Experiential Benefits of Interactive Conflict Negotiation Practices in Computer-Supported Shift Planning

ALARITH UHDE, University of Siegen, Germany

MATTHIAS LASCHKE, University of Siegen, Germany

MARC HASSENZAHL, University of Siegen, Germany

Shift planning plays a key role for the health and well-being of healthcare workers. It determines when they work and when they can take time off to recover or engage in social activities. Current computer-support in shift planning is typically designed from a managerial perspective and focuses on process efficiency, with the long-term goal of full automation. This implies automatic resolutions of emotionally charged scheduling conflicts. In the present study, we measured the effects of such a fully automated process on workers' well-being, fairness, and team spirit, and compared them with a more interactive process that directly involves workers in the decision-making. In our experimental online study (n = 94), we found positive effects of the more interactive process on all measures. Our findings indicate that full automation may not be desirable from the worker perspective. We close with concrete suggestions to design more worker-centered, hybrid shift planning systems by optimizing worker control, considering the worker experience, and embedding shift planning in the broader work context.

1 INTRODUCTION

Shift planning is an essential work organization process in many healthcare institutions. It sets the general frame for all care activities by defining who works on which days and who can stand in if someone calls in sick. Shift planning also has implications for each healthcare worker's private life, health, and well-being, because it determines when they can sleep or participate in social events outside of work [19, 30]. Certain planning decisions around unpopular shifts can affect fairness and the interpersonal relationships in the team (i.e., the "team spirit") [2, 64, 70]. In sum, shift planning is an important work organization process in healthcare that has considerable consequences for the private and work lives of healthcare workers.

A perfect shift planning process would manage to integrate the personal needs of all workers with the requirements of the healthcare institution. Of course, that is not always possible. Sometimes many workers want to spend time with their friends or families during certain shifts (e.g., around public holidays such as Christmas), and the remaining workers cannot cover the demand to assure patient safety. In such cases, all possible solutions imply that some additional workers

will have to be assigned to work and cancel their private plans. These difficult decisions with personal consequences for individual healthcare workers are an inextricable part of shift planning.

Current computer-supported shift planning systems can automatically identify such situations in which conflicts arise between workers' requests for free shifts on the one hand, and requirements of the healthcare institution on the other. They can also make reasonable decisions to automatically resolve them [12]. These computer-supported systems rely on algorithmic problem-solving techniques and use formalized data about worker requests, shift lengths, legal regulations, worker qualifications, and many other parameters considered relevant [71]. The algorithm identifies a planning conflict if there is no possible solution that satisfies all legal regulations and also all workers' requests in the formalized representation. To solve this problem, a typical algorithm removes some "less important" restrictions such as a worker's request to find a valid solution [12]. Such computational approaches allow for efficient, fully automated shift planning without the need for further human interventions.

However, in practice, some planning conflicts can have solutions that are difficult to detect automatically, because the algorithm does not have all relevant context information. For example, two healthcare workers could have a request for a free shift on a particular Friday evening, but one of them needs to be assigned to work. The first worker has planned to meet with an old friend, the second worker wants to go to a concert. The concert has a fixed time, but one way to resolve this planning conflict is to call the friend and try to reschedule their meeting to the Thursday or Saturday. This solution would still enable both workers to integrate their private needs with the schedule. However, the process requires some manual communication with the friend. In another example, one worker may want to go to a party that starts at 6pm, but their colleague cannot take over the shift before 7pm. If it would still be acceptable for the first worker to arrive at the party one or two hours late, the colleagues can still make it work in practice. But this solution requires some communication with the worker to see whether they are flexible. Otherwise, an automatic system would simply identify a worker shortage between 6pm and 7pm. Some other context information is inaccessible to the algorithm because of privacy regulations (e.g., personal relationships between workers), or because entering all details that might be important for each request requires a lot of (often unnecessary) effort. In other words, fully automated conflict resolution techniques can only find solutions based on the available data, and they oversee some solutions that require more context information and flexibility of the involved people.

Each individual request for free time can represent a subjectively important private appointment for a healthcare worker. In their everyday work lives, they often have to work at unusual hours or on weekends, and organizing a fulfilling social life under these circumstances is already difficult [20, 30]. Thus, each granted request can contribute to a better work-life balance for an individual healthcare worker, and shift planning systems should be designed to support workers with their private plans as much as possible. From our perspective, the primary goal of conflict resolution between workers' requests should be to find a solution that works for everyone involved, even if it may be slightly less efficient than a fully automated alternative.

Because requests for free time are usually important for the healthcare workers, negotiations to resolve planning conflicts can become emotional. On the one hand, depending on individual negotiation styles [34] and contextual factors such as time pressure [10], conflict negotiations may lead to negative emotional experiences. On the other hand, they also represent an occasion for pro-social interactions between workers, which can create positive experiences [68]. For example, healthcare workers can help their colleagues by being flexible with their own requests (e.g., rescheduling it or going later to a party), or they may receive help themselves. Involvement in the decision-making process of conflicts that affect workers' lives is essential for their fairness experiences [70], which can contribute to their satisfaction with the work schedule and work-life balance [53]. In addition, a positive team spirit can also support a cooperative attitude

during conflict negotiations [70]. All in all, conflict negotiations can have experiential consequences for workers, and we think that they should be designed to support more positive experiences.

In this paper, we investigated how interactive conflict negotiations can be integrated in computer-supported shift planning, so that they add to a positive experience for healthcare workers. Our long-term goal is not to replace automatic shift planning entirely and give up its benefits of efficiency. Instead, we want to work more specifically towards improved worker experiences of conflict resolutions, which we consider the most critical phases of shift planning from the workers' perspective. This paper builds on several interactive conflict negotiation practices developed by healthcare workers in previous work, which helped them find solutions that integrate their own needs with the needs of their colleagues and the shift plan [68]. Our main contribution are the results from an experimental study in which we could confirm that such interactive practices actually have positive consequences on workers' well-being, fairness experiences, and their team spirit, compared with a fully automated process.

2 RELATED WORK

2.1 Effects of Worker Involvement in Shift Planning

Overall, shift work has negative effects on workers' health and well-being. It affects their sleep [11], psychological and physiological health [9, 19, 41], and social life [4, 7, 49, 72]. Accordingly, healthcare workers, who often work in shifts, have relatively low average subjective well-being, compared with the general population [54, 55]. Problems related to shift work are a main reason why healthcare workers consider leaving the profession [13, 31] and they are a reason for young people not to choose a career as a healthcare worker [36].

Some negative effects of shift work can be reduced through improvements of the shift plans and the planning process. For example, the order of shifts (i.e., morning, evening, night) and the shift lengths can be adjusted for each worker to support more healthy sleep patterns [11, 19, 22, 32]. More stable and predictable shift plans can also help workers pursue a more fulfilling social life [21]. Finally, giving workers more control of their shift plans can mitigate some negative impacts of shift work on health and well-being [30, 35, 42].

Besides these effects on well-being, the shift planning process also affects the group dynamics in the team. Critical planning decisions, for example about who has to work despite having personal plans, have implications for healthcare workers' fairness experiences and team spirit [64, 70]. Involving workers in the decision-making process increases fairness and gives room for negotiations between colleagues that can affect the team spirit [70]. Moreover, the effects of worker involvement on team spirit, well-being, and fairness can reinforce each other on the long run. For example, a positive team spirit can reduce further work-life conflicts, which in turn supports well-being [60, 61].

Despite these positive effects, worker involvement can also have negative effects from an organizational perspective. Interactive shift planning that is based on manual interactions (e.g., "self-scheduling" [51]) can be less efficient than automatic shift planning [12]. It can also be impractical in larger teams, where more people need to interact with all of their colleagues [66]. In some cases, shift planning based on manual interactions can lead to invalid shift plans that, for example, do not comply with legally required minimal staffing levels [6]. Finally, automatic shift planning can lead to more consistent decisions across different teams [66].

2.2 Computer-Supported Shift Planning and Worker Involvement

These advantages of automation from an organizational perspective have motivated a long tradition of research on computer-supported shift planning (e.g., [12, 50, 71, 73]). Most of these computer-supported systems are based on an

automatic process with minimal worker involvement [12, 71]. In some of these systems, workers can submit requests for free shifts (e.g., [48, 50]), and optionally provide additional metadata with their requests, such as a subjective importance rating [18]. The planning algorithm uses these data to make autonomous decisions.

Some more recent computer-supported approaches have focused more specifically on worker involvement. But their effects on workers varied with the specific implementations. One problem of these previous studies is that they report only summative effects of the system as a whole and do not link the effects to specific design decisions. For example, Rönnberg and Larsson [62] allowed workers to submit their preferred, full shift plans. Possible conflicts were resolved by the head nurse. This process led to high quality shift plans compared with the previous, manual process (i.e., legally compliant). But healthcare workers suspected that they might lose influence about their work times. Nabe-Nielsen and colleagues [52] implemented a similar process, but additionally allowed healthcare workers to make changes to a preliminary version of the group schedule. The healthcare workers experienced this shift planning process as more flexible than two alternatives using fixed shift plans, but also as less predictable.

