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Considering User Attitude in Early Development of Environmentally-Friendly Technology: A Case Study of NoMix Toilets

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BRIEF. A sociological survey of a technological innovation in wastewater management (urine source separation) indicates that most users accept NoMix toilets and adopt the necessary behavioral changes.

ABSTRACT: Urine source separation (NoMix technology) has been proposed as sustainable alternative to centralized wastewater treatment systems. Radical changes necessitate an early inclusion of sociological expertise, thus offering a real chance for transdisciplinary collaboration. The practical aim of our survey is to find out how users accept and use existing NoMix toilets and how this could be encouraged. We collected 1249 questionnaires from 2002–2004 in one Swiss school and one Swiss research institute. The technological immaturity of NoMix toilets was noted by many. Nevertheless, acceptance was high: 72% liked the idea and 86% would move into apartments with NoMix toilets. Moreover, most users found that NoMix toilets equal conventional toilets with respect to design (78%), hygiene (84%), and smell (78%). Like many other innovations, the NoMix technology only functions properly if it is used adequately, which we demonstrate for water saving and sitting to urinate. Many users adopted this behavior, e.g., 72% sat. Because perception and use of NoMix toilets is subjective, it can be

influenced with certain measures such as good information and cleaning, or discussions with peers. We discuss the importance of social psychology for understanding the factors that influence the acceptance of environmentally friendly innovations.

INTRODUCTION

Urine source separation. Our Central European wastewater management system disposes of wastewater with acceptable environmental impact. Nevertheless, professionals increasingly question the centralized system's sustainability. Major criticisms concern its inflexibility and infrastructure costs, water and nutrient wastage, and loss of untreated wastewater through combined sewer overflows and leaky pipes (1, 2). Additionally, wastewater treatment always lagged behind environmental problems such as eutrophication or more recently discharges of micropollutants (e.g., pharmaceuticals, 3, 4). Moreover, if sludge is not re-used in agriculture due to fears of toxicity (5), other means for phosphorous-recycling are needed (6). Source control and waste design are alternatives (7), a plausible starting point being the toilet.

Although urine constitutes less than 1% of domestic wastewater, it typically contains 80% of nitrogen and 50% of phosphorus (8). Urine can be separated from wastewater with NoMix toilets or waterfree urinals, with the eventual effect of replacing nutrient removal at treatment plants (9). By separating only 50% of the urine, compact, energy-efficient treatment technologies without nitrification, denitrification, and phosphorus removal are possible, because the remaining nutrients are removed through sludge (10). The NoMix technology can save energy and can even transform wastewater management from an energy consuming to an energy producing process (in one example from consuming 11.5 W/person to producing 2.3 W/person; 10). Furthermore, the NoMix technology can contribute to phosphorus recycling (11) and removal of micropollutants (12); and a family of four could save ca. 80 liters toilet-flush water/day (8). By investing about 260–440 US$/person in the NoMix technology, we estimate that the total annual costs would equal those of typical conventional wastewater treatment systems (13). This is a challenging, but

not impossible benchmark. With more stringent nutrient emission targets, even higher investments can be tolerated.

To sum it up: The NoMix technology cannot do much that cannot be achieved with end-of-pipe technology, but it can do it more energy-efficiently, and high nutrient removal efficiency is feasible with the simplest possible wastewater treatment. Hence, the inherent difficulties of setting nutrient emission targets to aquatic ecosystems (14) can be avoided, thereby implementing the precautionary principle also in countries where environmental protection has little priority. Perhaps most important is the ability of the NoMix technology to question the prevailing paradigm of end-of-pipe technology as the only way to manage wastewater. Breaking this paradigm has far-reaching consequences for regions where sewer-based wastewater management is unsuitable (15). The applicability of urine source separation to other contexts such as dry toilets (16), offers a cost-efficient nutrient containment scheme in areas where sewers and treatment plants are out of the question (17).

Sociological research to study a toilet. Real-world sociological research in an early phase of technology development is mandatory for all environmentally-friendly technologies that affect people in daily life to identify the most efficient means to optimize acceptance and compliance. Social psychology offers theories and many studies to explain acceptance and adoption of innovations by users. For instance, "The Theory of Planned Behavior" (18) is a theoretical framework to systematically identify factors influencing behavioral choices and has been successfully applied to environmentally-friendly behavior (e.g., 19, 20).

