Loughborough University

ISS-EWATUS

Integrated Support System for Efficient Water Usage and Resources Management (ISS-EWATUS)

Open Public Event

Thursday 5th May 2016
9:30am to 1.00pm
School of Business and Economics, Sir Richard Morris Building (BE2.50)

Organiser: Dr Lili Yang, Reader

In collaboration with partners from Poland, Greece, Spain, Netherlands and UK

European Commission funded ISS-EWATUS (www.issewatus.eu) represents a collaboration of water management and ICT research specialists. At this event, researchers will present their progress and interim findings. There will be an opportunity to ask questions and discuss the project with consortium members and other water stakeholders.

Highlighted Points of the Event:

- An app-based decision support system to offer residential water users feedback on their household's water consumption, broken down by end use, as well as bespoke water-saving tips.
- A social-media platform to link consumers and water experts.
- A municipal decision support system to facilitate a reduction in leaks in the water delivery system.
- An adaptive pricing policy to promote water-saving behaviour and reduce peaks in water and energy distribution loads.

Attendance is free and refreshments are provided. Please register by contacting Kim Perren at: K.Perren@Lboro.ac.uk

Funded by EU's 7th Framework Programme for Research and Technological Development

Open Public Event of the EU Project __ ISS-EWATUS

09:00am – 09:30am	**Arrival (Tea/Coffee/Biscuits/Juices)**
09:30am – 12:30am	**Chair: Dr Lili Yang, Reader,** School of Business and Economics, Loughborough University **Welcome speech by Professor Tracy Bhamra,** Pro Vice-Chancellor for Enterprise, Loughborough University **Presentation by Professor Jim Saker, Associate Dean (Enterprise),** School of Business and Economics, Loughborough University **Presentation by Professor Tom Jackson, Acting Associate Dean (Research),** School of Business and Economics, Loughborough University **Introduction to the ISS-EWATUS project:** Project Leader Dr Ewa Magiera Institute of Computer Science, University of Silesia in Katowice, Poland **Presentation on the Decision Support System at Household Level:** Professor Shuang-Hua Yang Head of Computer Science Department, Loughborough University; Dr Tomasz Jach Institute of Computer Science, University of Silesia in Katowice, Poland Dr Kim Perren School of Business & Economics, Loughborough University **Presentation on the Decision Support System for municipal networks:** Prof Chrysi Laspidou Department of Civil Engineering, University of Thessaly, Greece **Break** **Presentation on the collection and storage of spatio-temporal data:** Dr Rafal Ulanczyk Institute for Ecology of Industrial Areas, Poland **Presentation on the social media platform - Watersocial.org:** Dr Zhenchen Wang/ Safa El-Jamal, Software Engineering Laboratory, Brunel University
12:30pm – 13:30pm	**Lunch**

A case study of Internet of Things: a wireless household water consumption monitoring system

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***Abstract*—In this paper IoT application is illustrated through a real implementation of global household water consumption monitoring system across two countries in the Europe. A novel wireless water consumption monitoring system is designed, in which flow rate/temperature sensors are placed at different detection spots in a house to collect data, and the collected data is routed to a remote computer server via the home WiFi and the Internet. The designed system was installed and tested in 30 recruited households, 10 in Sosnowiec, Poland and 20 in Skiathos, Greece. It has been demonstrated that the global system is capable of providing remote, near real-time monitoring of water consumption in different households. Lessons learned from this real applicationy has been summarised to guide further work.**

I. Introduction

Water is one of the most important natural resources on the earth to life, prosperity and wealth. As Marshall [1] remarked, water has played a crucial role in the location, function and growth of communities. However, the water crisis has been announced by the World Economic Forum as the No. 1 global risk based on the impact to society (as a measure of devastation) and the 8th based on the likelihood of occurring within 10 years [2]. The World Health Organization has reported that 750 million people around the world lack access to safe water, which is approximately one-ninth of the world's population [5]. More disturbingly, these numbers will continue to grow. Some part of western, modern world becomes not much different from areas of third world affected by water scarcity. The extreme weather and the global warming will cause drinkable water less available in more areas, even now the water scarcity has already affected 17% of EU territory. In the light of these disturbing facts, any cause of water wastage should be identified and removed if possible. Water usage at a household level can be effectively reduced by increasing consumers' awareness and changing their inappropriate water use behaviours in the daily routine, e.g. brushing teeth with a running tap, using toilet as a dustbin, leaving a leaky faucet unfixed and etc.. To cut off such wastage, a real-time household water consumption monitoring system is required, through which the detailed information of the amount and the way water is used in a household can be collected, and further analysed to identify wastage and find potential saving opportunities.

The Internet of Things (IoT) is a scenario in which objects, animals or people with communication, sensory or action capability are uniquely addressed and inter-connected via wired/wireless technologies to achieve desired goals. Since the concept of IoT was introduced in 2005, the deployment of it has been seen in a diversity of domains, such as smart cities and homes [9], [10], smart grid [11], healthcare [12], environment monitoring [14], emergencies [13], logistics [15], industrial control [16], [17] and etc.. IoT has also been applied for water resource management, e.g. monitoring of tap water quality in cities, detection of leakages and wastes in rivers and sea, monitoring of water level variations in rivers, dams and reservoirs, detection of liquid presence outside tanks and pressure variations along pipes. In this paper a novel wireless monitoring system for water consumption at a household level is designed using the concept of IoT, in which sensors are installed at different detection points in a house for data acquisition, and the acquired data is routed to a remote computer server for analysis via the local WiFi and the Internet. The designed system was installed and tested in up to 30 households, 10 in Sosnowiec, Poland and 20 in Skiathos, Greece. It has been demonstrated that it is capable of providing remote, near real-time monitoring of water consumption in different households. It can be considered as the application of IoT in the field of household water management.

