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Effects of the implementation of information technology on employees' strain and job satisfaction: a context-dependent approach

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The effects on staff of the implementation of new office information technology were investigated in ten companies in Vienna using a longitudinal design. Strain and satisfaction of 331 employees (implementation sample: $n = 212$; control sample: $n = 119$) were measured at five points in time over a period of 22 months. The study is based on a context-dependent approach. Personal factors (individual differences, external load) were assessed by questionnaires, and situational factors (job design, implementation content and implementation context) by objective measures. The impact of these factors on employees' strain responses was tested using structural equation modelling (SEM). While the implementation of new technology as such made no significant contribution to the explanation of strain variables, a reasonable model fit was achieved when implementation characteristics were taken into account. The data suggest that negative effects of implementations must be expected if (1) adaptational demands do not include the enhancement of employee qualifications, (2) character-based user interfaces are not replaced, and (3) employees have few or no opportunities to participate in the implementation process.

1. Introduction

This study aimed to test a context-dependent approach to the analysis of positive and negative effects on the users of new information technology (IT) implementations: effects on users' strain and satisfaction and, hence, on their long-term well-being, health and job performance.

The introduction of new IT has a remarkable positive as well as negative potential for inducing changes in job satisfaction and strain. Numerous studies have attempted to evaluate these effects. In the 1970s and 1980s, most studies focused on the effects of visual display units (VDUs). Work with VDUs has been shown to be accompanied by an increase in eye complaints (Dainoff, 1982; Smith, Cohen, and Stammerjohn, 1981) and musculoskeletal complaints (Knave, Wibom, Voss, Hedström, and Bergquist, 1985; Sauter, Schleifer, and Knutson, 1991). Compared to control groups working with conventional technologies, a higher level of job stress was found in most of the cross-sectional studies investigating the effects of computerized office work (Agervold, 1987; Stellman, Klitzman, Gordon, and Snow, 1987). Working time with the VDU (Lindström, 1991; Steffy, and Jones, 1989), ergonomic deficiencies in the hardware (Sullivan, 1990), and software (Widdel, and Kaster, 1991) were found to be relevant stressors.

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At the end of the 1980s, research emphasis shifted from the investigation of stressors related to the technology itself (e.g. VDUs) to the investigation of stressors in the context of its use. These contextual factors can be found in person-related factors, in job/task aspects related to these technologies, and in the organizational context (Frese, 1991; Smith, 1987, 1997).

1.1. *Person-related factors*

Regarding the person-related contextual factors of IT implementation, demographic variables, attitudes and differences in personality have been investigated. While the age of the employees seemed to be an important factor in the earlier years of IT use, recent studies have shown no or only little difference between older and younger employees with regard to job satisfaction and attitudes related to IT (Dyck, 1994; Marquié, Thon, and Baracat, 1994).

1.1.1. *Gender effects*: A more complex picture emerges from studies investigating gender effects related to information technology. Earlier studies reported more negative effects of IT on strain and satisfaction in women compared to men (Evans, 1987; Knights, and Sturdy, 1987). A hypothesis of 'polarization' between women and men, not only in terms of qualifications, but also in strain and job satisfaction, emerged and was further confirmed by some topical studies (Aronsson, Dallner, and Aborg, 1994; Parasuraman, and Igbaria, 1990). Other authors found positive effects of computerization in women (Dunkle, King, Kraemer, and Danziger, 1994). There is agreement in these studies that the differential effects between men and women are gender effects (that is, differences in contextual factors of job design, organization and social roles). Men are more often found in positions requiring higher qualifications, and women have a higher load from duties outside work (Lundberg, Mardberg, and Frankenhäuser, 1994).

1.1.2. *Attitude dimensions*: Attitudes towards IT constitute another personal contextual factor. Cognitive attitude components (attitude towards the practicability of the 'computer as a tool') and emotional attitude components ('computer anxiety') have been investigated (Gardner, Young, and Ruth, 1989; Igbaria, and Parasuraman, 1989; Rosen, and Maguire, 1990). Attitudes towards IT is related to acceptance and therefore to the employees' job satisfaction.

1.1.3. *Locus of control*: One of the most important individual variables in relation to work in general, locus of control, has also been investigated as a personal contextual factor influencing relations between IT use and strain and satisfaction of the employees. It has been shown that high values for internal locus of control are correlated with a positive attitude towards IT (Crable, Brodzinski, Scherer, and Jones, 1994) and a tendency towards more intense use of IT systems (Livingston, Maxfield, Attebery, and Portis, 1990), although these relationships are comparatively weak.

1.2. *Job design*

One attempt to define contextual factors on the job/task-level has been to develop computer-related work taxonomies; for instance, a differentiation between data entry, data

retrieval and dialogue-based work, and word processing (Smith, 1986). However, as most modern computer software is dialogue-based, in our study other job design criteria had to be taken into account. In addition to changes in qualification demands and increases or decreases in work pressure and variability, job control was found to be the most important job design facet related to computer work. The introduction of IT can result in either an increase or a decrease in job control (Hockey, Briner, Tattersall, and Wiethoff, 1989; Kraemer, and Danziger, 1990; Westlander, Aronsson, Johansson, Ahlin, and Söderberg, 1990). Related aspects of job design have been analysed in cross-sectional studies (Agervold, 1987; Aronsson *et al.*, 1994; Stellman *et al.*, 1987) as well as in some longitudinal studies (Carayon, 1992, 1993; Huuhtanen, and Leino, 1992).

To summarize the research regarding job design and computer work, the most important dimensions potentially affected by computer work are work pressure, job control, variety, and concentration demands. The use of computer technology has the potential to produce both an increase and a decrease in these job design dimensions (Smith, Carayon, Eberts, and Salvendy, 1992).

1.3. *Implementation characteristics*

The effects of the implementation of IT depends on the content of change (i.e. adaptational demands of the users, software-ergonomic changes) and the context of change (Smith, and Carayon, 1995). Effects of the change can be short-term, that is, only related to the time span of the implementation phase itself, or long-term, depending on factors of the management of organizational change. Employee participation is an important dimension of the context of organizational change. In earlier studies, research focused on the effects of participation in systems development. It has been shown that increased participation has a positive effect on job satisfaction and, to a lesser degree, also on performance indicators (such as systems use, Ives, and Olson, 1984). More recent studies confirmed these positive effects of employee participation for the implementation of IT as well (Baronas, and Louis, 1988; Igbaria, Parasuraman, and Badawy, 1994; Jarvenpaa, and Ives, 1991). Not only 'active' participation in decision making, but also 'passive' participation (i.e. receiving comprehensive information about the benefits and possible problems with the new system) seems to have positive effects (Griffith, and Northcraft, 1993, 1996). The amount and design of employee training and the management of the implementation (i.e. professionality, time constraints) can also affect the employees' strain and satisfaction (Eriksson, 1990; Leonard-Barton, 1988).

