Sustainable development: Implications and definition for open sustainability

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Sustainable Development: Implications and Definition for Open Sustainability

Abstract

This study deals with sustainable development from a triple bottom-line perspective, including the economic, social, and environmental dimensions. Specifically, this study investigates whether various sustainability factors are related to small businesses' intentions to exploit open sustainability, which is described as meeting sustainability challenges through the exploitation of internal and external initiatives. Empirical data were collected from 139 companies. The results show that some factors from all three sustainability dimensions affect companies' intentions to exploit open sustainability, while company size and operations type do not influence the use of open sustainability. As an emerging concept, the definition of open sustainability is presented.

Keywords: sustainable development; development; open sustainability; innovation; environmental policy; environmental sustainability; social sustainability; collaboration

1 Introduction

Persistent, ongoing changes in the operating environment of companies of all sizes drive increasing demands for sustainable products, services, and innovations (e.g., Porter and Kramer, 2011; Lioutas and Charatsari, 2018). Whereas traditional innovation relates to the development of new products, materials, processes, services, and organizational forms to gain competitive advantage (Ettlie and Reza, 1992; Baregheh et al., 2009), sustainable innovation refers to the generation of new ideas, goods, services, processes, or management systems that can deal with environmental problems (Rennings, 2000; Li et al., 2017). However, small businesses do not have the resources to develop and implement sustainable innovations alone. Some characteristics of small businesses, like deficiency in capital, knowledge, or skilled labor, may hinder sustainability efforts (Bos-Brouwers, 2010; Lewis and Cassells, 2010). Therefore, to involve small businesses in sustainable development, one solution is open sustainability.

Open sustainability is an important concept referring to sustainability initiatives conducted outside the focal company. The operationalization of the concept of open sustainability initiatives in this study follows the definitions of open innovation (Chesbrough, 2003; Ganzerla et al., 2014) and sustainable development (Laperche and Picard, 2013; Sáez-Martínez et al., 2014; Sousa-Zomer and Cauchick Miguel, 2018). Based on this operationalization, open sustainability is defined as the systematic encouragement and exploration of a wide range of internal and external sources in the development of environmentally, socially and economically sustainable technologies, services, business models, and other initiatives. Thus, the focus of encouragement and exploration is sustainable development beyond basic business operations.

Small businesses have to create value by seeking new business opportunities from external networks and must seize opportunities by collaborating with external partners. Thus, companies need to collaborate and actively develop solutions to apply open innovation to sustainability issues.

The study examines the possible links between sustainability factors and open sustainability. The research question is as follows: *what sustainability factors are related to small businesses' intentions to exploit open sustainability*? This study contributes to the literature on sustainable development and innovation management by identifying the drivers of open sustainability. Although these drivers are explored in only one industry (the horse industry), the results shed light on the concept of open sustainability. For scholars, this study provides empirical-level insights into the concept of open sustainability in an under-studied industry that faces present and future pressures become more sustainable. At the practical level, the context of the horse industry does not significantly differ from other agriculture-related industries; therefore, the results can be valuable to various decision makers, public servants, and the agricultural industry as a whole.

The following two sections present a review of the sustainable development and innovation management literature to discuss the movement toward open sustainability. Next, the hypotheses for the empirical research conducted in Finland are developed. The empirical research consists of a survey examining the drivers of open sustainability among small businesses in the horse industry. Next, the results are presented and analyzed, followed by the discussion and conclusions.

2 Sustainable Development

According to Brundtland et al. (1987), "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This idea informs the 17 sustainable development goals set in 2015 by the United Nations (UN, 2015) aimed to ensure prosperity for all while protecting the planet. Work to develop assessment methods and metrics for sustainability is ongoing (Böhringer and Jochem, 2007; Hacking and Guthrie, 2008; Pope et al., 2004; Singh et al., 2009; Vanclay, 2004). In addition, conceptions of sustainability typically include three major dimensions: environmental, economic, and social (Delai and Takahashi, 2011; Mamede and Gomes, 2014; Svensson and Wagner, 2015; Khan et al., 2016). In this study, various factors of these three dimensions are used to describe the drivers of the intentions to exploit open sustainability.

The *environmental dimension* refers to the life-support systems essential to the existence of humanity (Goodland, 1995). According to Daly (1990), the environmental dimension supports the following principles: the usage rate of renewable resources should not exceed the renewal rate, pollution should not exceed the environment's assimilation capacity, and the depletion of non-renewable resources should not exceed the development rate of renewable substitutes.

These principles require the development of limits on human activities. The planetary boundaries first presented by Rockström et al. (2009) and further developed by Steffen et al. (2015) represent widely accepted environmental challenges and limits to which human activity should be restrained. In summary, the environmental dimension encompasses relevant factors such as land use, waste handling, hygiene, and energy and water consumption (e.g., Delai and Takahashi, 2011; Khan et al., 2016).

The *social dimension*, which has received less attention, concerns the maintenance of common social capital, including community values and morals. According to Goodland and Daly (1996), social sustainability can be achieved through community participation and a strong civil society. Maintaining social capital requires investments in areas such as education or, like physical capital, it will deteriorate (Goodland, 1995). The social dimension highlights the relationship between companies and their stakeholders and factors such as health, safety, and social aspects (e.g., Delai and Takahashi, 2011; Khan et al., 2016).

