Sustainable entrepreneurship in the equestrian sector through horse manure: a PLS-SEM approach

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Abstract

Purpose – Horses play an important role in the agricultural industry around the world. The equestrian sector offers new markets and sustainable business opportunities. This paper, based on a structural equation modelling approach, seeks to explore the interests of Romanian entrepreneurs in developing a sustainable business in the equestrian sector by investing in the use of horse manure. This manure is an important renewable resource in the circular economy, including in the production of bioenergy and bio-fertilizers. The present research investigates whether there is an interest in developing such a business in Romania, built around three pillars: the environment, society and the economy.

Design/methodology/approach – PLS-SEM is an appropriate method for this research, where prediction of interest for sustainable entrepreneurship plays a central role. In total, 153 responses have been collected and validated based on a questionnaire and the invitations to complete were sent to people who are already entrepreneurs or have intention to become entrepreneurs in the near future.

Findings – The structural model shows that society's interest has the strongest effect on developing a sustainable business model through horse manure. Surprisingly, the study does not reflect an expected correlation between the interest in the environment and the development of a sustainable business model through horse manure resulting in bioenergy.

Originality/value – This study contributes to arousing the interest in research and even the development of a business by presenting the sustainability factors in the horse industry and adopting technological innovations, services, products and business models. The study was conducted in Romania, where, currently, the manure produced by horses is underexploited, and the equestrian sector requires new business models, innovations and sustainable development.

Keywords Horse manure, Bioenergy, Biofertilisers, Circular economy, Renewable resources, Sustainable entrepreneurship

Paper type Research paper

Introduction

Global challenges such as climate change, ecosystem degradation, waste and poverty are interconnected issues that need to be explored and addressed from several perspectives. An increasingly well-known phenomenon that leads to sustainability and evolution is sustainable entrepreneurship.

The development of industry, excessive consumption and increasing numbers of environmental disasters have led to multiple debates, and the concept of sustainable development is central to new theories of economic development (Capatina *et al.*, 2017).

This type of entrepreneurship can help address the decline of the environment, including socially. More and more companies, from small startups to multinationals, are claiming to

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contribute to a more sustainable future. Increased awareness of environmental problems has changed the mentalities of entrepreneurs, considering the impacts of their business models on sustainable development (Méndez-Picazo *et al.*, 2021).

This research examines the motivation shown by current and future entrepreneurs in designing a responsible, sustainable entrepreneurship model for horse manure processing. Waste, especially that which disrupts the environment and the climate system, can be transformed and have a positive role.

Both practitioners and academics face controversies around horse manure, which can cause environmental damage. Poorly managed manure spills into water courses, unbalancing ecological systems, and society feels the consequences of pollution caused by bad management practices.

To our knowledge, limited research has been conducted on manure management in sustainable entrepreneurship. This research aims to bridge this gap by outlining the economic, social and environmental effects of developing a sustainable business model based on horse manure, using a structural equation modelling partial least squares (PLS-SEM) approach. We adopted this method as it works effectively with a small sample size, handles constructs related to multi-item measures and incorporates reflective and formative measurement models (Hair *et al.*, 2021).

The transition to bioenergy and biofertiliser production offers society some of the energy needed to sustain its current ecological and economic needs. Sustainability-oriented, responsible entrepreneurship strategies include increasing production capacity, following national and global regulations, assessing environmental considerations, creating an entrepreneurial culture and strengthening scientific research and international cooperation.

In the early days of a new business, entrepreneurs run the risk of disengagement because they can lack the perspective required to discern the true signals generated by the environment. A positive attitude towards sustainable entrepreneurship and confidence in research can, however, help to overcome this problem (Dragan *et al.*, 2021). Entrepreneurs who create and use opportunities need specific relationships and support for successful innovation in an ecosystem (Kanda *et al.*, 2018).

This study broadens our understanding of responsible entrepreneurship oriented towards sustainability and helps to identify the factors in the economy, environment and society that could develop green entrepreneurship in the livestock sector.

The research question of this study is as follows.

RQ. When entrepreneurs consider a business based on using horse manure would their motivation be mainly financial, social or environmental?

Sustainable development has emerged as a social goal, focusing on human well-being and mitigating environmental degradation, so developing a business based on processing horse manure could bring many benefits.

The paper is structured as follows. After a structured presentation of the challenges related to sustainable entrepreneurship in general, and horse manure management in particular, we present the conceptual framework of the research and the method employed. Then we analyse the main findings leading to hypotheses validation, discuss the results in line with other research papers and outline the conclusions.

Literature review

Planetary boundaries, ecosystem challenges

The planetary boundaries framework, as discussed in the research conducted by Steffen *et al.* (2015), needs to be implemented alongside the achievement of targets aimed at addressing sustainability needs at the global level, such as the provision of affordable bioenergy, including that extracted from horse manure.

Environmental, economic and social issues are considered global governance challenges that need to be addressed if we are to generate a safe space for humanity and to manage the inter-related planetary boundaries properly (Galaz *et al.*, 2012).

Management research on the declining state of ecosystems faces a challenge: sustainability is no longer a fringe topic and governments and business actors seek to invest in eco-efficiency measures as one way of addressing the planetary boundaries. Data retrieved from ecological analyses indicate, alarmingly, that many non-sustainable entrepreneurial approaches are having negative impacts on the environment, the economy and society (Whiteman *et al.*, 2013).