Submitting full shift plans potentially maximizes control, but it adds work load for the healthcare workers and thus causes new problems. For example, Bailyn and colleagues [6] reported a case where an approach using full worker-submitted shift plans has failed. Healthcare workers were supposed to collaboratively create almost the entire shift plan by themselves. The head nurse published a draft with some prefilled shifts (because a few workers had fixed shift plans), and relied on the other healthcare workers to fill in the remaining shifts and to create a functional shift plan. After a while, some shifts were not covered appropriately anymore, and the workers stopped engaging in collaborative shift planning and conflict resolution. The head nurse had to intervene and eventually returned to their previous planning process. The extra work, a lack of collaborative behavior, and possibly the large group size (over 70 registered nurses) may have contributed to these problems [6]. Thus, despite short-term positive effects (e.g., higher subjective control of the schedule, better quality of patient care), the shift plans became inconsistent after a while, and the system was unsustainable on the long run.

Uhde and colleagues [68] followed a different approach and asked workers to only plan for appointments that are (subjectively) important to them, while leaving everything else to the computer to plan automatically. For the less important shifts, healthcare workers could submit more abstract, long-term preferences. For example, they could submit that they generally preferred to work in the morning, or that they have a weekly recurring appointment (e.g., a sports club). Workers were supposed to resolve conflicts among themselves, and they managed to find solutions that integrated everyone's needs in most cases. In terms of actual involvement, some healthcare workers used the system more actively and submitted many requests, while others hardly used it at all, because they generally tended to make fewer private plans. One problem for the workers in this study was that the shift plans were only released two weeks in advance, which reduced predictability.

2.3 Conflict Resolution and Worker Experience

As indicated above, most of the previous work on computer-supported shift planning excludes healthcare workers from the decision-making process. The few studies that involve workers reported more general findings of the shift planning approach as a whole. Here, we summarize previous work that is more specifically focused on conflict resolution in (typically manual) healthcare shift planning.

Several factors that relate to healthcare workers' experiences of conflict negotiations have been studied as antecedents or process aspects, including negotiation styles, team spirit, and contextual factors such as time pressure and work load [2, 10, 60, 61]. Integrative negotiation styles can lead to positive experiences [34], and are the most common style

among healthcare workers [43]. In contrast, avoiding or "dominating" negotiation styles [34] and the use of harsh language [63] can lead to negative experiences during conflict negotiations.

Fairness of decision-making processes such as conflict negotiations also plays an important role. It is associated with fewer interpersonal conflicts [57], higher satisfaction with the shift plan, and a better subjective work-life balance [53]. Fairness is often studied in work settings where the decisions are made by a supervisor [47, 56, 64]. But a few studies have focused on decisions made by workers themselves [68, 70]. In healthcare shift planning more specifically, workers' subjective fairness experiences are based on two different fairness norms [23]. For generally desirable resources (e.g., free weekends, holidays), healthcare workers' fairness experiences depend on the equality norm, which means that they consider shift plans fairer if such resources are distributed equally among workers [70]. However, subjective fairness of specific conflict resolutions is based on the need norm, meaning that the decision should be based on the individual needs of everyone involved [23, 70]. For example, if one worker is a single parent and has to take care of their child, their need is typically considered higher than the need of a colleague who wants to go to the cinema. One problem with the need norm in automatic shift planning is that the needs cannot easily be formalized and compared. Thus, conflict resolution based on direct worker involvement has been suggested [70].

One previous system has been presented that included an explicit face-to-face negotiation process among workers in otherwise automated shift planning [68]. However, healthcare workers did not use the system's software-based process directly, and instead developed several interactive conflict negotiation practices themselves. These interactive conflict negotiation practices represent the concrete actions healthcare workers took to negotiate shift planning conflicts among each other and with the shift planning system. Healthcare workers first tried to reschedule their private appointments if possible, to avoid a conflict altogether (e.g., meeting with a friend on Thursday instead of Friday, if a co-worker already has a request on that Friday). If that was not possible because of the nature of the request (e.g., a concert with a fixed time), the second step was to try and activate alternative resources, such as colleagues from other wards or splitting the shift. Third, some conflicts were expectable, for example around public holidays, and the workers used informal team rules during group meetings to find a solution. Finally, if none of these practices worked, conflicts were resolved by the management.

In conflict negotiations based on interactions between healthcare workers, team spirit becomes important, because it affects workers' openness to negotiate [70]. A negative team spirit can lead to interpersonal conflicts in the team [2]. It can also negatively affect conflict management styles, and lead to conflict avoidance and a lack of consideration for others' needs [2, 3].

2.4 Summary and Research Questions

Overall, shift work has negative effects on workers' well-being. These negative effects can be mitigated in part by involving workers in decision-making processes, particularly in conflict negotiations around their requests for free time. During such conflict negotiations, fairness and a positive team spirit become important, and they can be part of an overall positive experience. In addition, successful negotiations can help workers better integrate their private and work lives, with positive long-term effects on their health and well-being.

Computer-supported shift planning has several advantages in terms of efficiency and the quality of shift plans, but it often lacks worker involvement. Some recent, hybrid systems have attempted to integrate the advantages of computer-supported shift planning with selective worker inclusion. For example, automatic shift planning can be used for all (subjectively) non-critical shifts, and workers can resolve the remaining conflicts about their important requests manually. Such a hybrid approach could lead to better overall shift planning that is both efficient and has positive

effects on workers. Our goal in this study is to investigate the experiential consequences of concrete, interactive conflict negotiation practices, that is, the specific activities workers can take during conflict negotiation to find solutions that reconcile their private needs with organizational requirements.

Based on previous literature, we assumed positive effects of worker inclusion on subjective well-being, fairness, and team spirit. This led to our four hypotheses:

H1: Interactive conflict negotiation practices lead to a more positive emotional experience for workers (i.e., affect balance) than fully automated conflict resolution.

H2: Interactive conflict negotiation practices lead to more need fulfillment than fully automated conflict resolution.

H3: Interactive conflict negotiation practices are perceived as fairer than fully automated conflict resolution.

H4: Interactive conflict negotiation practices lead to a better long-term team spirit than fully automated conflict resolution.

3 METHOD

We used the experimental vignette methodology (EVM; [1]) to test our hypotheses in an online study. EVM is an experimental method based on immersive scenarios, typically presented as short texts. It allows researchers to experimentally control situational factors and to vary certain aspects of interest. In our specific case, we chose EVM because it allowed us to experimentally test the effect of specific interactive conflict negotiation practices, independent of their outcome in practice (i.e., whether a worker's request was granted or not). Thus, EVM allowed us to provide enough context to create and compare realistic scenarios while removing other factors that may influence the participants' experiences in field studies. EVM has been widely used in Human-Computer Interaction [25, 56, 70] and beyond [5, 67].

3.1 Participants

In total, 94 German-speaking healthcare workers completed our online study. We recruited participants through snowball sampling, social media channels, and indirectly by asking the healthcare managers of around fifty healthcare institutions to forward our call. As compensation, participants could participate in a raffle for a 30 € voucher, and we additionally donated 50 Cents for each complete questionnaire to a non-profit organization to increase motivation to participate.

The sample included 13 participants who identified as male and 81 who identified as female. The average age was 39 years ($sd = 11.20$; $min = 21$; $max = 63$). Participants had 16 years of work experience on average ($sd = 12.10$; $min = 0.5$; $max = 46$). 62 participants worked as registered nurses, and another 17 had an additional role as ward leader. 6 participants worked as childcare nurses, 3 as nurse assistants, 3 had other healthcare-related occupations (intern, midwife, healthcare specialist), and 3 did not disclose their specific occupation.

3.2 Procedure

The participants accessed the study through a link or a QR code provided during the advertisement for the study. They landed on a welcome page that informed them about the overall process of the study, the expected length (15 minutes), and anonymous data analysis. On the next screen, participants were introduced to the general scenario, which was based on a hybrid shift planning model inspired by [68]. We asked them to imagine that a new scheduling system was introduced in their team. They could access this new system through an app on a tablet in their office. The scheduling system allowed each healthcare worker to submit long-term preferences for early shifts, late shifts, or specific times in

a week (e.g., Wednesday from 16:00 to 18:00, so they could join their sports club). We said that these preferences only needed to be entered once and were valid until changed. In addition, the shift planning system allowed workers to enter requests for specific free days or shifts.

On the following pages, we presented four vignettes of planning scenarios in relation to such requests. In the "conflict negotiation" condition, we used the four interactive conflict negotiation practices presented in [68]. Healthcare workers could try to find a solution using these practices, and used a fully automated process as a fallback. In the "automatic" condition, the process consisted only of the fully automated processes, as is common in many shift planning systems (e.g., [12, 18, 48]). Participants were randomly assigned to either condition (between-participants variation). 53 participants finished the conflict negotiation condition and 41 finished the automatic condition. The vignettes in both conditions focused on the process of handling possible planning conflicts, but left the result open. Thus, we left open whether a participant's request was granted in the final shift plan or not. We left the final decision out, because we were primarily interested in the experience of the process, not the result.

