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Digital age business model innovation for sustainability in University Industry Collaboration Model

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Abstract. This study aims to investigate a digitalization-related business model as a result from the university-SME collaboration. The SME of the case study (Preventos Informatics Ltd) specializes in water distribution systems in industrial scale, telemetry, and sensor data-based monitoring of the water distribution. The business model of the company is a result of an innovation process during 2016-2017. The SME was established 2018. This study examines the commercialization process's success factors and compares the original business model to the finally implemented one after two years. The study reviews the current literature of sustainable business models and digitalization and reflects the results from this study. Based on the results, by quantifying the sustainability, environmental aspects and digitalization, value added can be brought to the business model. Our study suggests that by adding more digitalization, sensor technologies, and data-analysis, quantifying the real value of innovations is possible.

1 Introduction

When collaborating for research, development, and innovation (RDI) and working together for a shared outcome, lot of skills, knowledge, and resources must be shared. Openly shared information can be seen as an accelerator for boosting and promoting novel innovations [1]. Depending on the partners, one of the major factors explaining the effectiveness of cooperation may be, in addition to skills and knowledge, the organizational culture, and how it is used to set up RDI cooperation [35]. As stated in [2], free resources, such as open data, drive the promise of public and private sector innovations. This promise could lead to, for example, the provision of open data to increase citizen engagement. As more open data becomes available, businesses and governments will have more information to access, which should improve decision-making and steer societal development debates in the needed directions. In addition, citizens' commitment can be used to harness the wisdom of the community as a tool for cooperation between municipalities to increase their resource efficiency and enable citizens to participate in the development of municipal activities [3]. As open data can be easily reused, the ingenuity and novelty are reached through the

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integration into business models and the effective use of real-time open data in strategic decision-making.

This article focuses on the business model innovation for the digitalization of the water management sector. Here companies can provide integrated sensor data to build a new kind of competitive advantage, for example, as digital data managing services, or e.g., decision-making support tools for sustainability goals. In the university-industry collaboration context, collaborative innovation usually deals with a specific project with their named goals. The generic problem seems to be the lack of follow-up results [4], which can be partly explained by different operating cultures. On the other hand, if companies find their way to save time and manage the risk of collaborative resources and universities are allowed to do basic research on behalf of companies, a greater number of positive results can be expected [5]. In the field of sustainability–universities have an important role to play in cooperation [6], especially additional value of accessing to technological facilities, their social capital (usually also international view instead of local), student engagement, and sustainable-oriented values [7]. The next decade will have sustainability as centre development goals by the Horizon Europe, indicating clear financial benefits for all new sustainability promoting technologies. In future oriented universities the nature of collaboration is typically co-innovation. Start-ups in such work are expected to be agile, while higher education units and university researchers can leverage technological innovation, ideas, and strategies for entrepreneurs and investors to form a view on financing and the feasibility of commercialization [9].

In the context of sustainability research, one of the key roles of the Earth in sustaining life is water [10] and especially clean water as a condition of life for the planet [11]. That includes humankind making number of bad decisions in the past, which has led to pollution of some freshwater reserves and river flows [12]. Besides of quality of raw water sources, the aging infrastructure of urban water supply systems impairs water safety. On the other hand, the leaking pipes increase water distribution's energy use, having a major negative effect on overall sustainability. For reliable and efficient decision making in the future, the accurate data is needed [13, 14] to make existing problems and opportunities visible in correct scope and scale efficiently. For this specific data collection need, a business model for water monitoring services was created [15]. The idea was to start with a business idea, brainstorm items on the business model canvas, evaluate items in a multi-criteria evaluation based on feasibility, and finally select and design a business model. This service design and co-creation process has been reported in a previous study [15] as part of the Akseli project, which sought and tested new tools and approaches to accelerate business development through smart specialization water safety projects. This study seeks an answer to a research question in this follow-up publication: What were the essential additions to the collaborative sustainable development business model to achieve real implementation after university-industry collaboration?