The focus of the *economic dimension* is "the maintenance of capital" (Goodland, 1995). This dimension encompasses the resource base that provides renewable and exhaustible inputs to production processes and is composed of factors like costs, profits, and new business creation (e.g., Mamede and Gomes, 2014; Svensson and Wagner, 2015).

In the past, sustainability issues were addressed more often in large companies than in small- and medium-sized enterprises (SMEs) (Bos-Brouwers, 2010). Despite these limiting factors, sustainability is gaining interest in SMEs (Rasi et al., 2012; Williams and Schaefer, 2013; Halme and Korpela, 2014; Hoogendoorn et al., 2015). Legislation compliance and economic benefits are the main drivers of sustainable actions in SMEs (Lewis and Cassells, 2010; Williams and Schaefer, 2013; de Paiva Duarte, 2015). Moreover, Hoogendoorn et al. (2015) found that stringent legislation increases activity in green products and services. Outside of legislation and economic benefits, stakeholders have a great influence on the introduction of sustainable practices in SMEs. Stakeholders such as employees, customers (Raar, 2015; Salem et al., 2018), and local communities (Lewis and Cassells, 2010) with vertical partners have the most impact (Rasi et al., 2012). Company management also plays a role in introducing sustainable practices in SMEs, and Williams and Schaefer (2013) found the personal values and beliefs of managers was the main motivation for them to engage in environmentally friendly practices. Halme and Korpela (2014) found that social capital and equity improvements can be obtained even with the reported low resources available for sustainability improvements in SMEs. Environmental technology innovations, on the other hand, require more resources and specific industry knowledge.

The results of summarized studies show that economic and legislative factors seem to keep the leading position, and actions can be seen as non-transferable costs (Simpson et al., 2004). This study acknowledges the vital role of the economy as a driving force toward more sustainable practices. However, rather than focusing solely on the economic drivers, this study also

investigates the influence of companies' positions on different sustainability dimensions on their intentions to exploit open sustainability. Studying these dimensions separately can lead to the conclusion that economic factors are most dominant; therefore, one interesting aspect herein is the role of mediation effects on exploiting open sustainability.

3 Open Sustainability

Information-sharing and collaborative initiatives inside and outside organizations are crucial in today's business world. Small businesses, in particular, have to search for new business opportunities through external collaboration. This is emphasized by the open-innovation paradigm that stresses utilizing external information in cooperation with other knowledge sources and benefiting from intellectual property and related tools to create new business models (Chesbrough, 2003). Thus, open innovation is defined as "the systematic encouragement and exploration of a wide range of internal and external sources for innovative opportunities, the integration of this exploration with company capabilities and resources, and the exploitation of these opportunities through multiple channels" (Ganzerla et al., 2014, p. 1684).

Open innovation plays a key role in effective, strategic sustainable management (Kennedy et al., 2017; Lopes et al., 2017). Rising costs and increased consumer demand for a more sustainable future (e.g., De Brito et al., 2008) have brought collaboration and active interaction to the core of organizing for and creating sustainable solutions (cf. Lozano, 2007; Lacoste, 2016; Meqdadi et al., 2017; Shrivastava and Guimarães-Costa, 2017). Small businesses must create value by seeking new business opportunities from external networks and seize opportunities by collaborating with external partners. For example, Yoon et al. (2016) stated that small businesses could benefit from adopting open innovation strategies to adapt to changes in the market and in customer demand. Furthermore, this strategy can aid small businesses' economic survival and future sustainability (Yoon et al., 2016). De Marchi and Grandinetti (2013) found that high green innovators are those that interact the most with external organizations, utilizing external sources of information, acquiring R&D from outside the focal company, and co-developing new solutions. De Marchi and Grandinetti's (2013) study conducted in the context of Italian manufacturers revealed that green innovators draw information from and cooperate with a larger value network than non-green innovators.

Overall, researchers found that various forms of external cooperation play crucial roles in creating sustainable solutions (e.g., Lozano, 2007; Horbach et al., 2013; Del Río et al., 2015; Shrivastava and Guimarães-Costa, 2017). For example, Lopes et al. (2017) highlighted that interactions among stakeholders that result in technological and integrated changes in production processes, products, and new knowledge (internal and external) can promote more sustainable products and processes. Scandelius and Cohen's (2016) found that three stakeholder groups (employees, suppliers, and industry colleagues) are especially important in developing sustainable solutions. Arnold (2017) suggested that interactions and co-creation

between companies and stakeholders should focus on the whole value chain to foster sustainability. Moreover, both public and private actors are essential in facilitating sustainability (Klewitz et al., 2012).

Current research also investigates the various initiatives, such as new services, technologies, and business models, enabling societies and individual organizations to become more sustainable (e.g., Boons and Lüdeke-Freund, 2013). For example, utilization and investment in technological solutions play important roles in several sustainability challenges (Long et al., 2016). The adoption of service-related activities is also an engine for the sustainable development of individual companies, industries, and value chains (Snyder et al., 2016). For example, Laperche and Picard (2013) reported that a growing amount of services within a particular supply can decrease the environmental impact of an economic activity by providing the appropriate service activities during the product life cycle or by delivering the desired function rather than providing tangible products (Laperche and Picard, 2013). In addition, business models with social components enable interactions with customers that encourage sustainable consumption practices (Salem et al., 2018: Sousa-Zomer and Cauchick Miguel, 2018).

