Electronic Markets (2020) 30:679–697
https://doi.org/10.1007/s12525-020-00422-7

RESEARCH PAPER

Implementation of triple bottom line to a business model canvas in reverse logistics

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Received: 30 April 2018 / Accepted: 14 April 2020 / Published online: 12 May 2020

Abstract
Waste generation, especially hazardous waste, can strongly affect the environment and human lives. There is an urgent need to implement sustainable hazardous waste management tools to reduce their harmful impact on the environment stemming from incorrect waste management. However, there is still a lack of business model concepts combining sustainable development and risk management in reverse logistic value chains for hazardous waste. Therefore, the authors develop a novel sustainable business model canvas for both an entity and the logistics system using the Osterwalder's Business Model Canvas integrated with the concept of sustainable development in economic, social and environmental areas (Triple Bottom Line, TBL) and risk-related elements. Then, using the developed sustainable business model canvas, the model for the logistics system for the treatment of hazardous waste containing asbestos was successfully created. The model was implemented in the prototype of computer software in the form of electronic network services.

Keywords Business model · Business model canvas · Sustainable development · Triple bottom line · Risk

JEL classification L22 · Q01 · M21 · L26 · Q53

Introduction

Every human being is a part of the natural environment and benefits from its biodiversity and natural resources: air, water, and the soil with all the minerals. By the massive extraction of the planet's surfaces, people reuse or transform these resources irreversibly changing the ecosystem and the place where they live. The end of product's life is critical for the environment and is called the product life cycle. If the consumer is obliged or intends to dispose of the product, and disposes of the waste, the environment is contaminated, especially since the waste is collected from the holder and accumulated without treatment in landfills. Waste generation is part of the society's life, but generating hazardous waste[1] harm the environment substantially. Selective waste collection or segregation: (1) promotes the protection of human health (social aspect); (2) prevents damage to consumer goods (economic aspect); (3) prevents deterioration of the aesthetic values of the environment; and (4) protects the environment against surface and groundwater pollution, soil and air pollution (environmental aspect). The impact of selective collection on these four aspects depends on the people's awareness during the exploitation of the environmental resources, especially the decision-makers of various organizations responsible for the intensity of resource transformation and generation of pollution in the economic processes. In this sense, people's

This article is part of the Topical Collection on *Sustainability in business models in the network economy*

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[1] The classification of hazardous waste is based on the classification and labelling system for dangerous substances and preparations which ensures that similar principles are applied throughout the life cycle of materials. The properties of waste which render it hazardous are described in Annex III of Directive 2008/98/EC and are further specified by the Commission Decision 2014/955/EU (EU 2014b/955).

awareness of unnecessarily incurred, broadly understood economic, social and environmental costs should be shaped. At the substantive level, environmental protection for future generations is a matter of sustainable development and social responsibility (SR) (Wray-Lake et al. 2016), including government social responsibility (GSR) (Liu and Vredenburg 2014), corporate social responsibility (CSR) (Bocken and van Bogaert 2016, p. 109; Witek-Hajduk and Zaborek 2016; Jabłoński 2017, p. 5) and consumer and individual social responsibility (PSR) (Davis et al. 2017, p. 160; Majumdar and Rana 2015). Sustainable development requires systemic change in the way all the stakeholders understand and perform business activities (de Pádua Pieroni et al. 2018) and should apply to all final products that are produced in complex processes, often in cooperation with other entities. A group of cooperating entities creates simple or complex logistics chains. According to Porter's concept (1985, p. 35), the production of goods takes place in the value chain, from producer to consumer, in the so-called external value chain (see Fig. 1).

Adding value to the value chain involves the flow of different streams between links, consumption or transformation of resources, pollution emissions and waste generation. In each link, substances and objects that do not meet comestible, technical, health or consumable expectations, conditions and requirements, may become waste and pose a threat to the environment, especially to the health or life of citizens. Waste is everything that the holder disposes of, intends to dispose of or is obliged to dispose of. Processing of end-of-life products is studied in the field of logistics, referred to as "reverse logistics" (Banguera et al. 2017, p. 122; Himanshu et al. 2019; Wang et al. 2018, p. 2; Jalil et al. 2016, p. 246), see Fig. 2.

The reverse logistics system includes a value chain that has been redesigned to manage the flow of products or parts for resource efficient remanufacturing, recycling or disposal (Shad 2000). The waste holder is the initiator and therefore the first link in the reverse logistics system. Then, at the next link in the chain, the waste becomes a product to which the successive chain link adds value and thus generates income. Each link in the chain creates added value based on the operational logic resulting from a strategy, organizational vision or mission and values for internal and external stakeholders (Roberts 1992). System stakeholders are any group or individual that can affect or is affected by the whole system, part of the system or specific activities in the system (Freeman 1984, p. 46, for an overview, see Mitchell et al. 1997). In this paper, the internal stakeholders are defined as groups and individuals involved in the logistics chain, while the external stakeholder is society. A wide range of formal and informal (non-standard) relationships between internal stakeholders, demonstrating the entirety of the organization's activities and their parts, is referred to as "business model" (Høgevold et al. 2014). Stakeholders constitute every organization, they are its own resources, the meaning of its existence and shape its business model leading to its success (Clarkson 1995; Donaldson and Preston 1995), therefore, a stakeholder theory was developed as a theory of organizational management and ethics (Phillips et al. 2003). Every system operates in an environment that consists of internal and external factors and conditions that can affect the effectiveness of stakeholders and their relationships with other stakeholders. Six groups of factors are identified by the acronym PESTLE referring to political (P), economic (E), social (S), technological (T), legal (L) and environmental (E) contexts (Cincalova 2017, p. 548; Perera 2017). The analysis of the system environment can also take into account the five competitive forces identified by Porter (1985, p. 6) i.e. (1) competition in the industry, (2) potential of new entrants into the industry, (3) power of suppliers, (4) power of customers, (5) threat of substitute products (Aithal 2016, p. 112).

Organizations located in both logistics and reverse logistics value chains for their long-term and consensual coexistence with their environment should implement business models that should take into account the concept of sustainable development because it has become fundamental for their competitiveness and development (de Pádua Pieroni et al. 2018). This applies not only to each organization, but also to the value chain, including cooperation of all organizations within it. Sustainable development is a holistic view of civilization development and a broad spectrum of people's responsibility towards present and future generations. The literature focuses on the three areas (dimensions) of responsibility related to economic, social and environmental issues, which is referred to as the Triple Bottom Line (TBL) (Savitz and Weber 2014), three spheres (Pelletier et al. 2012, p. 13), 3P (Bocken and van Bogaert 2016, p. 109) or PPP (people, planet, profit) model (Silvius et al. 2012, p. 9). In particular, TBL is one of the concepts of multifaceted responsibility, referred to as multiple bottom lines (Carroll and Buchholtz 2008, p. 71).

The integration of sustainable development or risk management into the business model is the subject of many studies at both conceptual (Taran et al. 2014; Proença et al. 2015;

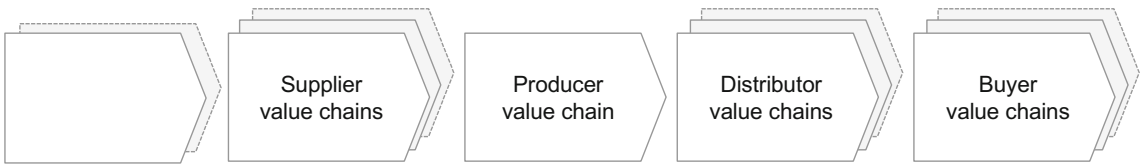

Fig. 1 The added value chain in Porter's concept (Porter 1985, p. 35)