Environmental, economic and social concerns are key business drivers and mobilising environmental values can help a startup enterprise gain the necessary external support (Riandita *et al.*, 2021). A more participative eco-minded framework towards environmental change of entrepreneurs from horse industry contribute to the SDGs, through their economic, social and environmental outcomes (Apostolopoulos *et al.*, 2018).

It is more imperative than ever that we acknowledge environmental decline and observe planetary boundaries (Salmivaara and Kibler, 2020). At the centre of sustainable development is the belief that economic prosperity, human development and environmental protection are interdependent. Sustainable growth is urgently needed in a world facing environmental degradation, inequality, injustice, poverty and lack of development opportunities (Hummels and Argyrou, 2021).

Special attention must be paid to the sustainable development of the livestock sector because of its importance to the world economy. Development is sustainable if the benefits of economic progress are widely distributed, extreme poverty is eradicated, social trust is encouraged through community-strengthening policies, and the environment is protected against human-induced degradation (Ataei *et al.*, 2018).

Sustainable entrepreneurship

It is a widely shared view in academic research that entrepreneurship can be a force strong enough to accelerate sustainable development by connecting entrepreneurial skills to environmental and social transformations (Johnson and Schaltegger, 2020). Entrepreneurship can make a significant contribution to sustainable development and can facilitate human well-being for present and future generations (Parrish, 2010).

Socially-oriented entrepreneurs work to generate sustainable change and genuine social transformation (Zahra *et al.*, 2009). Researchers often define social enterprises as hybrid organisations that aim both to fulfil a social mission and to make a profit, i.e. be financially sustainable (Short *et al.*, 2009). Equine sector entrepreneurs face difficulties in Romania when develop their business and tend to focus on the social-ethical sphere (Lupoae *et al.*, 2022).

It is extremely important for companies and stakeholders to systematically facilitate the development of sustainable entrepreneurship (Schaltegger and Wagner, 2011). It is widely accepted in both research and practice that sustainable entrepreneurship and startups play a key role in accelerating the transformation of society and business towards sustainable development (Trautwein, 2021).

The new business models required by the circular economy focus on reducing negative impacts on society and the environment—partly by using goods and services more efficiently—thus fostering entrepreneurship and intrapreneurship projects in the so-called green economy (Crecente *et al.*, 2021).

Entrepreneurship can contribute to both social welfare and an ecologically sustainable economy (Dean and McMullen, 2007), and according to Cohen and Winn (2007), the view that economic development and environmental protection cannot coexist is outdated.

Sustainable entrepreneurship is, therefore, gaining prominence as entrepreneurs place more and more emphasis on sustainability, alongside profitability, at the centre of their business models.

Sustainable entrepreneurship is defined as the discovery, creation and exploitation of opportunities to create future goods and services that would support the natural environment and provide development gains for future generations (Patzelt and Shepherd, 2011). Its activities embrace the economic, ecological and social dimensions of sustainability as part of its core business model (Schaltegger and Wagner, 2011). So far, research in entrepreneurship has focused mainly on profit-oriented entrepreneurs (Welter *et al.*, 2019).

Munoz and Cohen (2018) suggest that entrepreneurship should not be based solely on profit generation, and the notion of sustainable entrepreneurship allows it to be recognized as a solution and not a cause of environmental degradation and social inequality.

More and more companies are adopting the "sustainability clause" to ensure better climate protection (Engert, 2020). Unlike conventional entrepreneurship, which focuses mainly on profit maximisation, sustainable entrepreneurship is based on its potential to create economic, social and environmental value through its business model (Belz and Binder, 2017).

In difficult times, with significant challenges and threats such as global warming and the waste of non-renewable resources, current and future entrepreneurs must broaden their perspective. They must shift from a limited focus on economic dimensions and embrace the wider societal and ecological context (Volkamann *et al.*, 2021).

However, Elkington (2018) stated that, for most businesses, attention to balancing the needs of the environment, society and economy has become more of an accounting exercise, and little has actually been done to create a sustainable transformation of the economy.

Improved analytical skills can help broaden a company's scope and lead to more sustainable business practices (Ahmadpour Daryani and Karimi, 2018). In recent years, the number of sustainability projects has increased (Munoz and Cohen, 2018), and they have appeared in various types of market, including renewable energy (York *et al.*, 2016).

Horse manure management practices

The growing amount of waste generated globally due to industrialisation and economic activities requires much more careful management and investment. Part of this is the need to identify effective methods of manure management. One of the most promising ways is to use horse manure as a source of bio-waste to produce higher-value bioproducts (Mong *et al.*, 2021).

The simplest management option for horse manure is to remove it from the "hazardous waste" category by using it for energy (Da Lio *et al.*, 2021). The European Union (EU) encourages the conversion of waste into energy in order to maximise the contribution of the circular economy to decarbonisation and to reduce waste production, in line with the Paris Agreement and the European Green Deal (Siddi, 2020).

Horse manure is rarely used as a biofuel because its production is fragmented, and the classification of manure as waste or renewable fuel is still debatable (Kusch, 2014). In fact, according to the European stakeholders involved in manure treatment, the major barriers to the spread and exploitation of manure burning are economic factors such as the absence of investment capital, high processing costs and a long payback period, especially for small farms raising animals (Hou *et al.*, 2018).