The NoMix technology is a radical technological system change that necessitates an early inclusion of sociological expertise. This also offers the chance of integrating social with natural and engineering sciences. Sweden pioneered the NoMix technology from 1980 on (21). In Switzerland, NoMix toilets were introduced in a few small pilot projects of the research project Novaquatis (www.novaquatis.eawag.ch) from 1997 on. The European NoMix toilets were developed by small firms at low costs. Unfortunately, little sociological research has been published, but experience shows that NoMix toilets have practical drawbacks. Hence, our study aims at finding out whether people accept the

existing NoMix toilets and use them as required. If not, we want to find reasons for non-compliance, and how we could influence acceptance, behavior, or technology. A first focus group study (22) and preliminary questionnaire survey (23) found high acceptance for NoMix toilets, while few users would accept increased inconvenience or costs.

Because the larger Swiss pilot projects are conducted in organizations, the quantitative surveys are restricted to these; and because little is known, they are exploratory. Therefore, and because toilet use might be gender-specific, we included demographic variables although they often only weakly explain environmentally-friendly behavior (for references see 24). Moreover, uncertainties regarding urine transport, treatment, or application in agriculture are very high, which also influences acceptance.

Research questions. The practical aim is to find out whether users accept existing NoMix toilets, how they use them in daily life, and to find influential factors. The underlying question is whether real-world implementation with imperfect solutions is possible at this early stage of technology introduction or whether large investments by sanitary firms to optimize NoMix toilets are needed (25). The specific questions are: (1) How high is acceptance of NoMix toilets and which factors (e.g., socio-demography, length and frequency of usage, information, discussions) influence acceptance? (2) How do people perceive and use NoMix compared with conventional toilets and what are the influential factors? (3) What do people know about NoMix toilets, why do they like the idea, and which information sources are important?

MATERIALS AND METHODS

NoMix sanitary installations. The first modern NoMix toilets were invented by small Swedish firms in the 1990ies (21; www.dubbletten.nu, www.wost-man-ecology.se, www.gustavsberg.com). They consist of two bowls; the urine is flushed away in the front with little water (ca. 0.15 l, depending on the model) and collected in a storage tank. The feces are flushed to the sewers with a larger flush (4–6 l). Hence, these models can save flushing water if the urine-soiled toilet paper is disposed of in a separate bin after urinating (ca. 0.15 l flush instead 3 l). The German firm Roediger (www.roevac.com) recently

invented a NoMix toilet with a closing mechanism for the urine drain, which only opens when one sits. The advantage is that undiluted urine can be collected, that the toilet paper is flushed away as in conventional toilets, and that the design is modern. Disadvantages are that they consume as much water as any conventional dual-flush toilet (3/6 l) and that one has to fully sit to urinate, whereas with the Swedish models a crouching position suffices. Urine from men can also be collected with waterfree urinals (discussed in Supporting Information, p. S-7).

Setting and questionnaires. We collected data from autumn 2002 until spring 2004 in the only two Swiss organizations with NoMix toilets at that time: a vocational / design school in a Swiss German city and Eawag (Swiss Federal Institute of Aquatic Science and Technology). In the school, one of three conventional toilets was replaced with a NoMix toilet in a women's and one of two in a men's bathroom. In 2002, the women tested a model from Roediger, the men one from Gustavsberg; in 2003 the models were swapped. At Eawag, two conventional toilets (one of two for men, one of one for women) were replaced with NoMix toilets from Dubbletten in 2000. Being located near cafeteria and auditorium, they were easily accessible to visitors. At Eawag, but only in 2003 in the school, the users were asked to dispose of urine-soiled toilet paper in a bin after urinating. Additionally, three waterfree urinals replaced the existing water flushed urinals in both settings.

We used a short questionnaire (S) for people having used the NoMix toilet few times and a longer questionnaire (L) for several months of usage (Supporting Information, Tab. S-1). We asked the following types of questions: (1) demographic data (gender, age, education), length and frequency of usage of NoMix toilets, (2) acceptance (are NoMix toilets a good idea, willingness to move into apartments with NoMix toilets, willingness to pay, NoMix toilets as discussion topic), (3) do people perceive and use NoMix toilets differently than conventional ones (regarding design, hygiene, smell, sitting, flushing, disposal of toilet paper), change of opinion with time, and (4) knowledge, preference, and information sources (what do people know, reasons for liking NoMix toilets, different information sources). Questions on urinals were not included. Most questions were in closed multiple-choice format.