The "conflict negotiation" condition resembled the four interactive conflict negotiation practices reported in [68] (see Appendix A for an English translation of the full vignette texts). In the first vignette ("rescheduling"), participants had requested a day off, but they were later informed that a co-worker has also requested the same day off. They reacted by attempting to reschedule their private appointment to a different day, where no other worker has requested a day off, to increase the chance that it could be granted. In the second vignette ("external resources"), participants had requested a shift off for a private appointment they could not easily reschedule. A co-worker requested the same shift off. They discussed with their co-worker and tried to activate external resources so that both requests could be granted (e.g., by asking healthcare workers from other groups to stand in or by splitting the shift). The third vignette ("informal rules") described an expectable group conflict: Shift planning on Christmas[1]. Many workers wanted to get Christmas Eve off but not all requests could be granted. Here, the group leader initiated an open discussion during a team meeting based on an informal rule (i.e., "whoever works on Christmas gets New Year's Day off and vice versa"), again with an unknown result. Finally, the fourth vignette ("unavoidable conflict") described a conflict that could not easily be resolved, and for which no informal rules existed. The employer planned a company outing and healthcare workers from all wards of the institution wanted to join. In addition, the outing overlapped with the holiday season. Thus, the event could not be rescheduled, external resources were scarce (e.g., workers from other groups), and there were no established, informal rules. The healthcare workers searched for a solution together with a colleague who also wanted to go, but it was unlikely that they found a solution that allowed both of them to participate. In all four vignettes, the participants were told that the algorithm made a decision if healthcare workers could not find an alternative by themselves.

Participants in the "automatic" condition faced the same problems, but the process did not involve the interactive conflict negotiation practices. Instead, the decision was made by the system, which attempted to automatically find a good solution (the result was not described in the vignettes). This is state of the art in many automatic shift planning systems [12, 18, 48] and served as our control condition.

Following each vignette, we included several items to measure the dependent variables. Subjective well-being was measured based on affect balance and need fulfillment[2]. In addition, we measured process fairness and workers' expected impact on team spirit. After the fourth vignette was finished, we asked participants for their age, gender, job title, and

---

[1]Christmas is an important public holiday in the cultural context of our sample and many shift workers want to spend it with their friends or families [70].
[2]We did not include the third measure of subjective well-being, satisfaction with life [26], because it is relatively stable over time and effects of the few scenarios were unlikely.

Table 1. Summary statistics for all measures of the four vignettes and two resolution processes (n=94). m stands for the mean, sd stands for the standard deviation.

process	scenario	immersiveness		affect balance		need fulfillment		fairness		team spirit	
		m	sd	m	sd	m	sd	m	sd	m	sd
negotiation	rescheduling	6.36	1.03	−0.62	2.93	3.01	1.02	4.85	1.66	4.42	2.10
	resources	6.08	1.33	−0.47	3.21	2.98	1.01	4.85	1.84	4.75	2.08
	informal rules	6.36	1.20	0.43	3.00	2.99	1.07	5.51	1.59	5.13	1.72
	unavoidable	5.32	1.89	−1.60	3.03	2.51	1.03	4.49	2.22	4.11	1.95
	overall	6.03	1.46	−0.57	3.13	2.87	1.05	4.92	1.88	4.60	2.00
automatic	rescheduling	5.98	1.39	−1.17	2.67	2.97	0.96	4.10	1.70	4.10	1.81
	resources	6.07	1.26	−2.59	2.17	2.62	0.92	3.59	1.55	3.34	1.59
	informal rules	6.02	1.43	−0.02	3.36	2.75	0.94	4.15	1.63	3.78	1.90
	unavoidable	5.29	1.99	−0.02	3.40	2.74	1.00	4.44	1.83	3.80	1.73
	overall	5.84	1.57	−1.00	3.11	2.77	0.96	4.07	1.70	3.76	1.78

length of experience as a healthcare worker. Finally, at the end of the questionnaire, we included an open field for comments about the study, and a field to enter contact information for the raffle.

3.3 Measures

Summary statistics of all measures can be found in Table 1.

3.3.1 Immersiveness. As is common practice in EVM [1, 5], we measured how well participants could immerse into the scenario with one 7-point scale item ranging from 1 ("not at all") to 7 ("very well"). Immersiveness of all four vignettes was high across both conditions (means ranged between 5.29 and 6.36).

3.3.2 Affect Balance. We measured affect balance with two 7-point scales (positive and negative affect) by asking how positive/negative participants felt during the described situation. Both scales ranged from 1 ("not at all") to 7 ("extremely"). We calculated the affect balance as the difference between positive and negative affect. Higher values represent a more positive affect balance.

3.3.3 Psychological Need Fulfillment. To measure psychological need fulfillment, we used the need scales from Sheldon and colleagues [65] in a German translation [24]. We included the four needs that were reported as relevant in shift planning in previous research [68]: Autonomy, competence, popularity, and security. Each need was measured as the average of three items and overall need fulfillment was measured as the average of the four needs. An example item for autonomy was "I felt free to do things my own way." All items were measured with a 5-point scale from 1 ("not at all") to 5 ("extremely"). Internal consistencies of all needs in all four scenarios were good (all between Cronbach's $\alpha = .76$ and $\alpha = .93$).

3.3.4 Fairness. As reported above, our study focused on fairness of the decision-making process, not on the result. Accordingly, we measured the fairness of the process with one 7-point item adopted from [70]. The scale ranged from 1 ("unfair") to 7 ("fair").

3.3.5 Expected Team Spirit. Finally, we asked participants to estimate the long-term effect of the described decision-making process on team coherence on a 7-point scale from 1 ("negative") to 7 ("positive").

4 RESULTS

4.1 Well-being

4.1.1 Affect Balance. Our first hypothesis was that interactive conflict negotiation practices lead to a more positive affect balance, compared with a fully automated process. We tested this by running a 2 (resolution process) x 4 (scenario) ANOVA with affect balance as measure. We did not find a main effect of the resolution process ($F(1, 92) = 0.98, p = .33$), but a significant interaction effect ($F(3, 276) = 7.53, p < .01, \eta_p^2 = .08$). A post-hoc analysis with Holm-adjusted α values revealed a positive effect of the interactive "external resources" practice, compared with the automated process ($t(92) = 3.36, p < .01, d = .70$). There was no effect for the other three interactive practices.

We further explored whether the effect of the "external resources" practice was based on more positive affect or less negative affect, compared with the automatic process. Both differences, for positive ($t(91.83) = 3.63, p < .001, d = .74$) and negative affect ($t(88.74) = 3.29, p < .001, d = .66$), were significant. Thus, the interactive practice led to more positive and less negative affect, compared with the automatic process.

In sum, we could not confirm an overall positive effect for all interactive conflict negotiation practices on the emotional experience of healthcare workers (i.e., affect balance). However, we found a more specific, positive effect of the "external resources" practice on the healthcare workers' emotional experience, compared with an automated decision-making process. This effect was based both on more positive affect and less negative affect.

4.1.2 Need Fulfillment. Our second hypothesis was that interactive conflict negotiation practices lead to more need fulfillment, compared with the automatic process. We ran a 2 (resolution process) x 4 (scenario) ANOVA with overall need fulfillment as measure. Again, we found no main effect of the resolution process ($F(1, 92) = 0.85, p = .36$), but a significant interaction effect ($F(3, 276) = 7.02, p < .01, \eta_p^2 = .07$). A post-hoc analysis with Holm-adjusted α values revealed a positive effect of the interactive "external resources" practice, compared with the automatic process ($t(92) = 2.33, p < .05$). The other practices had no effect on need fulfillment.

We further explored the need fulfillment of the "external resources" practice for the four needs separately, and found a significant difference in autonomy ($t(92) = 2.95, p < .01, d = 0.61$) and competence ($t(92) = 2.48, p_{crit} = .025, p = .015, d = 0.52$). The differences in security and popularity were not significant.

Taken together, we could not confirm an overall effect of the interactive conflict negotiation practices on need fulfillment. However, we found a more specific effect of the "external resources" practice on need fulfillment, which was based on higher fulfillment of the autonomy and competence needs.

4.2 Fairness

Our third hypothesis was that interactive conflict negotiation practices are perceived as fairer than a fully automated process. We ran a 2 (resolution process) x 4 (scenario) ANOVA with fairness as measure and found a significant main effect of the resolution process ($F(1, 92) = 10.31, p < .01, \eta_p^2 = .10$). We also found a significant interaction effect ($F(3, 276) = 4.04, p < .01, \eta_p^2 = .04$). A post-hoc analysis with Holm-adjusted α values revealed a positive effect of the "informal rules" practice ($t(92) = 3.67, p < .01$) and the "external resources" practice ($t(92) = 3.40, p_{crit} = .025, p < .01$). The "rescheduling" and "unavoidable conflict" practices did not reach significance after Holm-adjustment.

