Sustainable business models for retrofitting and their benefits for historical buildings energy performance

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Abstract

This article analyses the benefits of sustainable business models in improving energy performance of buildings, in special historical buildings. The benefits are structured in economic benefits, environmental benefits and social benefits with a focus on energy savings, energy consumption reduction, reduction of greenhouse gas emissions and other social benefits. The main objective of this article consist in developing a tool for identifying the key factors that contribute to the improvement of energy performance in the case of business models for retrofitting of historical building. The news of this research consists in extended traditional tools for business models (e.g. Canvas Structure, or Triple Layer Business Model) to a sustainable business model for retrofitting and developed it for the specific case of historical buildings and for energy performance improvement. The key factors that contribute to the improvement of energy performance improvement. The key factors that contribute to the improvement of energy performance improvement. The key factors that contribute to the improvement of energy performance in the case of retrofitting for an historical building and also the benefits of sustainable business models for the owner and for the society are analyzed taking into account the three main dimensions of sustainability: the economic, the environmental and the social. The results offer relevant data for entrepreneurs, but also for policy makers and other specialists which are involved in the development of new standards for retrofitting of historical buildings.

Keywords: Sustainable business models, energy performance, historical buildings, environmental benefits, social benefits

1. Introduction

Business models are confronted with new challenges due to the high dynamic of the economy and our life expectations and due to the climate change awareness.

Therefore the concept of sustainable business models represents a solution for the transition to a more responsible business environment. The company responsibility has to increase in the context of globalisation and of the climate change impact. Therefore companies are publishing not only financial reports, they are publishing also non-financial reports based on sustainability aspects related to environmental protection or to social impact.

This article uses the general sense of sustainability with its three dimensions: economic, environment and social. These dimensions are reflected in the Triple Bottom Line concept [1].

Osterwalder developed its model elaborated with Pigneur based on the Canvas structure and the triple bottom line [2, 3] in order to find a response to the new environmental questions regarding sustainability. The resulted tool adds to the economic an environmental and a social dimension.

Infrastructure Management		Product		Customer Interface		
Key Partners	Key Resources	Value Proposition	ns	Customer Segments Customer Relation		
Key activities				Channels		
Financial Aspects						
Cost Structure			Revenue Stream			
Social & Environmental costs			Social & Environmental benefits			

Table 1. Triple layer business model canvas

Source: adapted from [2, 3]

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Sustainable business models find in the scientific literature specific definitions [4] and different archetypes [5] that helps for describing, and communicating a sustainable value proposition for the customer and for the stakeholders, explaining how this value it is created and delivered and how the company can capture economic value in a responsible way regarding the economic, social and ecologic context [6, 7].

Sustainable business models allow companies to rethink their common strategy based on financial values and to define new positive effects or significant reduced negative effects for the natural and social environment through changes in the way its activity create, deliver and capture value [8].

Hence this concept registered little attention in the context of retrofitting for historical buildings and there are no analysis regarding new generic sustainable business models for retrofitting and their benefits.

There has to be mentioned that retrofitting of historical buildings face with specific standards for conservation the historical and cultural heritages. All retrofitting solutions have to keep the original state of the historical building. The materials and textures used for retrofitting have to be as similar as possible to the old building. One exception is the energy performance that can be increased with new retrofitting solutions [9].

Energy performance in buildings is an optimum concept because it has to compare the energy efficiency with the thermal comfort. The energy performance is influenced by the construction materials, by the construction and its finishing quality, by the orientation of the building, by its usage and also by the behaviour of its owner [10].

Therefore this research wants to find responses to two research questions: Which are the main benefits of sustainable business models for retrofitting and how can sustainable business models for retrofitting increase the energy performance in buildings.

The research has to respond also to the specific new energy targets that are promoted in the European Union (EU) due to the climate change impact. In Europe, climate change represents a main topic and important directives at EU level promote a new legislative framework for improving the environment. According to Directives on Energy Efficiency and Renewable Energies until 2030 the energy efficiency target of 32.5% and the renewable energy target of 32% have to be achieved [11, 12]. In the future, in the 2050 strategy of EU, a roadmap and scenarios are elaborated for the development of the energy system and regarding greenhouse gas emissions. The new targets for 2050 are very high (with a reduction of greenhouse gas emissions of 80% by 2050).