Thus, based on the above literature, open sustainability is an important concept referring to sustainability initiatives conducted outside the focal company. The operationalization of the concept of open sustainability initiatives in this study follows the definitions of open innovation (Chesbrough, 2003; Ganzerla et al., 2014) and sustainable development (Laperche and Picard, 2013; Sáez-Martínez et al., 2014; Sousa-Zomer and Cauchick Miguel, 2018). Based on this operationalization, open sustainability is defined as the systematic encouragement and exploration of a wide range of internal and external sources in the development of environmentally, socially and economically sustainable technologies, services, business models, and other initiatives. This definition is also used to assess companies' open sustainability initiatives.

4 Hypothesis Development

4.1 The environmental dimension

Different drivers can motivate companies to exploit open sustainability (e.g., through initiatives such as collaborative technology adoption, technology investment, service adoption, and business participation). The desire to operate in an environmentally sustainable way and environmental commitment are motivators for green innovations, such as energy-saving technologies (Chen et al., 2006). In the environmental dimension of sustainable development, major changes are occurring in the general commitment to environmental causes and in services, technologies and business models to reduce negative environmental impacts, such as waste, and to deploy ecological processes, such as nutrient recycling (Pretty et al., 2011; Delai and Takahashi, 2011; Galdeano-Gómez et al., 2013). Commitment to environmental issues can

drive companies in their efforts to meet their environmental objectives (Chang and Chen, 2013). This relationship is also supported by the ability to pursue environmentalism and uncertain environmental regulations (Chang, 2016). Customer demands are also seen as motivators of green innovations, and Kesidou and Demirel (2012) found that satisfying minimum customer and societal requirements motivates eco-innovations. As Horbach et al. (2012) pointed out, customers demand that companies make products with improved environmental performances and develop process innovations that increase material efficiency and reduce energy consumption, waste, and the use of dangerous substances. Based on the current understanding, environmental factors appear to be drivers of the intentions to exploit open sustainability initiatives. Accordingly, the following hypothesis is proposed:

H1. The more important a company considers environmental factors to be, the higher their intention to exploit open sustainability.

4.2 The social dimension

Social factors refer to the relationship between companies and their stakeholders, respect for the environment, and socio-economic processes, and it involves paying attention to human capital development, social recognition, job creation, and health and safety issues (Delai and Takahashi, 2011; Galdeano-Gómez et al., 2013; Khan et al., 2016). Social factors, which affect the wellbeing of people, organizations, and communities, are also possible drivers that motivate companies to exploit open sustainability. Challenges related to the social sustainability include balancing societal and individual human needs, economic welfare, and nature's capacities (Choi and Ng, 2011; Delai and Takahashi, 2011; He et al., 2016; Khan et al., 2016; Lioutas and Charatsari, 2018). According to Huang et al. (2016), human training can engage employees to change their actions and perform more environmentally sustainable way. In addition, Del Río et al. (2015) suggested that companies' internal flow of information enhance sustainable innovations. Thus, managerial commitment to both the development of human capital and the support of information flows are important drivers of green innovation (Huang et al., 2016). For example, Qi et al. (2010) identified managerial concern as the most important driver of the adoption of green practices, though others suggest social recognition as another factor significant in the realization of green innovation (e.g., Doran and Ryan, 2012; Cai and Zhou, 2014; Jakhar, 2017). Based on this understanding, social factors appear to drive intentions to exploit open sustainability initiatives. Accordingly, the following hypothesis is proposed:

H2. The more important a company considers social factors, the higher their intention to exploit open sustainability.

4.3 The economic dimension

Economic factors refer to the resource base that provides renewable and exhaustible inputs to production processes and is composed of factors like costs, profits, and new business creation

(Mamede and Gomes, 2014; Svensson and Wagner, 2015). Most previous studies identify economic factors as drivers motivating companies to exploit open sustainability. The economic motivators for green innovations arise from conventional financial performance (e.g., cost reduction) and the interests of external stakeholders in organizations (e.g., improvements in economic well-being and standards of living) (Sheth et al., 2011). Cost savings are one of the most commonly proposed stimulators of green innovation (e.g., Horbach et al., 2012; Horbach et al., 2013; Lee, 2015; Hojnik and Ruzzier, 2016; Lioutas and Charatsari, 2018). Specifically, Hojnik and Ruzzier (2016) asserted that cost savings seem to drive environmental R&D investments and product, process, and organizational eco-innovation. Del Río et al. (2015) showed that energy and material cost reductions are drivers of both product and process eco-innovation. Schaltegger et al. (2016) defined sustainable entrepreneurship as "a sustainability mission-driven process of solving environmental and social problems of unsustainability by means of the exploration and exploitation of market opportunities created with innovative business models." As explained, economic factors are associated with cost reduction, income, new business opportunities, and indirect jobs. Based on this understanding, economic factors appear to be drivers of intentions to exploit open sustainability initiatives. Accordingly, the following hypothesis is proposed:

H3. The more important a company considers economic factors, the higher their intention to exploit open sustainability.