In sum, we could confirm a positive overall effect of the interactive conflict negotiation practices on process fairness from the perspective of healthcare workers, compared with automatic shift planning. This effect was particularly based on positive effects of the "external resources" and "informal rules" practices.
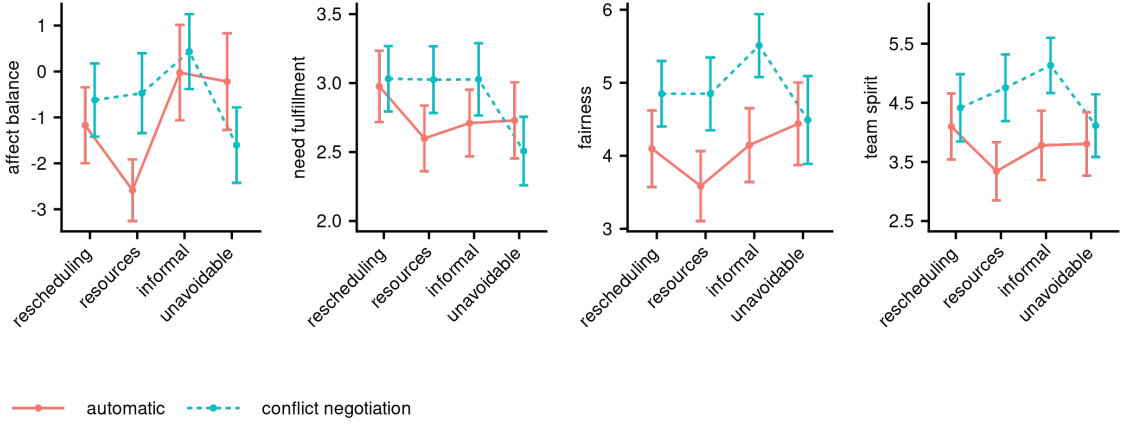
Fig. 1. Results for our four measures by resolution process and scenario. The error bars mark the 95% confidence intervals.

4.3 Team Spirit

Our fourth hypothesis was that interactive conflict negotiation practices lead to a more positive team spirit than a fully automated process. We ran a 2 (resolution process) x 4 (scenario) ANOVA with team spirit as measure and found a significant main effect of the resolution process ($F(1, 92) = 7.11, p < .01, \eta_p^2 = .07$). We also found a significant interaction effect ($F(3, 276) = 5.24, p < .01, \eta_p^2 = .05$). A post-hoc analysis with Holm-adjusted α values revealed a positive effect of the "external resources" practice ($t(92) = 3.58, p < .01$) and the "informal rules" practice ($t(92) = 3.43, p_{crit} = .025, p < .01$). The effects of the "rescheduling" and "unavoidable conflict" practices did not reach significance after Holm-adjustment.

Taken together, we could confirm a positive overall effect of the interactive conflict negotiation practices on team spirit, compared with automatic shift planning. This effect was specifically based on positive effects of the "external resources" and "informal rules" practices.

4.4 Open Comments

In addition to the quantitative measures, 21 participants left a comment at the end of our questionnaire (12 in the conflict negotiation condition, 9 in the automatic condition). In this section, we present the comments that were relevant to our research, organized by the different topics they addressed.

4.4.1 Overall Evaluation of the Shift Planning Process. The evaluation of the shift planning process seemed more positive in the interactive conflict negotiation condition, compared with the automatic condition. We received four positive comments on the process in the conflict negotiation condition. One participant found it "*very interesting, sounds good.*", another one simply commented "*tip-top.*" The other two participants especially appreciated the long-term preferences feature we had adopted from [68] (e.g., general preferences for morning shifts) and briefly mentioned in the introduction. Notably, this feature was part of both experimental conditions and did not play a role in the four scenarios.

In the automatic condition, one participant generally appreciated the interest of academic researchers in shift planning. However, there were no other positive comments on the shift planning process in this condition. One participant expressed a negative opinion: "*The case-based questions can only be answered in a negative way, because a system makes*

the decisions. Communication among each other and conflict resolutions are missing." The other comments were not related to the automatic shift planning process.

4.4.2 Conflict Negotiations. Three further comments (two from the automatic condition) were related to conflict negotiations more generally. One participant expressed that "*It is difficult, because you cannot please everyone.*" Another one also commented that "*It is difficult, especially with very emotional decisions such as Christmas* [our scenario 3] *which simply weighs more than a company outing* [our scenario 4]." The third comment highlighted the importance of a positive team spirit and interpersonal relations: "*Depending on the colleague you work with, swapping a shift or so is easier, or you are more considerate. Unfortunately.*"

4.4.3 Structural Problems in Healthcare Shift Work. Finally, three further comments (one from the automatic condition) were a bit longer and described systemic problems in healthcare from the worker perspective. These were not directly related to our research questions, but relevant to shift planning more generally. One participant complained that changes in the shift plan are not always transparent. This causes problems especially for workers who only work a few hours each week, and who rely on the good will of their colleagues to notify them about important changes to their shift plans. Another participant described general problems that result from shift work, such as health problems and difficulties to maintain a social life. They suggested allowing shift workers to retire earlier, because of these problems. Finally, the third participant argued that many difficulties in shift planning result from a general staff shortage, as well as outdated, rigid structures in the daily work organization.

5 DISCUSSION

In this paper, we presented an experimental online study in which we compared two different processes of handling conflicts between workers' requests in computer-supported shift planning. The "conflict negotiation" process was based on four interactive conflict negotiation practices that directly involved workers in the decision-making process. First, healthcare workers tried to *reschedule* their own request to avoid a conflict with a colleague's request. Second, they looked for *external resources* (e.g., workers from other wards, more flexible shift timings) to integrate both requests. Third, healthcare workers used *informal rules* to handle difficult but expectable conflicts, for example around public holidays with many requests. Fourth, workers attempted to find a good solution for all colleagues, even if the conflict turns out to be *unavoidable*. These interactive conflict negotiation practices were drawn from realistic practices of healthcare workers found in earlier work [68]. The other, "automatic" process was based on fully automated conflict resolution of the same four problem scenarios, as is currently state of the art in computer-supported shift planning systems (e.g., [12, 18, 48, 71]).

Overall, we found that involving healthcare workers through interactive conflict negotiation practices had positive effects on subjective process fairness and team spirit, compared with the fully automated shift planning process. These effects were especially pronounced for the "external resources" and "informal rules" practices. We also found a more specific positive effect of the "external resources" practice on healthcare workers' subjective well-being (i.e., emotional experience/affect balance and psychological need fulfillment). In addition, our analysis of the (qualitative) open comments confirmed that healthcare workers tended to appreciate the interactive process. In contrast, a participant in the automatic condition complained that the system makes decisions on their behalf, which takes away an opportunity to communicate and resolve conflicts among colleagues. Notably, they framed the removal of conflict resolution through automation as a problem, not as a desirable feature.

5.1 Broader Impact

Our findings further extend earlier work suggesting a positive effect of interactive conflict negotiation practices on healthcare workers' well-being and fairness. On the one hand, the semi-automated process indicates how we can overcome challenges of worker overload, which can result from giving workers full planning responsibility (e.g., [6]). On the other hand, we showed how a specific process can look like that gives workers direct and meaningful control about the shifts they actually care about, and that does not rely too much on external (even if human) decision-makers (e.g., [52, 62]). A key difference to most work in the automatic shift planning literature (e.g., [12, 71]) is that our process does not focus so much on "resolving" conflicts by making a decision for one worker and against another. Instead, the practices are more focused on avoiding such dichotomous decisions, and trying to account for both workers' needs while providing a functional shift plan. By integrating both manual and automated components in the overall process, we get the best of both worlds. We can benefit from the efficiency provided by automation where appropriate, for example in planning the many shifts that are not too relevant for individual workers or automating repeated preferences for early shifts. In addition, we can benefit from more detailed context information about the specific requests (e.g., is it somewhat flexible or not), and more sensitive information about workers. These may not be available in automated systems because of privacy concerns, technical limitations, and operational costs, but may contribute to more satisfactory decision-making. Finally, we found that some interactive conflict negotiation practices can not only help to solve conflicts, but they can also have positive effects on the workers' experiences, and thus contribute to a more fulfilling overall work experience. In other words, our findings are encouraging for further research on hybrid notions of computer-supported shift planning.

Beyond shift planning, our work also adds to the currently growing interest in worker-centered design and the increasing focus on workers' values, needs, and well-being in the development of workplace technologies (e.g., [14, 33, 37, 44–46, 68, 75]). Specifically, it offers a case of how work practices that may seem "mundane", superfluous, or even annoying (such as conflict resolution) can also be understood as valuable elements of the overall work experience. Similar approaches in shift planning [68] and in the communication between physicians with different specialization [45] have already been presented, and our study contributes measurable effects on workers' well-being. More broadly, this work also relates to recent approaches to automation that do not focus on efficiency alone, but primarily on promoting well-being and positive experiences of the users (e.g., [38, 39]).

In professional settings where people organize themselves in some way to work together, an occasional conflict or disagreement might be unavoidable. In some cases, technology plays a crucial role as the cause of conflicts, or it provides the data workers can refer to when taking action to resolve the conflicts [15, 27]. Such disagreements among workers or between workers and management may not simply be "resolved" through automated solutions that do not address underlying causes. For example, automated shift planning decisions about who works on subjectively important days (e.g., Christmas in our study) are typically not desirable from a worker perspective. Even if the final decision is made against their requests, workers want to have a say in the decision-making process, as indicated in our study and in previous work [68, 70]. Thus, instead of circumventing the social disagreement through automation, careful design of conflict resolution processes, built on an understanding of the workers' needs and subjective experiences, can lead to more positive outcomes (e.g., in terms of well-being, fairness, and a positive team spirit).