New business models and sustainable business models for retrofitting are a solution for increasing the buildings performance and for reducing the energy and carbon intensity. Therefore this model generates benefits for a large category of stakeholders such as building owners or homeowner associations, retrofitting service providers, utility and networks operators, financing companies and local authorities.

Historical buildings have two main negative environmental impacts. First of all, historical buildings have a low energy efficiency and are not aligned with the new environmental criteria for buildings. Secondly, the demolition waste will pollute landfills, if historical buildings will be replaced by new ones.

The benefits generated by the implementation of sustainable business models are a result of retrofitting solutions which can be clustered in two main groups: solutions for making an old house more energy efficient and usage of renewable energy sources and different solutions based on smart technologies for improving the air quality, reducing the water consumption and control the energy uses. The solutions that are making an old house more energy efficient are represented by: reducing the energy consumption due to optimizing the energy flows in the building (e.g. natural ventilation, passive cooling) and by use of new technologies, new building envelope or new lighting system.

2. Methodology

The methodology of this research is designed in four steps (Fig. 1).



Fig. 1. Four step methodology (Source: own design)

In Step 1 the generic sustainable business model for retrofitting is selected, which is elaborated based on the Business Models Canvas methodology, which describes the business model designed by Osterwalder and Pigneur [2] and the triple layers business model. The selected model has an economic, an environmental and a social dimension and was developed in a previous research for green retrofitting projects [13].

The economic dimension of the business model has nine groups of factors like in the classic canvas structure: value proposition, key resources, key activities, key partners, customer segment, channels, customer relationship, cost structure and revenues structure (Table 2).

Key partners	Key activities	Value proposition	Customer relationship	Customer segment	
Organizations from the building industry Financing institutions Specialists for design	Renovations works Financing Detailed planning Installation Key resources Specialized human resources Motivated management Technology equipment, Brand Know how	Energy savings Improved Maintenance Smart metering Structural assurance Building energy performance Intrinsic value	Mutual trust Transparency Loyalty Channels Personal contacts Own web site Specialized Events Online platforms E-Mail	Private owners of single-family historical houses Multi-family historical buildings Private owners of commercial historical buildings Public owners of institutional historical buildings	
Cost structure		Revenue structure			
 Fix costs (salaries, main services, on line platform, rent for the office), Variable costs (material input, transport) 		 reduction of energy costs revenues for renovation government incentives 			

Table 2. Economic dimension for the business model for retrofitting of historical buildings

Source: Own contribution for retrofitting and [13]

An interesting value proposition that is identified is the intrinsic value of a historical building. This value is characteristic for old buildings which have been built with rare materials (e.g. rare hardwood or heart pine from forests that no longer exist).

In Step 2 the environmental dimension of the generic sustainable business model for retrofitting of buildings is analysed, which was proposed in a previous research by Tantau [13] and identify its energy performance characteristics. The principles for designing the environmental dimension can be found in the theory of life cycle assessment (LCA). The current research adapted for the sustainable retrofitting of the historical buildings the tool described by Joyce for the environmental dimension that contained following blocks: functional value, supplies and outsourcing, materials, production, use phase, end of life, distribution, environmental impacts and environmental benefits [14].

In Step 3 the social dimension of the generic sustainable business model for retrofitting of buildings is analysed, which was proposed in a previous research by Tantau [13] and the energy performance characteristics are identified. The social impact of a sustainable business model is analysed based on the stakeholder management theory. The classic structure for the social dimension of a sustainable business model contains: social value, communities, governance, employees, social culture, end users, engagement measures, social impacts and social benefits [14]. The framework analysis for the impact of business models on societal transition was proposed by Bidmon and Knab [15] and one main premise of this analysis is that the social sustainability extend the creation of value and therefore generate also benefits to new categories of stakeholders [16].

The specific factors that characterize the environmental and social dimensions of a generic sustainable business model for retrofitting of historical buildings were identified using semi structured interviews with 11 experts between February and June 2019. The interviews were organised in Romania, therefore the results are focused on the Romanian specificity of retrofitting for historical buildings. Due to the fact that Romania is a Member State of the European Union where the Building Directives are enforced for all Member States, the main results can be extrapolated on a regional scale.

The interview guidelines consist of three parts. The first part describes the main elements of the business model canvas. The second part has questions regarding how to get a common understanding of the environmental dimension of the business models and for validating the environmental dimension of the generic sustainable business model for retrofitting of historical buildings and its benefits. In the third part the participants get a common understanding of the social dimension of the business models and validate this in the case of a generic sustainable business model for retrofitting of historical buildings underlying also its benefits.