4.4 Conceptual model

The concept of open sustainability requires more theoretical and empirical operationalization and understanding of its drivers, and this study examines possible links between sustainability factors and open sustainability. The study objective is to investigate what sustainability factors are related to small businesses' intentions to exploit open sustainability. Figure 1 presents the study's conceptual model.

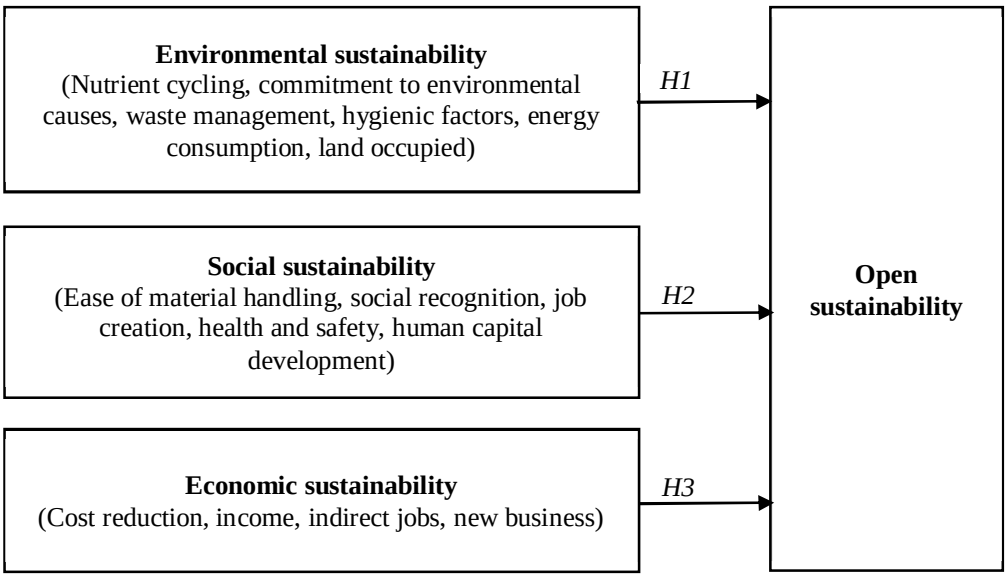

Figure 1. The conceptual model and hypotheses.

5 Methodology

5.1 Sample and data gathering

As a mostly unexplored research area, the concept of open sustainability requires deeper theoretical and empirical understanding from different perspectives and industries. In agricultural-related industries, for example, operators have to deal with pressures from different stakeholder groups while handling sustainability issues. Among agricultural-related industries, according to Elgåker (2012), the horse industry sector is part of a larger shift towards a post-productive rural landscape. The horse industry has features that are similar throughout the western world, but its development is closely tied to lifestyle changes related to possibilities created by the local social, economic, and land use conditions (Mather et al., 2006; Liljenstolpe, 2009; Elgåker et al., 2012). Elgåker et al. (2012) further argued that horse-related activities could be labelled as a business, a kind of land use with certain economic conditions, or a type of outdoor lifestyle outside the traditional agricultural economic system enabled by public use of common assets. Based on locational changes and the current environmental and economic challenges, the horse industry presents a good example of an industry in which small businesses need to transcend the boundaries between innovation activities and sustainability management to move toward open sustainability.

The empirical part of the study was executed in Finland, where there are currently around 15,000 stables and 75,000 horses. Today, horse industry operators in Finland are primarily small businesses that struggle to achieve profitable operations. Due to the geographical makeover from agricultural and forestry horses to equestrian horses (Andersson and Lehtola, 2011), many horse-industry companies are located near urban areas, meaning they need to pay

attention for example to the logistics and waste management issues of their operations to enable sustainability management. Thus, small businesses in the horse industry are frequently invited (or forced) to find collaborative solutions, services, and products to overcome their profitability and sustainability challenges. As small operators, they may have difficulties executing innovation activities or adapting innovative solutions, such as new technologies, on their own. Therefore, they need to open up their innovation activities as part of sustainability management. The research related to social and economic development among horse industry operators is lower than that on development within agriculture and rural society (Lobao and Meyer, 2001; Kolstrup et al., 2008; Elgåker et al., 2012). Therefore, the horse industry provides an interesting and important context for exploring the understudied concept of open sustainability.

In this study, data were gathered from an online survey questionnaire administered in August and early September 2016. The study population comprises Finnish small businesses operating in the horse industry. An invitation to participate in the survey was sent to 631 companies. Of the sent questionnaires, 580 reached the prospective participants, as 51 e-mail addresses were no longer valid. Two reminders were sent, and then the received data were analyzed. A total of 139 valid responses were received, yielding a response rate of approximately 24%. Table 1 presents the characteristics of respondents. Variance analysis performed to check the non-response bias indicates that the responses are representative of the whole sample.