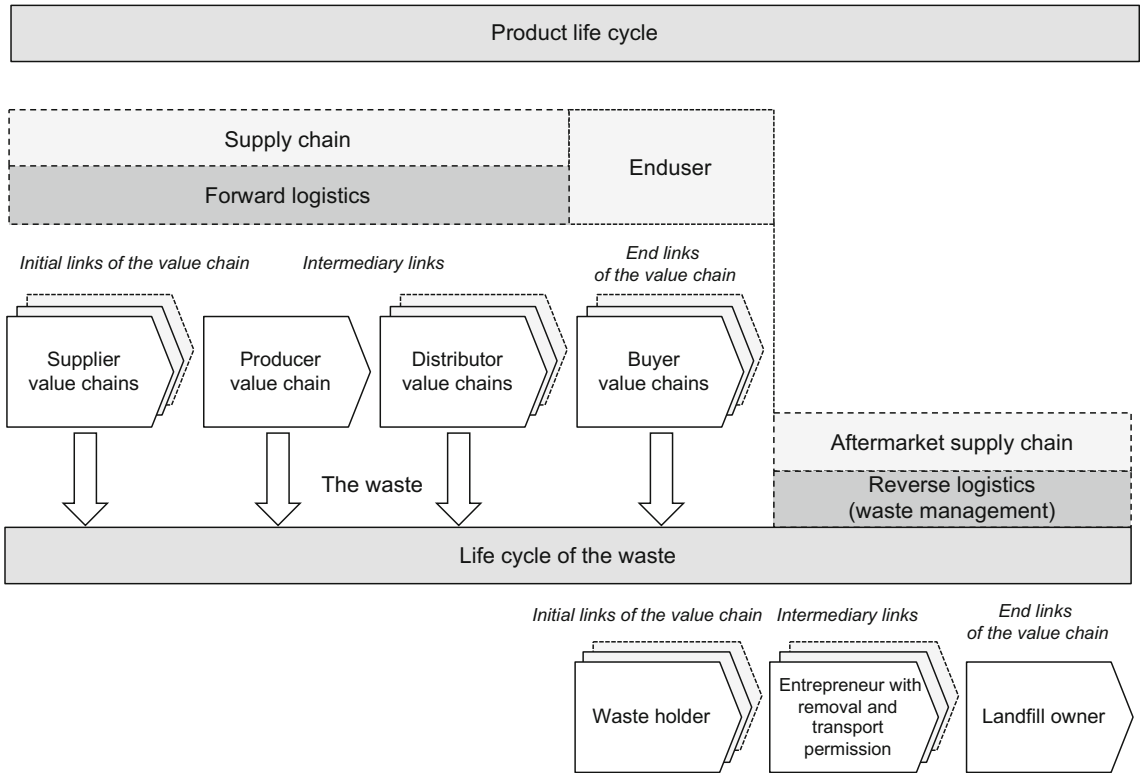

Fig. 2. Logistics and reverse logistics in the life cycle of products and waste

Bocken et al. 2014) and operational levels (IRM 2017; FRC 2018; Yip and Bocken 2018). Existing studies focus on aspects strictly related to the concept of sustainable business without considering the risk aspect, on the one hand, and on the integration of sustainable development with business models, for example TBL and reverse logistics (Nikolaou et al. 2013), on the other. Sustainable business models are primarily aimed at solving economic, social and environmental issues and sustainable risk-based business models can benefit from greater risk reduction, increased resilience (Marchese et al. 2018) and allow for behavioral analysis. This is particularly relevant for reverse logistic value chains where risk is integral part of economic activity, especially concerning hazardous waste (Muralikrishna and Manickam 2017). However, to the best of our knowledge there are no examples of the successful incorporation of the three aspects of the TBL sustainable development concept (Elkington 1997; Rodriguez et al. 2018) into the business model canvas (Høgevold et al. 2014), especially considering the risk assessment in all three aspects of TBL (Ghadge et al. 2012). Therefore, the paper fills this gap and, as a first aim, designs a canvas for a sustainable and risk-based business model that incorporates the organization's responsibility concerning both its activities and the environment in three TBL areas with a risk of achieving objectives being assessed. Then, we develop business model canvas for the value chain of the logistics system through the prism of the sustainable business model canvas of the entities forming the chain resulting in the model canvas that is not a simple sum of the individual models. To illustrate this canvas, we use the example of the logistics chain for the disposal of hazardous waste containing asbestos. A potential challenge is to choose a definition of the business model from different concepts, typologies, components, perspectives for understanding and perceiving the business model that will determine the level of detail for the other models, i.e. the sustainable development and risk model. In this way, all models will be presented in the same notation and level of detail, making them all consistent and equivalent.

While the multitude of definitions and descriptions of business models concerns the presentation of the logic of the organizations (its capturing, visualizing, understanding and communicating), especially those operating for profit (Osterwalder and Pigneur 2010; Zott and Amit 2013; Teece 2010; Bocken et al. 2014), the literature on the business models of organizational associations, e.g. clusters, networks, networks of organizations is still limited. There is still a need to explain how theoretically complex models are created and translated into business practice, especially for organizations belonging to different sectors of the economy and forming a common value network. The interaction of public and private organizations in the provision of public services for households (Díaz-Díaz et al. 2017) is interesting because it can increase our knowledge of customer needs in the value chain (Ojasalo and Ojasalo 2018) and their relationship within this

Table 1 Number of document occurrences for given keywords and their expressions in multidisciplinary databases: Scopus and Web of Science

Keyword / expression	Scopus			Web of Science		
	Anywhere in the paper	%	In the paper title	Anywhere in the paper	%	In the paper title
'business model'	26,065	–	5861	9,927	–	2,467
'business model' AND 'sustainable development'	1,213	4.65%	13	209	2.11%	4
'business model' AND 'risk'	1,981	7.60%	48	743	7.48%	18
'business model' AND 'conceptualization'	198	0.76%	9	92	0.93%	4
'business model' AND 'operationalization'	38	0.15%	2	19	0.19%	0

source: Self-study conducted in May 2018

chain (Lüdeke-Freund et al. 2018, p. 39). Interestingly, despite the growing number of studies on the circular economy and the implementation of various sustainable business models in this area (see for example Jabbour et al. 2019; Pieroni et al. 2019; Rizos et al. 2016), none of the concept of circular economy can be implemented in hazardous waste management due to legal or technological constraints. Thus, the literature lacks relevant studies and solutions on available sustainable business models that can be implemented outside the circular economy like for instance in hazardous waste management. Therefore, the second aim of the paper is to create a model of the reverse logistics chain with a linear structure for the disposal of hazardous waste containing asbestos based on developed canvas. It should be stressed that the value chain model for the disposal of hazardous waste containing asbestos can only be a linear model. The change from a linear model to a circular model for hazardous waste containing asbestos (Paglietti et al. 2016, p.144) (so-called closed-circuit management) with the current state of available techniques according to the Best Available Techniques (BAT) principle is economically (Spasiano and Pirozzi 2017, p. 89), socially and environmentally unjustified.

In order to achieve both of these aims we adopted the following structure of the paper. The next section presents the literature review on both the three areas of sustainable development and the different concepts of sustainable business models. This analysis allows us to capture the state of knowledge and the most recent directions of the research in these areas. The third section contains original model canvas of both sustainable business model for an individual entity and the sustainable business model for the value chain. In the fourth section a model for reverse logistics in the disposal of hazardous waste based on the developed canvas is created, while the last section offers a conclusion.

Theoretical background on building sustainable business model canvas

Dissemination of the sustainable development and risk concepts in business model literature

The paper seeks to incorporate three aspects of the TBL sustainable development concept and risk assessment into the business model canvas. Therefore, the first element of literature research is the bibliometric analysis of the occurrence of key words in the research. The bibliometric analysis is suitable for identifying gaps in research, current trends and relationships between several phenomena, including business models (Belussi et al. 2019). This will make it possible to determine to what extent these links have been established by existing studies. There is no doubt that the concepts of 'sustainability' and

Table 2 Number of document occurrences for given keywords and their expressions in multidisciplinary databases: Google Scholar and Google Patents

Keyword / expression	Google Scholar			Google Patents		
	Anywhere in the paper	%	In the paper title	Anywhere in the paper	%	In the paper title
'business model'	679,000	–	11,100	31,970	–	679,000
'business model' AND 'sustainable development'	48,800	7.19%	11	519	1.62%	48,800
'business model' AND 'risk'	262,000	38.59%	25	7,338	22.95%	262,000
'business model' AND 'conceptualization'	30,900	4.55%	3	312	0.98%	30,900
'business model' AND 'operationalization'	21,700	3.20%	1	30	0.09%	21,700

source: Self-study conducted in May 2018

Table 3 The areas of sustainable development with their field of application

Areas of sustainable development	Field of application	Source
The nine areas covered are values and behaviours, human development, economy, agriculture, forests, energy and power, buildings, mobility and materials.	business and markets in general and individual sectors	World Business Council for Sustainable Development. Vision (2010)
Three conceptual dimensions of human well-being, i.e. 'here and now', 'later' and 'elsewhere'. Twenty themes are distinguished, covering environmental, social and economic aspects of sustainable development: subjective well-being, consumption and income, nutrition, health, housing, education, leisure, physical safety, trust, institutions, energy resources, non-energy resources, land and ecosystems, water, air quality, climate, labour, physical capital, knowledge capital, and financial capital.	the measurement of sustainable development, including a set of indicators referring to various actors	UNECE (2013)
Three dimensions of sustainable development: the economic, social and environmental. Importance for humanity and the planet: People, Planet, Prosperity, Peace, Partnership. The 17 Sustainable Development Goals	a plan of action for people, planet and prosperity	UN (2015)
Basic model of sustainable development		
Triple-bottom Line (TBL)	business and markets in general and individual sectors	Elkington (1994)
Sustainable development instruments – measures		
Life Cycle	Field of application	Source
Life Cycle Costing (LCC), Life Cycle Assessment (LCA)	the evaluation of the environmental impacts of a product from its fabrication to the end of its life, including possible recycling; three areas of protection are considered: human health, the natural environment (also named ecosystems), and natural resources. "Life cycle costing, or LCC, is a compilation and assessment of all costs related to a product, over its entire life cycle, from production to use, maintenance and disposal."	UNEP/SETAC (2009)
Social Life Cycle Assessment (S-LCA)	the assessment of the positive and negative social impacts of a product or service in a life cycle perspective	UNEP/SETAC (2009)
Environmental Life Cycle Assessment (E-LCA)	the assessment of the environmental aspects and their potential environmental impacts throughout a product's life cycle.	UNEP/SETAC (2009)
Life Cycle Management (LCM),	an integrated concept for managing the total life cycle of goods and services towards more sustainable production and consumption, integrating economic, social and environmental aspects into an institutional context	UNEP/SETAC (2009)
Life Cycle Thinking (LCT)	the assessment of the environmental, social, and economic impact of a product over its entire life cycle aiming at reducing a product's resource use and emissions to the environment as well as improving its socio-economic performance throughout its life cycle	UNEP/SETAC (2009)

'risk' in business model canvas are reflected in scientific literature and business practice. The literature studies reveal the current state of knowledge, methodologies, tools, techniques, concepts and practical solutions that are adaptable and directly applicable to our research topics. However, they are not interconnected, as we prove below.

