Building collaboration between academia and local authorities: a case study in Norway

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Abstract: Universities and their environments are aimed to collaborate towards a better society. Academics must spread and apply their knowledge in real settings in order to advance in their careers and, on the other hand, local players present problems that may need the application of advanced knowledge and sometimes basic research to be solved. In the specific scenario of local authorities, this collaboration presents special features given the intrinsic and close relationship among actors and the non-profit orientation of these organizations. This paper presents the construction overtime of the collaboration between a department of a public university and a municipality conducted in Norway. Results show a remarkable outcome in terms of cross-fertilization for both research institutions and local authorities.

Keywords: Intelligent Waste Management; Local Authorities and Universities Collaboration**;** Green IT;

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1 Introduction

Recent studies show the changing role of higher education institutions from a conventional research and education role to serving as an innovation-promoting knowledge hub (Perez-Gonzalez, Soto-Acosta, & Popa, 2014; Youtie & Shapira, 2008). Thus, nowadays, modern universities are aimed to contribute to local and regional development processes, apart from their classical knowledge transfer within education and lifelong learning roles (Peer & Stoeglehner, 2013).

The so-called triple helix of university-industry-government (Carayannis & Campbell, 2012, 2009; Leydesdorff & Etzkowitz, 1996, 1998) is now ruling the whole university panorama and changing the vision of academics about their work. In this

scenario, professionals working in higher education institutions are aimed to build relationships with both sectors to achieve their professional goals and gain stability and recognition. Moreover, according to (Casper, 2013), the interdependences and virtuous circles present among local economies, number of contacts between industry and academia and, finally, the spread of knowledge are ruling the overall panorama of universities and local government and industry relationships (Del Giudice & Della Peruta, 2016; Del Giudice & Maggioni, 2014). Focusing on this issue, the relationship between academics and their environment has defined academic engagement as "knowledge-related collaboration by academic researchers with non-academic organisations" (Perkmann et al., 2013). The topic of academic engagement has been pervasive in literature from the pioneering work of Boyer (1996) to more recent developments in different fields (e.g. Georgakopoulos & Hawkins, 2013; Hammel et al., 2015; Mtawa, Fongwa, & Wangenge-Ouma, 2016; Perkmann et al., 2013; Porter et al., 2015). Digging deeper into the topic of engagement, according to Nye & Schramm (1999) and Reardon (2006) there are three kinds of setups in the relationships between university and the environment:

- Paternalistic / theory-testing partnership. Community is seen as a testbed for testing research hypothesis by academics.
- Professional/expertise partnership. Issues identified by local authorities are addressed by academics, nevertheless, the approach to solve these problems is controlled by universities without a deep dissemination of the knowledge they produce in the community.
- Empowerment/capacity-building partnerships. The understanding of problems by academics is gained by close cooperation with local residents and authorities. The ability of community/university partnerships to jointly solve problems is rooted in the generation of useable knowledge by universities.

Although the topic of the collaboration between local authorities and academia is not new and cases have been reported in the literature (Del Giudice, Della Peruta, & Maggioni, 2015; Hudson, 2006; Lundberg & Andresen, 2012; Reardon, 2006), the attractiveness and soundness of the topic along with the particularities of the collaboration with local government makes case studies inspiring to achieve the goals of local cooperation and cross-fertilization that higher education institutions need to put in place to fulfil their mission. According to Reardon (2006), in such collaborations, problems like skepticism on academics motivation and commitment may appear along with different paces in decision making and working styles. In these scenarios, knowing cases in different areas could shed some light into positive behaviours and best practices. This paper reports an effort on the collaboration between a public university and a municipality conducted in Norway. So, the justification of this work lays on the need to know the different steps to take by both sides of the collaboration in order to improve positive behaviours in all steps of the collaboration ladder.

Focusing on Norway, the report issued by Rambøll shows that the cooperation among municipalities and public universities is especially prominent in several sectors in Norway. In the information technology (IT) sector, the cooperation is less intense. The reason behind this pale collaboration is twofold: 1) the lack of interest from the municipalities' side; and 2) the preferred interest of students regarding the private sector. In any case, this report presents evidence of increased theoretical, professional and methodological competence in both sectors in the cases in which these two actors

collaborate together. Results of these collaborations also led to two different outcomes in both sides of the collaboration: innovative services and improved education. The last element worth to note in the sphere of this work is the mandate from government to municipalities to offer good services to citizens and the need to offer these services in a better and smarter way.

