $p > 0.05$ and $\chi^2 = 2.50$, $df = 3$, $p > 0.40$, respectively). This implies that the information request patterns were identical for the Workplace Safety Act and the Computer Workplace Ordinance.

3.2. Content

The data concerning the maximum number of items the checklist should contain were analyzed in a 1-factorial ANOVA with Group (Research vs. Practice) as the independent variable. In this analysis, the effect of Group was close to significance ($F[1, 78] = 2.69$, $df = 1$, 1-tailed $p = 0.052$). The value for the Practice group was smaller than that in the Research group (25 vs. 32 items). This finding provides some support for the initial hypothesis that the Practice Group emphasizes the efficiency of the evaluation, which is of inferior importance for the Research group. Figure 2 shows the distribution of the values, to illustrate the interval within which a checklist is regarded as acceptable. According to this figure, in both expert groups a clear majority preferred a checklist between 20 and 39 items.

Concerning prototypical cases illustrating the application of the checklist, 97% of the experts regarded this as essential, with no significant difference between Research and Practice group (95 vs. 98%, $\chi^2 < 1$).

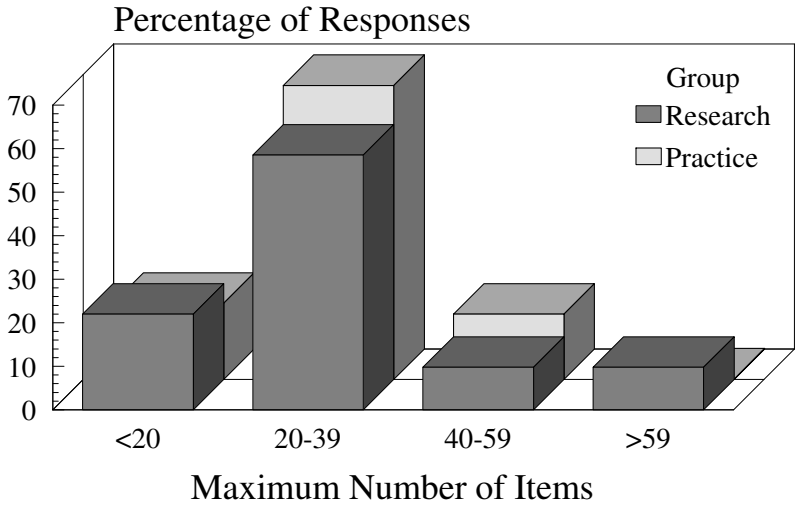

Figure 2. Percentage of responses for intervals of the specified maximum number of checklist items.

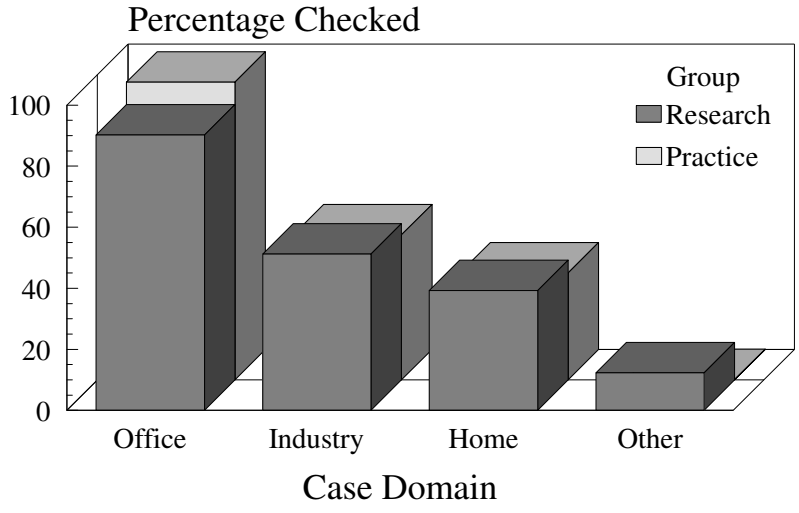

Figure 3. Percentage of checked options regarding the application of cases as illustrations.

The data for the question from which field cases should be presented were analyzed in a log-linear model with the independent variables Group (Research vs. Practice) and Domain (Office, Industry, Home, Other). Figure 3 shows the corresponding descriptive values. The main effect of Domain was significant ($\chi^2 = 588.32$, $df = 3$, $p < 0.001$). Especially, cases from the office were of interest, cases from industry or home played a minor role, and other settings were rather insignificant. These preferences were consistent across the expert groups; the main effect of Group and the interaction with Domain could not be confirmed ($\chi^2 < 1$ and $\chi^2 = 5.64$, $df = 3$, $p > 0.10$, respectively).

