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Assessing tap water awareness

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Abstract

Despite the often emphasized importance of water awareness, and notwithstanding the fact that calls for increasing public awareness are becoming commonplace, most studies do not define the concept, let alone operationalise it into measurable units. This is, however, essential to measure and evaluate efforts related to water awareness such as public campaigns, customer communication and other interventions. To address this gap, we conceptualise, operationalise and assess tap water awareness, hereby differentiating between cognitive awareness (head), affectional awareness (heart), and behavioural awareness (hands). In parallel, we also differentiate between tap water quality, quantity and system. By building on a variety of contemporary conceptual insights in literature and a series of expert interviews, an assessment framework is developed. A cohesive set of nine awareness components are identified and operationalised into a set of tangible questions which are put to the test in a large-scale online survey in the Netherlands, applying both a traditional and modern segmentation approach based on four types of perspectives ('quality & health concerned', 'aware & committed', 'egalitarian & solidary', and 'down to earth & confident'). Based on the analysis of the results of the first empirical application of our tap water awareness assessment framework, we conclude that tap water awareness in the Netherlands shows ample room for improvement. Interestingly, most significant variations in awareness are generally not related to sociodemographic factors but rather apply to the four customer perspectives on drinking water that are based on people's subjective views and preferences.

Keywords: Awareness, Tap water, Segmentation, Water quality perception

1. INTRODUCTION

Against the backdrop of increasing water demands, large-scale pollution, seawater intrusion, and changing precipitation patterns and temperatures, public awareness about freshwater availability, water stress, and consequently the necessity to use water more efficiently, now becomes more important than ever before (Schyns et al. 2019; Howell 2013; Teuling 2018). Despite this often emphasized importance of water awareness, and notwithstanding the fact that calls for increasing public awareness are becoming commonplace, most studies do not unequivocally define the concept, let alone, operationalise it concurrently into measurable units (Brouwer and Hessels 2019; Wang et al. 2018). Awareness is often referred to in broad terms and used in an exchangeable fashion across different water-related elements and goals such as surface water improvements (De Boer, Goosen, and Huitema 2003), drinking water quality (Doria 2010), and water quantity (Willis et al. 2011). The concept of awareness itself is multifaceted, and found to encompass different things, including, but certainly not limited to, cognitive knowledge, the degree of involvement and having a specific attitude. In this paper, we will focus on tap water awareness specifically, hereafter referred to as TWA.

2. TAP WATER AWARENESS ASSESSMENT FRAMEWORK

In this study, the development of the empirically-based assessment framework for analysing TWA was primarily guided by a conceptual and theoretical reflection on water awareness, as well as an exploration of how this concept has been used and translated in everyday awareness campaigns. The underlying assumption in many of these campaigns is grounded in the premise that awareness is determined by cognitive knowledge, and that raising awareness is about increasing public understanding. Also in the literature, the cognitive narrative of TWA seems prevailing (Anderson et al. 2007). Other scholars embrace a broader rationale by also incorporating the notions of perception and attitude, hereby acknowledging the growing importance of subjective experience in the drinking water domain (Brouwer et al. 2019). An even more inclusive notion of awareness applied by Boer et al. (2003), who define awareness as the realisation of

the existence of something. Moreover, along with cognition and affection they identified a third component of awareness: behavioural intention. Other scholars regard behaviour even as a pivotal element of awareness itself, for instance in the field of pro-environmental behaviour (Zabkar and Hosta 2013). Building on the work of these scholars, our conceptualisation of TWA is composed of three dimensions:

- **Cognition (Head):** Cognitive awareness refers to knowledge, inquiry and understanding (e.g. knowledge on the composition of tap water). The leading assumption related to the cognitive dimension is that the more people know about tap water, be it in terms of quality, quantity, and/or system, the higher their awareness.

- **Affection (Heart):** Affectional awareness relates to emotions, attitudes, interests, and feelings of belonging. Whereas the cognition (head) dimension relates to the question how much people know about tap water, the affective (heart) dimension is about how much people actually care about water. The leading associated assumption is that the less people take tap water for granted, the higher their TWA.

- **Behaviour (Hands):** Behavioural awareness relates to people's action in practice and consumption patterns as a part of daily life. The explicit consideration of actual behaviour in our framework is in line with the most recent insights from the behavioural science literature in which it is increasingly recognised that behavioural intention may not be the primary determinant of behaviour, but just one of the many factors (Kahneman 2003).

In parallel to this threefold - head, heart, hands - conceptualisation of TWA, we propose an additional more practical classification that is based on substantive characteristics of drinking water: water quality (QUAL), water quantity (QUANT) and water system (S). Table 1 shows the resulting framework consisting of nine components, ranging from 'water quality comprehension', relating to cognition and water quality, 'caring for water', relating to affection and water quantity, to 'tap water source protection', relating to behaviour and water system.