5.2 Design Implications

5.2.1 Optimize for Meaningful Involvement of Healthcare Workers in the Shift Planning Process. Our study revealed specific, positive effects of worker involvement on well-being, fairness, and team spirit. Notably, earlier work has also found negative effects of other ways to involve workers in computer-supported shift planning, for example on subjective control [62] and work load [6]. From our perspective, it becomes increasingly clear that the specific way this involvement is designed is essential for successful, interactive shift planning. Simply reassigning planning tasks to the healthcare workers for example by having them create full work schedules seems problematic, because it primarily increases their workload. In addition, these tasks do not seem to improve the healthcare workers' experiences, as long as they are not meaningfully involved in the actual decision-making processes, or if these processes do not consider the social dynamics in the team [6, 62]. Instead, shifting targeted control to the workers about the specific work and free times they care about seems more helpful. In future shift planning systems, the design of worker involvement should specifically be optimized for meaningful worker control about these subjectively important shifts.

This notion is further supported, considering that our participants also appreciated certain forms of automation. Specifically, some participants mentioned that the feature of automatically recurring long-term preferences such as a weekly sports club (see also [68]) would be desirable. This is a good example of an automation feature that adds value for the workers, does not take away worker control for subjectively important requests, and reduces their work load.

Finally, the most positive effects on workers' experiences resulted specifically from the two practices that require direct interactions between workers. The "external resources" practice is based on a face-to-face negotiation between two colleagues and led to higher subjective well-being, fairness, and team spirit than an automated alternative. The "informal rules" practice is based on a face-to-face negotiation in the team and led to higher fairness and team spirit. Unlike the "rescheduling" practice, social interactions and worker-based decision-making are inherent to these practices, and they cannot simply be added as another feature to a shift planning system that is otherwise supposed to be fully automated. Instead, they require an actual redesign of the decision-making process that directly involves workers. Our findings indicate that such a redesign would be beneficial from the worker perspective.

5.2.2 Design Shift Planning to Improve Subjective Experiences of Workers. Some earlier system proposals have already considered worker-oriented features such as fairness [18, 48] or well-being [58, 59]. These features are typically considered as "objective" criteria in the computer-supported shift planning literature. In the fully automated shift planning paradigm, this "objectivity" is crucial, because it makes the criteria formalizable and accessible for algorithmic processing. For example, Constantino and colleagues [18] suggested to (automatically) balance worker requests that are integrated in the shift plan, to optimize fairness.

However, this "objective" approach has several problems. First, there is no such thing as "objective fairness", because fairness can mean different things in different contexts. It can be based on equality, equity (i.e., performance), or need norms (and some derivates of the three [23]). These different definitions are incompatible with each other [40]. Thus, some subjectivity is always involved, at least in the decision for an underlying fairness norm, and automated solutions tend to be built on fairness definitions that are incompatible with workers' actual fairness experiences [70]. Second, fairness does not only concern the result of a decision-making process, but also the process itself [16, 17]. In shift planning, for example, involvement in the decision-making process increases workers' subjective fairness, independent of the result [70]. Finally, we think that fairness in shift planning only makes sense in the first place if we talk about fairness from the perspective of the affected healthcare workers. A solution that satisfies a fairness definition of the algorithm developers does not help workers in their everyday lives. To put it more drastically: We

think that a completely unequal solution that integrates five requests of one worker and only one request of another worker can be preferable to one where both get three requests granted, if that is what both workers think is the fairest solution. Such subjective perspectives of healthcare workers should be considered more prominently in future designs of computer-supported shift planning systems. At the end of the day, the workers should be satisfied with the systems, rather than the designers and their theoretical assumptions.

5.2.3 Embed Conflict Negotiation Practices in the Broader Work Context. We found positive effects of the interactive conflict negotiation practices, but simply adding a worker control feature that enables them to negotiate may not be sufficient to make the system work well in practice. Healthcare workers need to stay motivated to participate over a longer time period if the system is supposed to be sustainable [6]. Thus, socially embedding such a shift planning system, guiding the workers through the process, and enabling a cooperative culture, could be necessary for them to even engage in conflict negotiations. On the one hand, the user interface could support this, for example by indicating where conflicts may arise, where workers in other wards may be available (because they have not submitted a request themselves), and by allowing manual entries of flexible solutions. On the other hand, socially embedding such a system and motivating healthcare workers to participate may require good leadership skills of the group leader or other people in the healthcare institution [68].

One specific case where this could be especially important is the fourth scenario of our study, where workers are faced with a seemingly unavoidable conflict. Although the decision was delegated to the algorithm in our case, it could be desirable if the group leader takes responsibility for such difficult decisions, for a couple of reasons. First, these situations may be rather rare (e.g., once in nine months in [68]), so efficiency is not a core concern here. Second, human-made decisions have been found to increase workers' experience of having voice in the decision-making process, compared with algorithmic decisions [64]. In other words, the mere fact that a human makes the decision can signal that the workers' requests are taken seriously (see also [8]). And third, communication between leaders and workers plays a more generally important role for workers' fairness perceptions in inclusive shift planning [74].

5.3 Limitations and Further Research

Although the inclusive shift planning system was well-received by the healthcare workers in our study, there are some healthcare contexts in which such negotiations that rely on interpersonal communication may be challenging in practice. One such case is outpatient care, where colleagues may not meet each other regularly. Of course, workers can use other forms of communication, but the team dynamics may be more generally affected by such a work setting and discourage pro-social behavior [69]. Thus, we think that shift planning systems for such specific healthcare contexts need to be studied in more detail in the future.

In addition, our study only covered practices of prospective shift planning. Short-term changes of the shift plan, for example if some workers call in sick, pose another challenge in shift work that we did not cover here. Creating new shift plans and changing existing ones are often considered as separate processes from a management perspective. But from the worker perspective, they both affect their work and private time schedules. Thus, inclusive practices of short-term changes are an additional important topic for future work.

As with any study, the method we chose (vignette-based experimental online study) also comes with certain problems and advantages. Positive aspects include that it allowed us to experimentally vary and control the exact conflict negotiation practices in each condition, while preserving immersive and realistic overall scenarios. But of course, an online study alone with a specific sample from one cultural context is not sufficient. Future work should include

long-term studies using interactive prototypes that implement these interactive conflict negotiation practices, and confirm or further specify the positive effects we found.

Finally, shift planning itself needs to be understood within the broader organization of healthcare in our societies. Of course, improving such central processes can have positive effects. But the Covid-19 pandemic has revealed severe systemic problems in the healthcare systems of many countries. Currently, nursing is not an attractive job. Only few people want to enter the profession [36], and many healthcare workers retire early or switch to different jobs [13]. Among the remaining healthcare workers, there is a growing trend towards part-time instead of full-time employment (e.g., in Germany [28, 29]). As our participants pointed out in the open comments, many problems of shift planning are a consequence of the overall shortage of healthcare workers. This leads to a situation where healthcare work becomes overwhelmingly exhausting to many, and because of that one participant suggested allowing healthcare workers to retire early. We think that fundamental changes are needed to make healthcare work more attractive again, and to create more sustainable working conditions. Improving shift planning processes is important in this regard, but to overcome the structural problems, it needs to be complemented with fundamental improvements to the healthcare system.

6 CONCLUSION

Our study contributes experimental findings about healthcare workers' experiences during conflict negotiations in shift planning. Good, worker-centered design of such central processes of work organization successfully integrates the advantages of automation with meaningful worker control. We see this work as one stepping stone that can help create better work environments, and helps make future work in healthcare professions more attractive again.

REFERENCES

[1] Herman Aguinis and Kyle J. Bradley. 2014. Best Practice Recommendations for Designing and Implementing Experimental Vignette Methodology Studies. *Organizational Research Methods* 17, 4 (2014), 351–371. https://doi.org/10.1177/1094428114547952

[2] Joan Almost, Diane M. Doran, Linda Mcgillis Hall, and Heather Spence Laschinger. 2010. Antecedents and consequences of intra-group conflict among nurses: Antecedents and consequences of intra-group conflict. *Journal of Nursing Management* 18, 8 (2010), 981–992. https://doi.org/10.1111/j.1365-2834.2010.01154.x

[3] Joan Almost, Angela C. Wolff, Althea Stewart-Pyne, Loretta G. McCormick, Diane Strachan, and Christine D'Souza. 2016. Managing and mitigating conflict in healthcare teams: an integrative review. *Journal of Advanced Nursing* 72, 7 (2016), 1490–1505. https://doi.org/10.1111/jan.12903

[4] Anna Arlinghaus, Philip Bohle, Irena Iskra-Golec, Nicole Jansen, Sarah Jay, and Lucia Rotenberg. 2019. Working Time Society Consensus Statements: Evidence-based Effects of Shift Work and Non-standard Working Hours on Workers, Family and Community. *Industrial Health* 57, 2 (2019), 184–200. https://doi.org/10.2486/indhealth.SW-4

