IOP Conf. Series: Materials Science and Engineering **227** (2017) 012098 doi:10.1088/1757-899X/227/1/012098

Applying circular economy innovation theory in business process modeling and analysis

V Popa[1] **and L Popa**[2]
[1]Department of Defense Resources Management Studies , National Defence University, Mihai Viteazul, No. 160 , 500183,Braşov, România
[2]Department of Automation and Information Technologies, Transilvania University, Mihai Viteazul, No.5, 500036, Braşov, România

E-mail: vasilepopa2001@yahoo.com

Abstract. The overall aim of this paper is to develop a new conceptual framework for business process modeling and analysis using circular economy innovative theory as a source for business knowledge management. The last part of the paper presents an author's proposed basic structure for a new business models applying circular economy innovation theories. For people working on new innovative business models in the field of the circular economy this paper provides new ideas for clustering their concepts.

1. Introduction

The companies' are required, not only operating effective green business processes, but they also need to accommodate to changing business conditions at an unexpected rate. The conceptual framework for business process modeling there is focused on innovation in conditions of circular economy innovation requirements. Hedman and Kalling [1], on the other hand theorize that the business model concept is a model to integrate all main strategy perspectives into one framework. Mansfield and Fourie [2] describe business model and strategy as two distinctly different but complementary tools. Claiming that a discussion on the possible overlap between strategy and business model is not of interest, Seddon and Lewis [3], define the two terms in different levels of abstraction. "A business model is an abstract representation of some aspect of a firm's strategy."

2. Environmental innovations and corporate social responsibility -CSR

In most econometric studies, environmental innovations in general were analysed while only a few papers distinguished between end-of-pipe- innovations and cleaner production. In the literature, there is agreement that environmental innovations are more or less regulation driven though many studies show a positive role of cost-savings as a motivation especially for cleaner production technologies Horbach, [4]. The „Measuring Eco-Innovation"MEI definition is as follows, [5]: "Eco-innovation is the production, application or exploitation of a good, service, production process, organizational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resources use (including energy use) compared to relevant alternatives".

The Europen Commission has defined CSR as "the responsibility of enterprises for their impact on society". According with Archie B. Carroll and Kareem M. Shaban, "The green philosophy adopted by the company is not mandated by law. Rather, it is a voluntary initiative which aims to fulfill an ethical

responsibility of business" (Archie B, [6]). The business case for corporate social responsibility (CSR), has been broken down into four different categories by Simon Zadek [7]. Zadek has argued that companies pursue corporate social responsibility CSR strategies to (1) defend their reputations (pain alleviation), (2) justify benefits over costs (the 'traditional' business case), (3) integrate with their broader strategies (the 'strategic' business case), and (4) learn, innovate and manage risk (New Economy Business case) ,Zadek [7] .

2.1. Structuring new business models from the customer perspective

The overall objective of a company's business model is to identify a business opportunity by creating value for the stakeholders involved, to fulfill customers' needs and create customer surplus while generating a company profit. Until 2020 European Union has seven priorities as following: Capital Markets Union - Triggering sustainable finance for the clean economy; Energy Union and Climate Action; Investment Plan - Attracting additional Investments; *Circular Economy - Achieving a resource efficient, low-carbon economy; Innovation - Bringing new technologies from research to market*; Skills Agenda - Adapting the workforce; Digital Single Market Empowering citizens and consumers
The term "business model", it is defined as: "the chosen system of inputs, business activities, outputs and outcomes that aims to create value over the short, medium and long term." [8]

An activity in a company's business model, can be viewed as the engagement of human, material and/or financial resources of any party to the business model to serve a specific purpose toward the fulfillment of the customers objective [9], table 1.

Table 1. Structuring new business models from the customer perspective.