Despite the local orientation, findings and experiences can be of interest to a broader audience given that universities are aimed to develop a mature collaboration with local authorities in all parts of the world. In this paper, authors underline positive aspects like cooperation and the outcomes in terms of mutual understanding and collaboration towards a common and shared goal.

To do so, the remaining of the paper is structured as follows. Section 2 presents the Faculty of Computer Sciences at Østfold University College. Following that, section 3 introduces the Halden municipality in Norway. Section 4 presents the case study of the project. Then, section 5 explains the different levels of cooperation established between Halden municipality and Østfold University College and, finally, Section 6 wraps-up the paper, introducing main conclusions and suggesting futures avenues of research.

2 Østfold University College

Østfold University College (Norwegian: Høgskolen i Østfold) is a higher education institution in placed in south-eastern Norway. Østfold University College (Hiof), founded in 1955, is a medium-sized university college with around 7000 students and 550 staff members. Østfold University College offers 60 subjects of study in two regional cities - Halden and Fredrikstad. Hiof is articulated in 7 faculties including the Faculty of Computer Sciences, placed in the Halden campus.

With around 25 members and 500 students, the Faculty of Computer Sciences at Østfold University College, is one of the largest Computer Sciences faculties in Norway. The Faculty has two different research groups and offers four bachelor programmes, namely: Bachelor's programme in Computer Engineering, Bachelor's programme in Digital Media, Bachelor's programme in Computer Science and, finally Bachelor's programme in Information Systems. The Faculty of Computer Sciences at Østfold University College offers a Master's degree in “Applied Computer Science”. The master programme in Applied Computer Science extends over a period of two years and awards totally 120 ECTS, of which 45 ECTS credits make up the master's thesis.

Both in undergraduate and graduate studies, students must write a final thesis (master or bachelor) to complete their studies. These kind of tasks are developed by students under the supervision of one member of the department and are normally oriented towards the resolution of a real problem. Apart from this practical orientation, many courses require smaller projects. As reported in the literature, Problem-Based Learning (PBL) is a learning approach in which students use “triggers” from the problem case or scenario to define their own learning objectives (Wood, 2003). Having its origins in the 1960s, PBL has been reported as a valid approach for computing education e.g. (Garcia-Crespo et al., 2009; Macias, 2012; O’Grady, 2012; Santos et al., 2013; Tovar et al., 2007). However, one of the reported problems of the approach is counting with a rich set of cases and experiences for the students to be engaged and learn from them. PBL is a common approach in civil, electrical, computer and software engineering. In the

department of computer sciences at Hiof, PBL is also key to gain the learning objectives for many courses in both master and bachelor programmes.

3 Østfold County and Halden Municipality

Østfold is a county in the south east side of the Oslofjord bordering Sweden. Population is mainly located in the coastal area and as a consequence of this, main cities (Sarpsborg, Fredrikstad, Moss and Halden) are situated at the Oslofjord.

Halden is one of the most important municipalities in the Østfold region being the natural entrance to Sweden from Oslofjord. Halden's business include aspects like wood processing, agriculture, energy, information technology, electronics, engineering, chemicals and manufacturing industry. Halden is the largest forestry municipality in Østfold and is the second largest agriculture municipality in the county. Apart from this traditional activities, around 1500 people work in Halden in IT and Research & Development (R&D) activities. In this last factor, it is important to underline that Halden presents the third largest R&D environment per inhabitant in the country.

Halden has a population of 30,328 people, most of them (85%) living in the main city or in small villages outside the city. Halden municipality is responsible for the Municipal Solid Waste Collection (MSWC) which is done by a contractor on the behalf of the municipality.

4 The arena for the project

In Halden, organic and mixed waste are placed in a two chambered bin and collected every second week. The other fractions as paper/cardboard, plastic and glass/metal are collected at nine drop points (miljøstasjoner). Waste from summerhouses is collected from twenty containers located at different spots in Halden. Collection from the drop points and summerhouses is a challenging task since a lot of emptying is done on half-filled containers making the overall process quite inefficient.

As a part of this project, Halden Municipality installed ultrasonic sensors in bins. These sensors, in combination with algorithms for dynamic route planning, are expected to drive to a reduction in total emptying but also to a more efficient route planning reducing finally the overall carbon print of the service. However, still some challenges exist including aspects like local customization, filling rate and adjusting of type, and volume and amount of containers at the different drop points.