The data for the question what graphical elements should illustrate the checklist items were analyzed in a model with the independent variables Group (Research vs. Practice) and Type (Picture, Animation, Video, Other). The corresponding descriptive values are shown in Figure 4. The main effect of Type was significant ($\chi^2 = 272.57$, $df = 3$, $p < 0.001$). Pictures

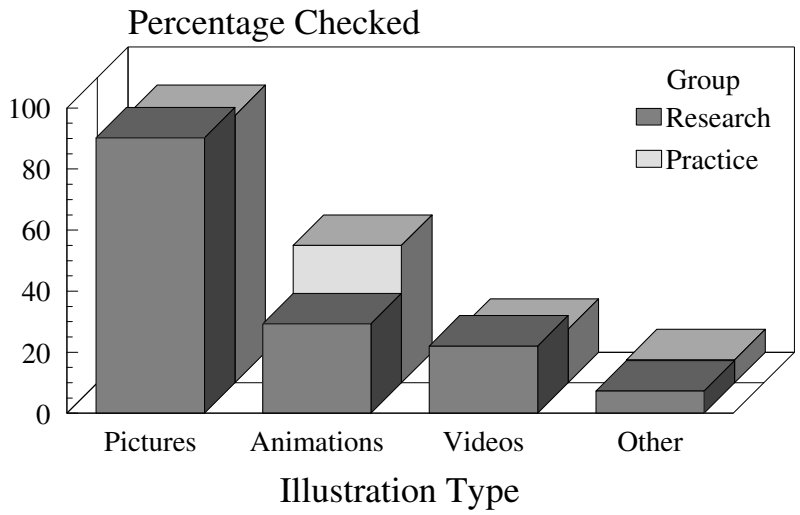

Figure 4. Percentage of checked options regarding the application of graphical elements as illustrations.

were regarded as the primary method to illustrate the checklist items, followed by animations, videos, and other media. Again, these preferences were consistent across experts, the main effect of Group and the interaction with Type could not be confirmed ($\chi^2 < 1$ and $\chi^2 = 3.83$, $df = 3$, $p > 0.20$, respectively).

According to 91% of the experts, the checklist should provide redesign suggestions, to fix identified problems. However, the two groups differed in the determination of their vote, 100% of the researchers and 82% of the practicians specified this requirement ($\chi^2 = 7.88$, $df = 1$, $p < 0.01$).

The opposite was found for the question, whether different checklists for experts and novices should be supplied. In general, 76% voted for this requirement, with 65% of the Research group and 87% of the Practice category ($\chi^2 = 5.32$, $df = 1$, $p < 0.05$).

Finally, asked to specify one or more checklists which could be regarded as models, 39% made a positive response, with no difference between the expert groups (43% vs. 35%, $\chi^2 < 1$). Of those with a positive response, 16% specified no checklist in the corresponding text field, 81% entered one checklist, and 3% specified two. Those specifying no checklist sometimes explained this response by annotating that they don't have the exact data at hand. The other subjects entered preferably SAHIB (3 subjects), followed by Richenhagen, Sigma, TBS, and TCO (2 subjects, each). All other mentioned checklists were specified by single subjects.

4. DISCUSSION

The expert poll about the evaluation of computer workplaces showed rather homogenous results regarding the essential requirements of corresponding checklists. The checklist should provide general information about the legal background, the Workplace Safety Act as well as the Computer Workplace Ordinance, and the practical application of these laws. Moreover, the checklist is expected to allow a concise evaluation, a clear majority of the experts voted for a checklist between 20 and 39 items, to fit the efficiency demands of practice. To illustrate its application, it should contain prototypical cases, especially from the office, whereas cases from industry and home settings were of minor importance. The items of the checklist need to be illustrated especially by pictures, but animations and videos were also viewed as potential media by a substantial subset of the experts. To fix identified problems with the computer workplace, the checklist should provide redesign suggestions. And finally, the participants of the poll suggested to make separate checklists for experts and novices available, due to the specific needs of these user groups.

The two differentiated subject groups, Research and Practice, showed a fairly high degree of coherence with regard to these requirements. One exception from this rule was the importance of legal background information, which was higher in the Practice group as in the Research category. Moreover, the practicians specified smaller values for the maximum number

of items the checklist should contain, implying a stronger efficiency focus. In this group, the provision of redesign suggestions is not as important as for the Research group, indicating that some practicians are specifically interested in the analysis of computer workplaces, but not so much in subsequent interventions. And finally, they favored more markedly to provide separate checklists for different user groups.

Responses to the question what checklists come close to these requirements were not very comprehensive. While 39% of the experts specified that there are such checklists, only 33% entered corresponding references, and generally not more than one. Beyond that, the specified references are heterogeneous, only SAHIB (Kurtz, Buchheim, Hippmann, & Sievers, 1996) received stronger support, as it was mentioned by three subjects.

To sum up, a pronounced discrepancy was found between the homogeneity of the responses regarding the requirements of the checklists and the heterogeneity which checklists actually fulfill these requirements. Thus, it seems that the practical needs in a computer workplace evaluation, although obvious, are still rarely matched. For example, the currently available checklists, as described in the introduction, have frequently much more items than suggested by the experts participating in the poll. A potential reason for this deficiency is that these checklists have been developed by ergonomics experts with extensive knowledge about the legal background, implementing this complicated matter in their checklists in a rather comprehensive way while loosing sight of the ergonomics of its application in practice. That is, the underlying goal conflict between speed and accuracy has been ignored or solved in a one-sided way, rather than viewing it as an optimization problem.

But optimization problems are quite common, for example in quality control (Rahim & Ben-Daya, 1998) or preventive maintenance (Gude & Schmidt, 1993). Adopting the analytical and empirical research methods of these fields opens the opportunity to handle the goal conflict in a more conscious and user oriented style. As an example, in a recent investigation Argyropoylos (1998) varied the number of items of a computer workplace checklist. The resulting checklist variants were used by different groups in evaluating a simulated office workplace with a standardized set of deficiencies. He found a clear speed-accuracy trade-off for his variants, implying that the more comprehensive checklist is not necessarily the best one, from an efficiency perspective. Such empirical evaluations might be one approach to guide the development of computer workplace checklists in a systematic and user centered way.

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