A two-stage approach to bibliographic research was applied, which was based on a structured literature review with quantitative and qualitative evaluation: 1) data mining and obtaining a set of documents from multidisciplinary databases; 2) quantitative and qualitative analysis of data and interpretation of obtained results. The first stage consisted of systematic searches of multidisciplinary databases: Scopus, Web of Science, Google Scholar, Google Patents, Springer Link, Elsevier: ScienceDirect. The following keywords were used in data mining: business model, sustainable development, risk, conceptualization, and operationalization, which were used to build an expression in the form of queries. The next step was to obtain and store scientific articles in the cloud computing.

The second stage is the quantitative and qualitative analysis of data and interpretation of the results obtained. It involved

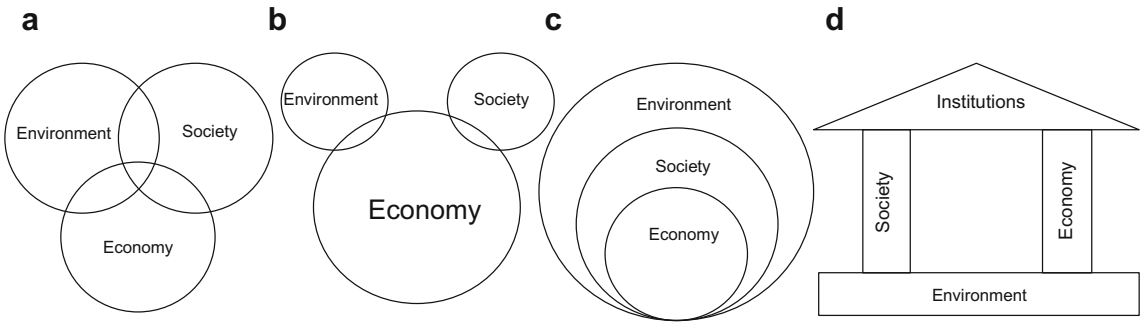

Fig. 3 Three-dimensional model of sustainable development: (**a**) three independent but overlapping areas; (**b**) "Mickey Mouse" diagram with the economy dominance; (**c**) environmental domination, (**d**) environmental foundations of social and economic pillars (UNEP model) (Pelletier et al. 2012, p. 14)

reviewing and statistical evaluation of the results, viewing source documents and creating thematic bookmarks. The results are presented in Table 1.

The keyword 'business model' and the number of occurrences anywhere in papers according to TITLE-ABS-KEY ('business model') is a reference in the analysis of the number of papers constituting the sub-themes. The analysis of the number of papers by sub-theme showed that the most numerous is the group concerning the 'business model' and 'risk' (approx. 7.6% in Scopus and approx. 7.5% in Web of Science), followed by 'business model' and 'sustainable development' (approx. 4.5% in Scopus and 2.1% in Web of Science). Due to a small number of papers on conceptualization and operationalization of the business model, the authors expanded their search to the Google Scholar database and the Google Patents database (see Table 2). The search in additional databases (Springer Link and Elsevier: ScienceDirect) did not change the distribution of the number of papers' occurrences, hence the results are not presented.

The quantitative analysis of the number of articles in selected data sources by sub-themes showed that the practical aspect of the business models is most popular in the case of 'business model' and 'risk' (approx. 38.5% in Google Scholar, approx. 22.9% in Google Patents). Second, most patents are related to 'sustainable development' (approx. 1.6%). Google Scholar database contains the most references because the search engine robot indexes not only multiply reviewed materials but also search the content of the indexes of publications and websites.

The qualitative analysis comprised the selection of scientific articles and monographs from among the excessive number of documents obtained from the quantitative analysis of bibliographic research. In the selection process, an application was used which determined the density of keywords in documents and specialized Internet platforms were used to determine the bibliometric parameters of documents in relation to authors, content and journals or monographs. From the Web of Science platform, an analytical tool *Publons* with text and graphic analysis including metrics: *Citations, Score, Altmetric* was used. From Scopus platform *SciVal* analytical tool with a group of metrics in *Overview, Trends, Reporting* commands was used. The qualitative assessment also included data, document metrics performed by the research community independent of publishers in ResearchGate including the following metrics: *Research Interest, Citations, Recommendations, Reads*. For the analysis of such a large collection of various types of data, formulas and sorting in MS Excel spreadsheet were used. The last step in the bibliographic research was the author's own substantive assessment and decision to include a scientific publication in the literature. The final result was a set of documents, which is the most similar to the presented research subject matter, obtained finally on the basis of substantive assessment. The final list of documents is quoted in the next section and was included in the bibliography.

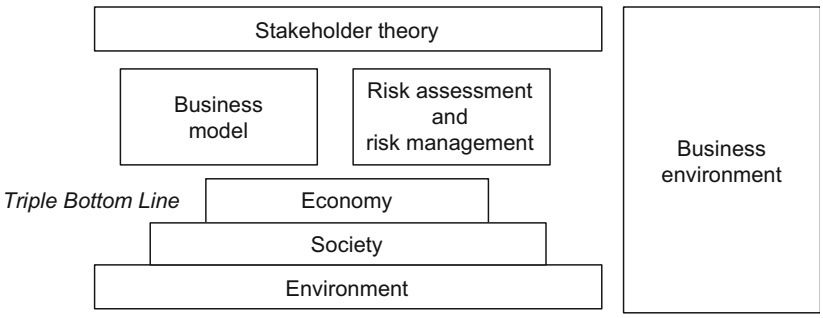

Fig. 4 Elements of the sustainable business model canvas in the theoretical model

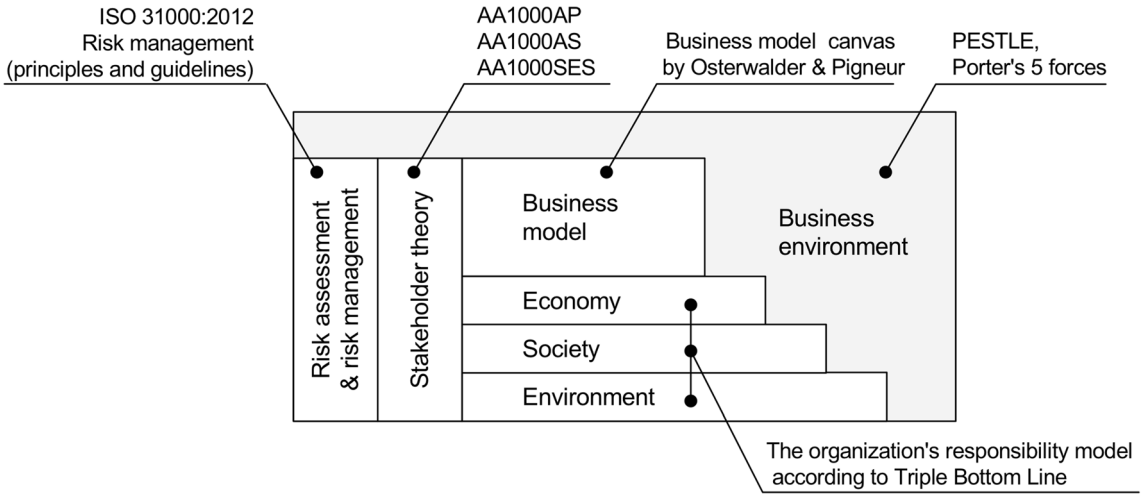

Fig. 5 Elements of the sustainable business model canvas in the application model

To summarize the process of bibliographical research, the authors conducted a quantitative and qualitative review of the literature in a structured manner. The main aspect of the qualitative assessment was the analysis of the density of keywords in scientific articles, which allowed to confirm the adequacy of the content to the research topic, followed by the evaluation by the scientific community expressed in document metrics by the *ResearchGate* service and metrics from *SciVal* and *Publons* platforms.

The areas of sustainable development

TBL became the basis for creating various models of sustainable development. The areas of sustainable development with their field of application is presented in Table 3. These are the areas that are the most referred to in the literature and thus, we will take them into account when elaborating the business model canvas incorporating TBL sustainable development concept and risk assessment.