1.4. *Synopsis*

In the majority of the studies summarized above, only singular factors (personal factors or job design or implementation characteristics) were investigated. Additionally, these studies were predominantly cross-sectional. This implies that results may have been partly biased by 'hidden' interactions with uncontrolled influential factors or by mediating effects, and that questions of causality cannot be settled unequivocally. The longitudinal studies in the organizational literature lay their emphasis mainly on the organizational aspects and only to a small degree on employees' strain and satisfaction (Leonard-Barton, 1988; Markus, and Robey, 1988; Tyre, and Orlikowski, 1994).

A longitudinal study of IT implementation, applying a context-dependent perspective by *simultaneously* analysing influences of contextual factors on *situational* and on *personal*

levels, would therefore be an adequate methodological approach to deal with these structural deficiencies.

1.5. *The 'Vienna Implementation Studies'*

In the 'First Vienna Implementation Study' we investigated first-time introductions of IT systems in a longitudinal study based on a context-dependent approach (Korunka, Weiss, and Karetta, 1993; Korunka, Weiss, Karetta, and Huemer, 1995). In seven companies, 279 employees engaged in different kinds of clerical work participated in a longitudinal research design.

In this first study, the validity of the context-dependent approach was confirmed for the first-time introduction of ITs: an analysis of the total sample showed only weak effects of the 'change' as such on employees' strain and job satisfaction. More negative effects on strain and satisfaction were found in a cluster of highly monotonous, low-qualified jobs, in organizations characterized by low participation measures, and for the female subsample. An analysis by hierarchical multiple regression analyses showed that gender effects resulted from gender-related differences in job design and implementation management, with the latter contextual factors being mainly responsible for changes in employees' strain and satisfaction related to the IT implementation.

The data presented here stem from the 'Second Vienna Implementation Study', which is a follow-up study dealing with effects of the *continuous implementation* of IT: nowadays information technologies are found in practically every office, and the employees working with them are frequently confronted with technological change. Employees are therefore *continuously* confronted with the implementation of ITs. In this study, *discrete manifestations of such continuous implementations* were investigated. These implementations were 'typical' IT-related changes in offices of the mid-1990s, such as the introduction of new software packages (e.g. the implementation of 'SAP', a widely used standard software for organizational processes instead of in-house software developments), software updates (e.g. larger updates in word processing software), or new user interfaces (e.g. a graphical interface [such as a windows operating system] instead of a character-based interface [DOS]). The entire project comprised a cross-sectional interview study (Korunka, Zauchner, and Weiss, 1997b), a cross-national comparison (Korunka, and Carayon, 1999), and a longitudinal study. The results of the latter are presented here.

1.6. *Study goals and hypotheses*

The goal of the longitudinal study described here was an analysis of the effects of continuous IT implementation on users' strain and satisfaction, based on a *context-dependent approach* as developed in our earlier studies (Korunka *et al.*, 1993, 1995). A similar approach has recently been developed in order to explain employees' reactions to organizational changes, such as the introduction of Total Quality Management (Edwards, Collinson, and Rees, 1998; Rosenthal, Hill, and Riccardo, 1997).

We assume that person-related factors have a causal influence on the general strain/dissatisfaction level of the employees, which, in turn, partly predicts the level of strain/dissatisfaction after implementation of new IT. As the main hypothesis, we expect that the implementation itself has no unequivocal effect on employees' strain/dissatisfaction. Rather, all implementation effects are expected to depend on the *implementation content* and *context*.

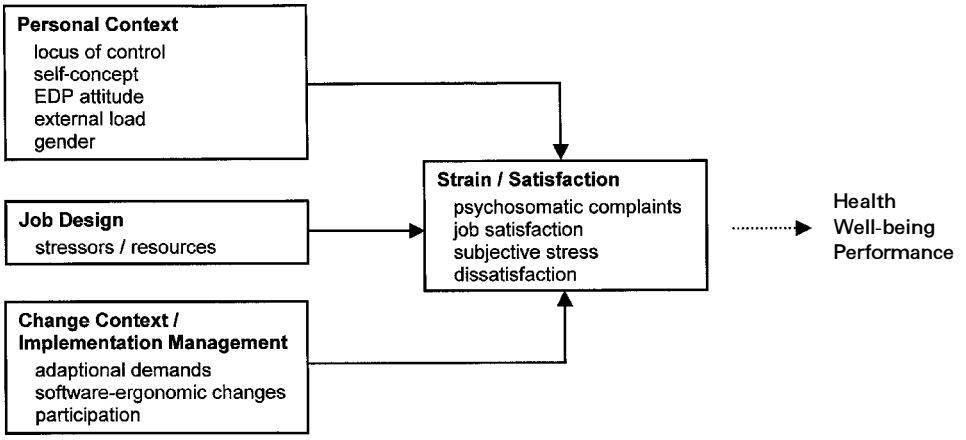


Figure 1. Hypothetical contextual factor model of IT implementation effects.

Those specific situational and personal contextual factors that were shown to have significant and meaningful effects in the 'First Vienna Implementation Study' (Korunka *et al.*, 1995) are included in the updated research model. Figure 1 gives a schematic illustration of the model: we hypothesize that the strain and satisfaction outcome variables, being conceptually related to health, well-being, and performance, are influenced by several contextual variables on different levels (personal factors, job design, and implementation characteristics). We here present a *simultaneous* assessment of this context-dependent conception in a stepwise built integrated model by means of structural equation modelling (SEM).

2. Method

2.1. *Participants*

We initially selected 120 medium to large companies (at least 100 employees) located in the Vienna area. A letter was sent to the head of the Electronic Data Processing (EDP) department of each company; subsequently, companies were contacted by telephone. The managers were asked if an implementation fulfilling the following criteria was planned for the near future.

- At least 20 employees affected by the IT implementation.
- No first-time introduction of information technologies.
- At least 4 h of training related to the implementation for each employee. A minimum amount of 8 h excluded minor implementations, e.g. a release update of a standard software package.

Ten companies (sales and production, $n = 7$; insurance, $n = 1$; bank, $n = 1$; public organization, $n = 1$) were found where an implementation as defined above was planned within the next 15 months and both management and union representatives agreed to participate in the study. In sum, 506 employees (between 19 and 97 employees per company) were affected by the prospective IT implementations.

In some cases, changes did not occur as previously planned: several employees were not included, or the implementations were delayed and not put into action during the observation period. Therefore, a 'control sample' (employees not directly affected by the implementation) was available. Data from $N = 331$ employees (implementation sample: n

= 212; control sample: n = 119) were included in the analyses (table 1). These employees were engaged in clerical work with different levels of qualification (e.g. secretarial work, accountancy, department management). Distributions of gender (χ^2 = 10.6, p = .22) and age (F = 1.58, p = .14) did not significantly differ between the two subsamples.

2.2. *Data collection*

Data for the 'Second Vienna Implementation Study' were collected between October 1994 and March 1997. Measurements were taken in each company at time intervals of 5.5 months (± 2 weeks) over a period of 22 months. At a point in time between the first and the last of the five measurements the implementation started in the companies. The time intervals were derived from discussions with experts in the management of changes in IT, and from experience gained from our previous study (Korunka *et al.*, 1995).