Table 1. Respondents' Characteristics

		No	%
Size	Fewer than 20 horses	68	48.9
	20–50 horses	62	44.6
	More than 50 horses	4	2.9
	No answer	5	3.6
Type of operation	Horserace	26	18.7
	Horse-riding	98	70.5
	Other	13	9.4
	No answer	2	1.4
Distance to large industry operator	Small (less than 10 km)	94	67.6
	Medium (10–20 km)	34	24.5
	Large (more than 20 km)	11	7.9

5.2 Measures

The measurement instrument is presented in Table 2. The dependent variable, open sustainability, is measured with four items by using key studies on managing sustainability outside the focal company (e.g., Lozano, 2007; Horbach et al., 2013; Del Río et al., 2015; Shrivastava and Guimarães-Costa, 2017). The items are drawn from this literature and modified to items by the authors. As the focus of the study is companies' intentions to exploit open sustainability, willingness is used as a measure of intention as suggested by Fishbein and Ajzen (2010). For each item, the respondents were asked to indicate their willingness to exploit open sustainability initiatives in their operations on a scale of 1 to 7.

Six independent variables representing the environmental dimension adopted from Delai and Takahashi (2011) and Khan et al. (2016) are as follows: nutrient cycling, commitment to environmental causes, waste management, hygienic factors, energy consumption, and land occupation. Five independent variables representing the social dimension adopted from Delai and Takahashi (2011) and Khan et al. (2016) are as follows: ease of material handling, social recognition, job creation, health and safety, and human capital development. Four independent variables representing the economic dimension adopted from Delai and Takahashi (2011), Mamede and Gomes (2014), and Svensson and Wagner (2015) are as follows: cost reduction, income, indirect jobs, and new business. For each item, the respondents were asked to indicate the significance of each factor on a scale of 1 to 7.

Two background variables, company size and type of operation, are also included in the survey. Company size is measured by the number of horses, and operation type consists of horse-riding and horseracing companies.

Table 2. Measurement instruments

Dimension	The form of items	Items	Scale	References
Environmental dimension	Indicate the significance of the following concerning the handling of sustainability problems	1) Nutrient cycling 2) Commitment to environmental cause 3) Waste management 4) Hygienic factors 5) Energy consumption 6) Land occupied	1 to 7 (1 = not at all significant, 7 = extremely significant)	Delai and Takahashi, 2011; Khan et al., 2016
Social dimension	Indicate the significance of the following concerning the handling of sustainability problems	7) Ease of material handling 8) Social recognition 9) Job creation 10) Health and safety 11) Human capital development	1 to 7 (1 = not at all significant, 7 = extremely significant)	Delai and Takahashi, 2011; Khan et al., 2016
Economic dimension	Indicate the significance of the following concerning the handling of sustainability problems	12) Cost reduction 13) Income 14) Indirect jobs 15) New business	1 to 7 (1 = not at all significant, 7 = extremely significant)	Delai and Takahashi, 2011; Mamede & Gomes, 2014; Svensson & Wagner, 2015
Open sustainability	Indicate your willingness to the following in order to solve sustainability problems	16) Adopting technology (collaboratively) 17) Investing in technology (collaboratively) 18) Adopting services (collaboratively) 19) Participating to business (collaboratively)	1 to 7 (1 = not at all willing, 7 = extremely willing)	Lozano, 2007; Horbach et al., 2013; Del Río et al., 2015; Shrivastava and Guimarães-Costa, 2017

5.3 Reliability and validity

The environmental, social, and economic dimensions of sustainability were measured using single item measures. Single item measures have many practical advantages, such as the simplicity and brevity of surveying respondents, which can result in higher response rates and lower costs (e.g., Wanous et al., 1997; Sarstedt and Wilczynski, 2009). Some scholars argue against the use of single item measures due to problems with their reliability and validity (Sarstedt and Wilczynski, 2009; Diamantopoulos et al., 2012). Other Scholars have found either no difference in the validity of multiple item and single item measures (Drolet and

Morrison, 2001; Bergkvist and Rossiter, 2007, 2009) or only marginal differences (Sarstedt and Wilczynski, 2009). For example, Drolet and Morrison (2001) found that the incremental information from each additional item is extremely small. Furthermore, they suggested that scholars should consider the issue of item information besides reliability. Consequently, single item measures are acceptable with some restrictions. Single item measures can be used when the research setting includes concrete singular objects and attributes (Bergkvist and Rossiter, 2007, 2009) that are homogenous (Loo, 2002) and unambiguous to the respondent (Sackett and Larson, 1990). These can be verified by a high internal consistency or a unidimensionality through factor analysis (Loo, 2002). In this study, the validity of single item measures is thus assessed the same as with other scales, namely by construct validity, internal validity, and external validity.

Construct validity is assessed by content validity, criterion validity, and discriminant validity, as suggested by Hair et al. (2010). Content validity was assured by utilizing items that were based on previous studies and by evaluating the measurement instrument with a four-member panel of researchers. Criterion validity was ensured by ensuring that the constructs behave in a credible manner (see correlation analyses presented in Appendix 1). Discriminant validity was assessed via internal consistency. Exploratory factor analyses showed a lack of significant cross-loadings, supporting unidimensionality. In addition, Cronbach Alpha values of each sustainability dimension were bigger than 0.80, which supports internal consistency. *Internal validity* was ensured by checking the non-response bias statistically and entering control variables in the models to master their effect. *External validity* is strongly related to the generalizability of the results (Easterby-Smith et al., 2002). The generalizability was ensured by selecting the sample in way that well represents the target group. Thus, the lack of non-response and common method biases increases the generalizability of the results.