Sample description and statistics. We collected 1249 questionnaires. For details of data collection, response rates, toilet and urinal visits, and information material see Supporting Information (p. S-2). We are confident that the school results are representative for Swiss German organizations with mainly young adults as visitors. The Eawag results are highly representative for employees (89% response rate) and visitors. However, the setting is unique, since Eawag is studying urine separation.

For demographic details see Table S-2 (Supporting Information). There were strong differences between the settings: School respondents were younger, had a lower education level (most were students of design introductory courses or apprentices), and had used NoMix toilets for shorter time, but more frequently than Eawag users. We operated with varying sample sizes because we often analyzed only a subset and because respondents did not answer all questions.

We analyzed data with a generalized linear model approach, mostly with forward stepwise logistic regression (details in Supporting Information, p. S-2–3). We present modeling information (Tabs. 2–3, and Tabs. S-3–4, Supporting Information) and parameters of final models (Tabs S-5–19, Supporting Information). We used simple indices (I.) as explanatory variables in some analyses by adding the values of individual answers: I. Design/Hygiene/Smell (index for opinion on design, hygiene, smell: the higher, the higher the opinion), and I. Our Information (having read an increasing number of our information sources).

RESULTS

Acceptance of NoMix toilets. Acceptance was very high, 72% of the long-term users (N=480) finding the idea convincing, 86% being willing to move into apartments with NoMix toilets, but only 28% being willing to pay nearly the double price for a NoMix toilet than for a conventional toilet (Tab. 1, Fig. 1a). Having discussed NoMix toilets in a negative manner with others was most strongly correlated with significantly lower acceptance (Fig. 1b). This variable “discussion” was added first to the model (step=1) for two measures of acceptance, A (idea) and B (apartment), explaining ca. 20% of variance (Nagelkerke R^2), and second for C (willingness to pay; Tab. 2). A positive perception of design, hygiene, and smell

was also positively correlated with acceptance (e.g., NoMix toilet is good idea: I. Design/Hygiene/Smell = 5.86±0.08, not good idea: 4.74±0.20; the index is a sum of the answers to the opinion of design, hygiene, and smell; scale: 3–9) as well as an increasing number of information sources (e.g., 83% that did not read any information liked the idea, but 94% that read ≥2 sources liked the idea). Fewer younger and less well-educated respondents would pay more for NoMix toilets (Tab. 2C).

Peer pressure. Because discussing NoMix toilets was the most important explanatory variable, we also analyzed it separately. Here, setting (school/Eawag) and increased information were the explaining variables (Tab. 2D, Fig. 1c). The NoMix toilet was discussed by 63% (46% in the school, 78% at Eawag; Tab. 1). Most comments were favorable (44%) or neutral (43%; Tab. 1). However, the 13% negative discussions were most strongly correlated with low acceptance (Fig. 1b).

Perception of design, hygiene, and smell. Most users found that NoMix toilets are the same or better than conventional toilets regarding design (78%), smell (78%), and hygiene (84%; Tab. 1, Fig. 1d). There were some weak differences between groups (gender, education, information). However, the most striking result is a highly significant (P<0.001) more negative opinion of Eawag users, and setting was always added first to the logistic regression model. Therefore, we also analyzed these two settings independently (Tab. 3).

In the school, the models of design, hygiene, and smell explained maximally 10% of variance (Tab. 3A). If users read nothing about NoMix toilets they had a more negative opinion than if they read our information (18% vs. 6% found the hygiene worse; smell: 31% vs. 9%). Moreover, 14% of Gustavsberg users said the toilet smelled worse than conventional toilets, but only 6% of Roediger users.

At Eawag, perception of design was correlated with education (results not presented) and gender: 32% women, but 22% men found the design worse (Tab. 3B). Interestingly, only 17% visitors (S-questionnaires) found the hygiene or smell worse, but 32% Eawag employees (L-questionnaires) found the hygiene and 50%(!) the smell worse. Most long-term users (85%) did not change their opinion with time; but if they did, they mostly adopted a more positive view (design: 82%, hygiene: 60%, smell: 58%).