Transforming manure into bioenergy and biofertilisers provides a sustainable alternative measure for waste recovery, and using manure as a feedstock for bioenergy provides a practical measure to reduce environmental burdens. Furthermore, using manure as soil fertiliser is beneficial because it can improve soil quality, but it can also lead to adverse effects such as water contamination or uncontrolled greenhouse gas emissions in the atmosphere (Lee *et al.*, 2021).

Biofertliser producers are trying to create entrepreneurial opportunities and respect the principles of sustainable development (Falguera *et al.*, 2012), so they have strategically focused on launching organic products. The significance of these businesses lies in the fact that they create innovative economic opportunities that contribute to sustainability rather than conflicting with it (Altenbuchner *et al.*, 2017). According to studies by Moreira *et al.* (2021), the application of biofertiliser (such as horse manure) is promising for the remediation of contaminated soils.

Clearly, sustainability is important in the context of entrepreneurship and plays a significant role in employment, improvement of productivity, technical innovation and structural change, especially in agricultural activities (Ataei *et al.*, 2019). There are two alternative paths to sustainability-oriented entrepreneurial actions in horse manure processing: one supported by policy-makers that create favorable business context and another determined by to an unsupportive environment for this kind of activities (Vuorio *et al.*, 2017).

Sustainable entrepreneurship in horse manure processing can create future goods and services with economic, social and ecological gains (Belz and Binder, 2017). A socially and ecologically sustainable economic system in this sector can work to facilitate a good and dignified life for all, while respecting nature as an integral part of life. A fundamental change in economic rationality is needed to achieve this (Izadi *et al.*, 2019).

Research methodology

Sample and data collection

The chosen sample consists of people who work in various fields of activity, some with previous entrepreneurial experience and others interested in becoming entrepreneurs in the equine sector. This study focuses on assessing entrepreneurs' motivations in developing a sustainable business based on processing horse manure into bioenergy and biofertiliser. The analysis aims to gain practical insights on sustainable entrepreneurship in Romania by examining the interrelationship between sustainability factors, specifically economic prosperity, environmental well-being and social well-being.

A questionnaire was administered online between October and December 2021, at the web address: https://forms.gle/XPMisG15qR4wMhjA7. The invitations to respond were sent to people who are already entrepreneurs or intend to become entrepreneurs in the near future; 153 answers were collected and validated. The characteristics of the respondents from different areas of Romania and different fields of activity can be found in Table 1.

We can see that most of the respondents are female, between 36 and 50 years old, live in urban areas and have entrepreneurial experience.

The constructs (Table 2), were developed on four latent variables, reflecting different entrepreneurial mindsets in the equestrian sector. The alternatives are taken to be maximising profit, protecting the environment and promoting social welfare. We clarified to respondents that the business under discussion is the conversion of horse manure into bioenergy and biofertiliser. The constructs were identified for each of the latent variables based on the questionnaire. At least four constructs were used for each variable and two for the outcome. The details of the constructs are explained in Table 2.

The responses from the questionnaire were converted into data using seven-point scales to measure each construct. Based on the survey data the evaluation was carried out to verify the research hypotheses.

In order to identify accurately the interests expressed by the current and future entrepreneurs, we started from the hypotheses presented in Table 3.

The method selected was modelling by structural equations, using PLS-SEM method. PLS-SEM can be considered an appropriate data analysis method due to its ability to obtain

Characteristic		Percentage
Gender	Male	*46.1%*
	Female	*53.9%*
Group age	less than 20 years	*0%*
	between 20 and 35 years	*34.4%*
	between 36 and 50 years old	*45.5%*
	older than 50 years	*20.1%*
Settlement	Urban	*81.2%*
	Rural	*18.8%*
Entrepreneurial experience	Without experience	*27.9%*
	Less than 5 years	*25.3%*
	Between 5 and 10 years	*14.3%*
	More than 10 years	*32.5%*
Field of work	Trade and services	*25.3%*
	Accounting, finance and public administration	*16.9%*
	Banking and insurance activities	*4.5%*
	Public catering, tourism and related activities	*2.6%*
	Health and social protection	*5.2%*
	Forestry and environmental protection	*1.3%*
	Agriculture and rural development	*15.6%*
	Education and Training	*6.5%*
	Another field	*22.1%*

Table 1.
Sample demographics

Source(s): Issued by the authors

Latent variables	Acronym	Indicators/manifest variables	Source
FINANCIAL AND ECONOMIC INTERESTS	FEI	Existence of a competitive advantage in the market	Crecente *et al.* (2021)
		Turning manure management issues into economic opportunities	Rantala *et al.* (2019)
		Business financing opportunities	Elkington (2018)
		Reduction of manure storage costs (lack of storage space)	Munoz and Cohen (2018)
		Making a profit by recovering animal waste	Patzelt and Shepherd (2011)
SOCIETAL INTERESTS	IOF	Social welfare	Onstee (2020)
		Protection of the common capital stock	Short *et al.* (2009)
		Balance between collective and individual needs	Zahra *et al.* (2009)
		Development of innovative technologies and services	Dean and McMullen (2007)
ENVIRONMENTAL INTERESTS	IFE	Solving manure storage problem to reduce pollution	Havukainen *et al.* (2020)
		The existence and production of alternative or renewable resources	Rantala *et al.* (2018)
		Development of Eco-innovation	Nasiri *et al.* (2018)
		Development of circular economy	Hadin *et al.* (2017)
Development of a sustainable business model by horse manure	RBIO	Production of bioenergy from manure	Hou *et al.* (2018)
		Production of biofertilisers from manure	Altenbuchner *et al.* (2017)
			Kusch (2014)