Step 4 consist in an assessment of the benefits of the generic sustainable business model for retrofitting of buildings. The identified benefits from semi structured interviews were integrated with benefits analysed in the scientific literature and were grouped in three classes: economic, environmental and social benefits.

3. Results and Discussions

The analysis of the economic dimension of the sustainable business model for retrofitting for historical buildings (Table 2) starts with the consideration that the main benefits are resumed by the value proposition statements. In general, the value proposition of a sustainable business model for retrofitting has to find solutions in order to fulfil the customers' needs (e.g. owners of historical buildings) and to promote new technologies or improvements of the building performance, including energy performance. In the case of retrofitting for historical buildings statements for the value proposition are: energy savings, improved maintenance, structural assurance, smart metering or functional performance. For example, the value proposition based on energy savings can be expressed in reduction of kWh/year (in %) due to the implementation of improved technologies for illuminating, heating or cooling.

In general, the customers segment consists in knowledgeable owners of historical buildings that are open to new technologies for heating, ventilation, lighting, smart metering, water and renewable energy sources.

Especially for sustainable business models for retrofitting of buildings the building owner has to understand the importance of the sustainability certification of the building [17] and to take into account also the sustainability certification costs.

Key partners for sustainable business models are energy service companies (ESCO) which are promoting Energy Savings Performance Contracts (ESPC). Based on Energy Savings Performance Contracts ESCO offer energy savings services including the energy efficiency audit, the energy savings project design, and other services related to procurement of raw materials and equipment, construction, maintenance, monitoring of energy savings amount.

The business model revenues have to take into account the renovation costs, the cost associated to sustainable retrofitting solutions, the government support schemes for renewable energy or other energy

efficiency programs and other environmental costs.

In the second step of this research the experts identified the main factors that were important for the environmental dimension of the business model for retrofitting of historical buildings (table 3).

In this step, an important factor that contribute to the sustainability of the business model for retrofitting is the functional value (e.g. the output of the retrofitting solution). Main functional values that were identified by the experts are: energy savings (kWh/year in %) reduction of CO_2 emissions (kgCO₂/year, in %), reduction of water demand and natural light design. The use of renewable energy sources represents an opportunity to increase the energy performance of a historical building. Photovoltaic panels and solar collectors can be installed on the southern part of the roof for an optimum energy performance (e.g. for absorbing maximum solar radiation). These can be also used as roof tiles. If the solar collectors are connected with a boiler, the heat from the daytime can be stored to be also used during the peak off periods or even in the night time. This solution also saves energy costs and reduces the load of the public power system.

Suppliers and	Sustainable Retrofitting	Functional Value	End of life	Use phase	
outsourcing					
Certified companies for historical building restoration (e.g. accredited heritage building contractors) Suppliers of specific materials for building restoration	Sustainability certification Fa çade restoration Renovation of historical buildings Energy Performance Contract Energy Audit Key Materials New materials that are designed for restoring historical buildings (e.g. specific nano- structured materials)	Energy savings Reduction of water demand Natural light design Renewable energy sources Natural ventilation Reduction of CO ₂ emissions	Increase the lifespan of the building Channels On line platform for historical buildings On line advertising	Reduced impact of the building to the environment	
Environmental	impacts	Environmental benefits			
Reduced environmental impact due to new		Reduction of energy demand			
materials and new or improved technologies Potential rebound effect due to new life style standards		Reduction of water demand Reduction of CO ₂ emissions			
		Natural resource savings due to energy saving			

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Table 3 Environmental	dimonsion	tor the	huendee	model	tor retroti	tting o	t historical	huuldinge
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Source: Own contribution for retrofitting and [13]

In one semi structure interview the natural ventilation was also identified as a potential retrofitting solution for improving the air quality and the indoor thermal comfort and also for energy savings.

For the environmental dimension of the business model the retrofitting of the historical building represents the main factor that has a positive impact of the environment due to the use of new materials and the implementation of improved technologies. Hence the experts admitted that even when we are implementing sustainable retrofitting solutions the expected reduction of energy demand due to technological energy savings can be significant reduced due to the specific behaviour of the building occupants. These results are also confirmed by the Jevons Paradox, which confirms an increase of energy consumption even when new technologies are implemented. The explanation of this paradox has its roots in the higher life style of the occupants that is increasing by using new technologies.