Business model category	**Short explanation**	**Example**	**Source**
Ownership-based business models	Customer purchases a product and owns it right away	Purchasing a washing machine	
Access- or Usage-based business models	Customer purchases a certain usage period or access period to a certain good	Leasing a washing machine for 12 Months	Sempels, 2014
Performance-based business models	Customer purchases a defined performance, normally not bound to a defined product	Leasing a washing machine for 1000 washing cycles	Cinquini, Di Minin and Varaldo, 2013
Result-based business models	Customer purchases a defined end result	Providing a pick-up and delivery washing service	Sempels, 2014

According with "The Communication from the commission to the European Parliament [10]", there are identified three circular economy innovations components (Technological innovation, Social innovation and Organisational innovation) and 11 directions as following: Design of materials and processes, Design of products, Resource management (waste, water, energy and raw materials), New production and consumption models, Citizens' involvement, Product service models, Design services, Integrated solutions and systems, Logistics, Business models and Policy supporting tools.

Based on document [10] and our expertise, we have created a matrix named "The influence of Circular economy innovations components "over"Business model category from the customer perspective". The calculation of the influence of Circular economy innovations components "over"Business model category from the customer perspective" are starts from a matrix (table 2) in which data is organized as following:

Table 2. The influence of Circular economy inovations components"over "Business model category from the customer perspective".

Business model category from the customer perspective	Circular economy inovations components					
	C_1	C_2	.....	Cj	.....	Cm
e_1	x_{11}	x_{12}	.....	x_{1j}	.....	x_{1m}
e_2	x_{21}	x_{22}	.....	x_{2j}	.....	x_{2m}
.....	.....	.....	.....	.....	.....	.....
e_i	x_{i1}	x_{i2}	.....	x_{ij}	.....	x_{im}
.....	.....	.....	.....	.....	.....	.....
e_n	x_{n1}	x_{n2}	.....	x_{nj}	.....	x_{nm}

For each criterion"j", is determined the criterion score (C_{sj}) by the relationship: $x_{ij.}$

$$C_{sj} = \sum_{i=1}^{n} Xij \quad (1)$$

X_{ij}

$$= \begin{cases} 1 \text{ if the criterion score } (C_{ij}) \text{ influences the business model category from the customer perspective} \\ 0 \text{ if the criterion score } (C_{ij}) \text{ does not influences the business model category from the customer perspect} \end{cases}$$

Where:
n – the number of business model category from the customer perspective.
For any number of business model category from the customer perspective (Bmccp) is determined the criterion score (C_{sj}) of business model by the relationship: $_j$

$$Bmccp_i = \sum_{j=1}^{m} Xij \quad (2)$$

X_{ij}

$$= \begin{cases} 1 \text{ if the criterion score } (C_{ij}) \text{ influences the business model category from the customer perspective} \\ 0 \text{ if the criterion score } (C_{ij}) \text{ does not influences the business model category from the customer perspect} \end{cases}$$

Where:

m – Circular economy inovations components number
The weighting coefficient (Wc) of criterion C_{sj} is determined by the relationship:

$$Wccj = \frac{Bmccpi}{\sum_{i=1}^{n} Bmccpi} 100 \quad (j=1.....m) \quad (3)$$

The influence of Circular economy inovations components"over "Business model category from the customer perspective" is presented in table 3 and figure 1.

Table 3. The influence of "Circular economy inovations components over "Business model category from the customer perspective".

Circular economy inovations components															
		Technological innovation				Social innovation			Organisational innovation						
Business model category from the customer perspective	Design of materials and processes	Design of products	Resource manage-ment (waste, water, energy and raw materials)	New production and consumption models	Citizens' involvement	Product service models	Design services	Integrated solutions and systems	Logistics	Business models	Policy supporting tools	Points	Weight (%)
Ownership-based business models	1	1	0	0	0	0	0	0	1	1	1	5	16,13
Access- or Usage-based business	1	1	1	0	0	1	0	0	1	1	0	6	19,35
Performance-based business models	1	1	1	0	1	1	1	0	1	1	1	9	29,03
Result-based business models	1	1	1	1	1	1	1	1	1	1	1	11	35,48
Total	4	4	3	1	2	3	2	1	4	4	3	31	100