Table 2.
Main constructs used in the conceptual model

Source(s): Issued by the authors

Hypothesis 1	Financial and economic motivations (FEI) significantly affect the development of a business model that aims to protect the environment (IFE)	FEI → IFE
Hypothesis 2	Financial and economic motivations (FEI) significantly affect the development of a sustainable business model based on horse manure (RBIO)	FEI → RBIO
Hypothesis 3	Social motivations (IOS) have a significant effect on the development of a sustainable business that aims to maximise profits from exploiting manure (FEI)	IOS → FEI
Hypothesis 4	Social motivations (IOS) significantly affect the development of a sustainable business that aims to protect the environment and promote social welfare (IFE)	IOS → IFE
Hypothesis 5	Social motivations (IOS) significantly affect the development of a sustainable business based on horse manure (RBIO)	IOS → RBIO
Hypothesis 6	Environmental motivations (IFE) significantly affect the development of a sustainable business model based on horse manure (RBIO)	IFE → RBIO

Source(s): Issued by the authors

Table 3.
Research hypotheses

remarkable results for smaller sample sizes. The number of responses, 153, is sufficient to conduct SEM analysis (Sideridis *et al.*, 2014). The research hypotheses were formulated to verify the relationships between the three pillars (economy, sociability, environment) and the outcome. The structural equation model was used to measure the effect of the three dimensions on the development of a sustainable entrepreneurship model.

SEM uses two types of variables: endogenous (dependent) and exogenous (independent). This allows us to test hypotheses related to variables that are not directly observable, and it is more flexible than other statistical methods because it helps to assess the structural level.

We identified specific indicators for each latent variable with a potential role as a precursor of the development of a sustainable business model based on horse manure, with bioenergy and biofertiliser as result. These indicators—all related to developing a sustainable business model based on horse manure—were: economic and financial interest, society's interest and interest in the environment.

Conceptual model

PLS-SEM tests the correlations between the building blocks of a sustainable horse manure business. The identified factors are related to the latent variables: FEI, IOS, IFE and RBIO. For FEI, the constructs considered in SEM will be related to profits, investment and resource use. For IOS, they are related to human safety and societal benefits. The environmental dimension. For IFE, they are related to such things as recycling and waste reduction.

The conceptual model presented in Figure 1 shows the links between the latent variables, and the formative and reflective measurement models of the variables. This model helps us to estimate the interdependencies between many dependent and independent variables.

The structural models represent hypotheses and relationships between latent variables, which are examined when PLS-SEM is applied (Hair *et al.*, 2021). The structural model shown in Figure 1 shows four latent variables, represented as ovoids (FEI, IOS, IFE and RBIO). The indicators, also called items or manifest variables, are directly measured variables that contain the results of the questionnaire-based research. The relationships between variables, and between variables and the indicators assigned to them, are represented in the form of unidirectional arrows, considered predictive relationships, but can also be interpreted as causal relationships. All items in the questionnaire were assessed using a 7-step Likert scale (from 1 - Total disagreement to 7 - Total agreement).

Figure 1 illustrates two types of variables connected with motivations for developing a sustainable business model based on horse manure. The first type of variable can be measured through a formative approach and relates to FEI: Economic and financial interest.

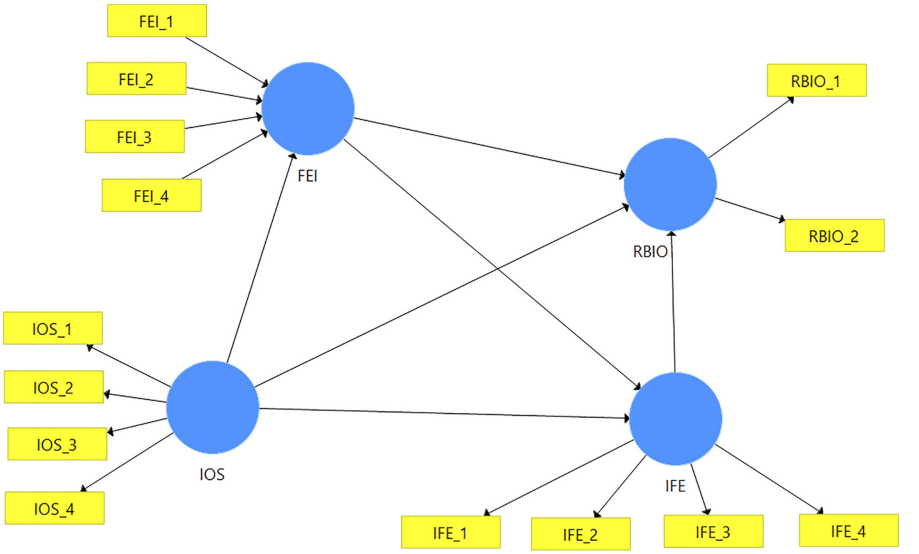


Figure 1.
The structural research model

Source(s): Smart PLS 3 processing software

The second type of variable can be measured by a reflective approach and relates to IOS (society's interest), IFE (environmental interest shown) and RBIO (development of a sustainable business model based on bioenergy.