Behavior. For detailed results of users of NoMix toilets regarding willingness to sit, sitting position, flushing, disposal of urine-soiled toilet paper after urinating, and also waterfree urinals see Supporting Information (p. S-6–8; Tab. S-3).

Information. Information was very important for acceptance, discussions with others, perception, and behavior, and enhanced the knowledge about the purpose of NoMix toilets: Most respondents (83%, Tab. 1) knew the purpose of NoMix toilets, and in logistic regression, the number of information sources (including external information) was added first (Supporting Information, Tab. S-4). Only 68% of users knew the purpose if they had not read any information, but 93% and 98% if they received information from 1 or ≥2 sources. Second, our own information contributed to knowledge and third a high education level (Supporting Information, p. S-9).

We then analyzed, which of our information material contributed to knowledge about the purpose of NoMix toilets (L-questionnaire). Besides the number of information sources, the instructions for use in the toilet cabin containing a very short rationale for urine separation were most important: Only 69% of people that had not read them knew the purpose, but 94% who read them (Supporting Information, Tab. S-4B). Our arguments for urine separation were all mentioned: benefits for wastewater treatment plants, improved water pollution control (nutrients, micropollutants), nutrient recycling (fertilizer), and water saving, albeit to differing degrees between the school and Eawag. For a discussion on the reasons for liking urine separation see Supporting Information (p. S-9–10).

DISCUSSION

Theoretical background. The NoMix toilet is an innovation that affects people in their intimate daily life. Since it does not yet equal modern sanitary standards and necessitates behavioral changes, acceptance cannot be taken for granted. Social psychology helps to explain the acceptance of such innovations and to find influential factors.

The “Theory of Planned Behavior” (TPB) by Ajzen (18) was frequently applied to explain environmentally-friendly behavior such as solid waste recycling (e.g., 19, 20). TPB postulates that

behavioral choices are mainly influenced by (A) attitude towards the behavior, (B) subjective norm (i.e., perception of social pressure), and (C) perceived behavioral control (i.e., ability to perform the behavior). Some authors postulate that additional factors such as moral norm, past experience, situational factors (e.g., inconvenience), and the consequences of the behavior (e.g., that it is rewarding) also influence behavior (20, 24). Others suggest clustering factors into environmental, situational (e.g., socio-demographic), and psychological variables (26). In any case, the decision of individuals for e.g., solid waste recycling can be understood as a set of preconditions that include sufficient motivation, knowledge, and the ability to overcome the inconveniences (for references see 20, 27). Motivation includes social pressure, economic, and altruistic aspects. Knowledge includes practical information on how to recycle. Inconveniences could be that people find recycling messy. Therefore, to increase the number of people willing to recycle (or sit on NoMix toilets) a first research aim is to find the factors with the strongest negative or positive influence.

Acceptance of NoMix toilets. Acceptance of the NoMix toilets was very high (Tab. 1, Fig. 1a), with little differences among groups. One exception is willingness to pay: at Eawag, 39% would pay substantially more for NoMix toilets compared with only 15% of the younger, less well-educated and presumably less well-off school users. It is striking that despite the more negative attitude of Eawag employees regarding practical aspects, 85% of Eawag users would move into apartments with NoMix toilets. The most promising measures to increase the already high acceptance are discussions with peers and information, apart from the more obvious measure of hygienic, odor free toilets (Tab. 2, Fig. 1b).

Peer pressure. In TPB, social pressure to perform a behavior (subjective norm) is one of the three modeled factors (18), and various examples of peer pressure are reported. For instance, 45% of 100 female students left the bathroom without hand washing when alone, but only 9% when not alone (28). Because the use of NoMix toilets is hardly observed by colleagues, one might expect that peer pressure is not important here. However, this speculation is not supported by the results: NoMix toilets were extensively discussed by users, especially at Eawag (Tab. 1, Fig. 1c), and the few negative discussions were most

strongly correlated with low acceptance (Fig. 1b). In future pilot projects, information events could offer the opportunity for peer discussions.