[5] Christiane Atzmüller and Peter M. Steiner. 2010. Experimental Vignette Studies in Survey Research. *Methodology* 6, 3 (2010), 128–138. https://doi.org/10.1027/1614-2241/a000014

[6] Lotte Bailyn, Robin Collins, and Yang Song. 2007. Self-scheduling for Hospital Nurses: An Attempt and its Difficulties. *Journal of Nursing Management* 15, 1 (2007), 72–77. https://doi.org/10.1111/j.1365-2934.2006.00633.x

[7] Jane Barton, Evelien Spelten, Peter Totterdell, Lawrence Smith, Simon Folkard, and Giovanni Costa. 1995. The Standard Shiftwork Index: A Battery of Questionnaires for Assessing Shiftwork-Related Problems. *Work & Stress* 9, 1 (1995), 4–30. https://doi.org/10.1080/02678379508251582

[8] Reuben Binns. 2020. On the Apparent Conflict Between Individual and Group Fairness. In *Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency*. ACM, New York, NY, USA, 514–524. https://doi.org/10.1145/3351095.3372864

[9] Philip Bohle and Andrew J. Tilley. 1989. The Impact of Night Work on Psychological Well-being. *Ergonomics* 32, 9 (1989), 1089–1099. https://doi.org/10.1080/00140138908966876

[10] Judith Brown, Laura Lewis, Kathy Ellis, Moira Stewart, Thomas R. Freeman, and M. Janet Kasperski. 2011. Conflict on interprofessional primary health care teams – can it be resolved? *Journal of Interprofessional Care* 25, 1 (2011), 4–10. https://doi.org/10.3109/13561820.2010.497750

[11] Stephanie Brown, Panagiotis Matsangas, and Nita L. Shattuck. 2016. Comparison of a Circadian-based and a Forward Rotating Watch Schedules on Sleep, Mood, and Psychomotor Vigilance Performance. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*. SAGE Publications Ltd., Thousand Oaks, CA, USA, 1167–1171. https://doi.org/10.1177/1541931215591181

[12] Edmund K. Burke, Patrick De Causmaecker, Greet Vanden Berghe, and Hendrik van Landeghem. 2004. The State of the Art of Nurse Rostering. *Journal of Scheduling* 59 (2004), 441–499. https://doi.org/10.1023/B:JOSH.0000046076.75950.0b

[13] Zenobia C. Y. Chan, Wun San Tam, Maggie K. Y. Lung, Wing Yan Wong, and Ching Wa Chau. 2013. A Systematic Literature Review of Nurse Shortage and the Intention to Leave. *Journal of Nursing Management* 21, 4 (2013), 605–613. https://doi.org/10.1111/j.1365-2834.2012.01437.x

[14] CHIWORK Collective, Naveena Karusala, Nabil Ch, Diana Tosca, Alberta Ansah, Emeline Brulé, Nadia Fereydooni, Le-En Huang, Azra Ismail, Pranjal Jain, Wendy Khoo, Isabel Muñoz, Clemens Schartmüller, Himanshu Verma, Preeti Vyas, Susanne Boll, Sarah Fox, Noopur Raval, Max Wilson, Anna Cox, Christian P. Janssen, Helena Mentis, Neha Kumar, Orit Shaer, , and Andrew Kun. 2022. Human-Computer Interaction and the Future of Work. In *Proceedings of the 2022 ACM Conference on Human Factors in Computing Systems Extended Abstracts*. ACM, New York, NY, USA, 3 pages. https://doi.org/10.1145/3491101.3516407

[15] Adrian K. Clear, Sam M. Finnigan, Patrick Olivier, and Rob Comber. 2017. "I'd Want to Burn the Data or at Least Nobble the Numbers": Towards Data-mediated Building Management for Comfort and Energy Use. In *Proceedings of the 2017 ACM Conference on Computer-Supported Cooperative Work & Social Computing*. ACM, New York, NY, USA, 2448–2461. https://doi.org/10.1145/2998181.2998188

[16] Jason A. Colquitt. 2001. On the Dimensionality of Organizational Justice: A Construct Validation of a Measure. *Journal of Applied Psychology* 86, 3 (2001), 386–400. https://doi.org/10.1037/0021-9010.86.3.386

[17] Jason A. Colquitt and Kate P. Zipay. 2015. Justice, Fairness, and Employee Reactions. *Annual Review of Organizational Psychology and Organizational Behavior* 2, 11 (2015), 25 pages. https://doi.org/10.1146/annurev-orgpsych-032414-111457

[18] Ademir A. Constantino, Dario Landa-Silva, Everton L. de Melo, and Wesley Romão. 2011. A Heuristic Algorithm for Nurse Scheduling With Balanced Preference Satisfaction. In *2011 IEEE Symposium on Computational Intelligence in Scheduling*. IEEE, Piscataway, NJ, USA, 39–45. https://doi.org/10.1109/scis.2011.5976549

[19] Giovanni Costa. 2010. Shift Work and Health: Current Problems and Preventive Actions. *Safety and Health at Work* 1, 2 (2010), 112–123. https://doi.org/10.5491/SHAW.2010.1.2.112

[20] Giovanni Costa. 2016. Introduction to Problems of Shift Work. In *Social and Family Issues in Shift Work and Non Standard Working Hours*. Springer International Publishing, Basel, Switzerland, 19–35. https://doi.org/10.1007/978-3-319-42286-2_2

[21] Giovanni Costa, Samantha Sartori, and Torbjorn Åkerstedt. 2006. Influence of Flexibility and Variability of Working Hours on Health and Well-being. *Chronobiology International* 23, 6 (2006), 1125–1137. https://doi.org/10.1080/0742052060108749

[22] Chiara Dall'Ora, Jane Ball, Alejandra Recio-Saucedo, and Peter Griffiths. 2016. Characteristics of shift work and their impact on employee performance and wellbeing: A literature review. *International Journal of Nursing Studies* 57 (2016), 12–27. https://doi.org/10.1016/j.ijnurstu.2016.01.007

[23] Morton Deutsch. 1975. Equity, Equality, and Need: What Determines Which Value Will Be Used As The Basis of Distributive Justice? *Journal of Social Issues* 31, 3 (1975), 137–149. https://doi.org/10.1111/j.1540-4560.1975.tb01000.x

[24] Sarah Diefenbach and Marc Hassenzahl. 2010. *Handbuch zur fun-ni Toolbox [Handbook for the fun-ni Toolbox]*. Folkwang Universität der Künste, Essen, Germany. Retrieved August 30, 2022 from https://www.yumpu.com/de/document/view/21348322/handbuch-zur-fun-ni-toolbox/37

[25] Sarah Diefenbach, Marc Hassenzahl, Kai Eckoldt, Lena Hartung, Eva Lenz, and Matthias Laschke. 2017. Designing for Well-being: A Case Study of Keeping Small Secrets. *Journal of Positive Psychology* 12, 2 (2017), 151–158. https://doi.org/10.1080/17439760.2016.1163405

[26] Edward Diener, Robert A. Emmons, Randy J. Larsen, and Sharon Griffin. 1985. The Satisfaction With Life Scale. *Journal of Personality Assessment* 49, 1 (1985), 71–75. https://doi.org/10.1207/s15327752jpa4901_13

[27] Lynn Dombrowski, Adriana Alvarado Garcia, and Jessica Despard. 2017. Low-Wage Precarious Workers' Sociotechnical Practices Working Towards Addressing Wage Theft. In *Proceedings of the 2017 ACM Conference on Human Factors in Computing Systems*. ACM, New York, NY, USA, 4585–4598. https://doi.org/10.1145/3025453.3025633

[28] Federal Statistical Office of Germany. 2001. Pflegestatistik 2001 [Care Statistics 2001]. Retrieved from https://www.statistischebibliothek.de/mir/receive/DESerie_mods_00000940.

[29] Federal Statistical Office of Germany. 2019. Pflegestatistik 2019 [Care Statistics 2019]. Retrieved from https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Gesundheit/Pflege/Publikationen/Downloads-Pflege/pflege-deutschlandergebnisse-5224001199004.html.