3. METHODOLOGY

The development of this study's conceptualization of TWA and the design of the operational questions of our TWA assessment framework was primarily dictated by a literature study and the outcomes of three interviews with professionals in the field of drinking water. Based on a pre-testing round with three content experts and a varied group of seven customers the questionnaire was revised to its final form. The final instrument was an online-survey questionnaire consisting of 33 questions, and contained, in addition to a series of questions that asked for sociodemographic information and the respondents' subjective views on drinking water, a mix of head (cognitive), heart (affective), and hands (behavioural) statements and questions on tap water quality, quantity and system issues.

To calculate the awareness profiles, the questionnaire was accompanied with an elaborate weighing system, as displayed in Table 1. For each of the TWA dimensions an equal sum of maximum of 36 points could be scored. The number of points per question was divided in such a way that the maximum score for all three components—water quality, water quantity, and water system— was also 36 points. In order to map the TWA scores of the Dutch population, the questionnaire was conducted in October 2019 among a representative sample of 1003 respondents. Given that relatively few respondents filled out the only non-compulsory question about their volume record on their latest water bill, this question that was disregarded in the analysis. Consequently, in the TWA assessment presented in this study, both the maximum number of points for the behavioural dimension and the water quantity component was lowered with 8 points. In consequence, the maximum score of awareness points was lowered from 108 to 100.

Based on the scoring methodology, a score was assigned to each respondents' answer. Next, the fraction of the maximum score was calculated and expressed as a percentage. In this way, respondent's scores could be clustered to scores of individual questions, components and dimensions. Data were analysed using a variety of statistical tests including the Kolmogorov-Smirnov test, Levene's test, and two-tailed ANOVA tests. The effect size (r) was calculated and interpreted according to (Cohen 1992). Finally, the Benjamini-Hochberg procedure was performed for each null-hypothesis (i.e., each component and dimension) to decrease the false discovery rate.

4. TAP WATER AWARENESS IN THE NETHERLANDS

As shown in Table 1, the results of this study show that the average Dutch citizen has a TWA score of 53.5%, meaning that, on average, people reached 53.5 points of the maximum total awareness points within

the systematics of our framework. Especially people's cognitive TWA, with an average score of 44.9%, shows ample room for improvement. Slightly better are the scores for both affective (56.9%) and behavioural (60.3%) TWA.

Table 1. TWA dimension and component scores, depicted are percentages of maximum number of points. Significance: *= p < ,05; **= p < ,01; ***= p < ,001; water quality (QUAL), water quantity (QUANT)and water system (S); (1) The average curtailment and efficiency behaviour score of respondents with 'aware & committed' perspective is higher, though not significant, as compared to respondents with the 'egalitarian & solidary' perspective. This can be explained by the difference in STD.

Dimension	Weight		Gender *(n=1001)*		Perspective *(n=999)*			
		Score	Male	Female	Quality & health concerned	Aware & committed	Egalitarian & solidary	Down to earth & confident
Total	108	53,5	48,6***	57,7***	52,2	56,9***	53,7	50,0***
Cognition	36	44,9	41,0	48,3	41,0*	46,9*	43,2	46,2
(QUAL) Water quality comprehension	10	40,7	38,2	42,9	35,8	45,5**	38,9	39,2
(QUANT) Water consumption knowledge	8	34,2	32,4	35,7	32,7	35,2	33,3	34,8
(S) Water system understanding	18	52,0	46,3***	56,8***	47,6*	52,9	49,9	55,3**
Affection	36	56,9	53,6*	59,8*	58,9	62,0***	58,4	48,1***
(QUAL) Water quality perception	16	55,7	54,5*	56,7*	53,3	58,9***	55,8	52,6***
(QUANT) Caring for water	12	57,8	52,9**	61,9**	61,4*	63,6***	61,8***	44,5***
(S) Sense of responsibility	8	58,2	52,7	62,8	66,1***	65,9***	58,5	44,5***
Behaviour	36	60,3	52,0	67,2	58,0	63,0**	61,1	57,1
(QUAL) Quality-driven behaviour	10	43,8	43,2	44,4	41,7	48,0**	41,7	42,0
(QUANT) Curtailment & efficiency behaviour	16	70,7	66,5***	74,3***	70,6	72,8(1)	72,1*	66,8
(S) Tap water source protection	10	68,3	49,2***	84,5***	64,1	70,0	71,9*	64,5

Regarding the component ***water quality comprehension***, our data, for instance, show that, most people are unaware of the quality requirements of tap water versus bottled water. In addition, we find that there is relatively little knowledge on the use of chlorine. Although in the Netherlands, in contrast to most other countries, tap water is distributed without disinfectant residuals (Smeets, Medema, and Van Dijk 2009), about one third (34%) mistakenly thinks it is still used. Conversely, we find that most people know about the minimal presence of anthropogenic substances in drinking water.

