Outcome Bbased Business Models Influenced with Internet of Things – in Agriculture

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Abstract—Industry 4.0 technologies and overall digitalization have accelerated the adoption of servitization models in the manufacturing industry such as outcome-based business model. While this model is gaining traction in the manufacturing space, there is little understanding of its applicability in other industries, in particular in agriculture. The aim and subject of this case study provides the main findings of the analysis of the feasibility of applying outcome-based business model in the agricultural sector, specifically winemaking. Result of the study confirm that the use of outcome-based business models in agriculture is still in the infant stage because of the many parameters in this industry that cannot be controlled. Therefore, the application of outcome-based business model in this sector can best take place following several modifications that are indicated in the paper.

Keywords - Outcome-based business model, Internet of Things, market maturity, technical readiness, agriculture.

I. INTRODUCTION

The focus of this research is the applicability of outcome-based business model (OBBM) in the agricultural sector. The agriculture sector is still in the early phases of its digital transformation [1]. Consequently, this is a sector that is yet to explore the full potential of the OBBMs. One of the key obstacles for more rapid digital transformation of agriculture are the up-front costs of the hardware and software required for establishmentment of the so-called smart farming practices [2,3]. To that end, OBBM might be a good choice for accelerating the introduction of data-based practices in the agriculture sector as service providers would offset the up-front costs in exchange for potentially higher earnings through revenue sharing with farmers. However, several issues have to be addressed before such business models are applied in the agriculture sector. These issues include the impact of climate variability on the yield, quality of the crops, the required energy resources such as water and energy used for irrigation, and the ability to continuously monitor all relevant operations in the field and act promptly on deviations.

Previous research has shown results on the use of OBBM in the manufacturing industry, however, there is a lack of research on the use of OBBM outside of the manufacturing industry, specifically the agricultural industry. The overall research goal of this study was to understand the applicability of outcome-based business contracts in agriculture. The main research objectives of this study is to indicate a set of recommendations related to the modification and customization of OBBSs from the manufacturing industry for the agricultural sector.

At the very beginning of the paper, the business model of OBBM and the basis of its foundation are presented. After that, within the same chapter, the readiness of the market to accept an innovative and new business process, as well as the application of technology and the development of digitization in the agricultural sector, was shown. In the fourth chapter, the subject, sample and objective of the case study are presented. In addition, research methods and models of the use of OBBM in the agricultural sector are presented. In the fifth chapter, the results of research on the use of OBBM in the specific case of digital transformation in the vineyard sector are presented. In the sixth chapter, the interpretation of the obtained results, as well as the limitations and shortcomings of this research, is presented. In the last part, the results of the case study, implications and a proposal for future research are presented in order to reduce the barriers to the adoption of technology by the agricultural sector.

II. THE OBBM AND DIGITALIZATION OF AGRICULTURE

A. The OBBM and its Values

Introduction of OBBM largely relies on using digital solutions in conjunction with the physical products which are the main offer of the vendor to ensure that these physical products are used in line with the agreements. Hence, the application of Industry 4.0 technologies such as IoT, Artificial Intelligence (AI), serverless computing, edge

and cloud computing are crucial for implementation of outcome-based business models. Application of OBBM can occur in all business operations, production processes and services where data collection, data analysis, data optimization, and data-based decision-making can be used to control the conditions relevant for achievement of desired outcomes.

Values likely to be created due to the use of OBBM include growth, efficiency, and effectiveness [4]. The main goal of this business model is to identify mutually agreed value propositions that will define the value or business opportunities to create and ways of distributing the value between customers and providers. Providers will assume greater responsibility by providing guaranteed enhanced performance of the products and services.

There are three value drivers identified for value creation transformation in OBBMs [5]. These value drivers are information transformation, behavior transformation and material transformation. This study emphasizes that for a successful business contract based on an outcome, it is vital to have a value-driven alignment of people, information, and material. Additionally, there must be a perfect alignment of information and behavior among the customer and vendors for a contract to succeed. Otherwise, there will be no value creation nor distribution according to the established business plan.

OBBM is based on a digital servitization system that establishes a multi-dimensional collaboration between various types of business models that exist in a value system. These diverse business models are operated by raw material suppliers to final customers. Digitalization helps to create a collaboration among these business entities to produce an optimal outcome to end customers [6]. Overall digital servitization makes value creation and value capture more effective and efficient. Businesses can now achieve a more preventive and proactive approach toward their maintenance processes with the help of the digitization of business processes and activities [7].