[30] Rudy Fenwick and Mark Tausig. 2001. Scheduling Stress: Family and Health Outcomes of Shift Work and Schedule Control. *Americal Behavioral Scientist* 44, 7 (2001), 1179–1198. https://doi.org/10.1177/00027640121956719

[31] Mervi Flinkman, Marjukka Laine, Helena Leino-Kilpi, Hans-Martin Hasselhorn, and Sanna Salanterä. 2008. Explaining young registered Finnish nurses' intention to leave the profession: A questionnaire survey. *International Journal of Nursing Studies* 45, 5 (2008), 727–739. https://doi.org/10.1016/j.ijnurstu.2006.12.006

[32] Simon Folkard, Karen A. Robertson, and Mick B. Spencer. 2007. A Fatigue/Risk Index to assess work schedules. *Somnologie - Schlafforschung und Schlafmedizin* 11, 3 (2007), 177–185. https://doi.org/10.1007/s11818-007-0308-6

[33] Sarah E. Fox, Vera Khovanskaya, Clara Crivellaro, Niloufar Salehi, Lynn Dombrowski, Chinmay Kulkarni, Lilly Irani, and Jodi Forlizzi. 2020. Worker-Centered Design: Expanding HCI Methods for Supporting Labor. In *Proceedings of the 2020 ACM Conference on Human Factors in Computing Systems Extended Abstracts*. ACM, New York, NY, USA, 1–8. https://doi.org/10.1145/3334480.3375157

[34] Raymond A. Friedman, Simon T. Tidd, Steven C. Currall, and James C. Tsai. 2000. What Goes Around Comes Around: The Impact of Personal Conflict Style on Work Conflict and Stress. *International Journal of Conflict Management* 11, 1 (2000), 32–55. https://doi.org/10.1108/eb022834

[35] Anne H. Garde, Karen Albertsen, Kirsten Nabe-Nielsen, Isabella G. Carneiro, Jørgen Skotte, Sofie M. Hansen, Henrik Lund, Helge Hvid, and Åse M. Hansen. 2012. Implementation of Self-rostering (the PRIO-Project): Effects on Working Hours, Recovery, and Health. *Scandinavian Journal of Work, Environment & Health* 38, 4 (2012), 314–326. https://doi.org/10.5271/sjweh.3306

[36] Jane Hemsley-Brown and Nicholas H. Foskett. 1999. Career Desirability: Young People's Perceptions of Nursing as a Career. *Journal of Advanced Nursing* 29, 6 (1999), 1342–1350. https://doi.org/10.1046/j.1365-2648.1999.01020.x

[37] Naveena Karusala, Azra Ismail, Karthik Bhat, Aakash Gautam, Sachin Pendse, Neha Kumar, Richard Anderson, Madeline Balaam, Shaowen Bardzell, Nicola Bidwell, Melissa Densmore, Elizabeth Kaziunas, Anne Marie Piper, Noopur Raval, Pushpendra Singh, Austin Toombs, Nervo Verdezoto, and Ding Wang. 2021. The Future of Care Work: Towards a Radical Politics of Care in CSCW Research and Practice. In *Companion Publication of the 2021 ACM Conference on Computer-Supported Cooperative Work & Social Computing*. ACM, New York, NY, USA, 338–342. https://doi.org/10.1145/3462204.3481734

[38] Holger Klapperich, Alarith Uhde, and Marc Hassenzahl. 2019. Understanding and Designing Automation with Peoples' Wellbeing in Mind. In *Contribution to the CHI Workshop on Everyday Automation Experience*. ACM, New York, NY, USA, 7 pages. https://doi.org/10.25819/ubsi/9894 arXiv:arXiv:2003.05530

[39] Holger Klapperich, Alarith Uhde, and Marc Hassenzahl. 2020. Designing Everyday Automation with Well-being in Mind. *Personal and Ubiquitous Computing* 24 (2020), 763–779. https://doi.org/10.1007/s00779-020-01452-w

[40] Jon M. Kleinberg, Sendhil Mullainathan, and Manish Raghavan. 2017. Inherent Trade-Offs in the Fair Determination of Risk Scores. In *Proceedings of Innovations in Theoretical Computer Science (ITCS)*. Simons Institute, Berkeley, CA, USA, 1–23. https://arxiv.org/pdf/1609.05807

[41] Anders Knutsson. 1989. Shift Work and Coronary Heart Disease. *Scandinavian Journal of Social Medicine. Supplementum* 44 (1989), 1–36. Retrieved January 7, 2021 from https://europepmc.org/article/med/2683043

[42] Tomohide Kubo, Masaya Takahashi, Fumiharu Togo, Xinxin Liu, Akihito Shimazu, Katsutoshi Tanaka, and Mitsutoshi Takaya. 2013. Effects on Employees of Controlling Working Hours and Working Schedules. *Occupational Medicine* 63, 2 (2013), 148–151. https://doi.org/10.1093/occmed/kqs234

[43] Leodoro J. Labrague, Zaid Al Hamdan, and Denise M. McEnroe-Petitte. 2018. An integrative review on conflict management styles among nursing professionals: implications for nursing management. *Journal of Nursing Management* 26, 8 (2018), 902–917. https://doi.org/10.1111/jonm.12626

[44] Frederic Laloux. 2014. *Reinventing Organizations*. Nelson Parker, Brussels, Belgium. https://doi.org/10.15358/9783800649143

[45] Matthias Laschke, Christoph Braun, Robin Neuhaus, and Marc Hassenzahl. 2020. Meaningful Technology at Work - A Reflective Design Case of Improving Radiologists' Wellbeing Through Medical Technology. In *Proceedings of the 2020 ACM Conference on Human Factors in Computing Systems*. ACM, New York, NY, USA, 12 pages. https://doi.org/10.1145/3313831.3376710

[46] Matthias Laschke, Alarith Uhde, and Marc Hassenzahl. 2020. Positive Work Practices. Opportunities and Challenges in Designing Meaningful Work-related Technology. In *Contribution to the CHI Workshop on Worker-Centered Design*. ACM, New York, NY, USA, 5 pages. https://doi.org/10.25819/ubsi/9896

[47] Min Kyung Lee, Daniel Kusbit, Evan Metsky, and Laura Dabbish. 2015. Working with Machines: The Impact of Algorithmic and Data-Driven Management on Human Workers. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems – CHI'15*. ACM, New York, NY, USA, 1603–1612. https://doi.org/10.1145/2702123.2702548

[48] Chun-Cheng Lin, Jia-Rong Kang, Ding-Jung Chiang, and Chien-Liang Chen. 2015. Nurse Scheduling with Joint Normalized Shift and Day-Off Preference Satisfaction Using a Genetic Algorithm with Immigrant Scheme. *International Journal of Distributed Sensor Networks* 11, 7 (2015), 10 pages. https://doi.org/10.1155/2015/595419

[49] Rebecca Loudoun. 2008. Balancing Shiftwork and Life Outside Work: Do 12-h Shifts Make a Difference? *Applied Ergonomics* 39, 5 (2008), 572–579. https://doi.org/10.1016/j.apergo.2007.12.004

[50] Holmes E. Miller, William P. Pierskalla, and Gustave J. Rath. 1976. Nurse Scheduling Using Mathematical Programming. *Operations Research* 24, 5 (1976), 857–870. https://doi.org/10.1287/opre.24.5.857

[51] Michelle L. Miller. 1984. Implementing Self-scheduling. *The Journal of Nursing Administration* 14, 3 (1984), 33–36. Retrieved November 11, 2021 from https://europepmc.org/article/med/6561241

[52] Kirsten Nabe-Nielsen, Anne Helene Garde, Birgit Aust, and Finn Diderichsen. 2012. Increasing Work-Time Influence: Consequences for Flexibility, Variability, Regularity and Predictability. *Ergonomics* 55, 4 (2012), 440–449. https://doi.org/10.1080/00140139.2011.646321

[53] Millicent Nelson and Richard J. Tarpey. 2010. Work Scheduling Satisfaction and Work Life Balance for Nurses: The Perception of Organizational Justice. *Academy of Health Care Management Journal* 6, 1 (2010), 25–36. Retrieved August 30, 2022 from https://www.abacademies.org/articles/volume-6-issue-1.pdf

[54] Jennifer Oates. 2018. What Keeps Nurses Happy? Implications for Workforce Well-being Strategies. *Nursing Management* 25, 1 (2018), 34–41. https://doi.org/10.7748/nm.2018.e1643

[55] Jennifer Oates, Julia Jones, and Nicholas Drey. 2017. Subjective Well-being of Mental Health Nurses in the United Kingdom: Results of an Online Survey. *International Journal of Mental Health Nursing* 26, 4 (2017), 391–401. https://doi.org/10.1111/inm.12263

[56] Sonja K. Ötting and Günter W. Maier. 2018. The Importance of Procedural Justice in Human-Machine Interactions: Intelligent Systems as New Decision Agents in Organizations. *Computers in Human Behavior* 89 (2018), 27–39. https://doi.org/10.1016/j.chb.2018.07.022

[57] Gabriel Oxenstierna, Linda L. Magnusson Hanson, Maria Widmark, Kristina Finnholm, Cecilia Stenfors, Stig Elofsson, and Töres Theorell. 2011. Conflicts at Work – The Relationship with Workplace Factors, Work Characteristics and Self-rated Health. *Industrial Health* 49, 4 (2011), 501–510. https://doi.org/10.2486/indhealth.MS1171

[58] Sanja Petrovic. 2019. "You Have to Get Wet to Learn How to Swim" Applied to Bridging the Gap Between Research Into Personnel Scheduling and its Implementation in Practice. *Annals of Operations Research* 275, 1 (2019), 161–179. https://doi.org/10.1007/s10479-017-2574-4

[59] Sanja Petrovic, Jane Parkin, and David Wrigley. 2020. Personnel Scheduling Considering Employee Well-being: Insights from Case Studies. In *Proceedings of the 2020 International Conference on the Practice and Theory of Automated Timetabling - PATAT 2021: Volume I.* 14. Retrieved March 31, 2022 from http://www.patatconference.org/patat2020/proceedings/papers/2.%20PATAT_2020_paper_63.pdf

[60] Anne Pisarski and Philip Bohle. 2001. Effects of Supervisor Support and Coping on Shiftwork Tolerance. *Journal of Human Ergology* 30, 1-2 (2001), 363–368. https://doi.org/10.11183/jhe1972.30.363