The component with the lowest awareness score relates to ***water consumption knowledge*****,** assessed by incorporating questions addressing both societal water use and the use of specific household appliances. For one illustration, on the open question of estimating the average daily water consumption of one person in the Netherlands, only 5% was able to give the correct answer of 120 litres (with a margin of ten litres). Most citizens, however, estimate this consumption below 50 litres (51%), between 91–110 litres (10%), or between 131–150 litres per day (6%). On the other end, we also find a group of respondents (16%) estimating that this average daily consumption of water is more than 191 litres a day.

Relatively much higher scores were achieved for the component ***water system understanding,*** *which, among others, relates to questions of* how well-informed people are about their drinking water utility's name and responsibilities, as well as the price and origin of tap water. In this regard, is noteworthy that 30% of the people are unable to name their water company. Knowledge about the responsibilities of drinking water companies is even more limited. For instance, 61% of respondents incorrectly believe that water companies are responsible for treating sewage water, whereas 10% believes that they are responsible for preventing dike breaches.

The lowest average affectional awareness was achieved for the component ***perceived quality of water***, which maps out how safe people experience their water, how often they think about the quality of their water and the extent that they take access to clean drinking water for granted. Looking at the answers to this last question, we find that a small majority of 51% of the respondents 'fully agrees' and a further 37% 'agrees' with the statement that clean tap water is something obvious. The percentage of respondents that instead do not regard clean tap water as something obvious, but instead for instance as rather special, is very small.

Questions addressing the extent that people take drinking water for granted are also incorporated in the component ***caring for water***, in this case with respect to water quantity. One element of caring for water is people's so-called intentional conservation behaviour, i.e. their intention to save (even) more tap water at home. In our study, 64% of the respondents indicated to have this intention. This, however, does not mean that they also frequently think about how much water they consume. Just over a third (38%) indicate that they think about this at least once a day. Interesting is also the question to what extent people take it for granted that their tap provides safe potable water 24 hours a day. About one-third (36%) indicated that they indeed take this for granted, 19% not at all.

Sense of responsibility is the component with on average the highest affectional awareness score. This relatively high score can partially be explained by the fact that 50% of the respondents indicate that they reflect on the origin of their water compared to 23% of the people who never do so, and partly by the fact that relatively many people feel a personal responsibility to contribute to the protection of their drinking water sources.

The scores for the behavioural TWA components are all relatively high, except for ***quality-driven behaviour***. For example, only 11% of respondents indicated that they had actively searched for water quality information in the past 24 months. Furthermore, it is notable that a relatively many respondents consume bottled non-sparkling water at home. For 13% of the respondents this is a daily routine, for 10% of the respondents a weekly routine. Just under half (46%) of the respondents indicated that they never consume bottled non-sparkling water at home. Bottled water is not only more expensive and less convenient, but more importantly, particularly troubling from an environmental perspective (Leal Filho et al. 2019; Van Der Linden 2015).

The component with the highest awareness score relates to ***curtailment & efficiency*** **behaviour**, assessed by asking people about their daily tooth brushing water-use pattern, their water-saving appliances installed in-house and in theory, but as explained above disregarded, the volume record on their latest water bill. The high score can mainly be explained by the tap water use while tooth brushing. 76% of the respondents state to always close the tap while brushing their teeth and another 16% almost always does so.

The last component of our TWA framework looks at behaviour from a water system perspective, and specifically focusses on ***tap water source protection***. To assess the extent to which people behave and act according to a consequence awareness in relation to water sources, the framework asks about disposal behaviour in relation to old medicines and products such brush softener or old weed killer, which are known to endanger the sources of drinking water (Sjerps, ter Laak, and Zwolsman 2017). The answers to both questions are almost identical. The majority (62% and 61%, respectively) indicates that they return these types of products to the pharmacy or a dedicated collection point. About one in five respondents indicated that they simply dispose these products in the trash. Flushing these products down in the toilet happens rarely (1% and 4% respectively).

5. AWARENESS AMONG DIFFERENT CUSTOMERS

This study not only looked at the tap water awareness of the average Dutch person, but also differentiated between different types of customers. This involved the division of respondents into different segments, both classical, based on 'hard' sociodemographic differences such as gender, age and educational background, as well as modern, based the more 'soft' differences on the basis of subjective views and perspectives. To the latter end, we built on the work Brouwer et al. (2019) who in their modern segmentation approach distinguished four different customer perspectives on drinking water:

I. Quality & health concerned: Customers characterised by a focus on personal preferences and needs, especially regarding their own health and tap water quality.
II. Aware & committed: Customers characterized by pro-environmental values and collective sustainability ideals.
III. Egalitarian & solidary: Customers characterized by great sense of solidarity with less-favoured households, low-income countries, and future generations.
IV. Down to earth & confident: Customers characterized by a great confidence in the responsibility of drinking water utilities, along with the desire not to be bothered about drinking water.