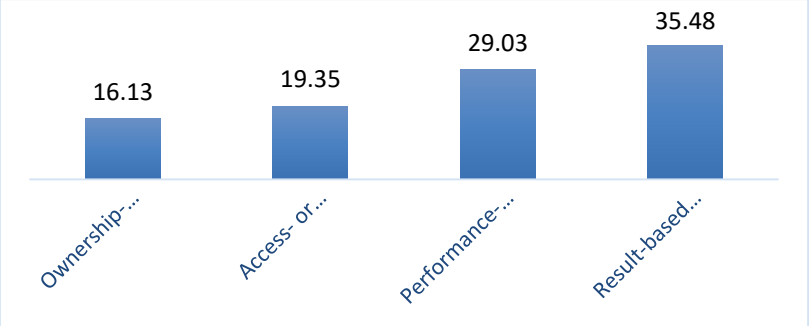

Figure 1. The influence of "Circular economy inovations components"over "Business model category from the customer perspective".

As we can see in figure 1, the items named "Result-based business models", is strongly influenced by

the "Circular economy inovations components", having the highest score (35, 48%).

According with this result, the companies'managers from Romanian economy, need to take in consideration the fact that the best "Business model category from the customer perspective" is "Result-based business models". In the "Result-based business models", outcome indicators can be at the organizational, sector, or societal goal level. An outcome indicator measures a change in a high-level characteristic of the environment in which the company is operating.

Figure 2 shows a general outline of Ellen McArthur Foundation model and the associated business models on each level.