Analysis and findings

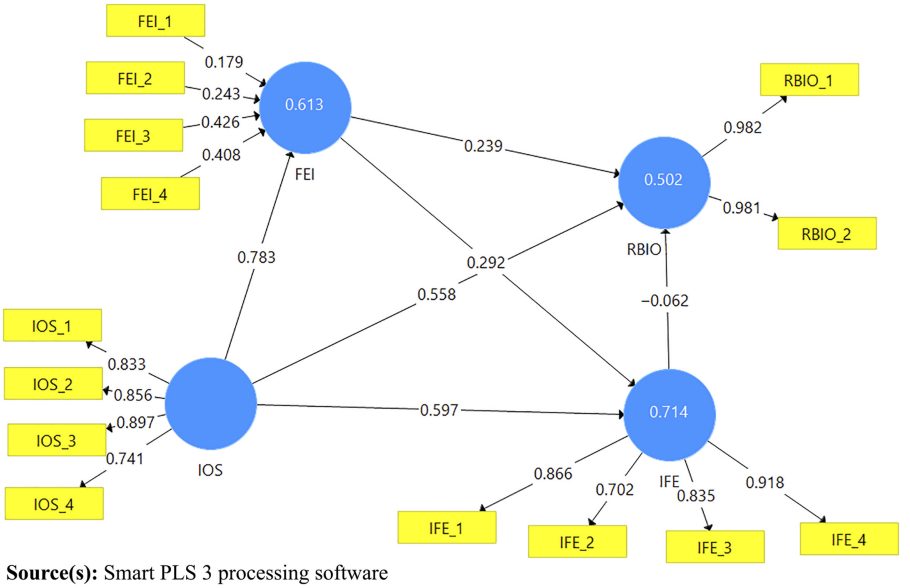
The structural model in Figure 2 shows that the entrepreneurs' societal interest in developing a sustainable business model based on horse manure (IOS) has the strongest effect on the economic and financial interest in developing such a business model (FEI) (ratio coefficient 0.783). The strongest effect on the development of a business model resulting in bioenergy (RBIO) is given by the interest in an entrepreneurial approach (IOS) at the societal level–ratio coefficient of 0.558. Surprisingly, a correlation that might have been expected—between interest in the environment (IFE) and the development of our business model, resulting in bioenergy (RBIO)—was not found.

The FEI, IOS and IFE variables explain 50.2% of the variance of the RBIO endogenous variable (coefficient of determination $R^2 = 0.502$). The FEI and IOS variables explain 71.4% of the variance of the IFE endogenous variable (coefficient of determination $R^2 = 0.714$). The IOS variable explains 61.3% of the variance of the FEI endogenous variable (coefficient of determination $R^2 = 0.613$).

The correlation coefficients are calculated by the SmartPLS 3 software and illustrated in Figure 3. The strongest correlation is between the IOS and FEI latent variables (correlation coefficient 0.783), and the weakest is between the IFE and RBIO latent variables (correlation coefficient −0.062).

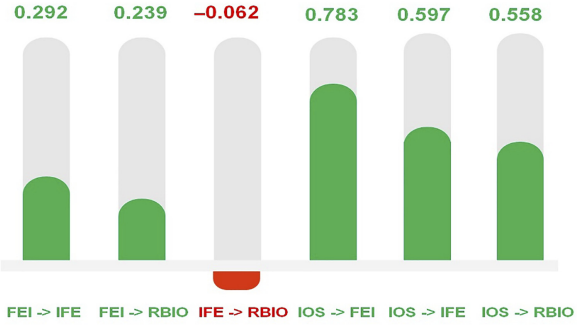
The evaluation of the reflective measurement model involves the determination of the level of internal consistency (Cronbach Alpha and composite confidence level), convergent validity (evaluated by the Average Variance Extracted) and Discriminant Validity (evaluated by the Fornell-Larcker criterion and the Heterotrait-Monotrait ratio (HTMT)).

External loadings highlight the link from latent variables to indicators and show how much every indicator or observable element absolutely contributes to the definition of a



Source(s): Smart PLS 3 processing software

Figure 2. Highlighting the correlation coefficients within the structural model



Source(s): Smart PLS 3 processing software

Figure 3. Graphical representation of correlation coefficients

reflective variable. External loadings of indicators associated with reflective variables exceed the recommended threshold of 0.7, marked in green in Table 4. The lowest reliability index is IFE 2 ($0.4928 = 0.702^2$), and the highest reliability index belongs to IFE 4 indicator ($0.8427 = 0.918^2$).

The reliability of each construct set for the variable was tested using Cronbach Alpha, which tests the validity of the internal consistency or the reliability of the way a variable is measured, reflecting the correlation degree of the variables within the structural model. The minimum accepted threshold for this indicator is 0.7. The values for Cronbach Alpha are assigned in Table 5 only to the reflective variables (IOS, IFE, RBIO), all three crossing the threshold of 0.7.

As with Cronbach Alpha, the confidence level (CR) is a reliability indicator determined by testing combinations of all variances and covariances of the actual scores into the composition of indicators within the latent variables and by dividing their sum by the total variance in the compound. If Cronbach Alpha assumes that the factor loadings are the same

for all indicators, the CR takes into account the variable indicator loadings. The acceptable values of CR are generally considered to be above the threshold of 0.7, and in our data, it exceeds the minimum recommended threshold for all three reflective variables (IOS-0.695, IFE-0.696, RBIO-0.963).

The Spearman rank correlation coefficient (Rho) is a nonparametric test used to measure the magnitude of the association between two variables, where the value $r = 1$ means a perfect positive correlation and the value $r = -1$ means a perfect negative correlation. We notice a positive correlation in the case of the three reflective variables (IOS, IFE, RBIO).

