

Young users accept NoMix toilets – a questionnaire survey on urine source separating toilets in a college in Switzerland

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Abstract We studied user behavior and acceptance of NoMix toilets by collecting 271 questionnaires from young adults. We discriminated between short- and long-term users (months of habituation). Most respondents noticed that the NoMix toilet is different. Nevertheless, the existing NoMix technology was well accepted regarding design, hygiene and smell in this institutional setting. Only few respondents changed their sitting or flushing behavior. The necessity to sit when urinating might be slightly problematic (62% sit), but it seems possible that people adopt this new behavior required by the NoMix toilet. General acceptance of the NoMix toilet was high: 70% of respondents found the idea convincing – many for environmental reasons – 87% were willing to move into an apartment with a NoMix toilet, and 20% would pay substantially more for a NoMix toilet. We informed about the NoMix toilet with instructions for use in the toilet cabin, an information poster, and an information leaflet that we distributed after questioning. Our information was noted by most respondents and significantly increased the knowledge about and the acceptance of the NoMix toilet. We recommend that future pilot projects with NoMix toilets consider a well devised information policy to support decision making and acceptance of this new technology.

Keywords Behavioral habituation; consumer; information; sustainability; technological innovation; wastewater

Introduction

Urine source separation (NoMix technology) is one promising approach to sustainability in urban wastewater management (Larsen and Gujer, 1997; Otterpohl, 2002). So far, most research has focused on technological aspects (Lienert and Larsen, 2004). However, since NoMix technology will affect people in their most intimate surroundings, public opinion will play an important role for its success. In an early phase of research and implementation, we want (1) to find out whether people will accept this innovation, (2) to receive more-detailed knowledge on technical drawbacks that need improvement, and (3) to receive guidelines for future research.

In Switzerland, only few NoMix toilets have been installed so far and all in pilot projects connected to the research project NOVAQUATIS (www.novaquatis.eawag.ch). Three NoMix toilets were installed at EAWAG in 1997/2000, four in private urban apartments in 2001, and two in a vocational college in 2002. We are currently assessing user attitudes and acceptance in all pilot projects. A first study with focus groups participants, who had the possibility to visit the NoMix toilets at EAWAG, provided promising results (Pahl-Wostl *et al.*, 2003). The majority of the 48 participants found the NoMix toilet a good idea, under condition that costs would be reasonable and that the NoMix technology

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would equal today's technology in convenience. These participants were very well informed about the rationale for urine source separation – they worked with a computer tool (www.novaquatis.eawag.ch, NoMix tool) and extensively discussed the topic – while they did not know the NoMix toilet very well, because they only visited it once or twice. In the present study we chose a different approach. The aim was to gain a representative response from users of the NoMix toilets in one pilot project, who obtained only a minimum of information on urine source separation. We distinguished between users that visited the NoMix toilet for the first time, and those that were using it for several months. We asked the following questions: (1) Do people observe and use the NoMix toilet differently than a conventional toilet? (2) Do they accept the NoMix toilet? (3) Do they change their attitude or behavior after several months of habituation? (4) How well do people pick up the information about the NoMix toilet and its purpose, how do they deal with our information, and can we influence their attitude with this minimum of effort? This study is the first quantitative survey in Switzerland – and to our knowledge the first internationally published quantitative study – on user acceptance and assessment of behavior towards the NoMix toilet.

Materials and methods

Setting, questionnaires and data collection

The survey was conducted in a vocational college in a Swiss German city. In May 2002, the University of Applied Sciences Basel (FHBB) replaced one of three conventional toilets with a NoMix toilet in a ladies' bathroom (by Roediger, www.roevac.de), and one of two in a gentlemen's bathroom (by Gustavsberg, www.gustavsberg.com). While the Gustavsberg model can be used as a conventional toilet, it is necessary to sit on the Roediger toilet to open the urine outlet. Both models offer the possibility to choose between a small and a large flush. Additionally, three waterfree urinals were installed in the men's bathroom. We used two different questionnaires: a short questionnaire (S) for people who had used the NoMix toilet for the first time or very few times and a longer questionnaire (L) for those who had used the NoMix toilet for several months (Table 1). We did not include questions on the urinals.