[61] Anne Pisarski, Sandra A. Lawrence, Philip Bohle, and Christine Brook. 2008. Organizational Influences on the Work Life Conflict and Health of Shiftworkers. *Applied Ergonomics* 39, 5 (2008), 580–588. https://doi.org/10.1016/j.apergo.2008.01.005

[62] Elina Rönnberg and Torbjörn Larsson. 2010. Automating the Self-scheduling Process of Nurses in Swedish Healthcare: A Pilot Study. *Health Care Management Science* 13, 1 (2010), 35–53. https://doi.org/10.1007/s10729-009-9107-x

[63] Yvonne Rogers. 2011. Interaction Design Gone Wild: Striving for Wild Theory. *Interactions* 18, 4 (2011), 58–62. https://doi.org/10.1145/1978822.1978834

[64] Nadine Schlicker, Markus Langer, Sonja K. Ötting, Kevin Baum, Cornelius J. König, and Dieter Wallach. 2021. What to Expect from Opening up 'Black Boxes'? Comparing Perceptions of Justice Between Human and Automated Agents. *Computers in Human Behavior* 122 (2021), 106837. https://doi.org/10.1016/j.chb.2021.106837

[65] Kennon M. Sheldon, Andrew J. Elliot, Youngmee Kim, and Tim Kasser. 2001. What is Satisfying About Satisfying Events? Testing 10 Candidate Psychological Needs. *Journal of Personality and Social Psychology* 80, 2 (2001), 325–339. https://doi.org/10.1037/0022-3514.80.2.325

[66] Rhian Silvestro and Claudio Silvestro. 2000. An Evaluation of Nurse Rostering Practices in the National Health Service. *Journal of Advanced Nursing* 32, 3 (2000), 525–535. https://doi.org/10.1046/j.1365-2648.2000.01512.x

[67] Amos Tversky and Daniel Kahneman. 1981. The Framing of Decisions and the Psychology of Choice. *Science* 211, 4481 (1981), 453–458. https://doi.org/10.1126/science.7455683

[68] Alarith Uhde, Matthias Laschke, and Marc Hassenzahl. 2021. Design and Appropriation of Computer-Supported Self-scheduling Practices in Healthcare Shift Work. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW1 (2021), 1–26. https://doi.org/10.1145/3449219

[69] Alarith Uhde, Mena Mesenhöller, and Marc Hassenzahl. 2020. Context Factors for Pro-social Practices in Health Care. In *New Perspectives on Digitalization: Local Issues and Global Impact.* Universitätsbibliothek Siegen, Siegen, Germany, 30–35. https://doi.org/10.25819/ubsi/2750

[70] Alarith Uhde, Nadine Schlicker, Dieter P. Wallach, and Marc Hassenzahl. 2020. Fairness and Decision-Making in Collaborative Shift Scheduling Systems. In *Proceedings of the 2020 ACM Conference on Human Factors in Computing Systems.* ACM, New York, NY, USA, 13 pages. https://doi.org/10.1145/3313831.3376656

[71] Jorne Van den Bergh, Jeroen Beliën, Philippe De Bruecker, Erik Demeulemeester, and Liesje De Boeck. 2012. Personnel Scheduling: A Literature Review. *European Journal of Operational Research* 226, 3 (2012), 367–385. https://doi.org/10.1016/j.ejor.2012.11.029

[72] James Walker. 1985. Social Problems of Shiftwork. In *Hours of Work: Temporal Factors in Work-Scheduling.* Wiley, Chichester, UK, 211–225. Retrieved January 7, 2021 from https://www.worldcat.org/title/hours-of-work-temporal-factors-in-work-scheduling/oclc/11091391

[73] D. Michael Warner. 1976. Scheduling Nursing Personnel According to Nursing Preference: A Mathematical Programming Approach. *Operations Research* 24, 5 (1976), 842–856. https://doi.org/10.1287/opre.24.5.842

[74] Herlinde Wynendaele, Paul Gemmel, Ellen Peeters, Dries Myny, and Jeroen Trybou. 2021. The Effect of Self-scheduling on Organizational Justice and Work Attitudes Through Leader-Member Exchange: A Cross-Sectional Study Using Propensity Scores. *International Journal of Nursing Studies* 112, 104032 (2021), 1–32. https://doi.org/10.1016/j.ijnurstu.2021.104032

[75] Angie Zhang, Alexander Boltz, Chun Wei Wang, and Min Kyung Lee. 2022. Algorithmic Management Reimagined for Workers and by Workers: Centering Worker Well-being in Gig Work. In *Proceedings of the 2022 ACM Conference on Human Factors in Computing Systems.* ACM, New York, NY, USA, 1–20. https://doi.org/10.1145/3491102.3501866

A VIGNETTES

Table 2. The four vignettes of the two resolution processes used in the study (translated from German).

Vignette	Conflict Negotiation	Automatic
1 (rescheduling)	It is early in March and an old friend has recently contacted you. He will be in your area in the second week of April. You want to meet him and he has already said that the Friday would be good for him. Thus, you have already requested that Friday as a day off. During a shift you hear from a colleague, that she has also requested the same day off. Her grandfather will turn 90 on that day and she would like to go to the family party. From experience you know that requests can not always be integrated into the schedule, for example if several colleagues request the same day off. You send a short message to your friend, asking if Wednesday or Thursday would also be good for him. On these days, nobody else has requested a day off yet. If it works, you can change your request. Otherwise you cannot say for certain, whether you will get the day off or not. The system normally handles such conflicts well and it will automatically try to include as many requests as possible.	It is early in March and an old friend has recently contacted you. He will be in your area in the second week of April. You want to meet him and he has already said that the Friday would be good for him. Thus, you have already requested that Friday as a day off. During a shift you learn that a colleague has also requested the same day off. Her grandfather will turn 90 on that day and she would like to go to the family party. From experience you know that requests can not always be integrated into the schedule, for example if several colleagues request the same day off. You send a short message to your friend and tell him that you cannot say for certain, whether you will get the day off or not. The system normally handles such conflicts well and it will automatically try to include as many requests as possible.
2 (resources)	You have made a doctor's appointment for early May. With this doctor it is difficult to get appointments. If you cancel an appointment, it often takes weeks to get a new one. You have requested this appointment as a free shift on the tablet. During a break a colleague tells you that he has requested the same shift off. He is a single father and has to fetch his child from the daycare center earlier than usual on that day. You know that other colleagues are on vacation or have a professional training on that day, so that probably one of you two has to work. You try to find a solution together. Maybe a healthcare worker from a different group can help out? Maybe you can split the shift somehow so that he works the first half and you the second? If you find a solution, you can directly enter it in the system and it will be integrated in the plan. Otherwise the system tries to automatically find a good solution, even in such tense situations. However, not all requests can be granted in every case.	You have made a doctor's appointment for early May. With this doctor it is difficult to get appointments. If you cancel an appointment, it often takes weeks to get a new one. You have requested this appointment as a free shift on the tablet. During a break you learn that a colleague has requested the same shift off. He is a single father and has to fetch his child from the daycare center earlier than usual on that day. You know that other colleagues are on vacation or have a professional training on that day, so that probably one of you two has to work. Even in such tense situations the system tries to automatically find a good solution. However, not all requests can be granted in every case.
3 (informal rule)	The shift plans for December will have to be made soon. Normally most colleagues either want Christmas or New Year's Day off and they enter their requests. Just like many other colleagues, you would like to have Christmas off this year. Based on experience, not all requests can always be granted. In your group you have come up with an informal rule: Whoever works on Christmas gets New Year's Eve off and vice versa. During a team meeting your group leader brings up the topic: Who works when? Together you try to find a solution, so that everyone has either Christmas or New Year's Day off. If you find such a solution, it will directly be integrated into the schedule. If that does not work, the system will try to automatically find a good solution, so that as many requests as possible can be granted.	The shift plans for December will have to be made soon. Normally most colleagues either want Christmas or New Year's Day off and they enter their requests. Just like many other colleagues, you would like to have Christmas off this year. Based on experience, not all requests can always be granted. As soon as everyone has entered their requests, the system will try to automatically find a good solution, so that as many requests as possible can be granted.
4 (unavoidable)	Your employer has planned a company outing. Healthcare workers from all groups want to participate and so do you. Of course the company needs to keep running. Unfortunately the date is also during the holiday season, so that some colleagues are not there. The staff situation is already tense. A colleague from your group tells you that she also wants to go. But it is unlikely that both of you can go. You discuss all the options, but it is difficult. The date cannot be changed and you cannot ask anyone from other groups, because they are also short on staff. The last company outing happened a few years ago and your colleague has not work in your company at the time. There does not seem to be a solution for both of you to go. In the end, you simply both submit a request on the tablet and let the system decide who should go.	Your employer has planned a company outing. Healthcare workers from all groups want to participate and so do you. Of course the company needs to keep running. Unfortunately the date is also during the holiday season, so that some colleagues are not there. The staff situation is already tense. You learn that a colleague from your group also wants to go. But it is unlikely that both of you can go. You submit your request on the tablet and let the system decide who should go.