In general, the TBL concept represents a triple balance of responsibility, taking into account the interaction of the system

Key partners KP	Key activities KA / Key resources KR	Value propositions VP	Customer relationships CR / Channels CH	Customer segments CS
Cost structure C$			Revenue streams R$	
Social and environmental costs			Social and environmental benefits	

Fig. 6 Triple bottom line business model canvas – the BMC visualization (Osterwalder and Pigneur 2010, p. 265)

and the environment in the economic, social and environmental areas. At the same time, these areas of sustainable development may be dependent in various ways (Pelletier et al. 2012) (see Fig. 3).

Building canvas of sustainable business models

Building the canvas of sustainable business models should be started with an analysis of stakeholders' responsibility regarding sustainable development. Stakeholder responsibility may concern not only the three areas mentioned in the introduction but also many others, e.g. ethical, legal or philanthropic areas. However, the three areas are the absolute minimum necessary to determine that an organization is responsible for its activities, see CSR (Bocken and van Bogaert 2016, p. 109; Witek-Hajduk and Zaborek 2016; Jabłoński 2017, p.5) or GSR concept (Liu and Vredenburg 2014). To achieve the first aim of the paper, which is to design a canvas for a sustainable and risk-based business model, we developed a cascade model canvas of three hierarchically dependent TBL areas with following priorities: Economy < Society < Environment. This hierarchy means that the responsibility of the entity in the economic area refers to social responsibility and concerns the environmental needs of society. The TBL model was complemented by the business model canvas, risk management process and stakeholder theory, supplemented as a whole by the business environment (see Fig. 4). The risk management process is reflected and reduced to two main elements: risk assessment (description) and risk management (response). We articulate only two risk components concerning the organization's environmental performance and its responsibilities in the three TBL areas. The risk elements are independent of business model and TBL and this independence is shown graphically in Figs. 4 and 5.

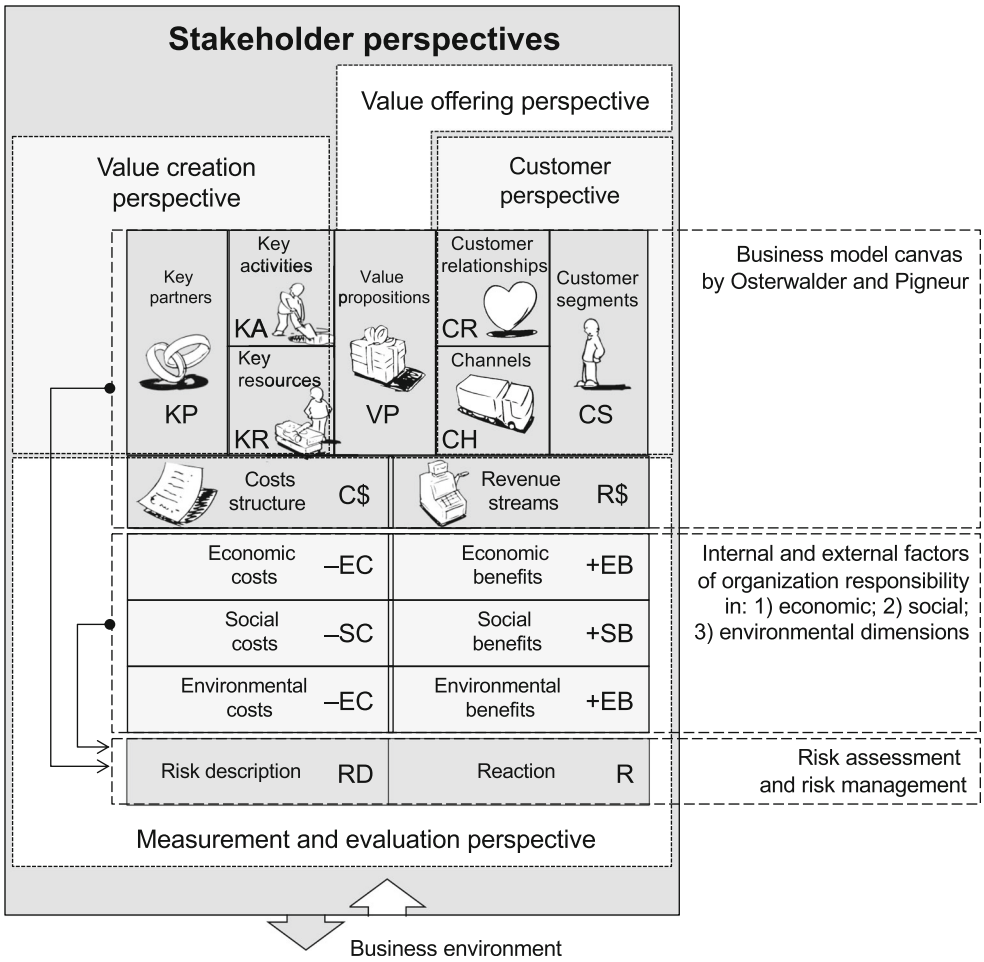

Fig. 7 A sustainable business model canvas with four stakeholder perspectives (Self-elaboration based on Osterwalder and Pigneur 2010)

We integrate the concept of sustainable development (TBL) into the business model canvas using the 9-element business model canvas (BMC) introduced by Osterwalder and Pigneur (2010, p. 265). The BMC has been widely recognized in the literature as an effective tool contributing to the success of companies in various industries (see for example Harima and Vemuri 2015; Klimova 2017; Ladd 2018). The model canvas includes organizational responsibility based on the TBL concept; risk assessment and risk management based on the risk management process diagram (ISO 31000 2018); stakeholder perspectives modelled on three standards: AA1000 (2008, 2015, 2018); and segmentation of the business environment based on six PESTLE areas with respect to Porter (1985) (see Fig. 5).

Canvas of sustainable business model for an organization

In order to achieve the first scientific aim of the research, which is to design a canvas for a sustainable and risk-based business model, we use the BMC enriched with the TBL concept of sustainable development. Osterwalder and Pigneur (2010) use canvas to present business model canvas consisting of nine components: 1) customer segments; 2) customer relationships; 3) distribution channels; 4) value proposition; 5) key resources; 6) key activities; 7) partners, 8) cost structure; 9) revenue streams. The model canvas contains two additional elements: (1) social and environmental costs of the business model, (2) social and environmental benefits of the business model. The BMC is a powerful visualization tool that clearly shows all the components and their interrelationships (see Fig. 6). The level of detail of the figures presented in the study is adapted to the level of detail of the BMC description.

The proposed 11-element BMC covers three TBL areas, with two elements (cost structure and revenue streams) playing a dual role. The cost structure and revenue streams are related to the business model, and at the same time, they should be complemented by the economic costs and benefits resulting from the organization's responsibility in this area. Furthermore, placing social and environmental costs in one element and corresponding benefits in another is a holistic view of the organization's responsibility in these three areas. Therefore, such integration of TBL into the business model canvas is inconsistent with the TBL sustainable business concept, which is characterized by transparency, accuracy, timeliness, and completeness of the description of the