The dependent variable, open sustainability, was checked for validity with the same procedure as the single item measures above. In addition, the reliability of the open sustainability construct is supported with a Cronbach's Alpha of 0.803.

5.4 Bias

The existence of non-response bias was checked with an analysis of the variance test. As those who were among the last to respond can be assumed most closely resembling non-respondents (Armstrong and Overton, 1977), the answers of the last respondents to those who responded in the first round were compared. The results indicated no significant differences (at the 5 percent significance level) between the first and last respondents regarding study items (the items of open sustainability and sustainability factors). Therefore, it is confirmed that non-response bias did not cause problems and the responses are well representative of the whole.

Common method biases were reduced using procedural remedies, as required when one respondent from each company is used (Podsakoff et al., 2003). The survey was anonymous,

which reduced the respondents' behaviors to edit their responses to be more socially desirable. The respondents were also instructed to fill the survey as honestly as possible in the cover letter. In addition, attention was paid to the wording and clarity of the items, as one way to decrease common method biases is careful construction of the items. Besides procedural techniques, Harman's single-factor test was used to statistically test common method bias. All study items were included in exploratory factor analysis, and the unrotated factor solution was analyzed as suggested by Podsakoff et al. (2003). No significant common method variance exists, because either of the criteria was met, namely formation of one factor from the factor analysis or one factor obtaining the majority of the covariance of the items.

6 Results

A matrix (Appendix 1) was produced from correlation analyses examining whether the constructs behave in a reliable manner shows consistent, significant correlations between the dependent variable (open sustainability) and the independent variables (the factors of the environmental, social, and economic dimensions of sustainability). These findings support the hypothesized relationships between the sustainability factors and open sustainability.

In hypotheses testing using linear regression analysis and computing variance inflation factors, the resulting values are significantly less than the cutoff value of 10, suggesting the absence of multicollinearity problems. The analyses presented in Table 3 show that all three hypotheses are supported by the data. In Model 1, the studied background variables (company size and operation type) do not influence the intention to exploit open sustainability. Model 2 presents the regression results for the relationship between open sustainability and the environmental dimension factors. The model is significant, and the included variables explain 20.2 percent of open sustainability. Model 2 shows that the more important a company considers hygienic factors and energy consumption, the higher their intention to exploit open sustainability. Model 3 presents the analyses of the relationship between open sustainability and the social dimension factors. The model is significant, and the included variables explain 17.6 percent of open sustainability. Model 3 confirms that the more important a company considers the ease of material handling, the higher their intention to exploit open sustainability. Model 4 presents the analysis results for the relationship between open sustainability and the economic-dimension factors. The model is significant, and the included variables explain 25.3 percent of open sustainability. Model 4 confirms that the more important a company considers cost reduction and new business creation, the higher their intention to exploit open sustainability.

Table 3. Regression results for open sustainability

	β	**SE**	**St. β**	**t**	**R**	**R^2**	**Adj. R^2**	**SE**	**F**
1. Constant	4.835	.639		7.565	.049	.002	-.014	1.70202	.150
Size	.026	.276	.009	.095					
Type of operation	-.156	.286	-.050	-.547					
2. Constant	1.522	.997		1.527	.449	.202	.145	1.58753	3.568***
Size	.191	.271	.063	.703					

Type of operation	-.198	.276	-.063	-.718					
Nutrient cycling	-.171	.196	-.161	-.872					
Commitment to environmental causes	.059	.198	.052	.296					
Waste management	-.262	.212	-.234	-1.237					
Hygienic factors	.413	.173	.373	2.390*					
Energy consumption	.564	.170	.406	3.315***					
Land occupation	-.074	.156	-.065	-.473					
3. Constant	.634	1.135		.559	.420	.176	.125	1.59247	3.457**
Size	.095	.268	.031	.354					
Type of operation	.004	.282	.001	.014					
Ease of material handling	.348	.160	.229	2.179*					
Social recognition	-.055	.181	-.047	-.301					
Job creation	.301	.155	.259	1.938					
Health and safety	.035	.176	.034	.200					
Human capital development	.006	.152	.005	.038					
4. Constant	-.321	1.006		-.319	.503	.253	.214	1.50518	6.488***
Size	.067	.248	.022	.270					
Type of operation	-.113	.263	-.036	-.428					
Cost reduction	.506	.160	.340	3.155**					
Income	-.018	.167	-.013	-.106					
Indirect jobs	-.014	.166	-.012	-.085					
New business	.363	.157	.309	2.313*					

Sign. *** ≤ 0.001, ** 0.001 < p ≤ 0.01, * 0.01 < p ≤ 0.05

These results are deepened by conducting mediation analyses followed by the causal steps approach of Baron and Kenny (1986). This approach concludes that mediation can be tested by estimating three regression analyses as follows: first, checking the effect of the independent variable on the dependent variable; second, checking the effect of the independent variable on the mediator; and third, checking the effect of both the independent variable and the mediator on the dependent variable (Baron and Kenny, 1986). The found mediation effects are presented next. The analyses are shown in Appendices 2 to 4 and summarized in Figure 2.