This design ensured high flexibility in meeting organizational conditions (e.g. delays in the implementation, changes in time schedules), at the same time guaranteeing at least one measurement before and one after each implementation. The additional measurements also permitted evaluation of the relative importance of the implementation in the economic and organizational context, as well as better control of other economic and organizational influences. The research design therefore permitted the differentiation of the two clearly defined conditions used for the analyses presented here.

- Time 1—$t1$ (3.5± 2 months before implementation) represents a phase largely uninfluenced by the planned implementation. Data were collected sufficiently long before the implementation in order to exclude anticipatory effects. External factors that might affect internal validity were additionally controlled for (see below).
- Time 2—$t2$ (4.5± 1.5 months after implementation) reflects medium/long-term effects of the implementation, that is, routine daily use of IT. Depending on the adaptational demands of the implementation (e.g. duration of training), measurements taken 3 to 6 months after the implementation were used.

As the data collection occurred in a period of economic restructuring in Austria (the measurement period coincided with economic adaptations for EC membership and a generally precarious economic situation in the Western industrialized countries), external influences on the employees had to be carefully controlled for. In addition to the information on external influences gained from interviews and informal discussions with the employees and the management of each company, print media reports were analysed. Both measures used in the analyses presented here were found to be widely unaffected by external factors. Owing to the design of the study and the use of appropriate scales and instruments for repeated measures, threats to internal validity ('maturation', 'instrumentation', or 'testing,' see Cook, and Campbell, 1979) were excluded.

2.3. *Measures*

2.3.1. *Job strain and satisfaction*: Subjective appraisal of stress was measured by the German adaptation of the 'work environment scales' (SBUS-B, Weyer, and Hodapp, 1978; Weyer, Hodapp, and Neuhäuser, 1980). Two scales were included in the statistical analyses: *subjectively experienced stress* and *dissatisfaction*. Subjective appraisals as measured by the SBUS scales are indicators of perceived strain at work (Hodapp, Neuser, and Weyer, 1988). *Job satisfaction* (satisfaction with the activity as such, with colleagues, the organization, working conditions, superiors, career prospects, salary, secure position, and time schedule

Table 1. Complete data sets at *t*2; age, gender, and implementation characteristics.

Company	Implementation group (*N*)	Women (%)	Mean age (SD)	Control group (*N*)	Women (%)	Mean age (SD)	Implementation	Training (hours)★
STADM	20	80	34.6 (9.8)	53	62	35.2 (11.6)	Self-developed software	4
GAS	13	62	38.5 (10.4)	2	0	36.5 (6.3)	Self-developed software	12
INF	0	–	–	12	50	33.6 (12.0)	–	–
COMM1†	12	83	35.3 (10.1)	0	–	–	SAP-R3‡	32
COMM2†	8	75	38.1 (8.4)	0	–	–	SAP-R3	16
INS1†	12	83	34.8 (9.7)	5	40	47.6 (6.1)	Winword 6.0	16
INS2†	49	59	36.4 (10.3)	0	–	–	OS2 (operating system)	12
AUFOOD	6	100	26.6 (6.0)	7	43	38.3 (8.7)	SAP-R3	8
INTFOOD	60	60	36.6 (9.9)	1	100	33.0	Self-developed software	32
BANK	19	79	33.3 (11.2)	1	100	20.0	Self-developed software	32
OIL	13	46	42.4 (7.5)	6	50	42.5 (8.5)	SAP-R2	24
COOL	0	–	–	32	34	38.3 (9.2)	–	–
	212	67	36.1 (10.0)§	119	50	36.8 (10.7)§		19.2

★ There were no significant differences between the sexes in the amount of training ($t = .328$; $p = .385$).
† Two different implementation projects were investigated in these companies.
‡ SAP: integrated business standard software (R2: text interface; R3: graphical interface)
§ Age (36.1 and 36.8 years) was about equal in both groups.

Table 2. Scales employed in the analyses, with means, standard deviations (SD) and internal consistency (α) at *t*1.

Dimension/scale	Items (*N*)	Range	Mean (SD)	α
Strain/Satisfaction				
Psychosomatic complaints	12	0–12	7.5 (2.8)	.74
Job satisfaction	9	1–7	5.0 (0.9)	.82
Subjectively experienced stress	26	0–26	8.9 (5.5)	.86
Dissatisfaction	28	0–28	8.6 (5.9)	.86
Job design				
Job complexity	4	1–5	3.3 (0.7)	.55
Decision latitude	6	1–5	3.1 (1.0)	.77
Variability	2	1–5	3.0 (0.9)	–
Concentration demands	4	1–5	3.0 (0.7)	.28
Comprehensiveness	7	1–5	2.7 (1.1)	.75
EDP* use	1	1–5	2.6 (1.0)	–
Qualifications	1	1–5	2.9 (0.6)	–
Person-related factors				
Internality	8	8–48	33.0 (4.3)	.66
Social externality	8	8–48	25.6 (5.1)	.73
Fatalistic externality	8	8–48	25.2 (5.5)	.78
Self concept	8	8–48	33.2 (5.3)	.80
EDP* attitude	24	1–5	3.6 (0.6)	.90
External load	10	Dichotomously assessed criterion		.78
Change/Implementation context				
Participation	12	Dichotomously assessed criterion (index)		
Adaptational demands	3	Dichotomously assessed criterion		.72
Software-ergonomic changes	1	Interface change (yes/no)		

*Electronic Data Processing.

of work) was measured by nine items of the German 'Arbeitsbeschreibungsbogen' (ABB, Neuberger, 1976; Oegerli, 1984). Compared to the SBUS dissatisfaction scale, which showed high sensitivity to the measurement of change in our earlier studies (e.g. Korunka *et al.*, 1993), this scale is a more integrative measure of job satisfaction. *Psychosomatic complaints* were assessed using 12 items. This instrument is a further development of a scale used in the 'First Vienna Implementation Study' (Korunka *et al.*, 1995). These four dependent variables were assessed at each measurement (table 2).

2.3.2. *Person-related contextual factors*: Locus of control was measured by the German 'Fragebogen zu Kompetenz- und Kontrollüberzeugungen' (Questionnaire for Competence and Control Beliefs, FKK, Krampen, 1991) consisting of four scales: *internality*, *social externality* ('powerful others'), *fatalistic externality*, and *self-concept*. General attitudes towards electronic data processing (*EDP attitudes*) were measured by the German 'Skala zu Einstellungen zur automatischen Datenverarbeitung' (EDP attitude scale, ADV-Skala, Müller-Böling, Müller, and Zerfas, 1984) in the adaptation of Leipelt (1992). A workload questionnaire was developed based on the 'Total Workload Scale' (Mardberg, Lundberg, and Frankenhäuser, 1991). Ten outside work activities (e.g. child care, household, private responsibilities, work in voluntary organizations) were selected. Time spent with these

activities and subjective perception of load were assessed. The sum score of the subjective perceptions was used for the analyses (*external load*). Table 2 contains descriptive information on all scales employed in the analyses.