Digitalization has reshaped the society with novel business models and technologies, but by current research, there is still lot to come from the SME sector [16]. E.g., in the industry side, with digitalization investments, many traditional businesses have transformed from tangible product developers to service businesses [17]. Also, decision-making is moving from asset level to fleet-level [18]. Development has been driven by the large-scale availability of a data, which has not been analysed for the decision-makers before. On the other hand, digitalization boosted the generation of open data and create opportunities for new innovations, specially e.g., for science [19], the public sector [20], and the developing countries [21].

In societies, things do not usually evolve by accident. Motivation and inspiration sources evolve by sustainability innovations, political guidelines, decisions, and restrictions, which are often behind the pressure towards new solutions. According to [23], decision-making in the public sector, related to the municipal area's infrastructure, is based on analysis of huge

amounts of fragmented data, which does force municipalities to seek and utilize more efficient data analysis methods and simultaneously develop data collection, analysing and decision-making tools. For the public sector, trying alone to reach the UN Sustainable Development Goals (SDGs), will be huge undertaking, especially if the given deadline 2030 is the target. In Finland, to meet the given goals in time, the government has published a roadmap with SDGs in close collaboration with private, third and public sectors. The roadmap is a tool to help to go towards globally influencing sustainable financing ecosystem [24]. The mentioned steps are as follows: 1) investments in a sufficient number and quality, 2) convincing the management, 3) customization and identifying proper instruments, 4) influence reflected on SGDs 5) and proper knowledge and skills [25].

For example, according to City on Kuopio, in Finland, they see that evaluation of public decision-making effects has to be based on a pro-active approach. To achieve this, the city included environmental aspects under the ideology of "resource wise" in their strategy. This strategy includes topics like, logistics, circular economy, traffic, renewable energy & energy efficiency, efficient water management and wise use of resources. Political decisions are often also boosting the product development and creates markets for environmentally friendly new technology [54].

2 Method

The studied business model was developed in a four-stage innovation process: 1) context definition, 2) idea generation, 3) determining the business model items through core indexing, and 4) defining the business model and re-designing due analysis of the evaluation information from multi-criteria decision support (MCDS) [15] [38]. The current study compares the 2017 collaboratively designed business model to 2020 implemented version. Many researchers consider business models as slowly constructing iterative processes [42]. Also, researchers agree on a research gap in business model creation and practice-based understanding business model processes [42, 43, 44, 45, 46, 47].

Considering collaborative sustainability, Although consumers are knowledgeable and concerned about global warming and the environment [26], multiple aspects are supporting sustainable purchasing, there are also barriers e.g., in environmental-friendly food shopping: knowledge and marketing do not leads only to good intentions but not into actual purchasing actions, consumers make wrong conclusions, prefer other qualities as more important or they have a lack of awareness, credibility and/or motivation for sustainable purchases [27]. Also, consumer's opinions are polarized towards environmental-friendliness and low price is often competing against sustainability [28]. Sometimes consumers need to be encouraged towards sustainable behaviour, e.g. by digitalization and gamification [29].

The water resources on Earth are stressed by the population and the socio-economic development [30]. Also, the covid-19 pandemic led into decreasing in global markets, although major markets improve somewhat quickly towards normal [30], the unfortunate influences are that companies are postponing their sustainable development activities. Business model development plays a crucial role in survival in changing market conditions [31]. From the real problem setting, the new business model's idea was to secure the domestic water for future generations, based on real real-time data describing the functioning of water distribution. For example, pressure bursts in aging infrastructure (pipes, pumps, valves) cause leaks in distribution network leading to waste of clean water and reducing water safety. Thus, there is a growing need for smart water management to improve predictive control of water distribution, to increase water safety and optimize the efficient use of clean water in general. According to [32], water distribution losses are circa 48 % in Ireland, 23 % in Finland, and 41 % in Romania. The business model responds to this need with a real-time monitoring system for water management to automatically detect and locate abnormal situations as

leakages and pressure bursts with modern IoT technology [33]. The crucial question from the business side is, what are the needed benefits, for the customer to be ready to pay for this sort of sustainability boosting solution?