According to Statistics Norway (Statistics Norway, 2014) municipalities handled 2.3 million tons of household waste in 2014 and generated 496 kg of municipal waste per capita in 2013, which is 15 kg above the European average. The amount of municipal waste is expected to grow by 25 % from 2005 to 2020 and, what is more important, better management of municipal waste will reduce greenhouse gas emissions (European Environmental Agency, 2016). To achieve these objectives, emissions could be reduced when using greener transportation systems, one of the problems faced by waste collectors is repetitive stops and starts and inefficient routing schemes (Maimoun et al., 2013). These inefficiencies are the main aims in this project.

This is specifically the arena of the leading project between the two institutions that will be explained in the following sections.

5 Building the relationship: a layered model

Taking into account the known benefits of problem based learning and the pressures and the overall convenience of collaboration between local authorities and academia, the department of computer sciences at Østfold University College developed a series of activities to create, maintain and nurture the relationship with local government and more precisely with the IT department at Halden Municipality. In this section, authors explain the four consecutive levels in the relationship between parts that are present in the model. Regarding the construction process, it is important to note that some of the authors present previous experience in software process models and improvement initiatives e.g. (Dzombeta et al., 2014; Larrucea et al., 2016; Lema et al., 2015; Ruiz-Rube et al., 2015). The construction process was entirely based on the mapping of these models with the current initiatives in the field and the development of special features to be implemented in the new model.

Level 1- INICIATION

The relationship started five years ago and was initiated by one of the authors searching for relevant and real cases for their courses on the use of technology in organizations. It was a cold door start and, at that time, received a pale but correct answer from Halden municipality. The collaboration initially was intended only to be one of the components in the PBL approach adopted at Hiof. Many companies and institutions in the region are being contacted and used as tools for PBL purposes and municipalities are part of this set. In the case of this regional government, small problems related to IT were addressed in class and some solutions in the forms of modest consultancy reports were issued by academics and students. No payments or contributions of any kind were adopted in this initial step. Overall, although results from a purely educational perspective were good, both the level of collaboration and the contribution and impact were very modest in this initial stage. Cooperative research projects require overcoming institutional and cultural barriers (Lundberg & Andresen, 2012) and in this case, the lack of trust on the applicability of the academic knowledge to the municipality was the most important barrier academics found to develop the partnership. This is roughly a paternalistic / theory-testing partnership, since just small contributions are intended to be developed at this stage (Nye & Schramm, 1999; Reardon, 2006).

Level 2- BASIC COLLABORATION

The main distinction between the previous stage and Basic Collaboration stage is the depth of the collaboration between partners. After some successful efforts in the previous stage, common trust and understanding increased pushing the relationship to a higher level. At this level, more complex problems were identified by the municipality without the contribution of academia in this process of identification. These problems were complex and more in terms of number of prospective projects identified. This circumstance leaded to a different kind of academic works, more advanced in terms of collaboration: bachelor and master theses. In this basic collaboration stage, some students, under the supervision of Hiof's faculty staff, developed solutions for the identified problems. Problems were solved (and theses developed) outside the municipality and there were no contribution of any kind from Halden municipality to support the works, apart from the effort to guide students in their developments. This situation can be seen as a professional/expertise partnership. The approach to solve these

problems is controlled by universities without a deep dissemination of the knowledge they produce outside the delimited projects.

Level 3- ESTABLISHED COLLABORATION

This basic collaboration turns into established collaboration overtime. The difference between these two situations is threefold. First, project identification is performed in close collaboration between institutions. Second, there is an economic contribution for the works performed and, third, there is an integration of academics and students in joint teams to address the problems in the form of projects (master and bachelor theses or applied projects, representing 15 ECTS in the Master programme and 20 ECTS in final bachelor projects).

This is a clear empowerment/capacity-building partnership, since the understanding of the functional problems of the municipality is making academics more efficient in both problem identification and solving. This understanding is rooted in the integration of academics in project teams beyond the supervision of students.

Level 4- MATURE COLLABORATION

From late 2014 onwards, the relationship went to a point in which the collaboration was aiming higher goals. Three circumstances leaded to this new level. First, the relationship between the department and the municipality expanded to more members of the IT department. Second, new resources joined IT department and, third, champions in the team aimed more ambitious projects and research oriented projects. The new people in the IT department possessed experience in research funding and this factor led to several meetings directed towards research funding calls identification and specific project definition.