2.3.3. *Situational contextual factors—job design and organization* : Based on observations and discussions with the implementation managers, 71 'representative jobs' describing the companies' work divisions were defined. Each of these 'representative jobs' represents a number of employees performing similar tasks. Job profiles of the 'representative jobs' were evaluated by a subscale of the 'Job Evaluation System for Mental Work' (TBS-GA, scale 'comprehensiveness'; Rudolph, Schönfelder, and Hacker, 1987), and the FAUST instrument (Zapf, Brodbeck, Frese, Peters, and Prümber, 1989; scales 'variability', 'concentration demands', 'decision latitude', and 'job complexity'). These measures are well-established in the German-speaking countries and fulfil test quality criteria satisfactorily. Further descriptive data on *employee qualifications* and the *amount of EDP use* were collected.

For each of the 'representative jobs', an employee interview was conducted within the first 2 months of the longitudinal study. Each answer was discussed with two investigators serving as interview partners. Classification was decided upon by the investigators, who also assessed the employee's job activities. For the few cases where the raters' independent judgements did not correspond, the discrepancies were resolved through discussion between them. By using this strategy, subjective appraisals of the employees were mostly excluded.

2.3.4. *Content factors of the implementation* : Adaptational demands of the employees due to the new implementation were measured by three items of the Interview Guide for Evaluating Continuous Implementations (Korunka, Weiss, and Zauchner, 1996, 1997a). This instrument is a structured interview guide mainly consisting of multiple-choice questions. The items referred to changes in the users' qualification demands ('yes/no' responses), duration of training (more/less than 8 h), and changes in program functionalities ('yes/no'). Changes in the user interfaces (from character-based user interfaces, CUI, to graphically oriented user interfaces, GUI) were used as an indicator of *software-ergonomic changes* (CUI-CUI: no improvement; CUI-GUI: improvement).

Another subscale of the Interview Guide for Evaluating Continuous Implementations was used to evaluate the degree of *employee participation* during the implementation process. The questions assess characteristics of active (e.g. participation in decision making, team membership) and passive (e.g. quality of information, measures to enhance acceptance of the new system) involvement in the implementation. The interviews with the implementation managers and a group of three to five users in each company were conducted before IT implementation. A sum score across items was used for statistical analysis.

2.4. *Data analyses*

While the 'First Vienna Implementation Study' (Korunka *et al.*, 1995) relied mainly on hierarchical multiple regression and ANOVA analyses, structural equation modelling (SEM) was chosen as an appropriate tool for the present analysis. All computations were performed using LISREL VIII (Jöreskog, and Sörbom, 1993b), feeding covariance matrices and using maximum likelihood (ML) estimation. Parametric assumptions were mostly fulfilled; some variables are dichotomous.

Compared to standard multiple regression approaches, SEM has the advantage of simultaneously testing an elaborate theoretical model as a whole. Also, longitudinal data are

particularly suited for this kind of analysis because they permit the determination of causalities from non-experimental (correlational) studies by taking the time characteristics of relationships into account. While SEM is often misunderstood as generally allowing statements about causal relationships, this is only true when a number of additional conditions are fulfilled. In addition to empirical correlations, temporal asymmetry, absence of moderator variable effects, and theoretical justification are necessary to legitimately speak of a causal relationship (Hildebrandt, Rudinger, and Schmidt, 1992). In this study, given the theoretical conceptualization and the absence of confounding variables, the strain/satisfaction level at *t*1 may directly or indirectly influence the strain/satisfaction level at *t*2, while a causal relation in the opposite direction is obviously impossible.

In order to avoid ML convergence problems due to model complexity, misspecifications, or the impact of single variables, a theoretically directed stepwise procedure was chosen for the present analysis, starting with a base model (Model 1) and subsequently increasing model complexity by adding further 'branches', that is, latent components together with their observed markers.

3. Results

The intercorrelation matrix of all variables included in the SEM analyses is given in table 3 (implementation group, subject to new software implementation), table 4 ('control' group, no change), and table 5 (total sample, groups pooled). The sample sizes decreased slightly for the SEM fitting because of listwise (casewise) missing data deletion (see the specified sample size for each model test).

3.1. *Model 1*

The initial base model (Model 1) assumes a basic relationship over time: job strain and dissatisfaction at *t*1, operationalized by four scales, is determined by a cluster of person-related factors, namely, locus of control (internality, social externality, fatalistic externality), self-concept (four subscales), and attitudes towards electronic data processing. The strain level at *t*1, in turn, predetermines the strain level at *t*2, measured by the same four indicators. Since the variable 'change' (new software implementation) has not yet been included, this model can be fitted for the entire sample ($N = 304$).

Figure 2 shows a graphic presentation of this model with the completely standardized parameter estimates (all *t*-values significant at $\alpha = .05$). To optimize the model fit, some theoretically meaningful residual correlations were set free (e.g. the residuals of social externality and fatalistic externality are positively correlated, and the residuals of the strain markers are positively correlated within scales over time, which is a typical pattern for repeated-measures models; cf. Jöreskog, and Sörbom, 1993a, p. 200). With χ^2 $(57, N = 304) = 163.75$, $p < .01$, goodness-of-fit index (GFI) = .92, normed fit index (NFI) = .91, comparative fit index (CFI) = .94, and a standardized root mean square residual (sRMR) of .099, the overall model fit is tolerable although not impressive (significant deviation; χ^2/df ratio = 2.87). Note that χ^2 is usually recommended as a *measure of fit* rather than a *test statistic* in SEM (Jöreskog, 1993, p. 308f.), since even if all the assumptions of the χ^2 test are met, the assumption that an (idealized) model exactly holds in the population is generally not realistic. Byrne (1989, p. 55) reports recommended acceptable values for the χ^2/df ratio ranging from 1.50 through < 3.00 to < 5.00, but adds that in her view this ratio should not exceed 2.00 for an adequate fit.

In the next step, in order to test for a general influence of the implementation, the dichotomous variable *change* (i.e. implementation group [change = yes] or control group

Table 3. Intercorrelation matrix for the implementation group (listwise deletion of missing values; $n = 194$).