2.1 Data collection and analysis

The business model process (Fig 1.) includes 5 phases: 1. Design of context (setting of goals plus identification of participants and their roles for the process), 2. Idea generation, 3. Evaluation of Ideas, 4. Core Value calculation, 5. Deployment to achieve value [15, 38]. Instead of building typical nine blocks in a business model canvas, BM consists of 12 building blocks, which are chosen with a portfolio decision analysis (PDA) and multi-criteria decision support (MCDS) [8]. Successful context definition, identification of participants, and goal setting are needed in business model creation.

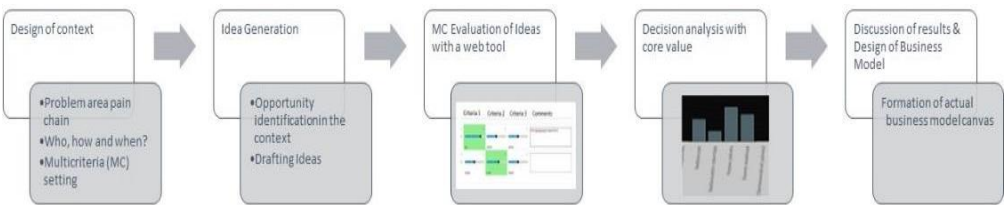


Fig. 1. MCDS business model process (visualising model based on [15, 38])

Based on 2017 developed business model, the Preventos Informatics Ltd. was founded on 2018 with few part-time personnel and first year turnover circa 33,000 €. In March 2019, the full-time operations started, yearly turnover raised to 58,000 €, and services were further developed in cooperation with existing customers, and also new customer relationships were in the mining and water utilities sectors. The updated business model with comparison to the 2017 model is presented in Figure 2.

2017 to 2020 Preventos Ltd. Business Model development analysed in Model Canvas Format

Customer Need Ready and easy to use, customized product. Automation of data analysis, predictive information. Smart water management to improve control, water use efficiency and water safety. Small water utilities have lack of resources, ICT skills and technical support. Ready and easy to use information services. Customized product for water management. Automatization of data analysis, information for predictive maintenance.			
Company Solutions Full-service package for company needs: Reporting Services. ICT service: monitoring water distribution, wireless data transfer and data analysis.		Competing Solutions Commercial information systems. Not many dedicated for water management.	
Key Partners Meter and sensor manufacturers, authorities, ICT automation systems Wireless IoT data logger	Value Proposition Easy to use, saving time, useful information available , Accurate long lasting wireless measurements , situational awareness	Key Tasks Ensure supply chain monitoring & operational stability, guaranteeing continuity.	Customer Relationships Refined measuring data, long-term customer relationships
Key Resources Service providers (software, knowledge transfer & accounting, field experts, environmental measurements & data production)		Customer Segments Companies and industrial sector. Water utilities (small to large), food industry (dairies), municipalities and cities (storm water)	
Cost Structure Sensors, wireless data loggers, cloud-based ICT system development, system maintenance, marketing and sales		Channels Internet, direct contacts, sensor-supplier , social media	
		Cash Flow Improved risk management, preventing and minimizing (environmental) damages. Improved water safety, planning of water network rehabilitation planning	

Fig 2. Extended Business Model Canvas comparison of 2017 designed BM and 2020 actual BM.

The CEO of Preventos Informatics Ltd. and participating researchers from the initial RDI process were interviewed to gather data about the comparison of 2017 with MCDS tools developed business model and actual 2020 existing business model. In the original canvas, the criteria for evaluating ideas (Fig. 1) in the business model process were business potential, customer need/benefit, and results were collected into extended business model canvas [15,

48]. These criteria’s turned out to be chosen wisely by the business model process participants, because no much has changed from 2017, but some building blocks have been iteratively developed serving customer needs even better than in original plan (Figure 2).

