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CIRCULAR TRANSFORMATION OF CURRENT BUSINESS SOLUTIONS IN WASTEWATER MANAGEMENT

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Abstract: The wastewater treatment technologies become more efficiency by biological treatment method business structure development. In this paper, we would like to present a circular economic transformation method to wastewater management development by economical way. The most used wastewater treatment technologies work with conventional business models (by a linear economic way). We determined a circular economic solve to get more effective and cost-efficient wastewater treatment system. The ReSOLVE framework and Mapping method were used and presented the main circular points (in focus of Regenerate part) of each technology to effectively application of treatment solutions. Regarding our research method results, we improved the Business Model Canvas and the main economic transformation points were given by the framework. In this short paper we would like to give answers to how could minimalize the wastewater production by business model development with low cost and effective economical background. The research clearly demonstrates that economic operators and members of the supply chain integrate their resources into circular systems, then business ecosystems can be continually redesigned, creating dynamically and efficiently self-regulating systems. The modern structure of environmental treatment methods does not mean exclusively technological development, the new business structure and innovative circular model could be more useful to rethink the economic loop and cascade solutions. Based on the research results we can almost be sure that the focus of related research will in the future be focused on sharing economy and big data applications.

Keywords: Conventional linear business models; Circular improve; ReSOLVE framework; Mapping analyze; Business Model Canvas

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Introduction

The currently applied economic approaches typically follow the linear principle, mostly the production-output structure. This system does not support the sustainability aspects of the environment and our natural resources and does not show the material cycle. The linear economic system favors high-volume production and low production costs, with the aim of obtaining the raw materials needed for production at the lowest possible cost. Conversely, by examining and applying the key pillars of sustainability, the social, environmental and economic dimensions, a circular system can be developed that is the basis of modern 21st-

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century economic processes (Michelini et al., 2017). Sustainability is an aspect system that the three dimensions hold together that is, if one of the changes, it also affects the other two (Aven, 2016). Linear economic models are less suitable for interpreting the social and economic effects of consumption because they do not prefer to avoid the negative externalities of production systems. The new development models close the linear systems and are arranged in circular processes. This is the next step in the linear-circular transformation toward sustainable systems. The circular concepts around water recycling focus on the importance of differentiating between treatment for potable and non-potable water. It also emphasizes its economic and social importance. But these studies do not deal with business models that may alter the amount and direction of utilization of intermediate water forms. (presented in Figure 1). Thus, the unfavorable direction of linear-circular transformation may be to focus primarily on technological changes in process development. Circular water use should be promoted in parallel with the development of energy and material cycles.

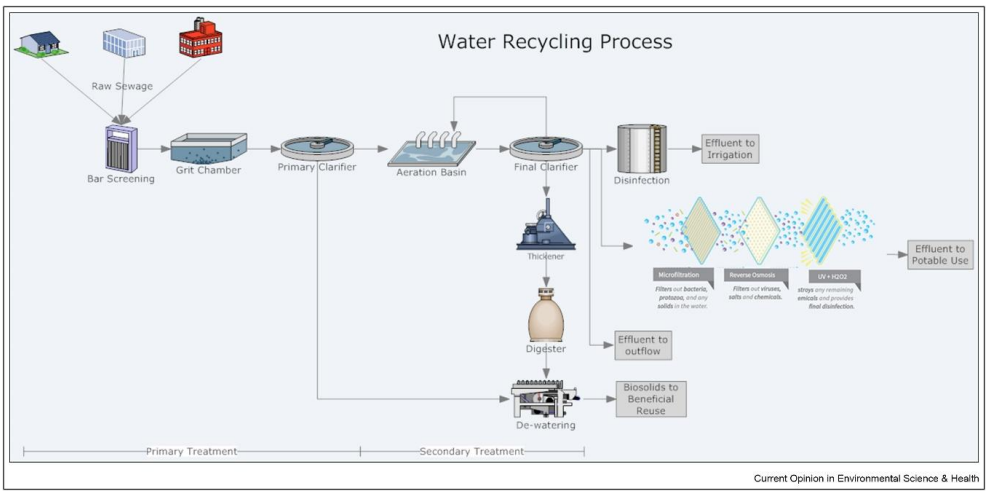

Figure 1. Conventional two stage biological wastewater treatment and potential options for circular wastewater reuse (Peezekoffie, 2017)