The convergent validity of the model is assessed by the Average Variance Extracted (AVE), which measures the variance captured by a variable relative to the variance due to measurement error. Generally, an AVE value of at least 0.5 or higher is expected, otherwise the error variance is higher than the variance explained. All three variables (IOS, IFE, RBIO) have AVE above the recommended threshold.

In the case of discriminant validity, the Fornell-Larcker criterion compares the square root of the Average Variance Extracted (AVE) with the correlation of the latent variables. It is recommended that the square root of the AVE of each reflective variable has a higher value than the correlations with other latent variables. This is the case in our data, since the AVE values for IFE (0.834), IOS (0.834) and RBIO (0.981) are higher than the correlations with the other latent variables, illustrated below the main diagonal in Table 6.

Table 4.
Representation of outer loadings (contributions) belonging to the indicators associated with the reflective variables

	FEI	IFE	IOS	RBIO
FEI_1	0.751			
FEI_2	0.807			
FEI_3	0.829			
FEI_4	0.775			
IFE_1		0.866		
IFE_2		0.702		
IFE_3		0.835		
IFE_4		0.918		
IOS_1			0.833	

Source(s): Smart PLS 3 processing software

Table 5.
Assessment of the internal consistency and convergent validity in the case of the reflective measurement model

	Crombach's alpha	Rho_A	Composite reability	Average variance extracted (AVE)
FEI_1		1.000		
IFE	0.852	0.875	0.901	0.696
IOS	0.851	0.854	0.901	0.695
RBIO	0.962	0.963	0.981	0.963

Source(s): Smart PLS 3 processing software

Table 6.
Assessment of discriminant validity in the case of the reflective measurement model (Fornell-Larcker criterion)

	FEI	IFE	IOS	RBIO
FEI				
IFE	0.759	0.834		
IOS	0.783	0.825	0.834	
RBIO	0.629	0.581	0.694	0.981

Source(s): Smart PLS 3 processing software

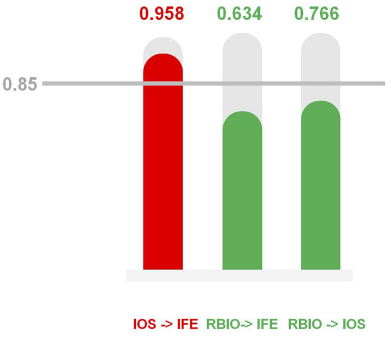
The other measure for discriminant validity is the Heterotrait Monotrait (HTMT) correlation ratio. HTMT achieves a higher degree of reliability than the cross-loading criterion and the Fornell-Lacker criterion. HTMT values close to 1 indicate the absence of discriminant validity. Using HTMT as a criterion involves comparing with a predefined threshold. If the HTMT value is higher than this threshold, it can be concluded that there is an absence of discriminant validity. Most statisticians recommend a minimum threshold of 0.85.

We observe in the case of this research that the Heterotrait Monotrait (HTMT) correlation ratio is below the threshold of 0.85 only in the case of the structural relations between the RBIO and IFE variables, respectively RBIO and IOS: see Figure 4.

The assessment of the formative measurement model was performed by determining the significance and relevance of the weights associated with the indicators that make up a latent variable. In this way, we analyzed the convergent validity, the collinearity between the indicators and the redundancy of the indicators.

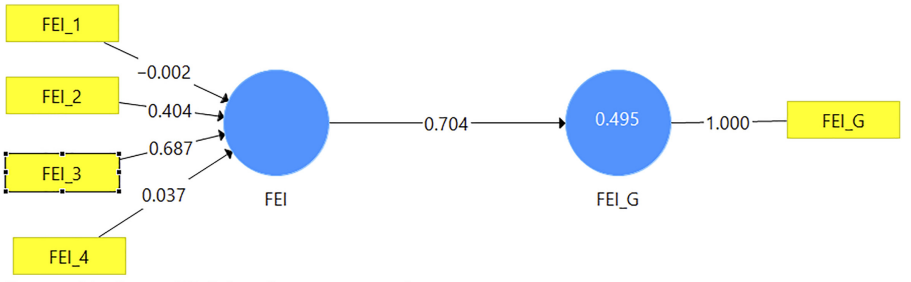
In the case of the formative assessment model, the weights show the links from the indicators to the latent variables, determining the relative contribution of each indicator to the definition of its variable. The weights are generated following multiple regressions whereby the scores of the latent variables represent dependent variables, and the formative indicators are the independent variables.

In the case of the FEI variable (financial and economic interest in developing a sustainable business model by horse manure), the largest weight belongs to the FEI indicator 3 (0.687), which reflects its relative importance: see Figure 5.



Note(s): Heterotrait Monotrait correlation ratio (HTMT)
Source(s): Smart PLS 3 software processing

Figure 4.
Assessment of discriminant validity in the case of the reflective measurement model



Source(s): Smart PLS 3 software processing

Figure 5.
Relevance of formative indicator weights

Determining convergent validity for formative variables involves redundancy analysis. To this end, we included two variables in our analysis: the FEI composite formative variables and the variables evaluated globally by distinct items in the questionnaire (FEI_G).

The correlation coefficient related to the structural relationship between FEI and FEI_G is 0.704, above the recommended threshold of 0.7, thus supporting the convergent validity of the FEI formative variable: see Figure 5.

