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CLASSROOM SURVEY TO GAUGE HOW THE THREE PILLARS OF SUSTAINABILITY ARE PRIORITISED FOR THE URBAN WATER AND WASTEWATER SYSTEM

Klassrumsundersökning för att mäta hur de tre pelarna för hållbarhet prioriteras för urbana vatten- och avloppssystem

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Abstract

This brief article presents the results of a survey conducted by the author during a lecture on 'Holistic Approach to the Study of Water and Wastewater Systems,' as a part of the course – Treatment Technologies (Reningsteknik), taught in the Department of Chemical and Engineering Sciences, at Karlstad University (Karlstad, Värmland, Sweden). While all the respondents – there were 23 of them – valued the social aspect the highest – perceptible differences were seen in the way the weighting factors were assigned, even among respondents hailing from the same city. A total of fourteen cities were represented by the 23 students surveyed. The grand average was 41.1 % (social), 32.6 % (environmental) and 26.3 % (economic).

Key words – Sustainability, social, economic, environmental, weighting factors, Sweden

Sammanfattning

Denna artikel presenterar resultaten av en undersökning som författaren genomförde under en föreläsning om »Holistisk strategi för vatten- och avloppssystem», som en del av kursen – Reningsteknik, undervisad på Institutionen för Kemisk- och Ingenjörsvetenskap vid Karlstads universitet (Karlstad, Värmland, Sverige). Medan alla respondenter – totalt 23 stycken – värderade den sociala aspekten högst, var det märkbara skillnader i det sätt som viktningsfaktorerna tilldelades, även bland respondenterna från samma stad. Totalt var 14 städer representerade av de 23 studenter. Genomsnittet var 41,1 % (socialt), 32,6 % (miljö) och 26,3 % (ekonomiskt).

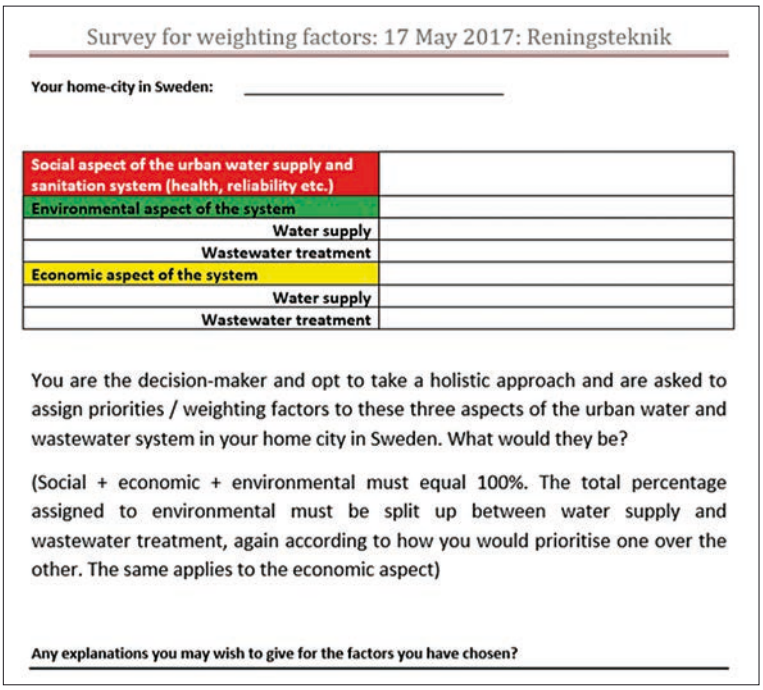
Introduction and background

The paradigm of a holistic outlook in analysing the sustainability of a system is now well-entrenched in academics, industry and government. If the world has to develop in a sustainable fashion, all the economies in it have to place sustainable development at the top of their respective agendas. For a national economy to advance towards sustainability, all the sectors comprising it need to embrace the triple bottom line approach. The urban water and wastewater system – a key component of urban infrastructures – with its complex forward and backward linkages to various sectors of the global economy is one of them. The underlying *mantra for sustainable urban water and wastewater systems* would be to provide the level of service desired by consumers and stipulated by regulations (value for the consumers' money in other words), while keeping a tight rein on the total expenses, optimising the consumption of materials, chemicals and energy, and progressively reducing – as and when possible – the environmental footprint of the water and wastewater system (Venkatesh, 2011).