B. Market Readiness for OBBM

The market acceptability of any innovative and new business model depends on its ease of implementation and adaptiveness. As OBBMs largely depend on the digitalization processes, the successful implementation of technological applications is a crucial factor to make the OBBM market-ready. Another element to making the OBBM more adaptive to the market acceptability is to understand the market needs and to perfectly align the model to customers' needs. However, it is difficult to determine the exact needs of customers [7,8]. Expected value creation for the customer may not be achieved or might be degraded for a lack of understanding of customer pain points and deficient processes by the service provider. Ganguly and Euchner (2018) argue that business firms have to evaluate new business model opportunities more carefully according to the needs of customers and then sign a deal with digital business solutions. Market acceptability and readiness to adopt OBBM largely depends on the effectiveness of solutions provided by the providers to its customers. Providers can consider a robust financial formula to ensure correct profit distribution. As miscalculations or no calculations can lead to a business failure and ultimately to market failure as well.

Financial clarity and understanding are also crucial for the digitalization of businesses to become market-ready. This is because revenue streams are not fully linked and proportional to the cost structures as in the traditional business model [9]. Further, it is common for new entrants to established markets to readily adopt OBBM than incumbent players who are afraid of losing control of the whole value creation process. Those incumbent companies prefer owning assets and investing in equipment rather than paying for outcomes that OBBM offer.

Market acceptability of OBBM models depends on the removal of the challenges of adoption before effective and seamless implementation into business activities. This means that businesses need to understand every change introduced by OBBM and its core digitalization processes for successful implementation of the service model and increase its acceptance by the market. Commonly, a huge digital change brings radical changes to the core business activities and core business values like value creation, value delivery, and value capture [6]. For instance, digitalization enables the manufacturing firms to use new kinds of capabilities like data analysis and software management to create value according to the customer's operational needs. These new capabilities are critical to the survival of new OBBMs and their ability to deliver the value created [10].

However, many companies do not have clear processes and have to face inertia or resistance from within the organization when they try to develop digital solutions for business processes beyond mechanical equipment [11]. Hence, it is foremost and vital to eliminate this inner organizational resistance to the adoption of digitalized business processes and therefore ultimate adoption of OBBM. From a technical perspective, companies need to develop smart products that are capable of being remotely monitored and controlled and for this task previous machine producers need to become software development companies as well or have very tight relationships with some of the IT companies that could help them in this journey. As noted by [6] data scientists are becoming a very important asset to any company that is looking into changing its business models toward more digital ones such as OBBM.

C. Digitalization of agriculture

In the agriculture sector, management of irrigation, fertilizer utilization and overall nutritional status management are crucial. Agriculture needs variable rate application of inputs according to variable changes in climate, soil, and moisture for different agricultural products at different geographical locations. IoT technologies based on sensors

have high usage in collecting data from agricultural fields [12]. The proper use of collected data from the farms is necessary to arrive at the right decision at the right time. IoT technologies are useful in highlighting the usage of soil and topography monitoring with proximal sensors to map useful data regarding soil moisture level, soil temperature, bulk density, and soil matrix [12,13]. Climate monitoring is majorly done by weather stations or rain gauges in new world vineyards.

The study conducted by Balafoutis et al. (2017) finds that the site-specific applications of technologies can help with achieving these objectives and emphasize that excessive nutrient and water supply can damage the health of the soil, and agriculture products as well as loss to the farmers with excessive cost and low-quality output. An example of digitalization of agriculture is the use of Precision Viticulture (PV) techniques. These are techniques that facilitate data collection and analysis promoting data-based decision-making [14]. PV covers the overall agricultural management activities from the operation of machinery to optimum use of inputs like fuel, fertilizer, water, and pesticides, as well as an assessment of the quality of output [12]. These techniques help in producing maximum yield with high-quality produce and low cost for inputs. This study shows the marked difference in quality and quantity parameters due to PV adoption in two different vineyards from the traditional agricultural methods.

In further reviewing the role of digitalization in agriculture, sensors can give detailed information about the soil features in variable fields [13]. By testing soil parameters at several points and with the use of advanced techniques for interpolating we can come to quite precise information for any spot that is of interest in the huge agricultural fields. This paper suggests the application of differential management techniques to reduce the variability in different fields.