When considering market potential, water rehabilitation needs in Finland are 320 million euros in the next 15-20 years. There are 1,500 water utilities in Finland of which municipalities own 400 of them and 1,100 are privately owned small water utilities. Many industries are dependent of water and there are 50 dairies, and in Europe there are 120,000 dairy refineries. Global water markets are growing also alongside of IoT industry, e.g., in US on 2019 the water market size was \$ 7.14 billion, and it is estimated on 2025 the US market will be \$ 13.81 billion [49].

3 Results and discussion

Preventos Informatics Ltd CEO Teemu Räsänen analyzed differences between the business models. These differences were found to be a practical cause of follow-up work focusing mostly into deeper analysis of customer needs, purchasing behavior, and other customers' purchasing decisions (Table 1). Also, the target segment classification work was seen as an important matter, because each segment has specific needs, marketing strategy-approaches, and decision-making strategies. The decision-making strategies were dependent to the customer type because it can be a company, municipal institution, or water cooperative.

Table 1. Comparison of 2017 designed and 2020 implemented business models.

BMC Building Block	Analysis of Differences Between 2017 and 2020
Customer Need	2020 more details: improved water management control, resources, ICT skills, automatization, predictive analysis
Company Solution	same principles, 2020 more details. Added: data analysis.
Competing Solution	same than 2017
Key Partners	same than 2017
Value Proposition	same principles, 2020 more details. Added: accurate, long lasting wireless measurements and situational awareness
Key Tasks	same than 2017
Customer Relationships	same than 2017
Customer Segments	a lot more detailed information 2020: water utilities and food industry. Added: municipalities and cities management.
Key Resources	same than 2017
Channels	Same: internet and direct contacts. Did not happen: sensor suppliers. More specified: social media
Cost Structure	same principles, 2020 more details. Added: marketing and sales costs.
Cash Flow	Same: improved risk management & damage prevention. Not: environmental. Added: planning of water network rehabilitation, improved water safety

4 Conclusion

Digitalization, IoT and platform solutions are currently one of the biggest new business model generators, crosscutting all business sectors. Preventos Informatics Ltd. digital water monitoring services were developed according to design thinking method which offers novel approaches into the problem solving and radical innovation development, but the actual strength is the human approach and in this case customer-oriented approach. In this case, according to Preventos CEO, the strength of the collaboration process with higher education unit was specifically the structure to include many potential customers representing, from many different target segments in workshops, which helped analysing their own needs for water monitoring services and by doing so generated the good seeds for continuation of innovation work. The largest customers and stakeholders were present and came to workshops from municipal waterworks facilities, mining sector, and private small water facilities and different officials to give wider perspective of customer needs at once. Participants had deep knowledge of what they would need in the future and used it to participate in idea evaluation according to InTo process. The CEO pinpointed to prefer to see potential financing bodies into workshops to get the financing feasibility view as part of new business collaborative development workshops.

Considering the experiences from water supply experts' point of view, the first priority seemed to exist in providing more decision-making information and the quality of the information produced to meet user needs for this business model development efforts. Therefore, in practice, it is important that the service can meet the right need and bring cost savings and, for example, increase water safety through, for example, preventive maintenance. For example, Preventos Informatics Ltd. provide service to detects possible leaks automatically in the water distribution system. The algorithm analyses the sensor measurements online and detects an anomalous situation, then generates alarms and visual graphical data to web user interface in order to give instantaneous information about the problem and it's location. Things that could indicate problem can be e.g., a detected pressure shock, caused by a momentary shutdown of the pump, which was a cause from a power failure. In active alarm mode, an alarm generates SMS message to key person(s) mobile phone and email alert notification is also dispatched to inform maintenance staff of the deviation in water distribution.