These cycles regenerate living systems, such as soil (irrigation), that provide renewable resources (biogas systems) for the economy. Technological cycles restore and recycle products, components and materials through strategies such as reuse, repair, remanufacturing or recycling (technology water using) (Tukker, 2015). The growing amount of wastewaters causes environmental and economic problems. The former conventional business models could not give answers for each environmental and economic questions, because the linear structure of wastewater treatment could not utilize innovative methods and new economic

solutions (e.g., reuse of primary raw materials, recycling of all reusable waste of treatment processes) (Nußholz, 2017). We suggest circular improved blocks to business model development and declare each point, which could be additional values to the circular structure. Development of the Business Model Canvas and the improvement of circular economic blocks of each segment of the treatment process could present additional scientific value to an efficient, sustainable economic structure. Our business results seem to be useful to future application in treatment systems of municipal wastewaters. This research paper would like to present a new solution to more effective wastewater treatment processes and find economic answers and business solutions to human inquiry about wastewater reduce and social environment. Within the topic, we do not want to present new technological innovations because the modern structure of environmental treatment methods does not mean exclusively technological development. New business structure and innovative circular model could be more useful to rethink the economic loop and solutions. In this paper, we would like to analyze and to show the possible application of new circular economic and business structure of municipal wastewater treatment systems.

Literature review

The lifecycle of products is a key issue in the analysis of circular processes. According to some approaches, the life cycle extension of products is a slowing down operation, which in the case of a slowing cycle, the "closing" element is recycling. An artificial extension of the useful life of products is a viable option to some extent, but sooner or later products end up in their life cycle (Bautista and Peña-Guzmán, 2019). In this case, it is questionable how these products can be (as efficiently) used as secondary raw materials. An important basis of circular economic models is that not only should the product lifetime be extended as efficiently as possible, but it must also be possible to reuse the raw materials at the end of their life cycle. The circular economy uses minimal or zero waste production and resource recycling. As a result, the products can be easily recycled at the end of the life cycle. The basis of the circular concept is a waste reduction, reuse, as well as recycling and repair (Boait et al., 2019).

Conventional and Business As Usual (BAU) structures of wastewater treatment

It is important to note that there is no representative volume of literature available for the water management sector, which is intended to provide a detailed presentation of the applied business models (Müller, Marlow and Moglia, 2016). Nonetheless, some communications (mostly on behalf of the EU) have emerged that also affect business structures somewhat. The most striking example is the study of Hoffjan et al. (Hoffjan et al., 2014), which presents the business models (Business As Usual - BAU) that can be adapted to the water management sector. Müller et al. (Müller, Marlow and Moglia, 2016) also proposed the introduction of business models for urban water management systems, including municipal wastewater treatment. In their work, it is described that systems can be interpreted

at three levels from a business perspective: strategic, economic and operational. Wastewater treatment plants should also be careful to coordinate regulatory requirements (quality and economic regulatory environment), retail preferences and willingness to pay, as well as risk management. Water management and water treatment are characterized by a number of sector-specific properties. Independently of countries, the structural aspects of the business are divided into technological, economic and social parts. The most relevant features are as follows (Müller, Marlow and Moglia, 2016; (Chesbrough, 2010):

- Technological part: environmentally acceptable efficiency, renewability in continuous operation and the pursuit of recyclable material production;
- Economic part: high capital requirement, limited proactive intervention, significant cost requirements (in terms of material costs), cost efficiency issues;
- Social part: endeavor to reduce human health risk, but at least reduce the risk of pollutant emissions below the norm.