Information. Information was not only important for acceptance, but also for discussions with others (Fig. 1c), perception, behavior, and to increase the knowledge about the purpose of NoMix toilets. We found that even the instructions for use in the toilet cabin containing a very short rationale for urine separation already sufficed. This confirms other studies, which also found that minimal additional information increased the positive response of users (29). Moreover, because the different user groups mentioned different reasons for finding urine source separation convincing (Supporting Information, p. S-9–10), our strategy to offer several arguments makes sense.

Demography. The demographic variables gender, age, and education were rarely included in the models. This is supported by the literature. Although researchers consistently use demographic variables to understand environmental behavior, the relationships are often weak (19, 24, 30).

Perception and use of NoMix toilets. Environmentally friendly behavior can be normative, and practical aspects were often better predictors of e.g., waste recycling than altruistic environmental concern (20, 26, 30). Similarly, ease of use was of high importance for correct operation and acceptance of water-saving appliances, highlighting the need for efficient and practical design (29). Sitting on NoMix toilets to urinate and disposing of toilet paper in a bin are such issues. We shortly discuss the most important findings below (details of behavior in Supporting Information, p. S-6–8).

Design, hygiene, and smell. Most users had a positive perception, with ca. 80% finding the design, hygiene, and smell of NoMix toilets the same or better than the same attributes for conventional toilets (Tabs. 1, 3, Fig. 1d). In comparison, professionals from sanitary firms generally find that the design of NoMix toilets does not equal that of other modern toilets. Interestingly, Eawag employees had a distinctly more negative opinion than Eawag visitors and school users. This indicates that the perception of practical aspects is subjective, which is supported by the positive relationship between information and hygiene/smell in the school. In the pilot projects, we occasionally received complaints of bad smell, which

was mainly caused by poor maintenance of the waterfree urinals. Possibly, Eawag employees remembered such instances, which also lead to some confounding between NoMix toilets and urinals.

Consequences of behavior. Sitting. If people do not sit on NoMix toilets to urinate, less urine is collected, which reduces the advantages of the technology. Many women (75%) in our survey were willing to sit (Tab. 1), compared with a British study, where 85% voided by crouching (31). The two most promising measures to enhance sitting on public NoMix toilets are again good information and clean toilets. Men might be reluctant to sit, but in public places ca. 70% use the urinals. Future research should specifically address questions concerning waterfree urinals and men's behavior in households.

A further question is whether the human anatomy differs so strongly that a flexible toilet design is needed. However, because 85% of the NoMix toilet users did not sit differently than on conventional toilets (Tab. 1), and because we found no differences between the distinctly different Roediger and Gustavsberg toilet, an inflexible NoMix toilet design seems to suffice.

Disposal of toilet paper. To save water, it is necessary to use the bin to dispose of urine-soiled toilet paper. We speculate that this is a normative behavior, where motivation increases if it is a socially accepted priority. If people do not adopt this behavior, the Swedish NoMix toilets may even consume more water than conventional dual-flush toilets, because a large flush (6 l) is used where a small flush (3 l) would suffice. In our case, compliance is high enough to result in a small water saving effect of the Swedish toilets: 58% of Eawag users disposed of urine-soiled paper in the bin and flushed with 0.15 l water (Tab. 1), while 42% used 6 l water after urinating. In this example, the outcome is a water saving effect of 84 l per 100 usages compared with conventional dual-flush toilets, where 85% would use the small flush (3 l) after urinating. However, as long as we do not know how representative our results are, both systems should be available for choice.

Conceptual considerations. *Setting.* We found strong differences between school and Eawag users, e.g., regarding the opinion of design, hygiene, and smell (Fig. 1d). Presumably, this was not caused by the toilet types, because the most strongly differing toilets were used within the school (Roediger vs. Gustavsberg), where we only detected one difference (smell). Second, the strong discrepancy between

Eawag employees and visitors cannot be explained by toilet design. Rather, the perception might be subjective, and studies in other settings are needed to draw objective conclusions. Interestingly, the differences disappeared when it came to acceptance. People obviously differentiated between practical drawbacks of NoMix toilets and generally finding urine separation a good idea.

Our study is seriously restricted because of its limitation to organizations. The main drawback of NoMix toilets is precipitation of urine crystals, which eventually blocks the pipes (32). Blockages can be removed by cleaning personnel in organizations. However, the focus group survey indicates that people are reluctant to accept increased maintenance in private homes (22), which needs to be backed with further quantitative surveys. Therefore, we recommend introducing NoMix toilets in homes only after carefully considering possible technical drawbacks or strong awareness-raising among household members.