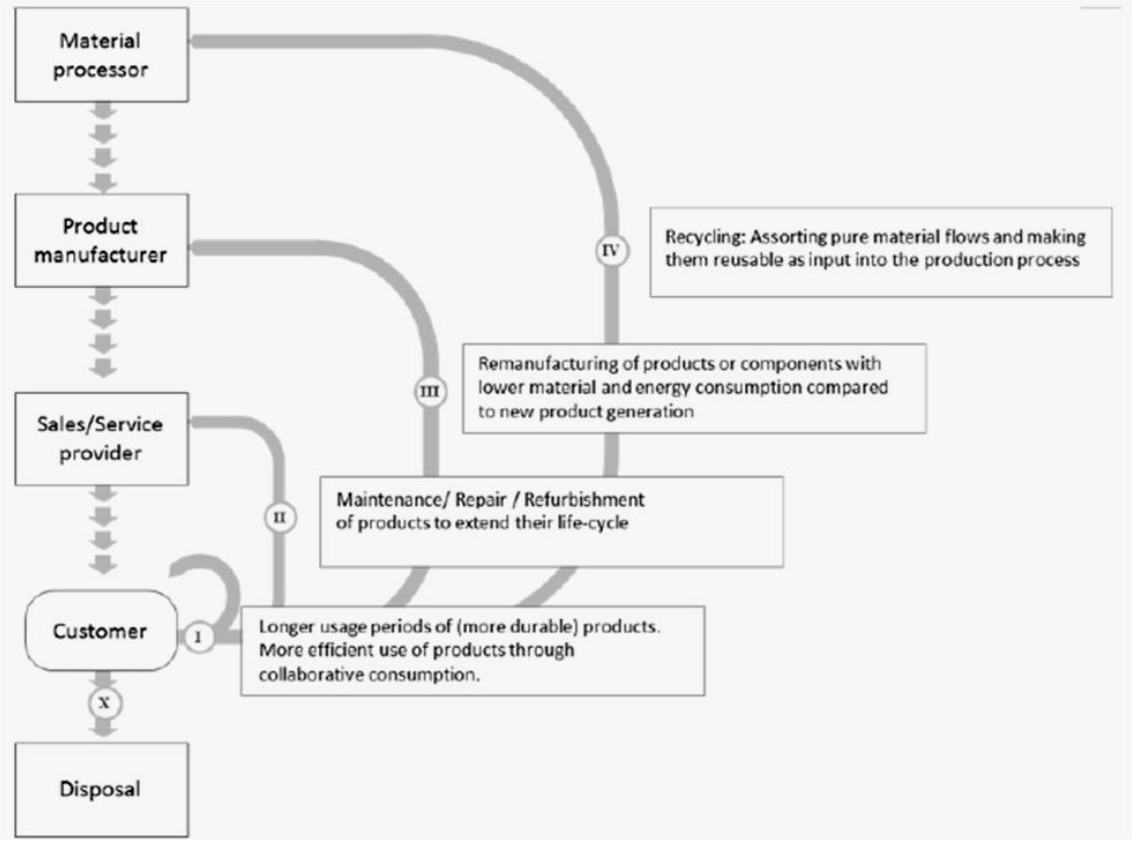

Figure 2. The general outline of Ellen McArthur Foundation model and the associated business models on each level. Source: Own drawing based on Ellen McArthur Foundation, 2014. Originally developed by Stahel and Reday-Mulvey, 1981.

The circular flow of income and spending shows connections between different sectors of an economy. It shows flows of goods and services and factors of production between companies and stakeholder. Scarcity of resources (material, human and financial) is a challenge for future production. As all resources get scarcer, circulating them within the circular economy is increasingly valuable.

Parallel to increasing scarcity of resources, there is increasing people focus on clean water, good soil and pure air, healthy food and consumer products. The structure of new business models along the circular flows, it is presented in table 4.

Table 4. Structuring new business models along the circular flows. Developed from Patrick Planing [9].

Cycle	Business model category along the circular flows	Short explanation	Example	Source
IV	Product Recycling/ Recycling 2.0	Recycling wins back base materials from used products, but loses much of the added (or embodied) value (energy, labor and use of capital).	PET bottles, (only 20-30% of PET can be reused as new bottles)	Ellen MacArthur Foundation (2013) Vol.3,Mentink B. [20]
III	Product transfor-mation	Product transformation uses certain components of products, which carry a high value, to be put together to form new products.	H&M collected clothes which fibres are used for damping components in the auto industry	Peter Lacy, David Rosenberg, Quentin Drewell, and Jakob Rutqvist [15]
III	Upgrading	Upgrading replaces outdated modules or components with technologically superior ones	Modular phone (e.g. Google Ara Project)	Parlikad, A. K., et. Al. (2003)
III	Remanu-facturing Next-Life sales	Remanufacturing is the process of restoring the product or part functionality to "as-new" quality.	Bosch remanufactured car parts	CircularEconomy Toolkit (University of Cambridge, Institute for Manufacturing, 2013)
III	Hybrid model / Gap-exploiter model	The hybrid model is a combination of a durable product and short-lived consumables. Companies profit from the gap in life-time of components.	Refilled printer ink cartridges	Bakker, & Hollander, D. [16]. Products that Last.
II	Reuse/ refurbish/ maintain/ redistribute/ Next-Life Sales	Direct Secondary Reusage or resale extends the product life so that the company can put the same products into the market to earn a second or third income.	Apple Certified Refurbished	CircularEconomy Toolkit (University of Cambridge, Institute for Manufacturing, 2013)
II	Performance model/ Products as Services / Result-based models	Company delivers product performance or certain defined results rather than the product itself.	Hours of thrust in a Rolls- Royce, 'Power- by-the-Hour' jet engine	Bakker, & Hollander, D. [16]
I	Access model /	Company provides	Carsharing, e.g.	Bakker, & Hollander, D. [16]

	Collaborative Consumption	product access rather than ownership	cargo, apartment sharing e.g. airbnb	
X	Energy recovery	Winning back energy through energy-from-waste (EfW) process	Waste incineration plants	http://www.edie.net/news/5/Circular-economy-failing-to-place-value-on-energy-recovery/

Based on document [10] and our expertise, we have created "The influence of Circular economy innovations components "over "Business model category from the customer perspective" Matrix. The influence of Circular economy innovations components "over "Business model category along the circular flows" Matrix is presented in table 5 and figure 3.