The Variance Inflation Factor (VIF) measures multicollinearity between a set of variables in a multiple regression. Values greater than 5 indicate high multicollinearity. Multicollinearity occurs when a group of independent variables are strongly correlated with each other.

The VIF appears in the definition of the variance of the estimated coefficients and measures how often the variance of the coefficients is overestimated due to the multicollinearity, compared with the situation of there being no collinearity within the structural model.

Smart PLS 3 software generates VIF values for both formative and reflective variables. The FEI 2 formative indicator has the highest level of variance inflation, while the FEI_G formative indicator has the lowest variance inflation level. All VIF values are below the threshold of 5.00 (Table 7), so we can conclude that the collinearity does not reach critical levels for any of the formative variables and implicitly does not create problems in estimating the analysed structural model.

PLS-SEM is based on a nonparametric bootstrap procedure to test the significance of the estimated correlation coefficients in PLS-SEM. In the bootstrapping procedure, subsamples with observations randomly extracted from the original dataset are created. The subsample is then used to estimate the structural model. This process is repeated until a large number of random data samples have been created, i.e. approximately 5,000. Parameter estimates (weights, external loadings and estimated correlation coefficients in the subsamples) are used to obtain standard estimation errors. With this information, *t*-test values and asymptotic meanings (*p*-values) are calculated to assess the significance of each estimate and to validate or reject the research hypotheses.

Figure 6 reflects the structural model generated after the application of the bootstrap procedure, whereby the values of the asymptotic significance (*p*-values) are highlighted on the connections between the latent variables.

The data presented in Tables 8 and 9 are useful for the validation/rejection of the hypotheses in the analysed structural model.

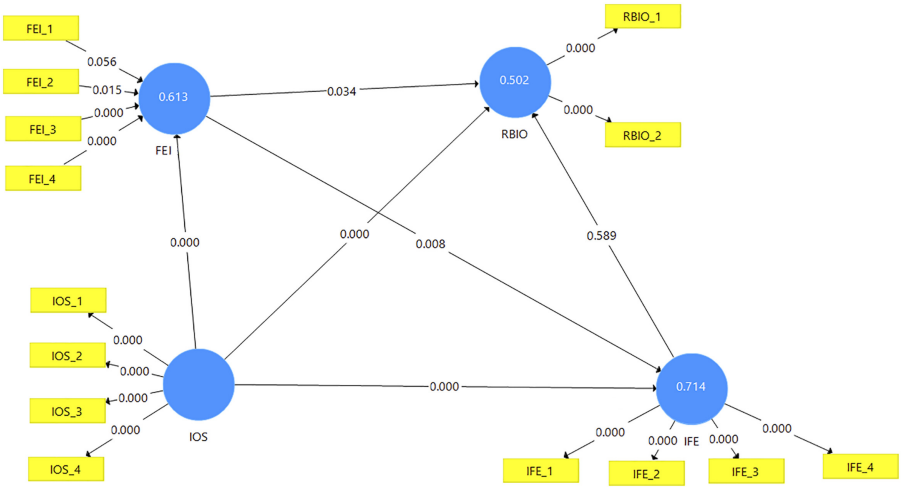
Five of the six hypotheses are validated. The *p*-value exceeds the maximum allowable significance level of 0.05 for the IFE-RBIO hypothesis (the interest in the environment has a significant effect on the decision to develop a sustainable business model by horse manure, 0.589 > 0.05). In addition, the *t*-test shows the magnitude of the correlation between the latent variables in this structural model.

As a preliminary conclusion, societal interest (IOS) has the strongest impact in the development of a sustainable business that maximises the economic and financial results achieved by capitalising on manure (FEI), (*t*-test = 17.427, *p*-value tends to zero), while the

Table 7. Assessment of collinearity statistics test

	VIF
FEI_1	2.071
FEI_2	2.341
FEI_3	1.638
FEI_4	1.363
FEI_G	1.000

Source(s): Smart PLS 3 software processing



Source(s): Smart PLS 3 software processing

Figure 6. Determining the *p*-values associated with the relations between the model variables, after applying the bootstrap procedure

	Original sample	Sample mean (M)	Standard deviation (STD)	*T* statistics (|O/STDEV|)	*p* values
FEI → IFE	0.292	0.313	0.110	2.651	0.008
FEI → RBIO	0.239	0.250	0.112	2.127	0.034
IFE → RBIO	−0.062	−0.066	0.114	0.541	0.589
IOS → FEI	0.783	0.788	0.045	17.427	0.000
ISO → IFE	0.597	0.578	0.106	5.623	0.000
IOS → RBIO	0.558	0.555	0.131	4.259	0.000

Source(s): Smart PLS 3 software processing

Table 8. Asymptotic *p*- and *t*-test significance values for the six hypotheses from the structural model

Hypothesis 1	The financial and economic interest (FEI) has a significant effect on the development of a business model that aims to protect the environment (IFE)	Supported
Hypothesis 2	The financial and economic interest (FEI) has a significant effect on the development of a sustainable business model based on horse manure (RBIO)	Supported
Hypothesis 3	Society's interests (IOS) have a significant effect on the development of a sustainable business that would maximise economic and financial results by capitalising on manure (FEI)	Supported
Hypothesis 4	Society's interests (IOS) have a significant effect on the development of a sustainable business that aims to protect the environment and ensure social welfare (IFE)	Supported
Hypothesis 5	Society's interests (IOS) have a significant effect on the development of a sustainable business based on horse manure (RBIO)	Supported
Hypothesis 6	The interest for the environment (IFE) has a significant effect on the decision to develop a sustainable business model based on horse manure (RBIO)	Rejected

Source(s): Issued by the authors

Table 9. Synthesis of hypotheses

interest for the environment (IFE) has the lowest impact on the decision to develop a sustainable business model based on horse manure (RBIO), (t-test = 0.541, p-value = 0.589).