The structure of conventional business models used in municipal wastewater treatment mostly follows the former economic structure. There is an example of an attempt to show circularity at some level of treatment, but in most cases, it is clear that both gray and black water is cleaned and therefore made reusable (Tóth et al., 2018). This means the possibility of reusing the product and does not carry the wrapping of the technological process. As a result, the cleaning process generates waste (typically chemicals and chemical precipitation) (Czikkely et al., 2018), (Czikkely and Fogarassy, 2018; Czikkely, Tóth and Fogarassy, 2018) which could not be utilized by the municipal wastewater treatment system (Rodriguez, 2018). Recent efforts indicate circular wastewater treatment as one of the cornerstones of circular water management (economic) systems, all segments which need to be transformed to a minimum with circulation (Magaril et al., 2019; Kot, 2018). Therefore it is important to combine sustainability, eco-efficiency and high-effective treatment technologies. For this, continuous and prominent development of business models and the inclusion of circular concepts as value creation in the business planning process are essential. Instead of technological innovation, a new business model innovation must be used which could reduce costs and produced wastewater amount. This is not a well-researched field in this context.

The emergence of circular economic aspects in business models

The prevailing economic concepts led to the degradation of our Earth's biodiversity and overall ecological status (Czikkely et al., 2018), as companies failed to take sustainability considerations into account and did not integrate them into their corporate governance concepts. Schaltegger et al. (Schaltegger, Lüdeke-Freund and Hansen, 2012) distinguishes “sustainable enterprise” from “sustainability enterprise” (Bocken et al., 2019). While the former is a financially stabilized initiative, the latter has already seen the environmental and social aspects. That is in close relations with eco-management and modern corporate governance behaviors. It is important to emphasize an approach that urges that business models

should play a key role in corporate sustainability and circular economic innovation. The changes in the business concept of the water business systems are more important to the competitiveness of the market than the previously applied product development and technological innovations. This economic concept has become the basis for business model research which necessarily means a circular trend in model development (Gunawan and Hutter, 2017). Schaltegger et al. (Schaltegger, Lüdeke-Freund and Hansen, 2012) and Schaltegger et al. (Schaltegger, Hansen and Lüdeke-Freund, 2016) explains the growing role of business planning in corporate sustainability implementation. Numerous studies report on the practical experiences of business-successful and flexible businesses with social and environmental values. Nevertheless, achieving sustainability and environmental goals through business model development is still the subject of professional discussion (Nosratabadi et al., 2019). Ilinova et al. (Ilinova, Cherepovitsyn and Evseeva, 2018) examined the aspects of rethinking business models through economic incentives. Armas-Cruz et al. (Armas-Cruz, Gil-Soto and Oreja-Rodríguez, 2017) focused on the potential for expansion of eco-businesses and concluded that the simple profitability of such business models does not make business decision makers interested in "frequently used business practices" (Business as Usual – BAU - forms) - or also known as "best practice" models are being transformed into sustainability considerations. The same idea is supported by Ferreira et al. (Ferreira et al., 2019) argue that "traditional" businesses only respond to emerging market needs. Business model development and the coordination of sustainability, social and ecological aspects are a common interest, otherwise, sustainability-focused businesses will remain only business opportunities and not future models of economic planning (Lakner and Popp, 2014). When defining the concept of circular business models, Scott (Scott, 2013) argues that such initiatives should either use recyclable biological raw materials or the continuous reuse of raw materials used for the technology.

Research methodology

The formerly used methodologies of wastewater treatment improvement present technological development and new treatment technique researches. The Research and Development (R&D) strategy should focus on the business environment and new economic solutions also because the human inquiry and urban population growing ask new solutions with low cost and economically effective methods. Although the research presents a wastewater improvement direction, we would like to focus on a business model implication and a combined method development also. The circular blocks of currently applied technologies use wastewater sludge recovery solutions but do not gives possibilities of circular transformation methods to other parts of the treatment chain. The paper would like to focus on that, from the applied ReSOLVE framework and mapping method to concept a modified Business Model Canvas structure. The new structure presented by the Results and Discussion section of the paper.