The calculation of the influence of Circular economy innovations components "over "Business model category along the circular flows" is starts from a matrix (table 5) in which data is organized in the table 4, below.

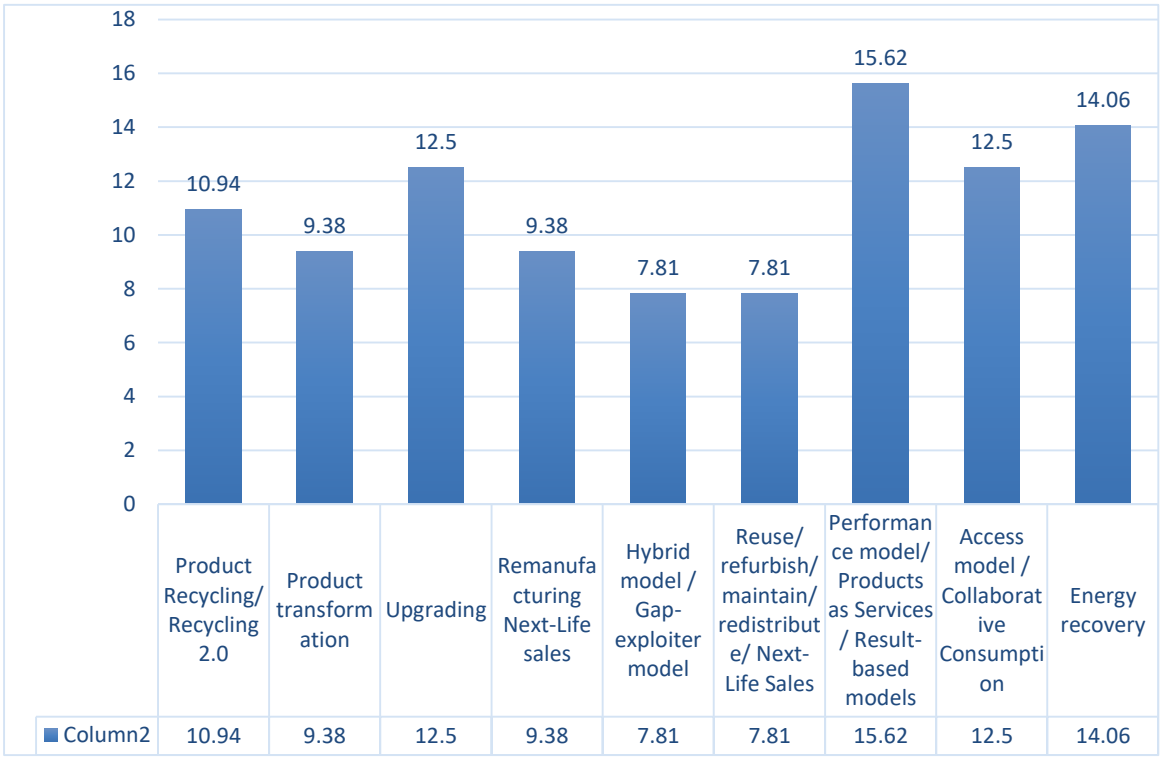

Figure 3. The influence of "Circular economy innovations components "over "Business model category along the circular flows".

As we can see in figure 3, the items named "Performance model/ Products as Services / Result-based models", it is strongly influenced by the "Circular economy innovations components", having the highest score (15.62%). According with this result, the companies 'managers from Romanian economy, need to take in consideration the fact that the best "Business model category along the circular flows" is "Performance model/ Products as Services / Result-based models".

Table 5. The influence of Circular economy innovations components over "Business model category along the circular flows" Matrix.