Most questions were closed questions in a multiple-choice format, so that respondents had only to tick the appropriate answer. We conducted three sets of surveys: (1) in May, directly after installation of the NoMix toilets (only S), (2) in August, when new pupils arrived (S, few L), and (3) in October/November, when people had used the NoMix toilet for some months (L, some S). In each survey-set we stood in front of the sanitary facilities for several days from ca. 8 a.m. to 5 p.m. and asked the people to fill in the questionnaire when they came out of the sanitary facilities. In October/November we also questioned 11 classes using the two classrooms near the NoMix toilets. We installed a short information poster in the bathroom and instructions for use in the toilet cabin. *After* questioning, the respondents received an information leaflet on the NoMix toilet and the survey.

Sample description and response

We collected 271 questionnaires (158 S, 113 L) from 239 people (27% of the L-respondents had been questioned as S-respondents); 65% were from women, and 35% from men. The majority were pupils of design introductory courses or apprentices (69%). Respondents were young (mean 24, median 21 years), ranging from 14–69 years. Because of this skewed age distribution, we dismissed any results regarding age. Most people had completed high school or an apprenticeship (66%), 20% had completed primary or secondary school, and 14% college or university. On 4 days in August and 6 days in October/November, we collected detailed data on visits to the sanitary facilities

Table 1 Overview of questions from the two questionnaires presented to users of NoMix toilets. We used a short questionnaire (S) for people who had used the NoMix toilet for the first or very few times, and a longer questionnaire (L) for people who had used the NoMix toilet for several months

Data group	Question
Personal data	S, L Sex, age, profession, education (what schooling did you last complete?)
Length, frequency of usage	S Did you visit NoMix toilet for first time? / If not, how many times?
	L Since when are you using the NoMix toilet? / How often do you use it?
Perception	S Did you notice anything special regarding the toilet? / If yes, what?
Judgment (design, hygiene, smell)	S, L How do you judge the NoMix toilet compared to a conventional toilet?
	L Did your opinion change during the last months? / If yes, how?
Behavior: sitting	S Did you sit down? / If not, why not? / If yes, did you have to sit differently?
	L Do you normally sit to urinate on the NoMix toilet? / Did this change? / Did you have to sit differently in the beginning? / If yes, how? / Did you get used to it?
Behavior: flushing	S To flush, did you use the small water volume? / If not, why not?
	L Do you usually use the small water volume to flush after urinating (NoMix and conventional toilet)? / If not, why not? / Do you flush the NoMix toilet differently than a few months ago?
Acceptance, willingness to pay	L How do you like the idea of the NoMix toilet? / Would you move into an apartment with a NoMix toilet installed? / Would you pay CHF 1300.- for a NoMix toilet instead of CHF 600.- for a conventional toilet?
Discussion topic	L Did you talk about the NoMix toilet with other people? / How were the comments?
Information, general	S, L Did you hear about the NoMix toilet before? / If so, where? / Do you know anything about the purpose? / If so, what do you know?
Information, by use	S Did you notice the information poster?
	L Did you read the information (instructions for use / poster / leaflet?)
Repeat	L Have you been questioned by us before?

by counting users, reading off door counters and a seating counter in the women's NoMix toilet. Of the women going to the toilet, 53% (± 4.1) visited the NoMix toilet, and 72% (± 12.4) sat down, while only 18% (± 2.8) of the men visited the NoMix toilet, but 73% (± 7.7) visited the urinals. On these days the NoMix toilets were visited 27.6 times (± 3.5), and we collected 25 (± 5.6) questionnaires. In the classes, we collected questionnaires from 55% (± 6.7) of the pupils. The non-respondents did not know the NoMix toilet, or were absent that day. Hence, by contacting people directly after their visit to the NoMix toilet and by distributing the questionnaires in the classes surrounding the toilets we reached a high proportion of the people who had used the NoMix toilet in 2002, and our results are presumably representative for this setting: Swiss German institution with a majority of young adults as visitors.

Data analysis

We used χ^2 -tests to determine differences among the following groups: short- and long-term users (questionnaire S or L), men and women, low, medium, and higher education, number or frequency of usages. We also differentiated between L-respondents who had been questioned by us before and those who had not, and we searched for relationships

between information and acceptance. We analyzed the group differences in continuous variables (age, length of usage) with t-tests or one-way ANOVAs. We used the statistical software SPSS (release 11.0.0, 2001; SPSS Inc, Chicago, Illinois). Below, we present distributions and the significant results only. Because different toilet models were used, sex is confounded with toilet type. There were no differences between short- and long-term users regarding sex, age, profession, and education. Few questions differed between the very first survey and the later ones. If this was the case, we excluded the first survey ($N = 46$) from the statistical analysis. Sample sizes also differ, because respondents did not answer all questions.