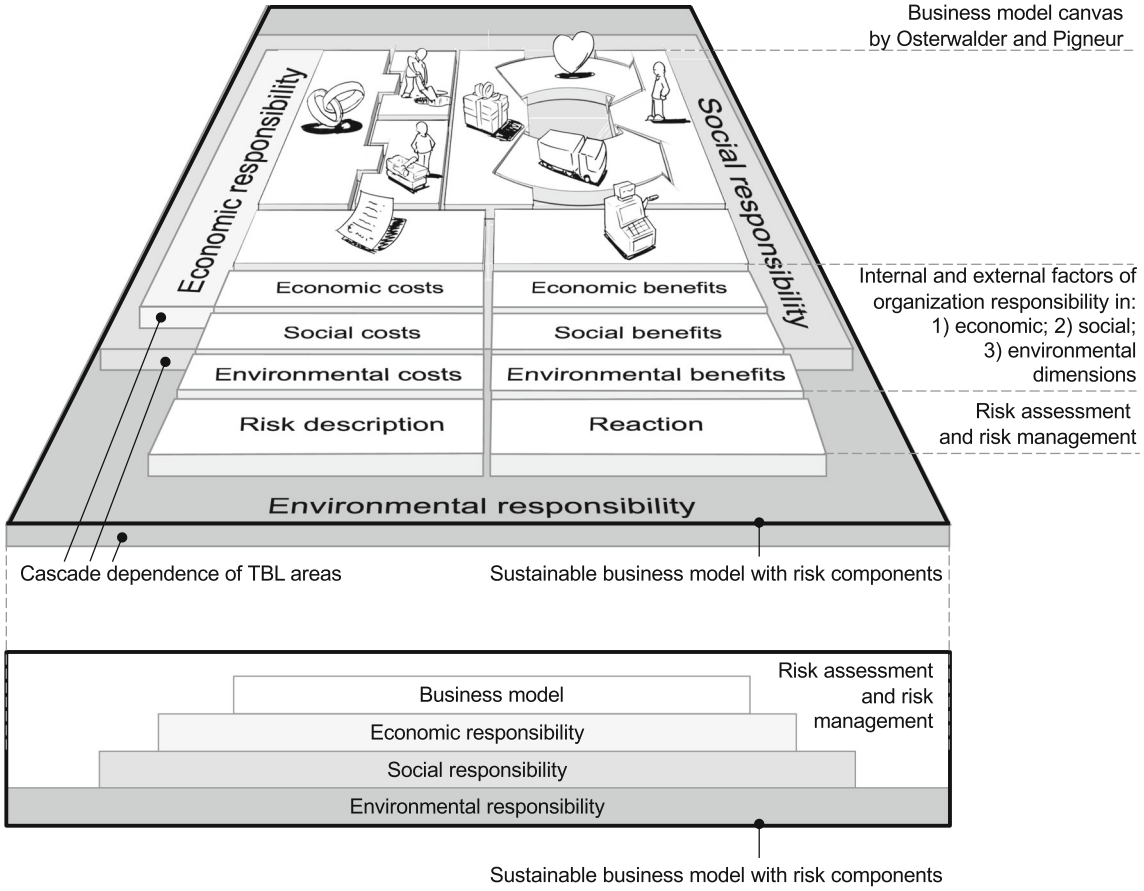

Fig. 8 3D canvas of the sustainable business model with risk components showing cascading dependence between TBL areas (Self-elaboration based on Osterwalder and Pigneur 2010)

organization's impact in the internal and external context (ISO 26000, p. 4) and scalability (Jabłoński 2016, p. 26; Nielsen and Lund 2018). In addition, the BMC does not reflect the risk of the business model in terms of identifying threats and opportunities that could potentially have a negative or positive impact on the functioning of the entity and the size of costs and revenues.

For this reason, we modified the business model canvas of Osterwalder and Pigneur (2010), complementing the 9-element model canvas with elements related to the concept of sustainable development in three TBL areas of responsibility, that interact with each other and with the business model. Furthermore, elements related to risk assessment and risk management were added to the business model canvas. Thus, the extended Osterwalder and Pigneur (2010) business model canvas represents a "sustainable business model". In the template created, the concept of "stakeholder value creation" takes on another terminological meaning. Stakeholders value creation requires a broader analysis of many areas of value creation that are relevant to all stakeholder groups. Defining key areas of value creation and defining value factors (the so-called value generators) within them allows to orient the management process towards long-term value (Jabłoński 2013, p. 31). The factors of value creation will be identified both in the material and intangible spheres together with the costs and benefits for stakeholders in the three dimensions of TBL sustainable business concept. The analysis of the sustainable business model canvas from the perspective of stakeholders in a descriptive way allowed for the distinction of four perspectives:

1. A value creation perspective covering three elements in the BMC template: "key partners", "key activities" and "key resources".
2. A value offering perspective that applies to the "value proposition" element.
3. A customer perspective covering three elements: "customer relations", "channels" and "customers' segments".
4. A measurement and evaluation of activities perspective covering the following elements: "cost structure", "revenues streams", "costs and benefits" in the three areas of responsibility with simultaneous implementation of economic, social and environmental objectives, "risk description" and "response". The description of these elements

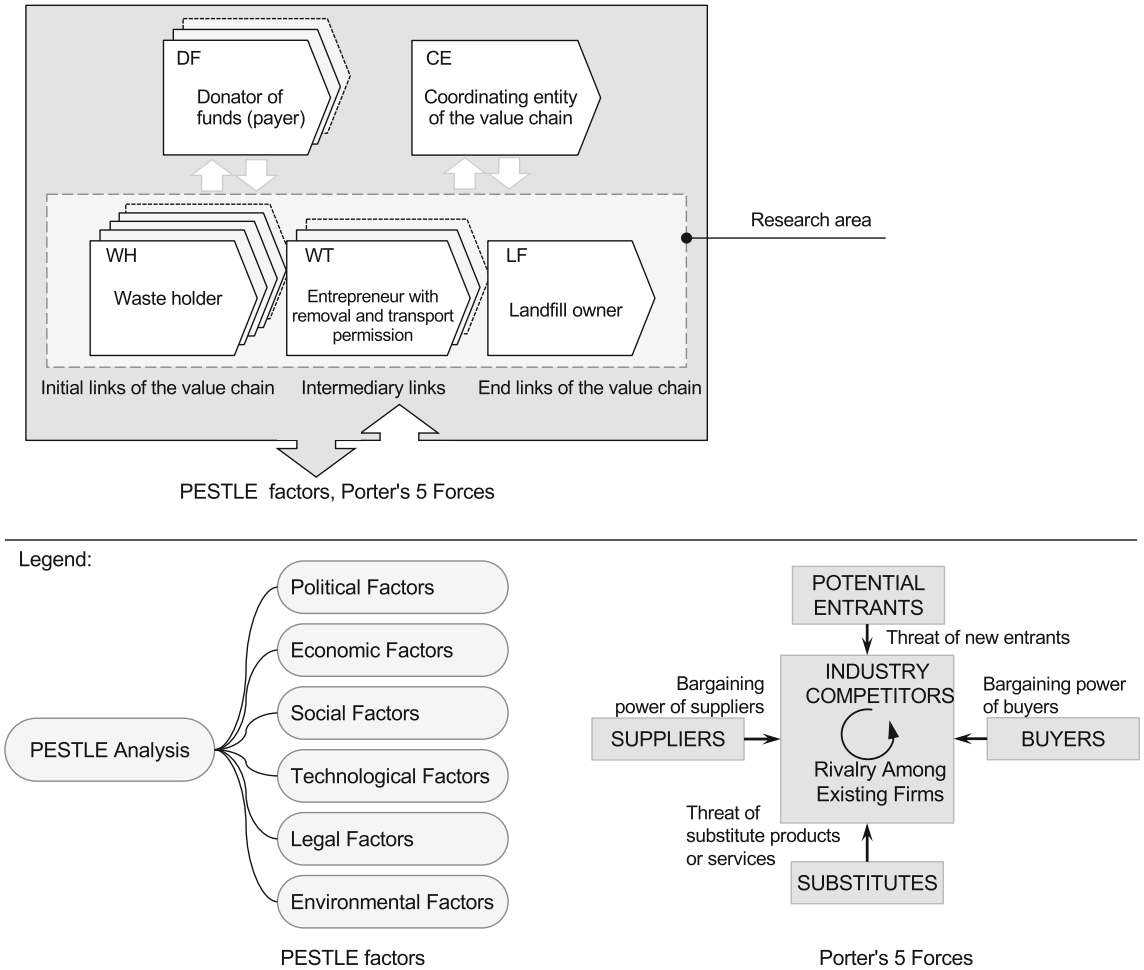

Fig. 9 Value network with separate links for the one-stage transport variant of the hazardous waste disposal logistics system

should be quantified and, if possible, measured by indicators logically related to the specific nature of the organization's operation on the market. The risk in the business model refer to the BMC, TBL's liability elements and the business environment (three arrows with different sources presented in Fig. 7). For the clarity of the presentation and legibility of the model canvas, we did not divide the risk into individual groups, although such efforts were carried

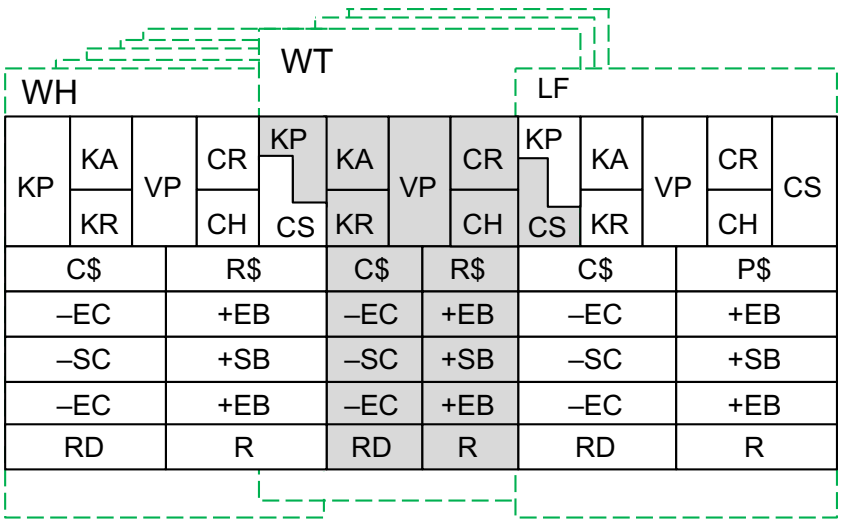

Fig. 10 The sustainable business model canvas for entities forming the logistics system