Scale	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 Psychosomatic complaints (*t*1)																								
2 Job satisfaction (*t*1)	-.28																							
3 Subjective stress (*t*1)	.36	-.35																						
4 Dissatisfaction (*t*1)	.22	-.56	.14																					
5 Psychosomatic complaints (*t*2)	.63	-.20	.32	.09																				
6 Job satisfaction (*t*2)	-.29	.69	-.26	-.53	-.25																			
7 Subjective stress (*t*2)	.31	-.29	.68	.11	.38	-.39																		
8 Dissatisfaction (*t*2)	.17	-.42	.10	.72	.10	-.65	.27																	
9 Job complexity	.02	-.19	.16	.11	.06	-.05	.17	.14																
10 Decision latitude	.10	.04	.25	-.12	.06	.10	.14	-.10	.48															
11 Variability	-.05	-.04	.01	-.08	-.01	-.05	.02	-.02	.18	.46														
12 Concentration demands	.01	.02	.10	-.07	.07	-.05	.11	.02	.32	.61	.50													
13 Comprehensiveness	-.07	-.00	.13	-.16	.06	.07	.09	-.07	.23	.29	.28	.24												
14 EDP* use	.07	.01	-.00	.07	.08	-.05	-.04	-.02	-.03	-.03	-.08	-.08	-.42											
15 Qualifications	-.11	.09	.01	-.08	-.03	.07	-.02	-.03	.26	.22	.18	.34	.14	.17										
16 Internality	-.20	.09	-.05	-.19	-.19	.22	-.14	-.25	.09	.04	-.06	.09	.14	-.12	.04									
17 Social externality	.22	-.20	.22	.24	.25	-.18	.18	.17	-.06	-.05	-.14	-.02	-.03	.01	-.01	-.24								
18 Fatalistic externality	.18	-.08	.14	.18	.22	-.13	.23	.19	-.11	-.11	-.10	-.07	-.08	.07	-.05	.30	.73							
19 Self-concept	-.23	.20	-.13	-.23	-.30	.22	-.20	-.24	-.01	.02	.11	.01	.12	-.17	.09	.51	-.53	-.56						
20 EDP* attitude	-.11	.25	-.23	-.10	-.21	.26	-.18	-.11	-.05	.02	-.04	.11	.06	-.09	.17	.27	-.18	-.20	.19					
21 External load	.12	-.19	.10	.05	.07	-.16	.03	.07	-.14	-.14	.06	.02	-.01	-.08	-.16	-.01	-.02	-.07	.11	-.01				
22 Gender	-.21	-.07	.06	.09	-.19	.02	-.02	.05	.40	.21	-.08	.06	.18	-.16	.11	.24	-.01	-.13	.10	.07	-.35			
23 Participation	.16	-.15	.27	-.01	.09	-.01	.11	-.14	-.15	.19	-.01	-.06	.27	.03	-.21	.10	.01	-.02	-.01	.02	-.05	.00		
24 Adaptional demands	.04	.03	.16	-.08	.05	.10	.02	-.17	-.34	.06	-.13	-.04	.27	-.07	-.22	.10	.03	.01	-.02	.10	-.05	-.02	.75	
25 Software-ergonomic changes	.02	.02	.05	.00	-.07	.21	-.13	-.17	.00	.15	-.03	-.09	.14	.02	.03	.06	-.02	-.03	.02	.12	.04	-.01	.38	.10

*Electronic Data Processing.

Table 4. Intercorrelation matrix for the 'control' group (listwise deletion of missing values; $n = 110$).

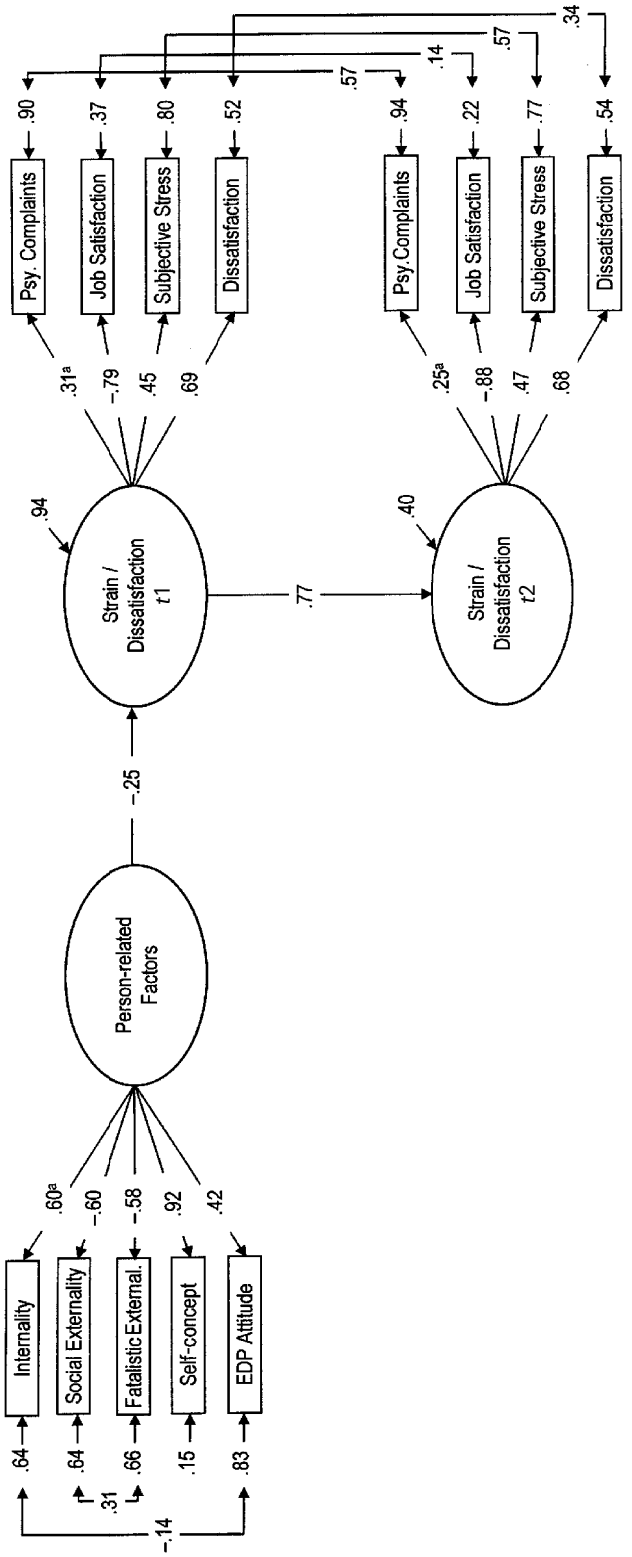
Scale	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1 Psychosomatic complaints (*t*1)																					
2 Job Satisfaction (*t*1)	-.11																				
3 Subjective stress (*t*1)	.33	-.41																			
4 Dissatisfaction (*t*1)	.22	-.57	.28																		
5 Psychosomatic complaints (*t*2)	.67	-.08	.41	.17																	
6 Job satisfaction (*t*2)	-.08	.67	-.34	-.42	.13																
7 Subjective stress (*t*2)	.29	-.28	.79	.18	.46	-.41															
8 Dissatisfaction (*t*2)	.07	-.42	.15	.65	.09	-.53	.19														
9 Job complexity	.07	.05	.18	-.18	.07	.07	.22	-.17													
10 Decision latitude	.09	-.25	.30	.01	.06	-.16	.28	-.02	.38												
11 Variability	-.08	-.16	.21	-.03	.04	-.18	.25	.01	.54	.28											
12 Concentration demands	.09	-.18	.26	-.05	.02	-.07	.27	-.10	.79	.50	.48										
13 Comprehensiveness	.19	.09	.17	-.15	.13	.15	.12	-.17	.64	.10	.36	.57									
14 EDP* use	-.03	-.01	-.14	-.05	-.07	-.12	.00	-.11	-.04	-.35	-.09	-.09	-.17								
15 Qualifications	-.05	.11	.12	-.25	-.04	.10	.21	-.13	.47	.39	.50	.49	.41	-.29							
16 Internality	-.02	-.02	-.10	-.11	-.13	.12	-.17	-.15	.16	.17	.15	.04	.07	-.04	.06						
17 Social externality	.19	-.11	.27	.27	.33	-.16	.27	.22	-.21	-.11	-.02	-.08	.01	.01	-.06	.49					
18 Fatalistic externality	.10	.12	-.07	.06	.17	.04	-.09	.01	-.15	-.17	-.19	-.17	-.06	.06	-.18	.46	.55				
19 Self-concept	-.19	-.07	-.07	-.11	-.24	.05	-.13	-.21	.18	.20	.17	.15	.03	-.15	.07	.62	-.61	-.55			
20 EDP* attitude	-.11	.18	-.25	-.16	-.25	.29	-.34	-.25	.04	.12	-.13	-.08	-.09	-.05	-.03	.26	-.36	-.12	.31		
21 External load	.01	-.03	.12	.06	.01	-.11	.15	-.03	-.10	-.15	-.02	-.01	.01	-.18	-.06	.23	.24	-.16	-.05	-.21	
22 Gender	-.02	-.28	.22	-.15	-.07	-.14	.15	.10	.23	.37	.18	.28	-.11	-.30	.22	.25	-.13	-.34	.27	-.13	-.30