The social aspect includes safety, health and reliability of water supply, and proper handling and treatment of sewage – almost a *sine qua non*, for that is the *raison-d'etre* of urban water and wastewater systems. But while justifying the purpose for which they exist, these systems have to try to be environment-friendly and economically-sustainable at the same time. It is a tight-rope walk, and priorities keep changing geographically and temporally. In Venkatesh, et al (2014) and Venkatesh (2014), the dynamic metabolism model (DMM) developed as part of the EU-project TRUST (European Union Seventh Framework Programme, FP7/2007e2013, under grant agreement no_ 265122) which calculated the values four different categories of sustainability-indicators – functional, physical, environmental and economic – was tested for proposed interventions in the urban water and wastewater system of Oslo. The social aspect was not explicitly modelled in the DMM. The indicators whose values were calculated in the analyses referred to, were not weighted or prioritised, and thereby no aggregation to a single 'sustainability index' of some kind was attempted. However, in a subsequently-published paper – Venkatesh et al (2015) – in order to compare different approaches to coagulation in a water treatment plant in Oppegård in southern Norway, experts were contacted for weighting factors for the three criteria – economic, environmental and water quality (the third one being a proxy for social) – and relative sustainability indices were calculated for the alternatives. In this article, a similar survey was carried out among students of a second-year engineering class, after a 90-minute lecture in which the holistic approach was introduced to them, and published case studies of Oslo presented. The responses thereby are characterised by the element of spontaneity and can be considered to be closer to how the respondents really value the three pillars of sustainability in general, and also when it comes to the urban water and wastewater system in particular. It must be mentioned at this juncture that an increase in costs and environmental impacts is deemed to be unsustainable, while an increase in water quality, reliability of supply and better sanitation (indicators of social sustainability) is desirable.

Survey questions

The survey sheet handed out to the students looked like the one shown in Figure 1. Apart from weighting factors for the three aspects – social, environmental and economic, they were also requested to indicate the split between the upstream (water supply) and downstream (wastewater handling) for the economic and environmental aspects. They waited till the end of the lecture – which itself was quite interactive – and got down to entering their weighting factors just before leaving the lecture hall.



Survey for weighting factors: 17 May 2017: Reningsteknik

Your home-city in Sweden: _____

Social aspect of the urban water supply and sanitation system (health, reliability etc.)	
Environmental aspect of the system	
Water supply	
Wastewater treatment	
Economic aspect of the system	
Water supply	
Wastewater treatment	

You are the decision-maker and opt to take a holistic approach and are asked to assign priorities / weighting factors to these three aspects of the urban water and wastewater system in your home city in Sweden. What would they be?

(Social + economic + environmental must equal 100%. The total percentage assigned to environmental must be split up between water supply and wastewater treatment, again according to how you would prioritise one over the other. The same applies to the economic aspect)

Any explanations you may wish to give for the factors you have chosen?

Figure 1. *The hand-out given to students for the survey.*

The responses

The 23 students hail from 14 different cities in Sweden, as shown in Figure 2. All these cities are in the southern part of the country, with nine of them being in the west. The cities are, in random order, Stockholm, Karlstad, Västerås, Bengtsfors, Falun, Malung, Arvika, Norrköping, Säffle, Kristianstad, Henån, Uppsala, Uddevalla and Sysslebäck. While there were two respondents each from the Swedish capital city and Kristianstad, Karlstad (the venue in which this survey was carried out), accounted for eight of them. All the other 11 had one representative-student each.