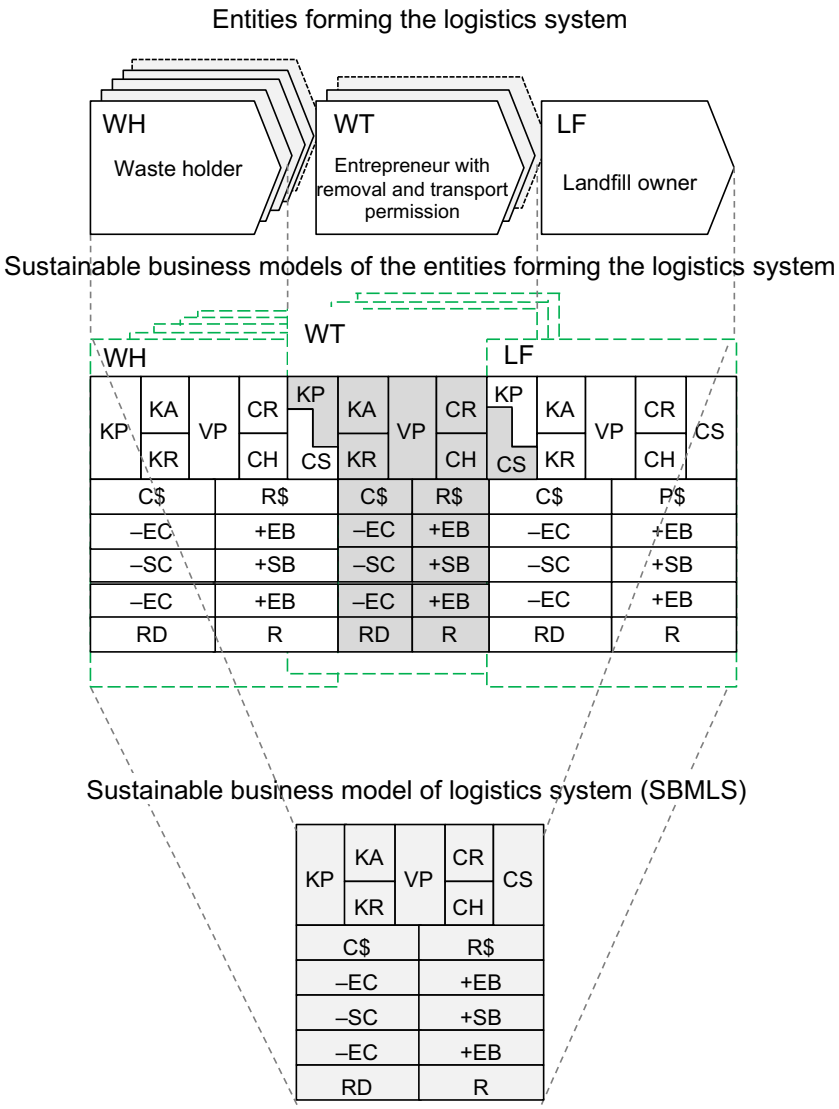

Fig. 11 A sustainable business model canvas of the logistic system developed based on sustainable business model canvas of entities constituting this system

out in other studies (see for example Michelini and Fiorentino 2012).

A sustainable business model canvas with four stakeholder perspectives is presented in Fig. 7.

These four stakeholder perspectives are related to their awareness of the organization's functioning and its interaction with the environment, the organization's responsibility for its impact on the economy (economic aspects), society and the environment, and the prevention of unforeseen, unplanned and negative effects of the organization's activities. The responsibility of decision-makers towards their own organization is important (not acting to their own detriment, responsibility towards system stakeholders, ethical value-based behavior), responsibility towards the environment due to the exchange of values (respecting the law and international regulations) and environmental stakeholders in terms of transparency and respect towards them.

The three-dimensional (3D) sustainable business model canvas, taking into account the organization's responsibility for its own activities and the environment with risk assessment (concerning two given components) includes the concept of sustainable development in three areas of TBL responsibility. These three areas can be placed in a cascaded dependency (see Fig. 8).

The 17-element sustainable business model canvas can form the basis for implementing sustainable business models in the value chain of reverse logistics, presented in the next section.

Canvas of a sustainable business model for the value chain

The sustainable business model canvas for the value chain is illustrated with an example of the logistics chain for the disposal of hazardous waste containing asbestos. In the

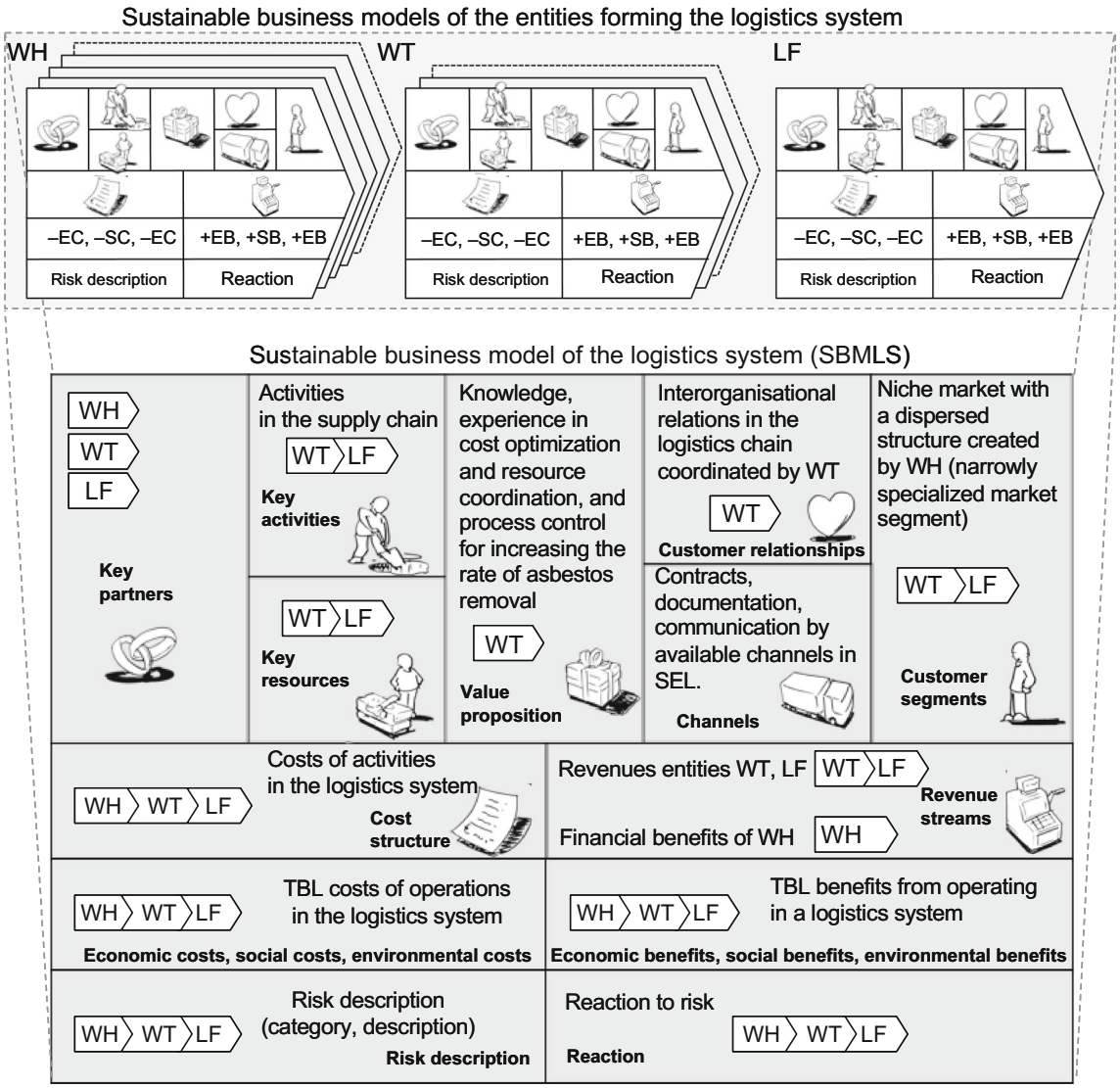

Fig. 12 A sustainable business model of the logistic system as a result of combining sustainable business models of entities constituting the system

conceptual canvas of this case study, we adopted the following assumptions:

1. The value chain refers to the reverse logistics of hazardous waste collection from WH by WT and deposited by LF. The method used for disposal of asbestos waste is its storage in underground or above-ground hazardous waste landfills or in separate parts of landfills for non-hazardous and neutral waste. This is the only method of processing asbestos waste permitted by Polish law (Journal of Laws of 1997, No. 101, item 628).
2. The value chain with a linear structure for the one-stage transport option consists of three groups of entities in the logistics chain of different groups of entities, marked with acronyms: WH, WT and LF.
3. The number of entities in the logistics chain may vary. There are many entities with hazardous products and waste, in this case, made of asbestos, a small number of entrepreneurs authorized to remove and transport such waste, and only a few hazardous waste landfills. The links presented between WH, WT and LF in the model canvas are examples representing groups of entities of different sizes. Most of them are households with asbestos products or asbestos waste. Only a few companies are authorized to dismantle asbestos products and transport hazardous waste. The number of ground-level hazardous waste landfills is small.
4. The role of both the coordinator (CE) of the logistics value chain for the disposal of hazardous waste and the payer (DF) financing the process of disposal of hazardous waste, such as entities with funds from European Union projects, are not discussed in the value chain model canvas.
5. However, the sustainable business model canvas presents the payer, that is, the donor of the funds (DF) and the coordinating entity (CE).