The ReSOLVE framework as a mosaic

The following aspects were taken into account when developing business modeling and circular economic platforms, i.e., developing the Business Model Canvas. Our business model analysis, model and circular development opportunities are reviewed by the circular economic rating criteria (MacArthur, 2014) (presented by Table 1 in the Results section). The Ellen MacArthur Foundation (MacArthur, 2014) laid down the pillars for building circular business models based on the ReSOLVE framework (mosaics in English that covers the following key expressions: regeneration, sharing, optimization, loop, virtualization, and exchange). The items listed are blocks that are organic creators of the Business Model Canvas, thus revealing the circular development possibilities of these blocks, it can illuminate the business model platforms that display circularity. The ReSOLVE method is based on the placement of circular blocks of business models to help fit the model to CE (circular economic aspects) (listed in Table 1 in the Results section of the paper). Water treatment technologies with biological adsorption materials contain a number of circular technology development points that can be detected by the ReSOLVE method and thus by the development of the Canvas Model. The main goal was to analyze and emphasize circularity options using the ReSOLVE methodology, and then apply the results of ReSOLVE to explain the blocks of the Business Model Canvas.

Application of Mapping method to the regenerate part of ReSOLVE

We would like to present some connected points of Regenerate blocks to declare the new scientific results of business model development. The mapping method is a cross-structure system to technological and economic analyses. This method was applied to determine the connection between the Regenerate part of ReSOLVE framework and environmental, ecological, energetical and human segments of new wastewater techniques. We would like to present some connected points of Regenerate blocks to declare the new scientific results of business model development (Müller et al., 2016). The Mapping structure (compare with other methods, e.g., benchmark analyze) gives help to declare the structural points of each segment of any production system. This method could analyze the cross-relations of improved points of the system. Table 2. in the Results section presents the results of the applied Mapping method. The application shows the results of a conceptual analyze of new water treatment structure and we could focus on necessary improvement points with that results.

Results and Discussion

In the following, we intend to present the business development opportunities that can form the circular blocks of the built Business Model Canvas through the current wastewater treatment business model. The technologies currently used are typically linear economic approaches. After removal of hazardous contaminations by artificial substances (chemicals and chemical charges), chemical precipitate containing pollutant concentrated impurities are removed from the system and

treated as waste. Removal chemical compounds should also be excluded, as they can in themselves constitute 'pollution'. If we analyze this economic structure from the business perspective, it can be seen that circularity does not appear at this level. In the following, we would like to point out the upgrading elements of the revised models, harmonizing the presentation of linear and new circular business solutions.

Results of ReSOLVE framework application

We would like to present the circular elements and results of ReSOLVE framework, which was defined by Ellen MacArthur Foundation (MacArthur, 2014) (and applied by Lewandowski (2016) (Lewandowski, 2016)). The applicated framework appears in the business model of the Osterwalder and Pigneur (2010) (known as Business Model Canvas - BMC) (Osterwalder and Pigneur, 2010) for the business development of reviewed wastewater treatment technologies. In the case of BMC, it is a model that allows us to develop the water technology developments, which I have already described in the literature review, and to lay the foundations for the circular model. The BMC consists of nine blocks that fix the base elements. These blocks are needed to create, transport and fix the value. It is important to emphasize that circular transformation does not mean that each segment of the business model has to be replaced with circular elements. There are blocks that are not replaced with circular parts, but they remain unchanged. As a result, they can support the operation of the business model and help the circulation of circular elements. Since a real business model cannot be based solely on circular blocks, the use of remaining non-circular elements is absolutely necessary for the optimal functioning of business functions (Oghazi and Mostaghel, 2018).

Table 1. The ReSOLVE framework method adaptation to biological water treatment technologies in focus of circular development blocks (Based on Ellen MacArthur Foundation (MacArthur, 2014); with Authors' own modifications)

Segments of ReSOLVE framework	Additional values to water treatment methods	Circular values*	Part of Business Model Canvas**	Abbreviations in Business Model Canvas
Regenerate (R 1-4)	The adsorption medium can be regenerated, recycled into the system for multiple uses.	+1	X	R1
	It improves the general state of the ecosystem.	+1	X	R2
	Renewable and alternative energy options.	+1	X	R3