The first project defined under this schema was “SURWA: Green transport in waste collection by means of ultrasonic sensors and advanced route planning”. This is a joint project developed by Halden Municipality, Østfold University College and ENEVO. The main objective is to develop and test new sensor technology and algorithmics for dynamic route planning in waste collection in medium sized municipalities. The project seeks to contribute to a stronger interdisciplinary cooperation between the university and regional partners and contribute to capacity building in research institutions, municipalities and industry. Research results from the project can contribute to better understand the needs and opportunities of intelligent waste collection based on the use of Internet of things items and smart routing planning. Rooting is the main objective of the project, while several secondary objectives are as follow:

1. Describe current trends of waste collection and use of dynamic route-planning in Norway including previous experiences. Define success factors and make proposals for actions.
2. Design and develop new hardware-firmware software based on information from the sensors, adopting an Internet of things and Fog computing approach including functionalities as follows:
    - Develop an app for inhabitants, so it is easy to find out when it is available space in the waste containers at the “miljøstasjoner”.
    - Develop new programs based on information from the sensors (documentation, billing, etc.).

- Develop new programs based on information from the sensors (e.g. Fire detection).
- Program for locking the containers (Filling only one container at a time in order to eliminate emptying of half full containers).

3. Develop a new smart routing algorithm and system for waste management for households that includes information from sensors and vehicles. Document the effect of dynamic Vehicle Routing Problem (VRP) vs. use of devices for static VRP like Radio Frequency IDentification (RFID) tags or other electronic labels.
4. Document the cost savings and the reduced travelling when using dynamic route planning in waste collection from «*miljøstasjoner* » and summerhouses in Halden. Develop a cost-benefit model. Extend the model to include environmental impacts according to the Smart city concept, calculating metrics like, for instance, carbon print.

The project was presented to a regional research open call (Oslofjordfondet) and was selected to be funded. This is intended to be a pilot project aiming to be continued in future national calls and also European calls.

A total three master students and four bachelor students in their final project plus eight more bachelor students in first grade projects are working in the project and, by the end of 2016, the project is intended to be concluded. Students have planned their works within the project to conclude their thesis at this time.

The Project involves three different parts: Halden Municipality, Østfold University College and, finally, Enevo a company headquartered in Espoo, Finland that is providing sensor technologies to the project. Sensors and back office technology enable crucial aspects in intelligent waste management such as fill level of containers, empty times and waste evolution, among other factors. The sensor data gives the municipality an overview of the actual number of flushes along with the optimization of the overall network. This can be used as the billing basis.

Author

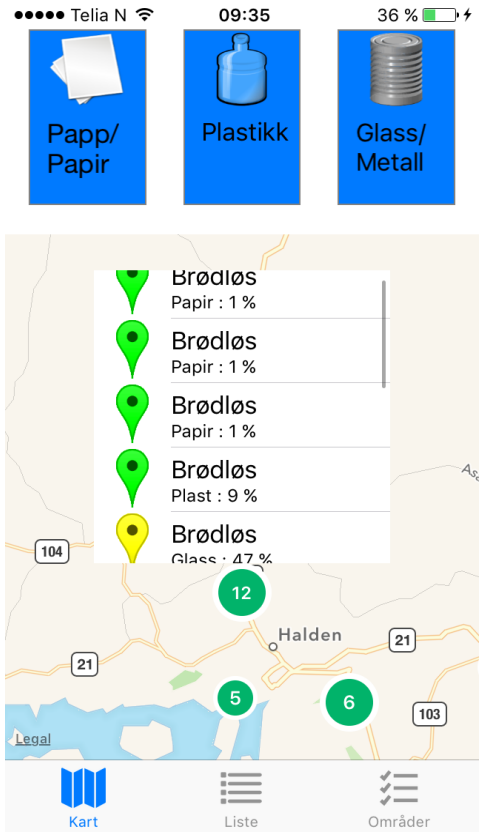

Figure 1. Citizen Application. Geolocalization

Another deliverable from the project is the development of an app that makes sensor data available for citizens. Published in June 2016, using this app, citizens have the ability to check whether a specific container is full or not and available alternatives for disposal. Figures 1 and 2 present some features of the application including aspects like map integration and waste classification. Figure 1 shows the map of the Halden area showing different containers of different kinds (Paper, glass, plastic…) along with the total numbers of containers per zone. Figure 2 is showing details on the specific containers available including information on the specific address as well as their level