Future research. In exploratory studies, causal relationships cannot be established. For instance, people with an initially negative attitude towards NoMix toilets could have selectively ignored information they perceived as irrelevant. This was suggested in a recycling study (30), while other studies confirmed that information actively increased environmentally-friendly behavior (33). To establish causal relationships also for NoMix toilets, different treatments of the most important influential factors could be tested among identical user groups. For instance, one group could receive no information, a second an information leaflet, and a third might visit an information event. Because the current NoMix pilot projects are limited to small user groups, an intelligent experimental setup is needed.

Introducing NoMix toilets. Research is now confronted with the problem that more pilot projects are needed to develop the NoMix technology (e.g., urine treatment) and to open a market for private industries. However, implementing an immature technology that affects people in daily life, without the appropriate sensitization and incentives might result in a severe backlash (see 16 for user satisfaction of dry toilets). Larger sanitary firms are convinced that users only accept technologies that equal today's standards ("perfect technology"), which necessitates large investments in an uncertain market (25). Understandably, sanitary firms are reluctant to carry this risk. However, our results suggest that introducing the existing NoMix toilets might not affect people as negatively as anticipated.

Despite the technological immaturity of NoMix toilets, which was well noted by many, and despite uncertainties regarding urine handling (e.g., processing), acceptance of NoMix toilets was extremely high in our two organizational settings. Obviously, people are open for this innovation, especially if they can choose among various arguments to find the personally most convincing ones. Research must now validate how representative our results are in other settings, quantify the environmental advantages, and carefully assess the pros and cons of NoMix toilets.

Early development of environmentally-friendly technology. Involving users in technology development is an important environmental issue. Many examples show that non-sustainable impacts of daily-life behavior can only be avoided with the cooperation of users: correct use of water-saving appliances in washrooms (29), disposal of domestic sanitary waste in bins rather than toilets (34), correct maintenance of dry toilets (16), or more generally the environmental consequences caused by non-recycling of household wastes (19, 20, 26, 27, 30), personal car use (24), or energy wastage in households (35). Some environmentally responsible behavior is "difficult", because it necessitates fundamental behavioral changes, such as reducing automobile use (24). Other technologies, e.g., water or energy saving appliances, bring economic advantages to users without any loss of comfort. Nevertheless, such devices are installed far less than they could be. Social psychology helps to better understand environmentally relevant behavior and must be included in an early research stage to avoid producing technological innovations that simply do not appeal to consumers.

The NoMix technology is currently in the early stage of development. It is an example of a technology with strong environmental advantages that will, however, only work with user acceptance and some behavioral changes. Finally, because of its innovative character and mutual dependencies between research and society, the NoMix technology offers a real chance to integrate social with natural and engineering sciences. A simple toilet may thus support transdisciplinary collaboration, an area where better performance is urgently needed.

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SUPPORTING INFORMATION AVAILABLE. We provide the following additional information: details on data collection, response rate, and statistical analysis (p. S-2–3); questionnaires (Tab. S-1); sample description (Tab. S-2); additional results and discussion on behavior (sitting, flushing, disposal of toilet paper) including urinals (p. S-6–8); additional results and discussion on knowledge and information (p. S-9–10); and detailed logistic regression models (Tabs. S-5–19). This material is available free of charge at: http://pubs.acs.org.

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Table 1. Frequencies. Overview of respondents that answered various dependent variables on the NoMix toilet in a positive manner. We show frequencies of groups that often differed significantly in logistic regression: (A) setting, (B) gender, (C) users that had (not) read our information material, and (D) frequencies over all groups (N: total sample sizes, excluding missings). Tables refer to the detailed logistic regression models. Note: despite differences between some groups, these may not have been important enough to be included by the logistic regression model.