From Figure 3, one can see that 12 students have assigned a weightage of 40 % to the social aspect, seven of them have given it a weighting of 50 % or more. A Stockholmer assigns the highest weightage to this criterion – 60 %, while one each from Karlstad, Kristianstad and Norrköping assigns 30 % to it. Some comments about the social aspect are worth quoting here. The Stockholmer who assigns 60 % opines, *'It is advisable to improve water quality and ensure that people do not contract water-borne diseases. Else, it would be a case of penny-wise-pound-foolish, as more money would need to be spent on medicines!'* Two respondents from Karlstad who assign 40 % and 50 % each to the social pillar of sustainability comment thus: *'Quality of drinking water is surely more important. This would make people drink water straight from the tap and not spend money on buying bottled water.'* A glimpse here of the socio-economic aspect…the 'grey' zone between the social and the economic. '*Water is cheap. So, I would give more weight to the environmental and social aspects, even if that would cost more…would be happy to pay more to treat water better.'* A Kristianstad respondent who gives a 40:30:30 to social:economic:environmental, simply states – *'Health must always be the top priority!'* The average for the sample set of 23 students for social sustainability is 41.1 %.

The economic criterion was split into two, as mentioned earlier – economic sustainability of the water supply system (water treatment and water distribution), and economic sustainability of the downstream wastewater handling system (wastewater transport and wastewater treatment/recycling/discharge). However, 20 of the 23 refrained from splitting the weightage between these two. The three who did, hail from Säffle, Arvika and Karlstad. Two of them weighted the economic aspect of the upstream slightly lower than that of the downstream – implying that optimising expenses on wastewater handling is more important than doing so on water supply. The least weightage for the economic aspect is 10 % (5 % each for the upstream and downstream). This translates into a much greater focus on supplying water of high quality and also reducing the environmental footprint of water supply and wastewater treatment. The Karlstad student, who assigned 10 % to the economic aspect, has split the remaining 90 % between the social aspect and the environmental aspect in a 5:4 ratio (that is, 50 % and 40 % respectively). The Kristianstad respondent who thinks exactly the same way as his Karlstad classmate does, however, gives 60 % to the environmental aspect! The highest weightage for the economic aspect comes from Malung. Some com-