The rest of the paper is organised as follows. Section II briefly describes the features of the IoT. The design of the IoT based water consumption monitoring system is given in Section III. Afterwards the application results of the monitoring system are presented in Section IV. The lessons learned and limitations identified from the case study are introduced in Section V before concluding the paper in Section VI.

II. Internet of things

The Internet of Things (IoT) is a paradigm in which a variety of pervasively present "things", such as devices, sensors, actuators, mobile phones, are provided with unique identifiers and the ability to interact with each other and cooperate with neighboring smart components to reach a common goal. A thing, in the Internet of Things, could be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low - or any other real or virtual object that can be assigned an IP address and provided with the ability to transfer data over a network. The

978-1-5090-0366-2/15/$31.00 ©2015 IEEE

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Procedia Engineering 119 (2015) 1391 – 1398

Procedia Engineering

www.elsevier.com/locate/procedia

13th Computer Control for Water Industry Conference, CCWI 2015

A Benchmarking Model for Household Water Consumption Based on Adaptive Logic Networks

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Abstract

Household water benchmarking is an important step in evaluating a household's water usage and comparing it with similar households. It can provide an indicator if a household consumes more water than usual during a certain period of time or some households consume more than other similar households in a particular region. This paper proposes a benchmarking model for household water consumption based on Adaptive Logic Networks (ALNs). Real world data collected by a water consumption monitoring system installed in Sosnowiec, Poland and Skiathos, Greece is respectively used to build a model for each city. The results indicate that the developed models can successfully prediction for a particular use purpose.

Peer-review under responsibility of the Scientific Committee of CCWI 2015

Keywords: Household water consumption; Benchmarking; Socio-demographical factors; Adaptive Logic Networks

1. Introduction

Water has been identified as one of the most significant natural resources and a key to prosperity and wealth. As Marshall [1] remarked, water has played a crucial role in the location, function and growth of communities. However the World Economic Forum has announced in 2015 that water crisis ranks the eighth global risk with the highest likelihood of occurring within 10 years [2]. In the light of these facts, any cause of wasting water should be identified and removed if possible. During daily routines, water usage at a household level can be effectively reduced by increasing consumers' awareness and changing their inappropriate habits, e.g. brushing teeth with the tap running, using toilet as a dustbin, leaving a leaky faucet unfixed and etc. To cut off unnecessary water wastage, a benchmarking model is required to provide a baseline measure with which the water consumption can be compared. Based on the comparison result, water wastage can be identified, and accordingly the intervention strategy can be designed and deployed.

There has been a great deal of research conducted on water benchmarking. [3] gives a comprehensive review on the state-of-the-art water benchmarking methodologies. In this paper we propose a benchmarking model based on Adaptive Logic Networks (ALNs). It takes the socio-demographical information as inputs and outputs a prediction

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Peer-review under responsibility of the Scientific Committee of CCWI 2015
doi:10.1016/j.proeng.2015.08.998

Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 119 (2015) 1447 – 1454

Procedia Engineering

www.elsevier.com/locate/procedia

13th International Conference on Computing and Control for the Water Industry, CCWI2015

Psychosocial and behavioural factors associated with intention to save water around the home: A Greek case study

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Abstract

As potable water becomes an increasingly scarce resource, its conservation has become a high priority around the world. This paper investigates psychosocial and behavioural factors influencing consumers' intention to engage in everyday water saving actions around the home. A web-based survey was used to collect data from 174 individuals in Greece. An extended theory of planned behaviour perspective was used to model intention to engage in water saving actions around the home. Research hypotheses were constructed regarding the influence of attitudes, subjective norms, perceived behavioural control, information exposure and current engagement in water saving actions. Engagement in water saving behaviour, and active engagement with information on water conservation, predicted intention to save water; however, mere exposure to information was not implicated. Subjective norms and perceptions of control predicted intention to save water but attitudes towards saving water did not.

Peer-review under responsibility of the Scientific Committee of CCWI 2015

Keywords: Household water saving; Theory of planned behaviour; Web survey; Linear regression

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Peer-review under responsibility of the Scientific Committee of CCWI 2015
doi:10.1016/j.proeng.2015.08.1005

Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 119 (2015) 1409 – 1418

Procedia Engineering

www.elsevier.com/locate/procedia

13th Computer Control for Water Industry Conference, CCWI 2015

Household Water Consumption: Insight from a Survey in Greece and Poland

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Abstract

Determining the behavior of domestic water consumers can facilitate a more proactive approach to water demand management, and serves as the foundation for the development of any intervention strategies that seek to bring about sustained and substantial reductions in domestic water consumption. As part of the European Union (EU) funded project Integrated Support System for Efficient Water Usage and Resources Management (ISS-EWATUS), a household water consumption survey was administered to address the question of how water was used within the home in the EU. The survey was distributed by the University of Thessaly in Greece, and the Institute for Ecology of Industrial Areas in Poland. This paper represents the research output of the survey, including the analysis of three major elements pertinent to the behavior of domestic water consumers: end use behaviors; socio-demographic and property characteristics; and psychosocial constructs such as attitudes and beliefs.

Peer-review under responsibility of the Scientific Committee of CCWI 2015

Keywords: Household water consumption; Consumer behavior; Survey

1. Introduction

Population growth, expansion of business activity, urban development, water pollution, climate change and drought have contributed to increased water scarcity in many parts of the world. It is estimated that a fifth of the world's population live in areas of physical water scarcity, where there is not enough water to meet all demands. One

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Peer-review under responsibility of the Scientific Committee of CCWI 2015
doi:10.1016/j.proeng.2015.08.1001