	Social judgment, improving the quality of human life.	+1	X	R4
Share (S1)	Market sales of developed technology.	0	X	S1
Optimize (O 1-4)	Reducing and minimizing waste production from water treatment technology.	+1	X	O1
	Optimizing and increasing resource efficiency.	0	0	O2
	Optimizes the operation of the existing wastewater treatment line.	0	0	O3
	Increasing the useful life of the feedstock used as an adsorption medium.	+1	X	O4
Loop (L1)	Reuse and recycle create an economic loop in the system.	+1	X	L1
Virtualize (V 1-2)	Possibility of using digital control during operation of technology.	0	0	V1
	Application of bioinformatics software, management.	0	0	V2
Exchange (E 1-2)	Introducing new technology.	+1	X	E1
	Use of a new adsorption medium as a primary raw material.	+1	X	E2

** +1: Increases the circular nature of the system, contributes to the implementation of the technology circular; 0: neutral from a circular point of view, does not contribute, but does not inhibit circularity; -1: inhibits the circular character, hinders its technological circular transformation.*
*** X is placed in the given location if it has been +1 in the circular evaluation and will be part of the circular development of the Business Model Canvas.*

Results of mapping analyze of Renegerate part

The mapping method was applied to declare the connection of each section in Regenerate part of ReSOLVE framework. Table 2 presents the new biological treatment technological solutions which could provide environmental friendly methods and drinking water with better chemical and biological quality. The Regenerate part of the ReSOLVE framework could divide into four blocks. Three parts belong to natural and environmental questions and one belongs to human life and social improvement. We would like to present four analyzing blocks in Table 2: comparison with linear solutions, additional values to circular transformations and the total effect on the environment. The mapping analyzes shows the cross-analytical observe of new technical solutions with all of the related questions (belongs to sustainability).

Table 2. Systematic mapping analyze of a regenerate segment of a new business model (Based on Müller et al. (Müller et al., 2017 with Authors' own research and edition)

Segments of Regenerate part of ReSOLVE		Comparison with linear conventional methods	On which field could be an added value?	Present a more effective technology	The methodology of reducing resources supply
The adsorption medium can be regenerated, recycled into the system for multiple uses	*Biological segment*	New first raw materials and recycling options because of the material quality	(Natural and environmental value)	The adsorbent could be utilized more times without new first raw materials	Reduce the total amount of natural resource supply

It improves the general state of the ecosystem	*Environmental segment*	The former linear structures could not reduce the number of natural resources	(Ecosystem conservation)	Options of useable material recycling and reusing	Usage of environmentally friendly materials
Renewable and alternative energy options	*Energetically segment*	New energy resource supply (e.g., water or heat energy)	(New energy resources)	The system could solve its own energy supply	Reduce conventional energy consumption
Social judgment, improving the quality of human life	*Human life quality segment*	The new system could provide drinking water with better quality	(Human life quality)	More effective treatment techniques produce drinking water	Sustainable water consumption and water supply

Conclusions and future research directions

The previous economic structures of wastewater treatment systems worked with conventional linear methods. It produces more wastes and does not use recycling or any other circular economic properties. This short communication study presents a new method to get a more effective economic structure. The circular transformation could solve the problem of linear treatment systems. The additional scientific value of the research is the new economic method with circular economic focus points. These seem to be the places where the wastewater system could improve by biological regenerable materials (such as composts, biological degradable sources, algae or any other biosorbents). The new structure follows the standard new-wave economic models and gives a future applicable methodology to get more effective urban (or industrial) treatment systems. In order to strive for the environmental sustainability of urbanization processes, the use of closed-flow technologies is important. The research have pointed out that wastewater treatment technologies using closed material flows not only result in good cleaning efficiency but also create favorable cycles from an economic and social perspective. Efforts should be made to apply clean technologies with zero waste production and fully enclosed material and energy flows, so we consider it important to pursue the circular transformation of all available wastewater treatment methods (not only

biological ones but conventional techniques). Conventional business models used in wastewater treatment were evaluated for transformation possibilities. It is important to emphasize that current methods of wastewater treatment do not fully and reassuringly meet the sustainability criteria. It should be understood that cleaning methods focus on efficiency, and closed flow systems are less important in implementing research and development programs. The Business Model Canvas was modified and developed using the ReSOLVE framework and Mapping method. The circular blocks were determined, which could be useful for developing the Business Model Canvas for circular economic transformations in the design of wastewater management technology systems. With the new business concept developed in this way, it is possible to reconsider and redesign the technology already introduced and to introduce circular business models that are highly effective in terms of sustainability. The circular novelty of technologies can be defined or redefined by the Canvas model from a business point of view.