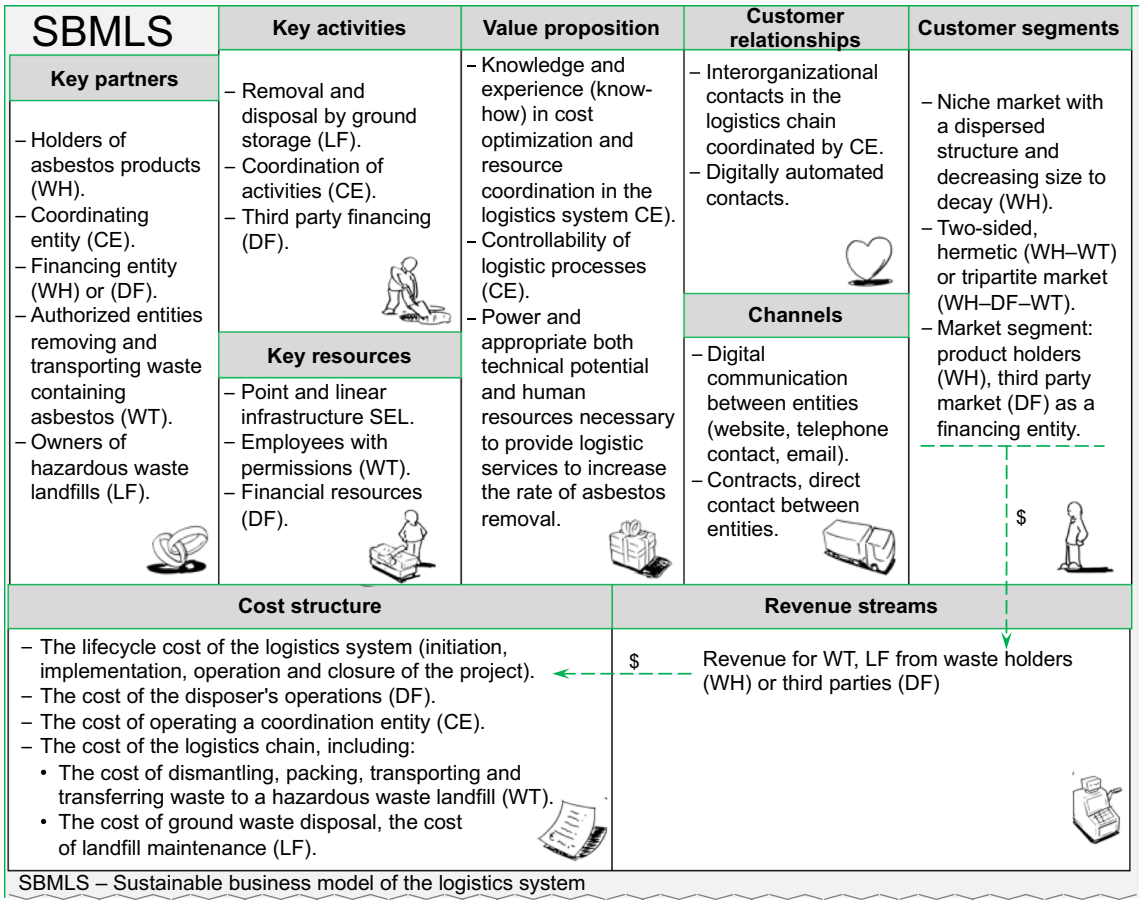

Fig. 13 The sustainable business model of the logistics system

Our research area is a value chain with separate links for the single-stage transport variant forming a logistic system consists of three links: the waste holder (WH), an entrepreneur with the right to dispose of and transport materials containing asbestos (WT), and the owner of the hazardous waste landfill (LF) (see Fig. 9).

In order to identify factors and conditions of interaction between entities and the environment, it is necessary to distinguish between market or non-market actors. Non-market actors are: WH, disposers of funds (DF), coordinating entity (CE) and LF. Market players, including WT, compete with each other within the industry. Most often, a company with the right to dispose of asbestos also has transport rights. Interactions between entities and the environment affecting the achievement of the objectives of individual entities are analyzed in the context of economic, social and environmental areas[2] (Cincalova 2017, p. 548; Perera 2017) including two competitive forces in the industry[3] (Porter 1985, p. 6).

For the presented value chain (see Fig. 9), based on the sustainable business model canvas (see Fig. 8), we developed the sustainable business model canvas of entities constituting the logistics system (see Fig. 10).

Based on the sustainable business model canvas for individual entities, a canvas for a logistic chain was developed in which logistic cooperation between entities was described in a logical way. This means that the

[2] In the paper we emphasize economic (E), social (S) and environmental (E) (TBL) contexts, while other contexts of PESTLE approach i.e. political (P), technological (T) and legal (L) were not presented, despite their significant impact. This approach is caused by a limited space in the paper and the avoidance of secondary topics, which could complicate the achievement of the goals set in the paper.

[3] Although Porter's model of five competitive forces is a useful analysis framework, in the case of conceptual model of the linear logistics chain with a specific hazardous waste, only two of Porter's five forces are applicable. This logistics chain is formed only by entities with rights in the activity of hazardous waste, and thus, there is a monopoly on the market of several companies in the region (Polish legal regulations prohibit the transport of hazardous waste outside its territory), which are entered in the specific register of such service companies. For example, for LF, which is the final recipient of waste, two competitive forces should be considered. There are no buyers, because the landfill is the last link in the chain, no substitutes, because legally other methods of asbestos waste disposal are not legally allowed, bargaining power of suppliers practically does not exist, because the landfill accepts asbestos waste from any authorized entity. Thus, both competitors in the sector and the threat of new entrants from authorized entities that may operate ground-based landfills (SN) are only important to the LF entity. However, Porter's five competitive forces model would be relevant for two-stage transport and in networked logistics chains.

Economic costs	Economic benefits
– The absorption of financial, material, technical and human resources necessary for the functioning of the logistics system becomes an alternative cost for the use of resources in other business processes.	– Reducing the costs of treatment of asbestos-related diseases. – Maintaining the professional activity of people by creating jobs (maintaining or increasing the level of employment). Keeping jobs resulting in an increase in the living standard of households. – Raising the living standard of households by eliminating asbestos-containing products (WH) resulting in the possibility of new investments. – Accelerating of the economic development in regions by providing services directly related to the removal of products and disposal of asbestos and intermediate services. – Increase in property and land values, an extension of the economic life of construction works. – Improvement of technical condition of buildings, including the safety of users. – Increase in the productivity of society due to the improvement of its physical and mental conditions. Improvement of economic prosperity stemming from a synergy between economic, social and human capitals, and natural capital. – Increase in state budget revenues due to tax revenues related to the purchase of new building materials, provision of construction services, an increase in income tax and land tax, increase in real estate turnover. – The increase in the value of national wealth, in which a greater part of the increase in value will concern owners of the land, construction objects and apartments (increase in the value of objects and apartments, construction land and agricultural land). – The increase in turnover on the real estate market leading to higher revenues for both the state budget and the own income of communes. – Raising the level of competitiveness and innovativeness of the region's economy by creating friendly investment conditions. – Improving the external appearance of buildings, increasing the investment and tourist attractiveness of the country and creating conditions for the development of the region, including agritourism development in rural areas. – Increase in economic capital.
SBMLS	

SBMLS – Sustainable business model of the logistics system

Fig. 14 The sustainable business model of the logistics system – economic costs and benefits

created canvas of sustainable business model of the logistics system (SBMLS) is different from the sum of the canvases for individual entities. The linear SBMLS has completely new features because it has to enable achieving the business objectives of the system. The SBMLS contains three models, including 9 elements of the BMC model, 6 elements of the sustainability model, and 2 elements of the risk model. Each of the elements of the SBMLS is not a simple assembly of individual chain elements (which indicates an additive effect). For example, WT play a key role in the value chain. Therefore, for the elements: "Value proposition", "Customer relations" and "Channels" of the SBMLS model, only descriptions of the links are presented. The value of the logistics chain to stakeholders creates a synergy. The value of the chain is greater than the sum of the values of its individual elements. Knowledge, experience in cost optimization and resource coordination, and the ability to control processes to increase asbestos removal rates are held by the WT operator. Removing this link from the economic market makes the value of the other links pointless and the chain's existence meaningless. A graphic representation of this phenomenon is shown in Fig. 11.

The sustainable business model of logistics system for the asbestos disposal

In order to achieve the second aim of the paper, we use the developed business model canvas for the linear value chain to build a sustainable business model of the logistics system for the disposal of hazardous waste containing asbestos. Figure 12 shows the transition from a sustainable business models of the entities forming the logistic system to the SBMLS.