Variable	(A) Setting		(B) Gender		(C) Inform.		(D) All (N)
	School	Eawag	Wo-men	Men	No	Yes	
Acceptance of NoMix toilet (Tab. 2)							
Idea of NoMix toilet is convincing	72%	73%	67%	80%	41%	74%	72% (451)
Would move in apartment with NoMix	87%	85%	86%	86%	62%	87%	86% (460)
Willing to pay more for NoMix toilet	15%	39%	24%	33%	11%	28%	28% (412)
Discussed NoMix toilet with others	46%	78%	62%	64%	27%	64%	63% (480)
Comments were neutral or positive	93%	84%	84%	91%	83%	87%	87% (297)
Perception of NoMix toilet compared with conventional toilet (Tab. 3)							
Design NoMix same/better	83%	73%	75%	81%	80%	78%	78% (1097)
Hygiene NoMix same/better	93%	77%	85%	84%	86%	84%	84% (1043)
Smell NoMix same/better	90%	70%	79%	78%	78%	78%	78% (1041)
Behavior on NoMix toilet (Tab. S-3, Supporting Information)							
Willing to sit on NoMix to urinate	64%	79%	75%	67%	53%	74%	72% (1069)
Did not have to sit differently	90%	81%	81%	91%	91%	85%	85% (948)
Used small flush after urinating	83%	86%	84%	86%	80%	85%	85% (915)
Disposed of toilet paper in bin	6%	58%	38%	42%	0%	42%	40% (301)
Knowledge and information (Tab. S-4, Supporting Information)							
Knows purpose of NoMix toilet	80%	86%	83%	83%	53%	85%	83% (1184)

Table 2. Acceptance. Stepwise forward logistic regression of: (A) "Is idea of NoMix toilets convincing?," (B) "willingness to move into apartment with NoMix toilet," (C) "willingness to pay more for NoMix toilet," and (D) "having discussed NoMix toilet with others" as most important explanatory variable. N: sample sizes, d.f.: degrees of freedom, step: order of inclusion of variable in model. For each step and final model we show χ^2: deviance change (is analogous to (explained) "Sums of Squares" in ordinary regression), R^2: Nagelkerke R^2 (approximates R^2 in ordinary regression: proportion of variance in dependent variable explained by independent variables), and significance levels: * = P<0.05, ** = P<0.01, *** = P<0.001. Variables without "step" were not included in model. Details in Supporting Information.

Sources of variation	d.f.	(A) Idea (N=299[a])				(B) Apartment (N=363)				(C) Pay more (N=328)				(D) Discussion (N=373)			
		Step	χ^2	R^2	P	Step	χ^2	R^2	P	Step	χ^2	R^2	P	Step	χ^2	R^2	P
Discussion	3	1	30.0	0.191	***	1	43.5	0.210	***	2	14.1	0.237	**	*not included in analysis*			
I. Design/hygiene/smell	1	2	9.2	0.245	**	2	12.3	0.265	***	4	5.8	0.291	*				
No. inform. sources[b]	2	3	7.0	0.286	*					3	9.0	0.270	*	2	19.7	0.232	***
Age	1					3	12.4	0.319	***	1	44.0	0.183	***				
I. Our Information[c]	1					4	8.7	0.355	**					3	4.9	0.247	*
Education	2									5	6.1	0.312	*				
Setting	1													1	49.3	0.170	***
Full model	(11)		46.1	0.286	***		76.9	0.355	***		79.1	0.312	***		74.0	0.247	***

[a] 77 people without opinion were excluded.
[b] Variable includes external information (mass media etc.).
[c] Index contains only our own information.

Table 3. Perception. Stepwise forward logistic regression of design, hygiene, smell. Because of highly significant differences between school (A) and Eawag (B), we analyzed these separately. Explanations see Tab. 2. Analysis of "toilet type" only in school (Roediger vs. Gustavsberg).

	Sources of variation	d.f.	Design				Hygiene				Smell			
			Step	χ^2	R^2	P	Step	χ^2	R^2	P	Step	χ^2	R^2	P
A	**School**		(N=364)				(N=358)				(N=357)			
	Our information	1					1	3.4	0.024	+	1	12.6	0.068	***
	Toilet type	1									2	6.0	0.100	*
	Full model	(2)	*Model not significant*					3.4	0.024	+		18.6	0.100	***
B	**Eawag** (N=531)													
	Education	2	1	10.1	0.027	**								
	Gender	1	2	4.6	0.039	*								
	Questionnaire type	1					1	11.7	0.033	**	1	67.8	0.170	***
	Our information	1									2	6.1	0.184	*
	Full model	(5)		14.7	0.039	**		11.7	0.033	**		73.9	0.184	***