Figure 2. *Locations of cities/towns in Sweden, respondents represent.*

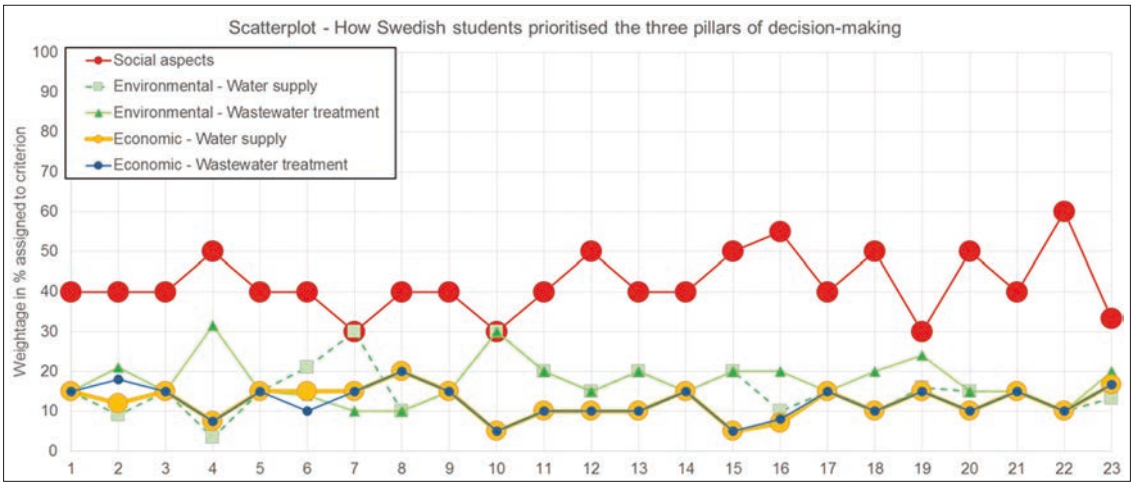


Figure 3. *Scatterplot of the 23 individual sets of responses.*

ments related to the social criterion above bordered on the economic as well. Here are some more, with a stronger economic focus – *'More people want better-quality water but they are not willing to pay for it.'* This one comes from Henån. A very insightful, far-thinking one from Bengtsfors – *'I would have weighted the economic aspect a little lower. But Bengtsfors is a small city and it is necessary to spend money on some other things to make more people move in. Once the population builds up and the city starts growing, the economy can be weighted less and the environment is a little more.*' The student now, wishes to assign a weighting factor of 20 % to the economic aspect. A Karlstad student gives it 10 % and says, *'Water is cheap, I think, currently. I would like to focus on social (50 %) and environmental (40 %) aspects more, even if that would cost more money. Personally, I would be happy to pay more for water and sanitation services.'*

Now for the environment. This too was split into two – upstream and downstream. In the lecture, the case of Oslo had been presented and the potential of the downstream to be a 'prosumer' of energy, a causer of some environmental impacts and an effective reducer of some others was explained. Again, not all the respondents have split up the weightage for the environmental category into two. The most striking response was from Uppsala – a split of 3.5 %: 31.5 %, with wastewater handling getting a weighting 9 times greater than water supply. The fact that wastewater treatment consumes a lot more chemicals than water treatment causing upstream impacts, and also causes eutrophication was not lost on this respondent. A Karlstad student observed, *'Wastewater causes more environmental damage, and so I would give it more weightage than water,*' and assigned 20 % to the downstream vis-à-vis 10 % to the upstream. For the lone respondent from Säffle who figures earlier in the discussion, wastewater handling is 2.33 times more important than water supply, when one thinks of the environment.

Figure 4 presents the city-wise averages (in most cases, the averages are the same as the weightages assigned by

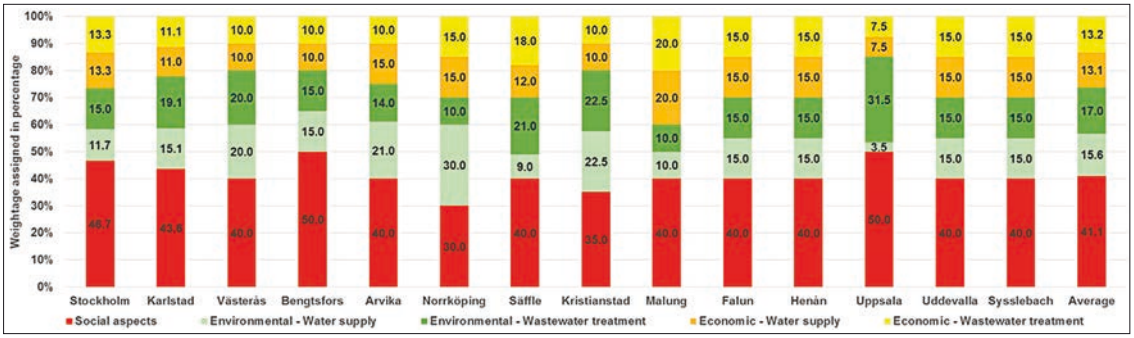


Figure 4. *Average weighting factors for the 14 cities represented in class, and a grand 'Swedish' class-average.*

the lone representatives of those cities), along-with the grand average at the extreme right. The limitation of this survey is of course, the small sample size. But what makes it interesting is the fact that 14 cities from Sweden are represented. It may not be appropriate to make any generalisations from Figure 3, without enlarging the sample size and having more responses from the cities in question.

Health and reliability triumph over moolah and milieu

The final output of this survey then is the average weighting factors. The social criterion takes 41.1 %, while the environmental aspects of water supply and wastewater treatment take 15.6 % and 17 % respectively (implying that wastewater treatment deserves a little more attention than water supply when it comes to reducing the environmental footprint). The economic criterion accounts for the remaining – split almost equally between the upstream and the downstream.

Acknowledgements

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