In the next step we elaborate the detailed description of the sustainable business model of the logistic system for the disposal of the hazardous waste containing asbestos. Due to the extensive scope of model information, the business model and individual areas of responsibility are presented in separate figures. The sustainable business model of the logistics system is shown in Fig. 13, the economic costs and benefits are presented in Fig. 14, the social costs and benefits are shown in Fig. 15, and the environmental costs and benefits are presented in Fig. 16. The sustainable business model for the logistic system is complemented by a risk assessment and risk response that applies to each element of the business model, also taking into account the model's interaction with the environment according to PESTLE and Porter (2008) (Fig. 17).

Social costs	Social benefits
– Increased risk of the exposition of people's health to local pollution of atmospheric dust during disassembly of products (so-called unorganized emission). Pollution of the environment with dust concerns mainly residents of a given property and persons carrying out the disassembly of asbestos products. – Increased risk of accidents during the process of disposal, packaging, securing, transport, handling, storage, which in the case of these events increases the cost of treatment and the elimination of people from professional activity or social functions. – Nuisance caused by dismantling processes, transport of asbestos waste from removal sites to disposal sites, like the local deterioration of the acoustic climate along communication routes, squares and unloading places.	– Improvement of the quality of life of citizens in health aspects by reducing sources of pollution with asbestos dust as well as eliminating environmental and health risks related to air, water or soil pollution or surfaces. The increase in social capital creating an investment in the development of civilization. – Improvement of the health conditions of residents and potential reduction of cases of asbestos-related diseases and thus a limitation of mortality due to asbestos-related diseases, in particular, lung cancer and pleural mesothelioma. – Increasing the sense of ecological and health safety of the society (creation of jobs favouring the health and well-being of individuals, without exposure to carcinogenic factors). – Enabling social progress through maintaining professional activity. – Raising the level of ecological and health awareness of society towards civic responsibility for health-friendly behaviours and the natural environment. – Increasing public involvement in the planning and implementation of pro-health and pro-ecological projects. – Reducing the spatial disparities of the region. Shaping spatial order by reducing landscape disproportions. – The growth of cultural services (recreation, tourism). Increase in the agritourism attractiveness of rural areas (increase in aesthetic value, experiences and spiritual experiences in contact with nature). – Increase in the attractiveness of asbestos treated areas for domestic and foreign investors. – Improvement of the appearance of buildings (increase in the aesthetic value of public and private spaces). Increase or decrease in building concentration. Acceleration of village modernization. – Stimulation of economic activity and the creation of new jobs in the SME sector in the area of transport and construction services and others related to the dismantling of asbestos products. – Reducing the migration of professional groups caused by maintaining or creating new jobs.
SBMLS	

SBMLS – Sustainable business model of the logistics system

Fig. 15 The sustainable business model of the logistics system – social costs and benefits

Environmental costs	Environmental benefits
– The consumption of energy, water and fuels (environmental resources) in the process of disassembly, transport and disposal contributes to gas emissions (excretion of liquid, solid and gaseous pollutants). – Waste generation in the process of removing and transporting asbestos waste. – The sensitivity of the regional environment to the functioning of the logistics system until the end of the disposal process (noise, vibrations, visual effects). – The use of soil and its contamination by functioning entities. – In case of landfills for hazardous waste: a) permanent occupation of space (land surface and soil until its recultivation), like impeding plant succession until the landfill is closed; b) violation of the surface structure resulting in a complete change of the local landscape.	– Reduction of dust emission, including asbestos fibres to the environment and obtaining conditions for improving the quality of atmospheric air, water and surface. – Elimination of the so-called "wild" landfills, mainly in forests, which contributes to the growth of landscape values. – Preserving and even increasing the value of the natural environment. – Reduction of space occupied by above-ground landfills for hazardous waste. – Shaping and maintaining spatial order, including natural capital. – An increase of the ecological potential of the region and natural (environmental) capital. – Better satisfaction of the physical and mental needs of human beings through the proper arrangement of their relationship with the environment. – Collision-free location of an underground landfill for hazardous waste.
	SBMLS

SBMLS – Sustainable business model of the logistics system

Fig. 16 The sustainable business model of the logistics system – environmental costs and benefits

Risk description (category, description)	Reaction
1. Risks at the tender stage: a) Delays resulting from procedural issues. Applies to entities of WH and WT.	1. Modifying the risk by employing qualified employees or providing support by external specialists with appropriate competences and experience.
2. Risks related to the supply of asbestos waste: a) Waste generation lower than planned – risk of lower revenues for WT and LF entities. b) Change in the method of co-financing – lack of interest in removing products – concerns the WH entity.	2. Adequate risk sharing by conducting a campaign aimed at asbestos product owners in order to acquire places with asbestos-containing products, using the "pull" marketing strategy and promoting good behaviour aimed at the reduction of sources of pollution of asbestos dust and fibres. Also the implementation of appropriate legislative changes introducing the obligation to remove products with the provision of financing services.
3. Risks related to legal regulations: a) Changes in environmental requirements, economic or regulatory instruments.	3. Sharing the risk associated with the legal area is primarily the pressure on the legislative bodies by making them aware of the success of achieving the goal of asbestos removal by 2032 - from the territory of Poland to the necessary legislative changes along with the monitoring of legal changes.
4. Other risks: a) Disapproval of society. b) Contamination of soil and groundwater in case of improper storage of products containing asbestos.	4. Other risks: a) Modifying risk by increasing public awareness of the need to remove products that are the source of environmental pollution using marketing campaigns. b) Modifying the risk by using procedures for dealing with hazardous materials in the storage process.

SBMLS

SBMLS – Sustainable business model of the logistics system

Fig. 17 The sustainable business model of the logistics system – risk assessment and risk response

Conclusion

A critical analysis of the business model canvas created by Osterwalder and Pigneur (2010) formed the basis to develop the sustainable business model canvas with an integrated TBL concept and the risk assessment of achieving goals. This was followed by the development of the sustainable business model canvas for the value chain through the prism of the sustainable business model canvas of the entities forming the chain. Then, based on the developed canvas, we created a sustainable business model for the logistics system for the disposal of hazardous waste containing asbestos. A linear logistics chain, consisting of three entities, results from Polish legal regulations. These regulations allow for the only possible method of utilizing asbestos waste by depositing it in hazardous waste landfills.

The design and implementation of a sustainable business model affects external and internal stakeholders in the logistics chain. For external stakeholders, sustainable business models aim to increase trust and confidence in the removal of asbestos from the environment. On the one hand, the functioning of logistics chains places a burden on the environment and generates economic and social costs that are visible in the business model, but on the other hand, the economic, social and environmental benefits significantly offset these costs. For internal stakeholders, instead of presenting business models of individual entities, we developed an integrated canvas of a sustainable business model for the value chain. This integration was made possible due to the modular structure of the business model canvas. The developed canvas of sustainable business model does not directly adopt the characteristics of the components from the business models of the constituent entities. The integrated model canvas is not additive, which means that it is not the sum of the individual business objectives and functions of the entities forming the value chain. The integrated model reveals a synergy in different areas. Therefore, setting the research aim of presenting the logistics system business model based on the business models of the entities forming the system, seems reasonable on the one hand and feasible on the other. The reverse relationship was not the subject of this research. Thus, presenting individual business models of the entities forming the logistics system within the TBL responsibility concept based on the sustainable business model of the logistics system, remains to be developed in further research.

Adding the TBL areas and risk assessment to the business model canvas allows to show how entities act according to the principle of responsibility within the three TBL areas. Methodologically, organizations operating in the economy, regardless of the ownership structure, form of ownership or form of operation, such as for profit or not for profit, should take into account and apply the sustainable development

paradigm. In addition, business models for individual organizations should be linked to the implementation of the sustainable development paradigm, for instance, in accordance with the TBL and include business risk assessment. Adding the above elements to the business model enables formal and integrated or non-financial reporting by the organization in accordance with the expectations of stakeholders and the requirements of the EU 2014a/95. Moreover, it is possible to satisfy the information needs of stakeholders, especially key stakeholders, on economic, social and environmental issues that would affect the organization's ability to create value and ways of using the generated value.

The presented sustainable business model with a linear value chain structure can be adapted to the business model of a closed-circuit economy if technologies meeting the BAT principle and economic, social and environmental requirements are developed (Lewandowski 2016). The presented sustainable business model was used to perform more complex logistic network models (a two-stage variant with waste transshipment sites) and digital modeling using a genetic algorithm (Wit 2016, p. 254) in order to ensure optimization of two-stage transport taking into account the sustainable development (TBL) assumptions. The genetic algorithm was implemented in the prototype of computer software, which is the specialized digital GeoAzbest Information System (GIS) (Wit 2013; Wit et al. 2013) working in the form of electronic network services. In this sense, the models developed have been verified and have undergone positive verification. The source of data for the GIS software are documents generated by individual links in the logistics chain and digital data obtained from WT. The digital GIS product belongs to the group of computer programs for transport management systems and in an integrated way supports management processes at every link of the logistics chain, including recording, visualization and reporting functionality required by law.

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