Results

Perception and judgment of NoMix toilet compared with conventional toilet

Of the 150 first-time users, 78% noticed something special, such as a different toilet shape (noted by 36%) or the division into two bowls (33%). The higher the education, the more likely people observed a difference (Table 2A). Most S- and L-respondents judged the NoMix toilet as same or better than a conventional one regarding design, hygiene, and smell (Figure 1). Generally, only 20% of the long-term users changed their

Table 2 Significant differences between groups regarding (A) perception and judgment of the NoMix toilet compared with a conventional toilet, (B) sitting- and flushing-behavior, (C) acceptance, and (D) information and knowledge about the purpose of the NoMix toilet. We used questionnaire S for first-time users, and L for several months of usage. We distinguished between three levels of education: high (college, university), medium (high school, apprenticeship), and low (primary, secondary school)

		N	df	P	Difference between groups	
A	Noticed something special	S	94	2	*	Education: 93% with high level, 90% medium, 65% low
	Change of opinion (design, hygiene, smell)	L	105		*	No change: used NoMix toilet for 12 weeks (± 0.49) Changed opinion: used NoMix toilet for 15.7 weeks (± 1.6)
	The smell is worse than conventional toilet	S, L	176	2	*	3% of the women, 13% of the men
	Change of opinion regarding smell	L	19	1	*	Worse smell: 0% of women, 33% of men that changed opinion
B	Habit to sit on NoMix toilet when urinating	L	110	1	**	73% of women, 42% of men usually sit
	Habit to sit on NoMix toilet when urinating	L	109	1	*	77% that were questioned before, 56% not questioned
	Usage of small water flush	S	145	1	***	77% of women, 48% of men used small flush
	Reason for not using small water flush	S	45	3	*	Women: 64% did not notice, 36% defecation men: 37% did not notice, 32% defecation, 30% by habit
C	Would move in apartment with NoMix toilet	L	107	1	**	94% of women, 75% of men
	Had discussed the NoMix toilet with others	L	113	1	*	51% of women, 31% of men
D	Users that noticed instructions or poster	S	100	4	*	Education: 93% with high level, 92% medium, 64% low
	Users that heard about NoMix toilet before	S, L	189	1	***	25% of short-term users, 72% of long-term users
	Users that read the information leaflet	L	82	1	*	42% that were questioned before, 19% not questioned
	Knew something about purpose of NoMix	S	173	2	**	Education: 87% with high level, 78% medium, 54% low
	Knew something about purpose of NoMix	S, L	219	1	*	70% of short-term users, 84% of long-term users

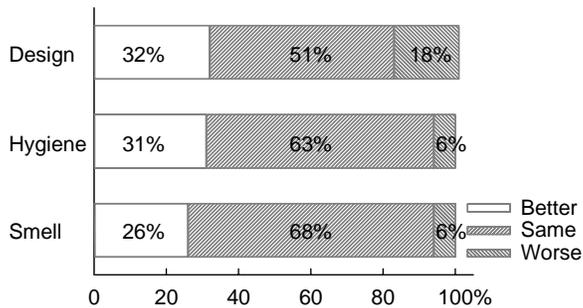


Figure 1 Answers to: “How do you judge the NoMix toilet compared to a conventional one?” $N = 225$ (design), $N = 176$ (hygiene, smell)

opinion after several months of usage – but if they did, it was mostly into a more positive one (design 94%, hygiene 88%, smell 84%). The people that changed their opinion had been using the NoMix toilet for longer time (Table 2A). More men (using the Gustavsberg toilet) found the smell worse than women (using the Roediger toilet) and more men changed their opinion regarding smell to a more negative one (Table 2A).

Behavior: do people sit to urinate/do they flush with the small water volume after urinating?

Of the short-term users 68% sat on the NoMix toilet. Reasons for not sitting were mainly habit (33%) or disgust (48%). Of the long-term users, 62% usually sat to urinate on the NoMix toilet. More women than men and more respondents that had been questioned before usually sat (Table 2B). 93% of the short-term users did not sit differently on the NoMix toilet (90% women, and 97% men). The few women that had to sit differently mostly wrote “more to the front for urinating” or “more to the back for defecating”. The sitting behavior of 92% of the long-term users did not change during the last months, and 90% did not have to sit differently on the NoMix toilet in the beginning. However, 82% of those that *did* have to sit differently did *not* get used to it. Of the short-term users, 68% had used the small water-flush; and more women than men (Table 2B). Reasons for using the large flush were “defecation” (33%), “did not notice the possibility” (50%), or “habit” (17%), women differing significantly from men (Table 2B). Very few long-term users said they rarely or never use the small flush after urinating (NoMix 2%, conventional 7%); however, 15–23% did not know which flush they use. 91% answered that they had not changed their flushing behavior.