* Electronic Data Processing.

Table 5. Intercorrelation matrix for the total sample (groups pooled, listwise deletion of missing values; $N = 304$).

Scale	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1 Psychosomatic complaints (*t*1)																					
2 Job Satisfaction (*t*1)	-.22																				
3 Subjective stress (*t*1)	.35	-.37																			
4 Dissatisfaction (*t*1)	.22	-.56	.19																		
5 Psychosomatic complaints (*t*2)	.64	-.15	.36	.12																	
6 Job satisfaction (*t*2)	-.21	.68	-.29	-.48	-.20																
7 Subjective stress (*t*2)	.30	-.29	.73	.14	.41	-.40															
8 Dissatisfaction (*t*2)	.13	-.42	.12	.70	.10	-.61	.24														
9 Job complexity	.04	-.10	.17	.00	.06	-.01	.19	.04													
10 Decision latitude	.09	-.08	.25	-.08	.04	-.01	.19	-.07	.43												
11 Variability	-.06	-.09	.08	-.06	.01	-.10	.11	-.01	.31	.39											
12 Concentration demands	.05	-.08	.17	-.06	.04	-.06	.18	-.03	.52	.56	.48										
13 Comprehensiveness	.01	.03	.14	-.15	.08	.09	.10	-.10	.34	.22	.30	.33									
14 EDP* use	.03	.01	-.05	.03	.04	-.07	-.02	-.05	-.03	-.17	-.09	-.10	-.34								
15 Qualifications	-.09	.10	.06	-.14	-.03	.08	.07	-.07	.34	.27	.30	.40	.22	.00							
16 Internality	-.13	.05	-.07	-.16	-.17	.18	-.16	-.22	.12	.08	.02	.06	-.12	-.08	.05						
17 Social externality	.21	-.16	.24	.25	.27	-.17	.21	.19	-.11	-.07	-.09	-.04	-.02	.00	-.03	-.34					
18 Fatalistic externality	.15	-.00	.05	.13	.20	-.07	.10	.13	-.13	-.13	-.13	-.11	-.08	.06	-.10	-.36	.66				
19 Self-concept	-.21	.09	-.10	-.18	-.27	.15	-.17	-.22	.07	.09	.13	.07	.09	-.16	.08	.55	-.56	-.55			
20 EDP* attitude	-.11	.22	-.24	-.12	-.22	.27	-.25	-.15	-.02	.06	-.08	.02	.01	-.08	.09	-.26	-.24	-.17	.24		
21 External load	.08	-.13	.11	.05	.04	-.14	.07	.04	-.12	-.14	.03	.01	-.01	.01	-.12	-.10	.07	.01	.05	-.09	
22 Gender	-.14	-.14	.13	.11	-.13	.04	.05	.06	.34	.24	.01	.14	.16	-.19	.16	.25	-.06	-.21	.17	.08	-.33

* Electronic Data Processing.



[a] Factor loading (λ) set to 1.0

Note: All estimates significant at $\alpha = .05$. Abbreviations: EDP ... Electronic Data Processing; Psy. Complaints ... Psychosomatic Complaints

Figure 2. Model 1 (base model), estimated for the entire sample ($N = 304$). Structural and measurement models with their standardized parameter estimates.

[change = no] membership) was introduced as a factor potentially influencing the post-change strain/dissatisfaction level at *t*2. With a standardized estimate of .02 and a corresponding *t*-value of 0.43, the influence of the factor *change* as such remained clearly insignificant. Thus, there is no general difference between implementation group and control group in the structure of variables determining their strain level at *t*2 (i.e. the implementation as such is not uniformly effective as a stressor).