Further, the Internet of Food (IOF) 2020, H2020 DEMETER and Atlas provide insight into the digitalization of agriculture [15]. These projects explored and validate various IoT and data analysis components and solutions to demonstrate the key role of digital technologies in transformation of European agriculture [15]. Through a number of usage scenarios and pilots (potato production processing, pig health tracking; poultry chain management, intelligent fruit logistics, irrigation and fertilization management, grazing cow monitoring, etc.) the projects have demonstrated digitalization of agriculture is both possible and required. At the same time, it was shown that there are still a number of challenges that have to be overcome, of which the costs of introducing digital solutions ranks very high. This was shown by the DEMETER's farmers survey which indicated the barriers to smart farming technology adoption. Besides cost, other points of concern for adopting digital technology for farming include the lack of resources and data privacy [15].

An additional technology that can be helpful for the outcome-based agriculture produce is robotic technology which is most useful in agricultural farms where the level of mechanization is very high. Robotic pruning and canopy management can save huge labor costs and efforts and hence results in more profit for the producers [16]. Analysis of field variables can be used by the technology developers to focus on particular field tasks and develop and apply the appropriate technology accordingly [16]. Unfortunately, the H2020 project such as AgRobofood is coming to an end.

III. METHODOLOGY

A. Research Question

The research question addressed in this study is the following:

- RQ1: What are the applications of OBBM in the agricultural sector?

B. Research Method

This was a qualitative research study. This is a research method that facilitates the study of a phenomena and is especially useful in addressing questions regarding the why of something [17]. The study entailed exploring the phenomena of OBBM application in the agricultural industry following its success in the manufacturing industry. Thus, this encompassed conducting some comprehensive assessments of the use of this model. By using the qualitative research method this study provided insight into the experience of applying OBBM in the manufacturing industry and then agriculture.

C. Research Process

The research process of this study involved the following key steps: pre-study, literature review, and case studies. The pre-study was an initial step of this paper conducted to identify the research gap [18]. This research gap refers to the lack of research on the use of OBBM beyond the manufacturing industry. The second step of the research process involved conducting a review of the literature. This was done to identify the findings of previous studies on OBBM application. The final step in the research process involved the description of the case studies. The case studies illustrated a newer application area in the agricultural sector.

D. The sample used in Case Studie

The following case study weas used to achieve the research objective:

- A group of vineyards located in Montenegro running digital transformation pilots.

The vineyards case study leverages IoT and Machine Learning (ML) technologies to improve farming opera-

tions. Thus, this case provides a very good example of the digital infrastructure that can be expected in vineyards and of the monitored parameters as the important factors in setting up OBBM based collaboration.

IV. RESULTS

A. Results of Case Study: Smart vineyards case-Agricultural industry

The vineyard use case is analyzed based on a deployment of a vineyard management digital solution in Montenegro (see Figure 1).

The deployment includes devices with a set of sensors for monitoring environmental parameters:

- air temperature,
- relative air humidity,
- rainfall,
- leaf wetness,
- radiation,
- wind speed,
- soil moisture, soil temperature and soil electro-conductivity (EC), and
- the number of insects caught in pheromone traps

The expectation was that the use of this digital technology will result in better prediction of grape diseases, reduced use of pesticides, reduced workload for people working in the vineyard, and eventually improved grape quality and increased yield.

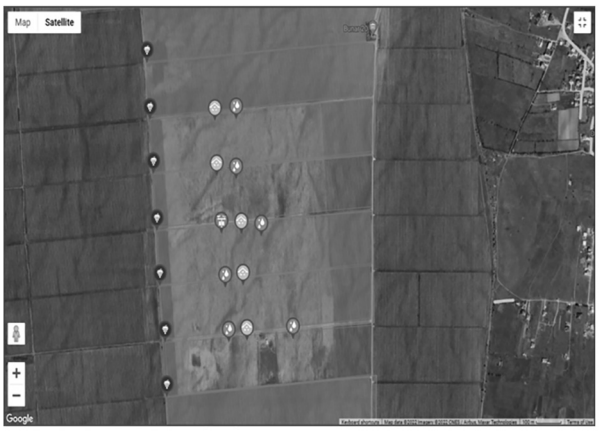

Figure 1. Map showing the vineyard

The monitored area covers 25 ha.

- Represents weather station, 1 in the whole monitored area.
- Represents smart pheromone trap, 5 per the whole monitored area.
- Represent devices equipped with sensors for monitoring soil conditions, 6 per the whole monitored area.