First, the mediation effects between energy consumption and open sustainability are presented. In Model 5, energy consumption affects open sustainability and the included variables explain 14.4 percent of open sustainability. In Model 6, energy consumption is shown to affect new business creation and the included variables explain 22.9 percent of new business creation. In Model 7, energy consumption is shown to affect cost reduction with 21.4 percent of the variance explained. Finally, Model 8 explains 26.4 percent of open sustainability, showing that both new business creation and cost reduction affect open sustainability. However, in Model 8 energy consumption has no effect on open sustainability. Thus, all the conditions of mediation hold and it can be concluded that energy consumption influences open sustainability through its effects on new business creation and cost reduction.

Second, the mediation effects between the ease of material handling and open sustainability are presented. In Model 9, the ease of material handling affects open sustainability and all the

included variables explain 13.7 percent of open sustainability. In Model 10, the ease of material handling is shown to affect new business creation and the included variables explain 11.2 percent of new business creation. In Model 11, the ease of material handling is shown to affect cost reduction and the included variables explain 31.8 percent of new cost reduction. In Model 12, with 26.3 percent of variance explained, the ease of material handling has no effect on open sustainability, while both the new business creation and cost reduction affect open sustainability. Thus, all the conditions of mediation hold and it can be concluded that the ease of material handling influences open sustainability through its effect on new business creation and cost reduction.

Third, the mediation effects between hygienic factors and open sustainability are presented. In Model 13, hygienic factors affect open sustainability. Together, the included variables explain 10.8 percent of open sustainability. In Model 14, hygienic factors are shown to affect the new business creation and the included variables explain 15.1 percent of new business creation. In Model 15, hygienic factors are shown to affect cost reduction with 23.2 percent of the variance explained. Model 16 explains 25.8 percent of the variance of open sustainability and shows that hygienic factors have no effect on open sustainability while new business creation and cost reduction do affect open sustainability. Thus, the conditions of mediation hold and it can be concluded that hygienic factors influence open sustainability through their effects on new business creation and cost reduction.

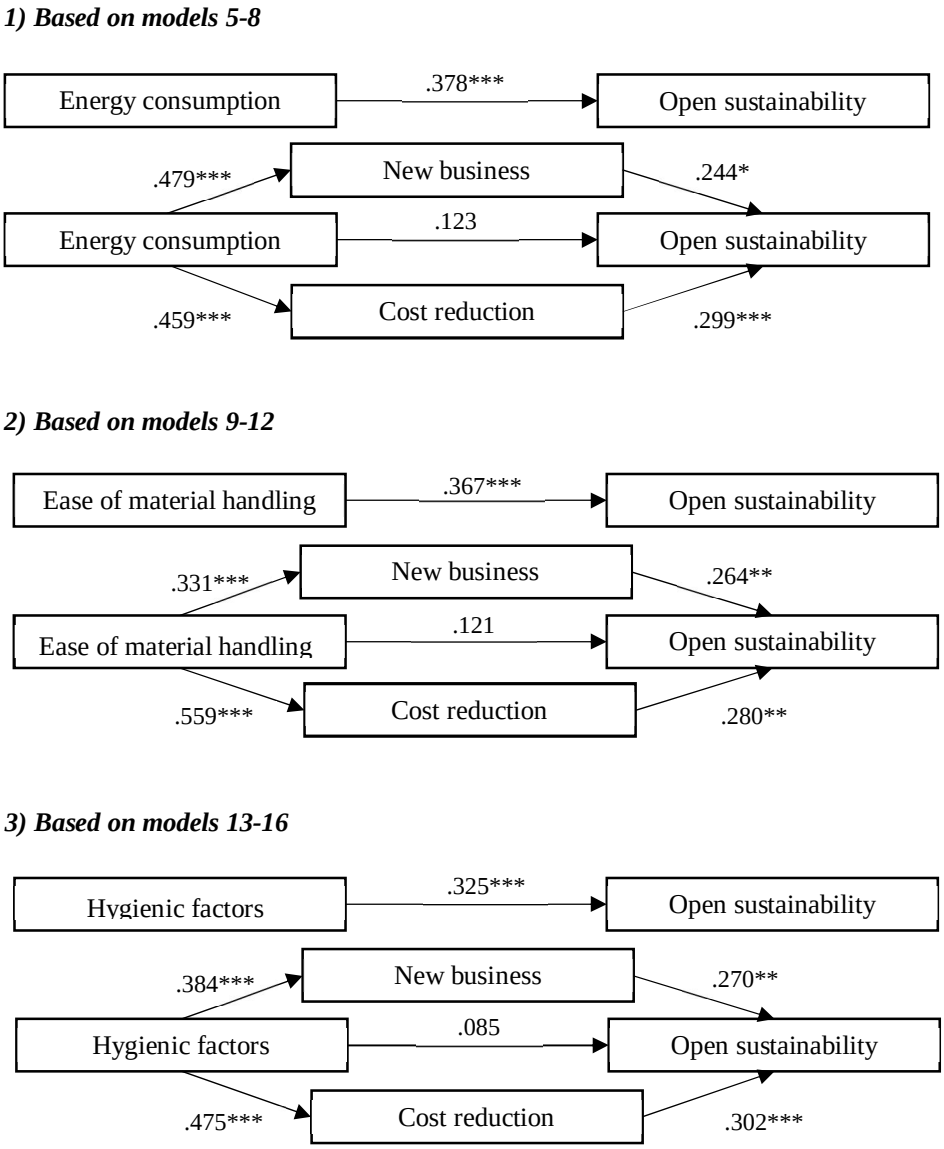

Figure 2. Mediation effects.