Discussion

A series of studies in this area suggest that environmental protection needs to be taken into account in planning the survival and development of a venture in the equestrian sector (Aksoy and Bayram Arlı, 2020). To cope with the urgent need for market incentives to foster sustainable business practices (Vallaster *et al.*, 2018), our study highlights that equine entrepreneurship models should purposefully balance profit creation and value creation for society.

Our results support previous work emphasising that sustainable development should be considered a key pillar when establishing a long-term business in the equine sector in fluctuating economic conditions (Ukko *et al.*, 2019). Furthermore, the state of play in Romania on transforming horse manure into bioenergy and biofertilisers is similar to that in Finland, where only a fraction of the potential of horse manure is used within innovative business models (Rantala *et al.*, 2018).

It is clear from the literature on sustainable entrepreneurship in the horse industry that entrepreneurs intending to engage fully in sustainable production practices are faced by a number of indicators requiring time and energy (Thirupathi and Vinodh, 2016). The development of a concise set of indicators related to the three dimensions of sustainability, mentioned in our study, can provide faster and easier support for starting such a sustainable business.

Our findings confirm that, for sustainable entrepreneurship in the equestrian sector, economic development, environmental development and social development must be considered as interconnected factors (Aksoy and Bayram Arlı, 2020). Furthermore, our study predicts emerging intentions of existent or potential entrepreneurs to invest in sustainable business models in equine industry and reveals the need from policymakers to support them in new business creation (Belchior and Lyons, 2021).

The most novel insight in our findings is that potential entrepreneurs in the equestrian sector are unaware of the need to integrate sustainability issues in their planning: the hypothesis that environmental motives have no significant effect on the decision to develop a sustainable business model based on horse manure was rejected.

Conclusions

This study was conducted in Romania, where the manure produced by horses is underexploited, and the equestrian sector requires new business models, innovations and sustainable development. The structural equation model analysed three dimensions of sustainable development linked with entrepreneurial intentions. The analysis found that the dimension of societal need indicates a positive and strong correlation with entrepreneurs' interest in transforming horse manure into bioenergy or biofertiliser. Another finding was that improvements in social sustainability have a positive effect on maximising a company's results.

Horse manure's environmental and social impact makes it a controversial topic, and current or future entrepreneurs can take advantage of this by initiating business ventures in this field. The answer to the research question reflects the pivotal role of financial and economic motivations in the entrepreneurial mindsets of those that transform horse manure into bioenergy and biofertilizers.

This paper, importantly, draws attention to the main impediments to developing a startup based on horse manure management, especially following the results obtained through the PLS-SEM method. According to the research, interest in the environment is not relevant in deciding whether or not to develop a sustainable business model based on horse manure.

There is an acute need for entrepreneurs in the equestrian sector with a shared vision on sustainability pillars of a business, able to cope with environmental challenges.

This research presents a starting point in stimulating entrepreneurs' interest in a sector that has been overlooked but is full of possibilities.

Theoretical contributions

This study will prompt research interest in the development of a business by presenting the sustainability factors that stimulate entrepreneurship in the horse industry and studying technological innovations, services, products and innovative business models in this field.

The present research can also be a guide for future researchers, offering them theoretical perspectives on the identification of entrepreneurial opportunities in the equine sector.

Practical and social implications

The ultimate goal of developing sustainable entrepreneurship models is to improve people's quality of life. Sociologists emphasise the importance of social capital in community satisfaction, while eco-minded people suggest that human well-being is possible by protecting the environment.

The ecological dimension is an important factor in the development of sustainable entrepreneurship, leading to decrease of environmental damage and to maximize human well-being.

Every day, horses produce an average of 20 kg of manure, which contains nitrogen and ammonia. Storage solutions and strategies are needed to prevent environmental pollution and consequential damage to society. Horse manure is both costly to horse owners and mostly underused, despite its potential usefulness in renewable energy or as a source of nutrient recycling.

Using PLS-SEM to understand the interrelationship between factors allows current and future entrepreneurs to develop a sustainable business and thus gain a competitive advantage in the equestrian sector. This knowledge can generate new opportunities for an entrepreneur, so that he can systematically focus on the determining factors influencing society's expectations. The three dimensions (economy, societal, environment) need to be considered when measuring the progress of sustainable entrepreneurship based on horse manure and when making decisions.

Research limitations

The limitations in this research are mainly related to the convenience sample of respondents. Thus, the findings can't be generalized to the entire population of entrepreneurs with appetite to invest in a sustainable business model in equine industry. Furthermore, not all the respondents included in the sample are actually entrepreneurs, fact that could affect their perceptions on the challenge to develop a business in the equine sector.

Future research

In the future, we aim to conduct a qualitative study based on in-depth interviews in order to identify all the complex aspects of sustainable entrepreneurship based on horse manure. It would also be interesting to conduct international research and to explore the introduction of the ecological factor into organisational culture, which might lead to more businesses transforming manure or waste into renewable resources. An interdisciplinary study would also be useful, aiming to develop an interesting and profitable model for sustainable entrepreneurship.

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