Data from all devices is collected via two LoRa gateways and sent to the cloud, where it's processed, and visualized. Data about the grapes such as the grape type and planting date are also stored in the cloud. Based on the measurements from the vineyard, taking into account the industry best practices, and vegetation status timely recommendations are generated by the solution. This system demonstrates the role of technology in fostering the application of OBBM in agriculture. This is because the technology in the system helps users to establish conditions for the best outcomes in planting grapes. In the smart vineyard there is also a weather station. The weather station is used to collect environmental parameters such as air temperature, relative air humidity, rainfall, leaf wetness, radiation, wind speed, wind direction, and active radiation. Based on these data items and appropriate algorithms/receipts, calculations and recommendations for grape spraying against different kinds of diseases and insects are done. Further, notifications on activities to be done are created and sent to the vineyard keeper, and once he executes them, the result of the spraying operation is made accessible in the cloud. Thus, this further illustrates the application of OBBM through technology that enables grape which helps in preventing disease in the vineyard a significant outcome. This means that the vineyard keeper can utilize the data attained from the algorithm and notifications to take up activities that will prevent disease such as spraying the crops as earlier mentioned.

The smart vineyard can also include the use of a smart pheromone trap. The trap can be used for monitoring grape moth activity calculating their number daily. Based on this information the order for their spraying can be executed. It is quite easy to install this device, but maintenance is required depending on the number of grape moths collected on the plate. Consequently, it will be necessary to change the plate with glue every few days up to a few weeks. Additionally, the pheromone sensor requires replacement every 4-6 weeks. This further fosters OBBM use in the vineyard because it enhances the chances of an outcome of crops that are disease free because of the automatic monitoring of grape moth.

There are sensors for monitoring soil moisture (ECH20, Teros 10) deployed at two depths (25 and 50 cm) covering the main part of the root zone in a smart vineyard. Sentek sensor measures soil moisture, soil temperature and EC at 6 depth, each 10 cm. By combining measured moisture with soil characteristics, grape requirements for water through the vegetation and forecasted temperature and precipitation instructions for activities to be undertaken are created (when to spray, what type of fungicide to use). This is essential in fostering an outcome of adequate moisture of the crops further demonstrating the significant role of OBBM in agriculture.

Because of the use of digital technology discussed above, the expectation is there are several parameters expected to improve. For instance, vineyards should experience improvement in yield following the implementation of digital technologies. This increased yield is because of

the reduction of loss due to disease prevention.

Further, there should be some improvement in energy costs. Another expectation is the improvement in water costs. Additionally, the implemented technology will also reduce pesticide usage. Thus, all these outcomes illustrate the key benefits of the integration of OBBM in agriculture. The OBBM integration illustrate that there are ways of monitoring various parameters of interest in agriculture and viticulture. Therefore, this can serve as the basis for the introduction of OBBM that can very beneficial to winemakers. This is because OBBM can help winemakers to introduce technology more easily. For instance, OBBM in the vineyard reduces the cost of introducing and maintaining sensors and weather station. Additionally, there are some parameters that are difficult to control in agriculture such as temperature and precipitation. This explains the reason it was easier to introduce OBBM in the manufacturing industry compared to agriculture. In agriculture the introduction of OBBM can take place successfully following certain modifications.

Further, the implementation of OBBM enabled via digital technology enhances the agricultural activities in the vineyards through additional benefits. These benefits include considerable savings in the use of pesticides. OBBM also fosters the reduction of the damage caused by diseases through a process of early recognition of symptoms. All these serve to increase yield by reducing damage to the grapes because of disease.

V. DISCUSSION

A. OBBM in Agriculture

The case study on the vineyards demonstrates that there is the possibility of using OBBMs in agriculture through the collection of data, but there remain challenges. This is via the introduction of digital technology that can to a small extent contribute to better outcomes for the vineyards despite the uncontrollable parameters. Implementation of OBBM will require adding various elements of technology to the current farm management system. This includes the application of precision technologies together with big data analytics. This will be essential in fostering efficiency in agriculture which will be an outcome of increased profitability. The vineyard case study identified some examples of precision technology including sensors. At the same time, the way that farmers will be utilizing Big Data will significantly contribute to further improving farming outcomes and the use of OBBM. Therefore, the implementation of OBBM in agriculture will make the farming process futuristic by making the focus be on the outcome. Through OBBM it will be possible to make agriculture as per the vineyard case take place in a disease-free environment. That is, in instances in which there will be more yields of crops. The case study on the vineyard has shown that following the use of the right technology then outcome-based farming can become a norm in agriculture. While the use of OBBM in agriculture still feels a long way from emerging as the norm as demonstrated in manufacturing it is not impossible to attain.