Acceptance, willingness to pay, and discussion topic (only questionnaire L)

Acceptance was high: 70% of the long-term users found the idea of the NoMix toilet convincing, 19% had no opinion, and only 10% said it was not convincing ($N = 108$; Figure 2A). 87% would move into an apartment with a NoMix toilet, women being far more willing than men (Table 2C). 20% would pay CHF 1300.- for a NoMix toilet instead of CHF 600.- for a conventional one. 43% had discussed the NoMix toilet with other people, women discussing it more than men (Table 2C). Most comments were favorable (58%) or neutral (35%); only 7% were negative.

Information

General. Most short-term users noticed the instructions for use or poster (88%, $N = 154$), and more with higher education (Table 2D). Over all, 46% had heard about the NoMix toilet before; 60% from our own information (Table 3). Many more long-term than short-term users had heard about the NoMix toilet (Table 2D), and received their

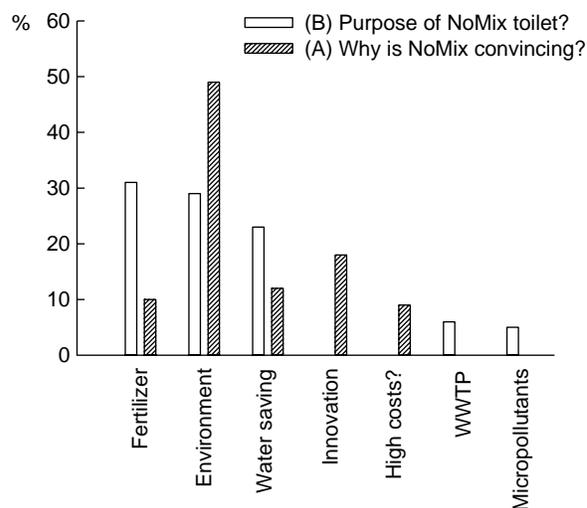


Figure 2 (A) Main reasons of long-term users for finding the idea of NoMix toilets convincing ($N = 68$): environmental care or sustainability (49%), good innovation (18%), water saving (12%), and re-use of nutrients as fertilizer (10%). Some said that the costs might be too high (9%), and there were various other comments. (B) Main answers to knowledge about the purpose of the NoMix toilet of all respondents ($N = 167$): re-use of nutrients as fertilizer (31%), environmental care (29%), water saving (23%). 19% answered “separating urine from feces” without mentioning other purposes. 17% of the answers were related to arguments that were not mentioned by us such as “economic advantages”, or were clearly wrong such as “less blockages”, “more hygienic”, “eliminate smell chemically”, “do not mix urine and/or feces and toilet paper” (WWTP = wastewater treatment plant)

information from our sources (Table 3). More people had read the information leaflet (distributed after questioning) if they had been questioned before (Table 2D). Most respondents (74%) said they knew something about the purpose of the NoMix toilet ($N = 187$, Figure 2B), and especially those with higher education or long-term users (Table 2D).

Information, knowledge, and acceptance. More long-term users were informed about the purpose of the NoMix toilet if they had read any of our information, more respondents found the idea of the NoMix toilet convincing if they had read the instructions for use, and more people would move into an apartment with a NoMix toilet installed if they had read the instructions or the poster (Table 4). The willingness to pay more for the NoMix toilet was not influenced by information or knowledge.