TWA viewed from this segmentation perspective reveals two distinct patterns. The first pattern is that women have a substantial and significantly higher tap water consciousness ($p < .001$), a difference that primarily relates to the affectional dimension ($p < .05$). It is remarkable that women score higher than men on all components, albeit not always significantly. Figure 1 illustrates these different scores into a TWA profile. Other social demo-graphic variables, such as age, educational background and income, do not show such clear patterns and are therefore not considered in this article.

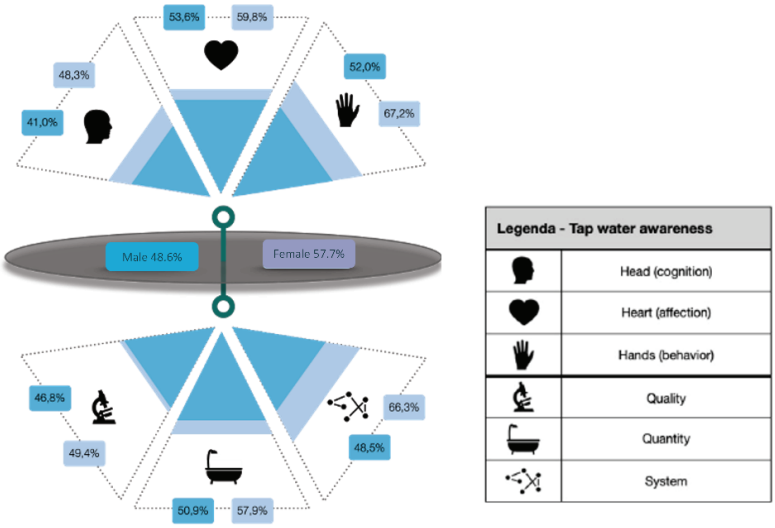

Figure 1. illustration of the aggregated tap water awareness profile for both women and men.

The second pattern relates to the four customer perspectives on drinking water. As presented in Table 1, we find that the respondents with the 'aware & committed' perspective show a significantly higher overall TWA ($p < .001$). On the contrary, respondents with the 'down to earth & confident' perspective show a significantly lower overall tap water consciousness ($p < .001$). When zooming in, it can be observed that not only the total awareness scores reach this significance, but also all three separate awareness dimensions. Indeed, respondents with the 'aware & committed' perspective show a significantly higher cognitive ($p < .05$), affective ($p < .001$), and behavioural awareness ($p < .01$). Interestingly, respondents with the 'down to earth & confident' perspective do not show a lower cognitive TWA. This is a telling result, for it suggests that their relative low behavioural TWA cannot be explained by the fact that they have less water knowledge, but simply because they care less. A partly opposite result can be seen in respondents with the 'quality & health concerned' perspective, characterised by their focus on personal preferences and health. Even if these customers show a lower cognitive tap water consciousness, they, at the same time, show a higher affectional tap water consciousness.

6. CONCLUSIONS

This study shows that a complex and multifaceted concept such as TWA, which seems to have become a catch-all term, can be well conceptualised and operationalised into a practicable empirically-based assessment framework. Consistent with the organizing principle of head, heart, and hands, this three-by-three dimensioned assessment framework distinguishes between cognitive, affective and behavioural awareness of tap water; nine components; and a questionnaire, which subsequently has been empirically tested in a large-scale survey in the Netherlands.

Overall, this assessment has demonstrated that, as previously observed by the OECD (2014), TWA in the Netherlands shows ample room for improvement. This is especially the case for the cognitive dimension of TWA. The scores for both affective and behavioural tap water awareness are slightly higher, with the components 'tap water source protection' and 'curtailment & efficiency behaviour' as positive outliers.

The tap water assessment analysis becomes even more interesting when we break down the scores for the different dimensions and components to different types of customers. It is striking that women score higher than men on most aspects of TWA, whereas other socio-demographic variables were not or hardly distinctive.

Segmentation based on the drinking water customer perspectives show, as previously reported by, for instance, Koop et al. (2021), clear differences all along the line.

The combined insight into the different customer perspectives and the proposed assessment framework may facilitate both the effective implementation and evaluation of future TWA raising campaigns. After all, for policymakers it is important to acknowledge that TWA consists of more than caring for water alone, and that e.g. the tap water knowledge people may have not always aligns with their conservation efforts or quality protecting behaviour. Moreover, it is important to appreciate that techniques that may work well for customers with, for instance, the 'aware & committed' perspective may generate an entirely different effect on customers holding a 'quality & health concerned' perspective. Future research is needed to determine which strategies can best be used to increase the TWA of different types of customers.

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