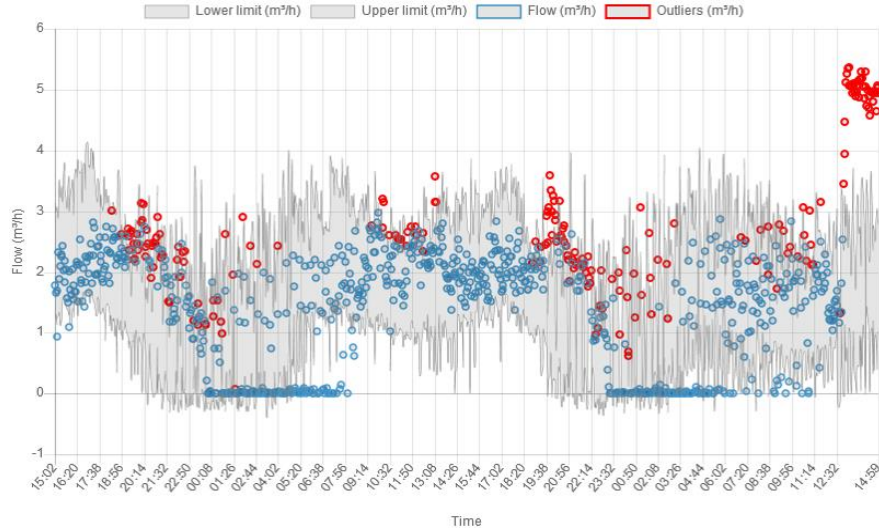


Fig. 3. Time series data from real-time monitoring system pinpointing the abnormal situations.

For customer usability, visualization has an important role in analyzing the causes for the interferences, comparing data within different time periods, and transforming data into information and knowledge (Figure 3). Basically, visualization will make things more understandable, and visual images are also lot easier for people to remember and share information to larger audiences.

Preventos customer promise is in addition to cost savings, to provide reliability and the ability to react more quickly to faults so that they are detected more quickly. Informative map application points out leakages to certain locations and makes it easier for maintenance staff to navigate immediately to the right spot. This is usually possible only with expensive software's from large operators, but Preventos has commercialized map application with integration of traffic light system for small water utilities as well with lower priced solution (Figure 4).

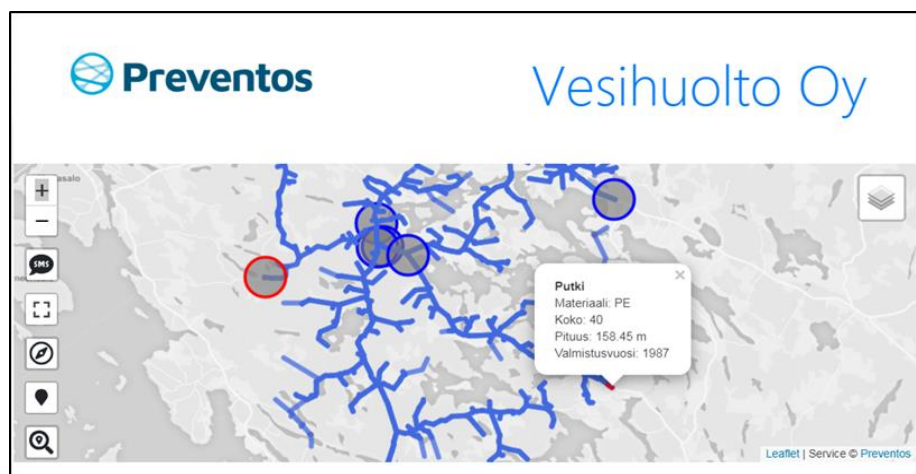


Fig. 4. Water supply infrastructure related information presented on the map as spatial information.

Considering the findings, research can e.g., offer new know-how for digital design process tools and support mass customization considerations; companies might have with the newest business models [50, 51]. And considering the newest technologies, also innovation seeding options like collaborative hackathons [34, 36, 43], capstone courses [39] and digital citizen science solutions [55] should be given a tough, as these methods have also shown productivity [40] sustainability context. The research can also push newest technologies like Artificial Intelligence [52, 53] and industry 4.0 technologies [22] to forms that help companies produce new circularity and sustainability enhancing products and services. All in all, as SME resources are typically tight, emphasis could be put to the fuzzy front end [37] towards novel innovations to proceed towards efficient, win-win based and trust driven innovations [41].

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