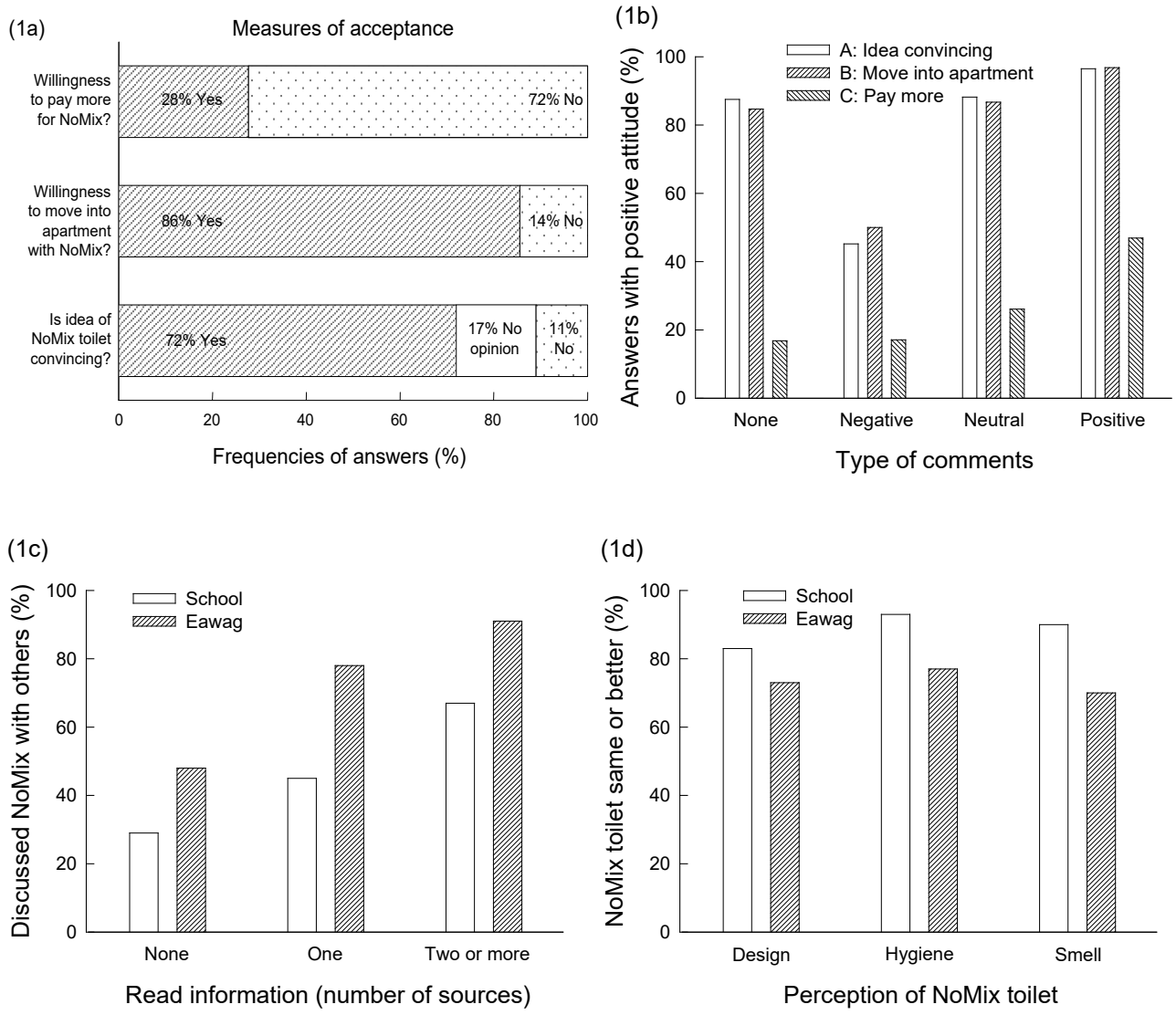

Figure 1. Acceptance and Perception. (1a) Frequencies of answers from long-term users concerning acceptance, (1b) answers indicating a positive attitude in relation to discussions with others, (1c) frequencies of people having discussed NoMix toilets in relation to the number of information sources they had read, and (1d) frequencies of respondents considering NoMix toilets the same or better than conventional toilets regarding design, hygiene, and smell in the two settings.