B. Obstacles and Solutions to OBBM Implementation

However, the implementation of OBBM in the agricultural industry unlike the manufacturing industry is not an easy process because of challenges related to the application of this model. This is because the agricultural industry entails parameters that are beyond control unlike in manufacturing. Some of these parameters are climate, the amount of annual rain, and possible diseases to crops. For this reason, it becomes difficult to determine the outcomes that emanated from the use of the intelligent solutions applied based on the OBBMs. This is significant because the use of OBBMs in agriculture cannot with certainty illustrates the gains.

At the same time, major obstacles also become apparent for the digital technology implementation, and transformation from traditional product-based business models to OBBM. These challenges are ranging from proper utilization of digitalization technologies, organizational changes, changed relationships, and financial measures to understanding accurate needs and requirements of customers as well as business opportunities and future risks related to proper adoption and implementation of advanced technologies.

The success of OBBMs depends on the effective implementation of advanced technologies and a perfect alignment of relationships between people, systems and technologies. Companies must ensure digital business models address true customer needs, align with internal strategies, and maintain a judicious balance between risk and reward. Companies can decide upon the value proportion, creation and delivery mechanism in advance before any agreement is reached between business providers and customers. Otherwise, it often creates friction and disagreement among customers and service providers later.

Compensation is a huge factor to work upon. Innovative value distribution methods can be explored for payment. Outcome-based businesses can be compensated with two methods: payments for availability or payment for economic performance. In the first method of payment which is paid for availability, customers pay the suppliers for the product utilization irrespective of its economic output. The second payment method depends on the economic results gained by the customers as a result of enhanced product performance by the suppliers. Payment by economic value encouraged suppliers to perform effectively in more operations and make them more responsible for the customers' needs. The advancement of technologies has huge potential to deepen the usability of outcome-based business models in businesses.

VI. CONCLUSION

A. Conclusion

This study aimed to understand the scope of the possibility of using OBBM in the agriculture sector following its successful application in the manufacturing industry. As a result, the agriculture sector was explored as how it is responding to the industry 4.0 technologies like IoT, data analytics, cloud computing and other advanced technologies as a base to achieve outcome-based business contracts. However, the use of OBBM in agriculture is still in the infant stage because of the many parameters in this industry that cannot be controlled. Therefore, the application of OBBM in agriculture can best take place following several modifications to overcome the challenges posed by the uncontrollable parameters.

B. Implication

The findings of this study were instrumental in demonstrating the extent of the market maturity and technical readiness for the adoption of IoT-OBBM based in agriculture. Based on the analysis of the state of the art and the agriculture industry case studies, this study shows that it is possible to use OBBM in agriculture. However, in applying IoT-based OBBM it is essential to carefully review the scenario. This means that users must carefully review the conditions under which OBBM can be utilized and validated to ensure protection for users and businesses.

Collaboration, integration and perfect alignment are required not only between the service providers but among the systems, processes, information, management, technologies, people, and overall internal and external business environment. In using digital technology that fosters better outcomes in agriculture such as the reduced use of pesticides there should be more collaboration and integration between service providers and farmers. This includes creating an agreement for the value proposition, value creation and value delivery after farmers utilize the technology. Thus, this will demonstrate to farmers the benefits of using OBBM.

Technological deployment is the main factor and prerequisite that can help in the achievement of these above-mentioned alignments. Hence, the main hurdles for technology implementation and adoption can be removed for smooth and flawless data and information collection, analysis and usage. Addressing these obstacles includes constantly monitoring and providing compensation.

C. Future Studies

Implementing OBBMs beyond manufacturing is difficult as shown by the case of agriculture. This study has demonstrated that a successful application of OBBMs in agriculture is challenging as it depends on several factors which cannot be easily controlled. However, it remains important to continue research into the potential of using OBBM in agriculture as a way of lowering barriers for technology adoption by farmers. This will serve to expand the literature and reveal additional cases where the use of OBBM is successful. For instance, there can be additional research conducted regarding the application of OBBM in the agriculture sector. This is a sector in which the use of OBBM remains at an infant stage.

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