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CYKLICZNA TRANSFORMACJA AKTUALNYCH ROZWIĄZAŃ BIZNESOWYCH W ZARZĄDZANIU ŚCIEKAMI

Streszczenie: Technologie oczyszczania ścieków stają się bardziej wydajne dzięki rozwojowi struktury biznesowej metod oczyszczania biologicznego. W tym artykule chcielibyśmy przedstawić ekonomiczną metodę cyklicznej transformacji gospodarczej w rozwoju gospodarki ściekowej. Najczęściej stosowane technologie oczyszczania ścieków działają w oparciu o konwencjonalne modele biznesowe (w sposób liniowy ekonomiczny). Zdecydowaliśmy się na rozwiązanie ekonomiczne o obiegu zamkniętym, aby uzyskać bardziej wydajny i opłacalny system oczyszczania ścieków. Zastosowano szkielet ReSOLVE i metodę mapowania, które przedstawiły główne okrągłe punkty (w części Regenerate) każdej technologii w celu skutecznego zastosowania rozwiązań naprawczych Jeśli chodzi o wyniki naszych metod badawczych, poprawiliśmy osnowe modelu biznesowego, a główne punkty transformacji gospodarczej zostały określone w ramach. W tym krótkim artykule chcielibyśmy odpowiedzieć na pytanie, w jaki sposób można zminimalizować produkcję ścieków poprzez opracowanie modelu biznesowego z niskim kosztem i efektywnym zapleczem ekonomicznym. Badanie wyraźnie pokazuje, że podmioty gospodarcze i członkowie łańcucha dostaw integrują swoje zasoby w systemy o obiegu zamkniętym, a następnie ekosystemy biznesowe można nieustannie przeprojektowywać, tworząc dynamicznie i skutecznie samoregulujące się systemy. Nowoczesna struktura metod oczyszczania środowiska nie oznacza wyłącznie rozwoju technologicznego, nowa struktura biznesowa i innowacyjny model kołowy mogą być bardziej przydatne do ponownego przemyślenia pętli ekonomicznej i rozwiązań kaskadowych. Na podstawie wyników badań możemy być prawie pewni, że badania pokrewne będą w przyszłości koncentrować się na udostępnianiu aplikacji ekonomicznych i dużych zbiorów danych.

Słowa kluczowe: konwencjonalne liniowe modele biznesowe; Okrągły poprawa; Ramy ReSOLVE; Analiza mapowania; Osnowa modelu biznesowego

废水管理中当前业务解决方案的周期转换

摘要:随着生物处理方法业务结构的发展，废水处理技术变得更加高效。在本文中，我们想提出一种循环经济转化方法，以经济的方式发展废水管理。最常用的废水处理技术（通过线性经济方式）可与常规业务模型配合使用。我们确定了一种循环经济解决方案，以获得更有效和更具成本效益的废水处理系统。使用了ReSOLVE框架和Mapping方法，并提出了每种技术的主要要点（以Regenerate部分为重点），以有效地应用处理解决方案。关于我们的研究方法结果，我们改进了业务模型画布，并通过该框架给出了主要的经济转型点。在这篇简短的论文中，我们想给出答案，即如何通过低成本和有效经济背景的商业模式开发来最大程度地减少废水的产生。该研究清楚地表明，经

济运营商和供应链中的成员将其资源整合到循环系统中，然后可以不断重新设计业务生态系统，从而创建动态且有效的自我调节系统。现代环境处理方法的结构并不仅意味着技术的发展，新的业务结构和创新的循环模式可能更有助于重新思考经济循环和级联解决方案。根据研究结果，我们几乎可以确定，相关研究的焦点将集中在共享经济和大数据应用程序上。

关键字：常规线性业务模型；循环改进；ReSOLVE框架；映射分析；商业模式画布