	Circular economy innovations components												
	Technological innovation			Social innovation			Organisational innovation						
Business model category along the circular flows	Design of materials and processes	Design of products	Resource management (waste, water, energy and raw materials)	New production and consumption models	Citizens' involvement	Product service models	Design services	Integrated solutions and systems	Logistics	Business models	Policy supporting tools	Points	Weight (%)
Product Recycling/ Recycling 2.0	1	0	1	0	1	0	0	1	1	1	1	7	10.94
Product transformation	1	1	0	1	0	1	0	0	1	1	0	6	09.38
Upgrading	1	0	1	1	1	1	0	1	1	1	0	8	12.50
Remanufacturing	0	0	1	0	0	1	1	0	1	1	1	6	09.38
Next-Life sales Hybrid model / Gap-exploiter model	1	0	1	0	0	1	0	0	1	1	0	5	07.81
Reuse/ refurbish/ maintain/ redistribute/ Next- Life Sales	0	0	1	0	0	0	1	1	1	1	0	5	07.81
Performance model/ Products as Services / Result-based models	1	1	1	1	1	1	0	1	1	1	1	10	15.62
Access model/ Collaborative Consumption	1	0	1	1	0	0	1	1	1	1	1	8	12.50
Energy recovery	0	0	1	1	1	1	1	1	1	1	1	9	14.06
Total	6	2	8	5	4	6	4	6	9	9	5	64	100

3. Conclusions

In every industrial sector, circular economy innovations components are involved in green product complexity in order to obtain good business outcomes.

A good business model yields value propositions that are compelling to customers, achieves advantageous cost and risk structures, and enables significant value capture by the business that generates and delivers products and services.
The business model category, from the customer perspective, is focused on increasing green product lifecycle and is now a critical element in circular economy industries that traditionally provided customer-oriented products.
To extent the type of any circular economy innovation processes (technological innovation, social innovation and organisational innovation), the managers should be determined by current company business performance and future expectations according with their organization's tolerance to risk.
As product complexity increases and innovation applications make their way into more and more product offerings, today's high tech companies need to find a way to break down the barriers and integrate appropriate elements and cross-link elements of their enterprises; Circular economy innovation components are more than just new green product development process. It is also about redesigning the core circular economy business practices that help take these products to market eco profitably.

4. References

[1] Hedman J and Kalling T 2003 The business model concept: theoretical underpinnings and empirical illustrations *European Journal of Information Systems*. EJIS **12(1)**
[2] Mansfield G M and Fourie L C H 2004 Strategy and business models-strange bedfellows? A case for convergence and its evolution into strategic architecture *South African Journal of Business Management*. SAJBM **35(1)**
[3] Seddon P B and Lewis G P 2003 Strategy and business models: What's the difference *In 7th Pacific Asia Conference on Information Systems, Adelaide* (Australia) 219
[4] Jens Horbach, Christian R and Klaus R Determinants of Eco-innovations by Type of Environmental Impact The Role of Regulatory Push/Pull, *Technology Push and Market Pull*, Discussion Paper No. 11-027 Centre for European Economic Research
[5] Kemp R and Pearson P 2008 *Final report MEI* Measuring Eco-Innovation, project about measuring eco-innovation Maastricht
[6] Archie B C and Shaban K M 2010 The Business Case for Corporate Social Responsibility: A Review of Concepts Research and Practice *International journal of management reviews* IJMR **12(1)**
[7] Zadek S 2000 Doing Good and Doing Well: Making the Business Case for Corporate Citizenship *The Conf. Board Trusted Insight for Business Worldwide* New York
[8] Business model background paper 2013 Int. Integrated Reporting Council
[9] Patrick Planning Business Model Innovation in a Circular Economy Reasons for Non-Acceptance of Circular Business Models *Open journal of business model innovation*
[10] Communication from the commission to the European Parliament, the council, the european economic and social committee and the committee of the regions. Towards a circular economy: A zero waste programme for Europe, , Annex: How can Horizon 2020 contribute to the circular economy? ***** COM/2014/0398 final http://eur-lex.europa.eu/legal-content/EN/TXT/DOC/?uri=CELEX:52014DC0398&from=EN, accessed 7.01.2017