Discussion

The NoMix toilet is perceived differently, but not used differently than a conventional toilet

While most first-time users (78%) noticed that the NoMix toilet is different, this did not influence them negatively. Generally, there was even a strong positive bias towards NoMix toilets regarding design, hygiene, and smell (Figure 1). This could be partially caused by the rather old age of the conventional toilets. This means that in this institutional setting, the existing NoMix technology is acceptable. However, more men (13%) than women (3%) said the NoMix toilet smelled worse, and this seemed to get worse with time (Table 2A). We think this could be due to the smell of the water-free urinals. If bad smell is a problem of the NoMix toilet model, we will be able to discern this in a later study, where women will use the men’s model and vice versa. Sitting to urinate in public places might be problematic for women. Indeed, 48% of those respondents that

Table 3 Sources of information. Of special interest is the difference between our information (instructions for use or poster, information leaflet), and external sources. We compared short- (S) with long-term users (L)

	N	df	P	Where did you hear about the NoMix toilet?					
				Instructions/poster	Information leaflet	Colleagues	Newspapers/magazines	Radio/TV	Other sources
S	28			4%	29%	25%	25%	7%	11%
L	84			9.5%	60%	9.5%	11%	1%	10%
All (S + L)	112	5	*	8%	52%	13%	14%	3%	10%

df = degrees of freedom, * = $P < 0.05$

Table 4 Relationships between our information (instructions for use, information poster, or information leaflet) and knowledge about the purpose or acceptance of the NoMix toilet. The questions were: (1) do you know anything about the purpose of the NoMix toilet? (2) how do you like the idea? (3) would you move into an apartment with a NoMix toilet installed?

Did you read:		Instructions for use?					Information poster?					Information leaflet?				
		N	df	P	Yes	No	N	df	P	Yes	No	N	df	P	Yes	No
Do you know purpose?	Yes	99	1	***	88%	22%	105	1	*	87%	60%	82	1	*	93%	73%
	No				12%	78%				13%	40%				7%	27%
Is idea convincing?	Yes	95	2	**	77%	22%	101	2	n.s.	75%	50%	80	2	n.s.	77%	60%
	No				9%	22%				8%	20%				12%	14%
	No opinion				14%	56%				18%	30%				12%	27%
Move into apartment?	Yes	95	1	*	92%	67%	101	1	*	92%	67%	78	1	n.s.	93%	91%
	No				8%	33%				8%	33%				7%	9%

N = sample sizes, df = degrees of freedom, n.s. = not significant, * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$

did not sit, find sitting in public places disgusting and would presumably only change their attitude if NoMix toilets were improved (e.g. disinfection of seat). Nevertheless, 62–77% of both sexes said that they sit on the NoMix toilet, which is supported by our objective measurement (counter) in the ladies' toilet, where 72% sat. We do not regard sitting in public as a problem for men, even if fewer men sat on the NoMix toilet (42%) than women (73%), because they can use the waterfree urinals – an option that was chosen by 73%. From our study in private apartments we know that some women have to sit more to the back when defecating on the Roediger NoMix toilet. Only few women in this survey supported this observation; possibly because the majority does not defecate at workplaces (Friedler *et al.*, 1996).

Acceptance for the NoMix toilet is high, but most people will not carry high additional costs

In accordance with the results obtained in the focus groups by Pahl-Wostl *et al.* (2003), a majority of the respondents found the NoMix idea convincing and would move into an apartment equipped with such a toilet. However, the gender difference – women were more willing to move into an apartment with NoMix toilet than men (Table 2C) – contradicts the results from the focus groups, where the opposite was found. Assuming that this is not caused by the confounding of gender and toilet type (see above), it could be due to different age sampling. With a larger number of surveys, the conclusions will gain in robustness. Interestingly, 47% of the respondents had discussed the NoMix toilet with others. We consider this number as relatively high, because our personal impression during the questioning was that most of the respondents did not show particularly large interest in the NoMix toilet. Again, acceptance was high, with only 7% negative comments. Men discussed the NoMix toilet considerably less than women (Table 2C); we assume that this is a real gender difference. As found in the focus group study, a majority of the citizens is hardly prepared to carry additional costs of NoMix toilets. Nevertheless, 20% of our respondents *would* pay substantially more. It is well known that the willingness to pay more for environmental friendly goods and services than for conventional ones is limited to relatively small price differences (low cost hypothesis, North, 1986; see e.g. Lant, 1993 concerning water conservation measures). Hence, today's high price for NoMix toilets is presumably a barrier for adoption of this technology, but if it can be lowered, the willingness to pay for NoMix toilets seems to be rather good.