In step 3 the social perspective of a sustainable business model for retrofitting was analysed and the

main factors that are important for this dimension were identified (Table 4). The analysis was oriented on the stakeholders' perspective for a sustainable business model for retrofitting.

Local communities	Governance	Social Value	Societal culture	End User
Local authorities	Transparent	Life healthy	Militate for promotion of	Implying owner
Universities	Create social value	Seismic safety	cultural heritage	cooperation for
Collaboration with other social projects	Employees Promoters of sustainable retrofitting solutions Trainings for sustainable	Comfort Cultural heritage Reduced material and construction waste Involving local communities in sustainable solutions Increase the grade of information about historical buildings Produce energy for other	Support active involvement of individuals against construction waste Militate for reducing the energy consumptions in buildings Engagement measurement Key stakeholders Best practice	reducing the energy consumption
	retrofitting	consumers (prosumers)		
Social imp	acts	Social ben	nefits	
Potential rebound ef	fect due to new life style	Improvement of the occupa	ints health	
standards		Reduction of CO ₂ emission	S	
		Construction waste reduction	on	
		Community engagement in the construction waste	n reducing the energy demand	d and in reducing
		Growth of awareness for imperformance.	plementing solutions for opti	mal energy
		Reduction of the load of the	e public power system due to a	energy savings
		Heritage tourism		

Table 4. Social dimension for the business model for retrofitting of historical buildings

Source: Own contribution for retrofitting and [13]

The factor that was identified by experts as a main contributor to the achievement of social benefits is the social value. The following statements were identified for the social value of a sustainable business model for retrofitting of historical buildings: healthy life, seismic safety, comfort and the previous ones were also validated: reducing material and construction waste, involving local owners in sustainable solutions and increase of the grade of information about sustainable retrofitting. A special answer for the social value of the analysed business model was dedicated to the retrofitting measures that install photovoltaic panels on the roof of a historical building in order to produce energy. In this case the owner of a historical building can produce energy for its use but also can deliver energy into the grid for other consumers.

Step 4 consists in the assessment of economic, environmental and social benefits of the generic sustainable business model for retrofitting of historical buildings.

The direct economic benefits of a business model for retrofitting of historical buildings have to be completed by other indirect benefits (e.g. improving the reliability of the building, energy savings or reduction of greenhouse emissions). Energy savings and the reduction of greenhouse gases are examples of multiple benefits because these represent economic as well as environmental benefits of a sustainable business model. The resulted economic benefits of a sustainable business model for retrofitting of historical buildings are presented in Table 5.

Table 5. Economic benefits of the sustainable business models*

Economic benefit	Path to achieve	Beneficiary
Income of energy selling as a producer (prosumer) or reducing the bill due to own energy production	Producing own energy	owner
Energy savings	Reducing the energy bill due to reduced energy demand (e.g. equipment based on new technologies)	owner
Reduce the cost of daily maintenance	Higher reliability	owner
Reduce the loss of heat	Improved insulation	owner
Reduce the loss of water	Water recycling facility	owner

Source: Own contribution

*The economic benefits have to be compared with the ROI of a common investment for renovation.

*New technologies and replacement of old ones will increase the investment costs. Therefore there is a need of NPV calculations

In the case of Energy Performance Contracts the initial investment for retrofitting will be recovered from the energy savings benefits and others related services.

The analysis of the functional value of a business model enables the identification of the environmental benefits of the sustainable business model for retrofitting of historical buildings. The identified environmental benefits and the related path for their achievement that were identified by the experts in the semi structured interviews are illustrated in table 6.

Environmental benefit	Path to achieve	Beneficiary
Reduction of the greenhouse gases emissions	Producing own energy as distributed energy (e.g. photovoltaics) reduce the emissions of greenhouse gases	society
Reduction of the greenhouse gases emissions	Energy savings and indirect calculation of reduced emissions of greenhouse gases	society
Reduction of the greenhouse gases emissions	Install own photovoltaic facility for producing energy	society
Reduction of the greenhouse gases emissions	Improving the air condition efficiency by implementing a system with an automatic control and regulation equipment	society
Saving resources	Install own photovoltaic facility for producing energy	society
Energy savings	Natural ventilation	owner, society
Energy savings	Natural light design	owner, society
Reducing the loss of heat	Improved insulation	society
Reducing the loss of heat	Replace conventional heating centrals with a heat pump	society
Reducing the loss of water	Water recycling facility	society

Table 6. Environmental benefits of the sustainable business models*

Source: Own contribution

*New technologies and replacement of old ones will increase the investment costs. Therefore there is a need of NPV calculations

The main social benefits that are typical for the social dimension of the sustainable business model for retrofitting of historical buildings and that were identified by the experts in the semi structured interviews are presented in Table 7.