3.2. *Model 2*

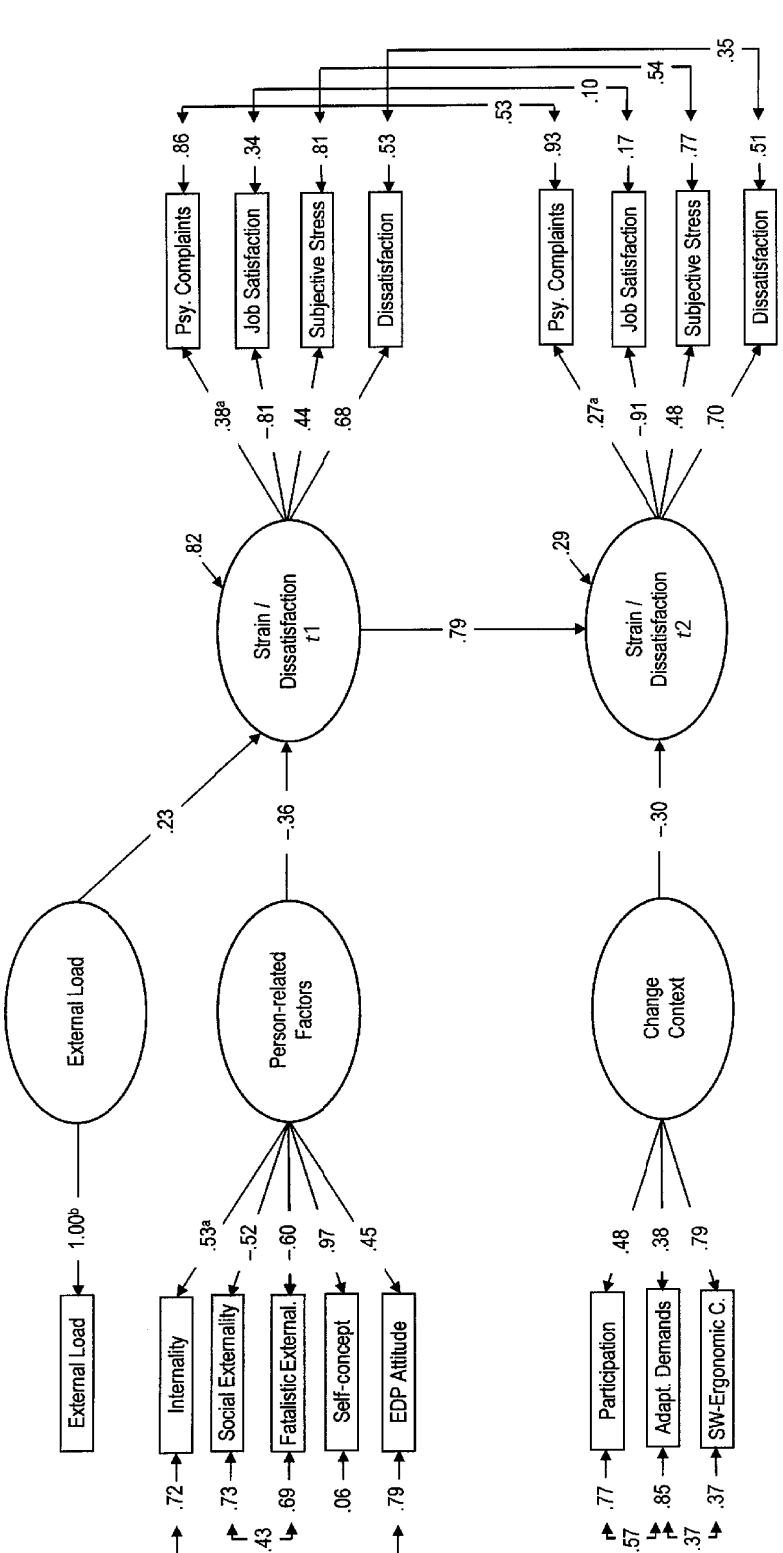
Consequently, for a more detailed investigation of the presumed contextual factors of change, the more complex Model 2 ('change content/context model') was designed, starting with the same base structure as in Model 1, but adding a *change content/context* factor with a path on strain-*t*2. This assumes that post-change strain responses vary dependent on the perceived contextual characteristics of the respective implementation. The change context factor has loadings on the indicator variables *employee participation*, *adaptational demands*, and *software-ergonomic changes*. Model 2 can only be fitted for the implementation group ($n = 194$), since change context measures are only available for those individuals who underwent the change. Additionally, the factor *external load* (outside work duties) which influences strain at *t*1 (and therefore, indirectly, also at *t*2) was found to meaningfully add to the model. This more complex contextual model is presented in figure 3 (all *t*-values significant except for the residual of the self-concept scale). With χ^2 (108, $n = 194$) = 179.85, $p < .01$, GFI = .90, NFI = .88, CFI = .95, and sRMR = .085, Model 2 provides a reasonable fit to the data (χ^2/df ratio = 1.67).

The inclusion of additional variables yielded no further improvement in fit and no more stable effects. In particular, the job design scales, six of which formed a well-defined factor (EDP use excluded; see table 2), had no appreciable influence on strain-*t*1 (standardized estimate .03 with $t = 0.30$).

3.3. *Comparative model assessment*

There is no 'strong' statistical rationale for directly comparing Model 1 to Model 2 (e.g. by means of a χ^2-difference test), because they are not nested, but are models on different levels of complexity: Model 2 includes more indicators than Model 1 and, for structural reasons, is based on a smaller sample. Considering that χ^2, with everything else held constant, monotonously increases with sample size, we also fitted Model 1 for the implementation group subsample alone, thereby allowing a better comparative assessment of model fit. Model 1 for the implementation group alone fits acceptably with χ^2 (57, $n = 194$) = 112.69, $p < .01$, GFI = .92, NFI = .90, CFI = .95, and sRMR = .093. The goodness-of-fit indices, as well as the standardized parameter estimates, are very similar to the total sample model, which speaks for the stability of this base model; however, the χ^2/df ratio is improved to 1.98, probably mainly due to the reduced subsample size.

Regarding the χ^2/df ratio (with equal sample size) and the different goodness-of-fit indices, the former tends to favour Model 2, while the latter are indifferent and possibly even slightly inclined in favour of Model 1. If one also adheres to the principle of parsimony on a substantive level, Model 1 should be preferred because it has a simpler structure and still meets acceptable fit criteria while using fewer indicators. (This would lead to the interpretation that the person-related factors suffice to explain strain not only at *t*1, but also at *t*2, which then could be explained entirely independently of the 'change' and its context variables). On the other hand, Model 2 is of more realistic complexity and expressiveness;



[a] Factor loading (λ) set to 1.0

[b] Factor loading (λ) set to 1.0, residual fixed

Note: All estimates significant at $\alpha = .05$ except for the residual of the self-concept scale (δ_5). Abbreviations: EDP ... Electronic Data Processing; Psy. Complaints ... Psychosomatic Complaints; Adapt. Demands ... Adaptional Demands; SW-Ergonomic C. ... Software-Ergonomic Changes.

Figure 3. Model 2 (change content/context model), estimated for the implementation group ($n = 194$). Structural and measurement models with their standardized parameter estimates.

it better suits the theoretical framework and gives more detailed answers to research questions concerning the effects of 'change' through continuous IT implementation. It therefore makes sense to focus on Model 2 in the substantive interpretation. Looking at this model in more detail, it should further be mentioned that apart from the overall model fit, it also has satisfying standardized residuals (SRs) closely approximating to a standard normal distribution (smallest SR = —3.83, median SR = 0.00, largest SR = 3.99).

4. Discussion

In the 'Second Vienna Implementation Study' (Korunka, and Carayon, 1999; Korunka *et al.*, 1997b), from which the data presented here are derived, the effects of the implementation of new information technology (IT) have been evaluated using a longitudinal design. In the analyses, a *context-dependent approach* was tested. Our assumption was that personal contextual factors and situational contextual factors at the job design level have general effects on users' strain and satisfaction, whereas implementation content and implementation context dimensions have causal effects on changes in users' strain and satisfaction due to the IT implementation. A two-step model testing procedure was applied: a base model tested the factorial structure of the four measured dimensions of strain and satisfaction and the relationship between the measurements before and after the implementation of the new ITs. A general implementation factor (dummy variable: yes/no) showed no significant effects. In the change content/context model, implementation content and implementation context dimensions were included. As expected, there were significant effects of these implementation characteristics on the changes in users' strain and satisfaction at *t*2. Since this model yields acceptable fit indices, the data presented here mainly corroborate the theoretical contextual factor model: change effects due to the implementation can only be satisfactorily explained by taking implementation content and context factors, as well as the basic framework of person-related contextual factors, into account.