The NoMix toilet might animate people to adapt their behavior

From a cultural-psychological perspective, humans and their environment, including objects of daily use, are in a constant exchange (Boesch, 1993; Kaufmann-Hayoz *et al.*, 1996). We hypothesized that people change their opinion towards the NoMix toilet with habituation and that the NoMix toilet influences them to change their habits (sitting to urinate/use of small water flush). Overall, few respondents (20%) changed their opinion regarding design, hygiene, or smell – and if so, over 80% had a more positive opinion. Those that *did* change their opinion needed over three months of habituation (Table 2A). Possibly, people could get used to sitting on the NoMix toilet, because 33% of those that did not sit said this was by habit. However, the few people (< 10%) that *did* have to sit differently did *not* get used to it. This must be considered by sanitary manufacturers since other studies showed that successful operation of a urine separation system is very dependent on well designed toilets and user behavior (Hanæus *et al.*, 1997). The flushing behavior was not significantly influenced by the NoMix toilet, 91% saying that it did not change with time. However, 15–23% of the users did not know which flush they use after urinating, 50% of the short-term users did not notice the small flush, and 30% of the men

used the large flush by habit (Table 2B). Probably, awareness could be heightened by designing clearly visible small flushing buttons and by better information (also see below).

Respondents were well informed and strongly influenced by our information

Education influences awareness. Respondents with higher education were more attentive than those that had only completed primary or secondary school: more first-time users with higher degrees noticed our information poster and that the NoMix toilet was different, and more users with higher education knew its purpose (Table 2).

Our information was noted by most respondents. The longer respondents used the NoMix toilet, the more likely they received information from us, rather than from external sources (Table 3) or knew the purpose of the NoMix toilet. Because we are yet in a very early phase of the innovation process, it is rather unlikely that many people heard about the NoMix technology from the mass media or other people. However, there was a newspaper article about the NoMix toilet in the local press a few days before we questioned the first-time users in August 2002, which seems to have been noted by ca. 30% of the respondents (results not shown). Asked about the purpose of the NoMix toilets, mainly nutrient recycling (31%), environmental care (29%), and water saving (23%) were mentioned (Figure 2). This reflects the information given on our instructions for use. The reasons for finding the NoMix toilet convincing were clearly dominated by care for the environment (49%), while the fertilizer argument was only taken up by 10%. This corresponds to the findings in the focus group study, where environmental care received more emphasis than nutrient recycling (Pahl-Wostl et al., 2003). Obviously, we succeeded in conveying our information in such a way that people understood the main arguments, but some arguments seem to be more convincing than others. Based on these findings, we conclude that in future pilot or implementation projects it is worth considering a communication concept that encompasses all relevant arguments.

Acceptance increased strongly with information. Knowledge about and acceptance of the NoMix toilet was much larger if users had read our information, especially the instructions for use, which were hanging in the toilet cabin (Table 4). Many other studies have documented a positive relationship between information and user acceptance, e.g. of urine separating toilets in Sweden (Drangert, 1998; Johansson, 2001). However, this finding strongly depends on the technology in question: in the case of genetically modified food, the best-informed lay people expressed the most opposition (Shaw, 2002). Our intervention also influenced the *behavior* of people: 77% of the respondents that had already been questioned by us said they usually sit on the NoMix toilet, but only 56% of those that had not been questioned before (Table 2B). Our results support the general observation that the decision-process to adopt an innovation is essentially an information-related activity in which the individual is motivated to reduce uncertainty about the advantages and disadvantages of the innovation (see Rogers, 1983). On the other hand, the willingness to pay was not influenced by our information. It seems as if short, concise information (instructions for use and a very short rationale for urine source separation) already suffices to strongly increase decision making and acceptance. It also seems possible to promote a new behavior (sitting when urinating) with the introduction of the NoMix toilet.

Conclusions

We conclude that young Swiss German adults are willing to accept and live with the NoMix toilet, both in workplaces and at home. This corresponds well with a focus group

study where most people were older than 30 years (Pahl-Wostl *et al.*, 2003). In general, our respondents noticed that the NoMix toilets are different than conventional toilets, but they seemed to find this positive and were not forced to use them differently. The idea of an environmental-friendly toilet seems appealing, even though the willingness to pay substantially more than for a conventional toilet is relatively small. Some of the feedback from users presented in this paper could further contribute to improving the NoMix toilets. Problematic points are – not surprisingly for an institutional setting – sitting to urinate and perhaps also smell. However, it does seem as if most young people are capable of adopting a new behavior such as always sitting on NoMix toilets. Since it is clearly possible to strongly support decision making and influence acceptance, a well devised information policy should form an integral part of any future implementation of NoMix toilets. Further quantitative research is needed to solve the problem of confounding between gender and toilet type and to investigate the attitude of users of NoMix toilets belonging to other age classes and in other settings.

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