Social benefit	Path to achieve	Beneficiary
Improved thermal comfort (for low	New windows, doors, insulation, new heating and cooling	owner
and high temperature) and occupant	solutions	
health		
Improved health because of	New insulation, improved air flow, natural ventilation	owner
elimination of dampness and		
moistures		
Improved health due to reduced noise	New windows, doors, insulation	owner
level		
Improved health due to indoor natural	New windows and natural lighting systems	owner
light		
Improved public image	Lower energy consumption, new technologies	owner
Reduction of CO ₂ emissions	Install own photovoltaic facility for producing energy	owner, society
Reducing the energy demand	Community engagement in reducing the energy demand	society
Reduction of the construction waste	Community engagement in reducing the construction waste	society

Table 7. Social benefits of the sustainable business models*

Source: Own contribution

The improved thermal comfort in historical buildings represents a main solution for reducing the respiratory and circulatory diseases of occupants in the case of very hot summers. In winter the improved thermal comfort reduces the hypertension, cardiovascular and the respiratory (e.g. pulmonary) diseases [18].

Studies indicate that dampness and mold increases the respiratory diseases (e.g. allergies, asthma) of occupants [19]. Therefore the retrofitting solutions for historical buildings (e.g. new insulation, improved air flow, natural ventilation) can reduce this risks and improve the health of the occupants.

Other benefits of sustainable retrofitting for occupants of historical (e.g. new windows, doors, insulation) consists in reducing the noise level, that eliminates the sleep disturbance or reduce the risk of cardiovascular diseases or in implementing of natural light solutions which improve the psychological condition of the occupants.

An interesting response was focused on the public image of the owners and its improvement because of the lower energy consumption of the historical building after the implementation of the sustainable retrofitting solutions.

The assessment from the step 4 indicate that sustainable business models for retrofitting of historical buildings have important benefits and the significant ones are related to the energy performance.

4. Conclusions

The sustainable business models tool for retrofitting of historical buildings is an instrument that proposes building energy performance and its related concepts (e.g. energy savings, water demand reduction, use of renewable energy sources, natural ventilation, new lighting technologies, smart metering) as a value proposition for this type of business models. The model integrates the economic, environmental and social dimensions in order to identify the main factors that generate benefits in the case of implementation of sustainable retrofitting solutions for historical buildings.

This tool for implementing new business models for retrofitting of historical houses offers solutions that enable the reduction of the environmental impact of retrofitting and the reduction of emissions of greenhouse gases with a positive contribution on reducing the climate change impact.

Therefore companies which are implementing such business models are connected to the new environmental standards are increasing their adaptability and are gaining new sustainable competitive advantages. The results of this research are focused on the Romanian specificity for retrofitting of historical buildings. Due to the fact that Romania is a Member State of the European Union and in this area the building directives are enforced in all member states, the main results can be extrapolated on a regional scale.

The future research can be focused on developing comparative studies of sustainable business models for retrofitting of historical buildings in different countries. The future results can be compared on a regional and international scale in order to identify best practices and opportunities for new sustainable competitive advantages. These also enables to find new measurements, which will contribute to the reduction the climate change impact of historical buildings.

Conflict of Interest

The author declares no conflict of interest.

Author Contributions

The main contribution of the author for this article is to develop a tool for identifying the key factors that contribute to the improvement of energy performance in the case of business models for retrofitting of an historical building. The news of this research consists in extended traditional tools for business models (e.g. Canvas Structure, or Triple Layer Business Model) to a sustainable business model for retrofitting and developed it for the specific case of historical buildings and for energy performance improvement.

Another main contribution of this work is to determine the benefits of sustainable business models for the owner and for the society.

There has to be mentioned that the key factors that contribute to the improvement of energy performance in the case of retrofitting for an historical building and also the benefits of sustainable business models for the owner and for the society are analyzed taking into account the three main dimensions of sustainability: the economic, the environmental and the social.

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