Some methodological restrictions have to be discussed prior to a further interpretation of these results. Apart from general SEM-specific idiosyncrasies (such as practical restrictions of model complexity and focus on contingencies), some aspects specific to this study are worth mentioning; they illustrate the difficulties of obtaining generalizable results even from a longitudinal field study. In this investigation, a real control group was not previously intended, because we could not expect to find a sample comparable to the implementation sample (similar jobs, same companies, etc.) where an IT implementation was *not* planned during the observation period. However, as noted earlier, some of the employees did not undergo the implementation as previously planned. These employees, termed the control group, cannot be expected to be entirely uninfluenced by the implementation. In most cases the implementation was only delayed, so that anticipatory effects must be assumed. In some other cases, where the implementation was not realized as planned, both negative effects (disappointment) and positive effects (relief) are conceivable. Therefore, the comparisons between the implementation group and the 'control group' have to be interpreted with care. It should also be emphasized that the greater organizational context of the companies investigated in this study (e.g. organizational characteristics of the companies, external economic influences) was not assessed. Furthermore, we are not dealing with a random or quotient sample: participation in the study depended on each company's and each employee's informed consent, so that generalizations have to be made with care.

With these caveats in mind, the models can be interpreted in more detail. Model 1, fitted for both groups combined, gives a basic picture of the role of person-related factors with

regard to the explanation of employees' strain and stress measurements at *t*1 and at *t*2. The parameters of the measurement model (figure 2, right half) confirm that the four scales employed as dependent variables are solid markers for their latent factor (with somewhat smaller, but significant loadings for 'psychosomatic complaints'), and that this factorial structure remains essentially unchanged over time. Fit indices suggest that the strain/dissatisfaction structure at *t*2 can partly be explained by just using the 'trait predictors' included in Model 1, although the model could probably be successfully expanded (e.g. by adding 'trait' characteristics of the management of the organization). Based upon these findings, let us further focus on the implementation model (Model 2), which provides further information about the role of the technological change (IT implementation) and the detailed influence of the particular predictors.

The theoretically-derived change content/context model shows good compatibility with the observed data, and the multivariate pattern of the dependent strain/dissatisfaction scales at *t*1 and *t*2 is adequately explained. Although the overall fit is not impressive, we are dealing with a stable model with good convergence properties, a nice distribution of residuals, and satisfying fit indices. All model modifications (setting specific parameters free) were carried out with care and with their substantive meaning in mind, and only some residual correlations, but no modifications of the characteristic factor loading matrices (Λ) and no additional factor intercorrelations were necessary. In the following, we will give a more detailed interpretation of the structural components (independent variables) of this change content/context model.

The significant influence of the personal dimensions on the users' strain and satisfaction was just as expected. In many studies, locus of control was found to be related to job satisfaction and also to well-being and strain (cf. Crable *et al.*, 1994). Also in the present study, higher values on the 'internality' (internal locus of control) and the 'self-concept' (indicating enhanced self-esteem) scales were accompanied by better job satisfaction and less strain. Positive attitudes towards EDP had a similar, but somewhat weaker effect on the outcome variables. Compared to the earlier days of the new office technologies, the attitude towards EDP seems to be gradually losing importance nowadays, probably because different forms of IT are eminent tools in nearly all office work now.

Model 2 incorporates an additional effect of external workload, leading to an increase in the 'baseline' strain values at *t*1. The scale used in this study was an adaptation that could still be improved by additionally taking the relationships and subjective perceptions of internal and external workload into account. Although this external load factor makes no major contribution to the overall model fit (χ^2/df ratio), other than gender it has a discriminative influence (significant path) on the strain/dissatisfaction dimension. This may signify that formerly, gender had an impact as a 'hidden' external load variable in work strain contexts (highly correlated with additional outside-work duties, e.g. in the household and education), while nowadays external load has become a more independently varying and specifically influential measure.

The job design dimension, as operationalized in this study, showed no significant effect when included in the model. Compared to our earlier studies (Korunka *et al.*, 1993), a relatively smaller range of 'typical' office work was investigated here. While six of the seven job design variables constituted a solid confirmatory factor together, the effect of this factor was minimal. However, since the job dimensions were carefully measured using an 'objective' instrument (see § 2.3), one could argue that the results observed may well generalize to all kinds of typical office work.

The magnitude of the effects of person-related and implementation content/context-related factors is in the same range. This denotes that while there is no effect of the change

as such, the change content/context variables in the model constitute a relevant factor in the explanation of the employees' post-implementation response: they have a strain/dissatisfaction-modulating effect that is quantitatively comparable to the influence of rather stable personal and attributional characteristics of the subjects under investigation. Additionally, the 'objective' measurement of the implementation-related variables has to be taken into account here, suggesting an even stronger relative influence of this factor (cf. Frese, 1985). If one further takes into consideration that the *t*2 measurements represent medium- to long-term effects of the implementations, the importance of the implementation content and context dimensions is emphasized even more.

The dimension with the highest standardized path coefficient here concerns the *change in user interface*. Those IT implementations that retain a character-based interface showed strong negative effects on users' strain and satisfaction compared to implementations that also included a change in user interface from character-based (CUI) to graphical (GUI). This result, consistent with a number of laboratory studies showing positive effects of GUIs on users' satisfaction, puts the recommendation of implementing graphical user interfaces together with new software applications on a strong and externally valid empirical basis.

Adaptational demands upon the users induced by the implementation (as measured by three items: changes in the users' qualification demands, duration of training, and changes in programme functionalities) were inversely related to the strain measures. This means that those implementations that were accompanied by high adaptational demands for the users seem to have had better effects on changes in strain and satisfaction than implementations accompanied by low adaptational demands. This finding may initially seem surprising, but only at first sight: taking into account that in our days of relatively high unemployment rates in industrialized countries, additional job qualifications are a key factor to opening up more or new job opportunities, it is quite plausible that employees will react with an increase in job satisfaction and even with a decrease in subjective strain when confronted with 'high' adaptational demands, as defined in this study. Alternatively, one might speculate that high adaptational demands also give a better reason for a more intense and maybe a more structured and more motivated acquaintance with the new technology, and that other content and context factors are more carefully considered by the management when adaptational demands are foreseen to be high. Indeed, there is a rather high extra-factorial intercorrelation between the residuals of the participation and the adaptational demands scale (δ_7 and δ_8; standardized estimate = .57).

Based on the results of our earlier studies (Korunka *et al.*, 1995) as well as on the outcomes of numerous studies from the literature, we expected positive effects of *employee participation* in the implementation process (and, conversely, negative effects when no or only scarce opportunities for participation were offered). The data from this study provide additional support for the positive effects of user participation in the case of continuous implementation of new ITs. Other than implementation-specific (content) dimensions, such as change of user interfaces, employee participation is a dimension related to all types of organizational change. It seems quite plausible, therefore, that the results regarding this dimension may also generalize to other organizational change processes. Cross-validational longitudinal studies in convergent as well as in divergent implementation settings would be of great value in permitting definitive statements here.

In conclusion, the results of this longitudinal study clearly corroborate the value of a context-dependent approach in evaluating the effects of the implementation of new information technologies. The managers responsible for IT implementation should therefore be encouraged to pay increased attention to current developments of user interfaces and to actively involve the employees in the process of change. Negative effects

of the implementation of IT on users' strain and satisfaction can only be prevented by an appropriate design of the implementation context.

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