Title

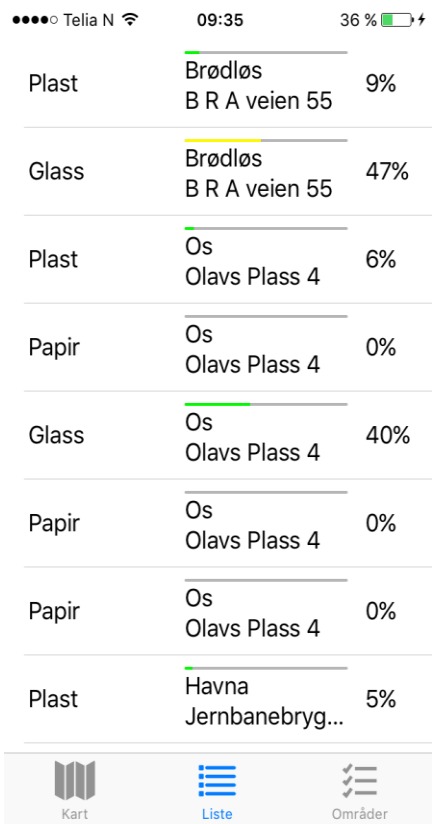

Figure 2. Citizen Application. Overall View

Finally, Figure 3 is presenting a photo on a Cabin container containing a sensor and the tests performed by team to check the accuracy of data provided compared with the actual state of containers. Tests were performed by project group to control possible deviations and detect improvements to app and framework process.

Author

Figure 3. Tests in a Cabin Container.

This project is an example to what we call cross-fertilization capacity-building partnerships. Since the understanding of the functional problems of the municipality is making academics not only more efficient in both problem identification and solving, but also on the understanding of the goals of academics by municipality representatives and their innovative vision and trust in research and development as a driving force behind a better service to the citizens leaded to a virtuous circle reported in this paper.

Cross fertilization implies benefits for all parts. In the student side, these benefits are present in several parts of their studies: a) first, in the form of cases for PBL; b) second, as a testbed for Bachelor thesis; and c) third, in the form of paid apprenticeships recognized by the master program with 15 ECTS, leading them to experience acquisition and finally as Master thesis. In the academics side, apart from the logical testbed and the PBL case source and master and bachelor thesis inspiration and testbed, municipalities are also an important partner in research funding proposals. Finally, in the case of local authorities, workers reported aspects like increased implication compared to other business partners, more continuity, trust, economic reasons (given the reduced cost or the collaboration), source of eventual future employees already tested to be competent and what is more important increased knowledge footprint.

6. DISCUSSION, CONCLUSIONS AND FUTURE WORKS

The framework presented in the paper is bridging the gap in the research of university and local authorities' collaboration. Although the topic is not new, being the works of Lundberg and Andresen (2012) the most comparable effort to date. However, the main differences between this work and the one presented in this paper are twofold: firstly, thee differences in the country of application (although Sweden and Norway are close countries) and secondly the framework itself, that is more oriented to research collaboration and cross collaboration.

Title

In this paper, authors present the collaboration stablished between a municipality in Norway and a public University located in the area. Based on previous works on relationships between universities and their environment, authors propose a new taxonomy in which a ladder for collaboration is presented, justified and instantiated in a case study. The framework is including a set of subsequent layers presenting the different levels of maturity in the framework. Results of the collaboration, that are mapped in the ladder presented via the case study, show remarkable outcomes for both parts along with a promising panorama for further development.

Future works are as follows. First, authors intend to develop a new project on the topic to study in a deeper extent aspects including algorithmics and sensors. Second, from the Østfold University College's side it is planned to develop relations with other municipalities in the region extending the model to the region. Secondly, it is also intended to further develop relations and include more departments within the university and, in addition, more kind of projects including international networks on several topics of interest for both parts. This will articulate the true concept of smart cities that include aspects like civil engineering, materials engineering, architecture, technology and urbanism, naming just some of the most important aspects in such initiatives. Finally, it is intended to present the framework in a picture including the implications and relationships among levels.

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