7 Discussion

The most novel insight in the findings is that, in addition to cost reduction, new business creation is a significant economic factor driving open sustainability. Previously, studies have most frequently proposed cost savings as the main driver of sustainable innovations (e.g., Horbach et al., 2012; Horbach et al., 2013; Del Río et al., 2015; Lee, 2015; Hojnik and Ruzzier, 2016; Lioutas and Charatsari, 2018). For example, Hojnik and Ruzzier (2016) asserted that cost savings drive environmental R&D investments and product, process, and organizational eco-innovation. The heavy focus on cost savings might arise because innovation activities are conducted within a small group of operators with the aim to solve a single problem. This study, in contrast, defines open sustainability as the systematic encouragement and exploration of a wide range of internal and external sources in the development of environmentally, socially and economically sustainable technologies, services, business models, and other initiatives. In

line with this comprehensive definition of open sustainability, new business creation can also be considered an ambitious, forward-looking driver. This study thus supports the findings of Schaltegger et al. (2016) that highlighted the exploration and exploitation of market opportunities enabled by innovative business models.

Among the environmental factors motivating companies to exploit open sustainability, the most significant are hygienic factors and energy consumption. This might occur because reducing energy consumption is has more business potential than other studied environmental factors when operating in open sustainability environments. Amid the social factors possibly motivating companies to exploit open sustainability, the only significant factor is ease of material handling. A possible explanation is that, in agricultural-related industries, material handling is often a tedious task requiring special expertise. This difficulty encourages intentions to create synergy with other operators in open sustainability activities, such as new, collaborative services and technologies. Many studies identify human capital development, collective learning, and support of information flows as important drivers of green innovation (Chen, 2008; Galdeano-Gómez et al., 2013; Del Río et al., 2015; He et al., 2016; Huang et al., 2016), so there insignificance in this study is surprising. It is possible that the focus on human capital development is more present in environmental factors rather than it is in new possibilities for business and sustainability enabled by open sustainability.

To avoid over-interpretation of economic factors, mediation analysis was carried out. The results indicate that energy consumption, ease of material handling, and hygienic factors all influence intentions to exploit open sustainability through their effects on new business creation and cost reduction. This insight is remarkable and provides a new starting point when discussing the drivers for open sustainability.

It is important to compare the findings against prior research on sustainable drivers and open sustainability, as well as small businesses and the horse industry. First, it can be asked why energy consumption, the ease of material handling, and hygienic factors were significant in the first place. As in other European countries, the location of horse industry companies has moved from the countryside to urban areas in Finland in recent decades, causing more sustainability and environmental challenges (Liljenstolpe, 2009). This causes problems for both hygiene and manure handling. The handling of this issue in turn results in additional costs. Solving these problems in a new way may provide new businesses, which will lead on increased revenue instead of additional costs. Regarding energy consumption in the urban horse industry, where material handling and hygiene are seen as problematic (Liljenstolpe, 2009), investment in small- or large-scale biogas plants or incinerators may be the only reasonable solution. This may lead to new businesses in terms of energy sales, or costs reduction when energy is used on the equine facilities. Although Del Río et al. (2015) and Horbach et al. (2012) suggested that energy and material cost reductions are drivers for product and process eco-innovation, the findings of this study showed them as mediating factors between the intention to exploit open sustainability and energy consumption, ease of material handling, and hygienic factors.

Second, it is essential to discuss why, exactly, the above-mentioned factors explain the intention to exploit open sustainability. Compared to non-significant factors like human capital development or social recognition, energy consumption, ease of material handling, and hygienic factors are all somewhat tangible and need a variety of resources and knowledge. This indicates that small businesses that deal with tangible problems have to search for new business opportunities through external collaboration (cf. Chesbrough, 2003; Ganzerla et al., 2014). The study thus suggests that, in small businesses in the horse industry that operate with tangible issues, participation in open sustainability initiatives is reasonable when it is defined as the systematic encouragement and exploration of a wide range of internal and external sources in the development of environmentally, socially and economically sustainable technologies, services, business models, and other initiatives (Chesbrough, 2003; Laperche and Picard, 2013; Ganzerla et al., 2014; Sáez-Martínez et al., 2014; Sousa-Zomer and Cauchick Miguel, 2018). By exploiting open sustainability, it is possible to overcome the challenges that hinder the inclusion of sustainability in small businesses, such as deficiency in capital, knowledge, or skilled labor (Bos-Brouwers, 2010; Lewis and Cassells, 2010). It has also presented that in small businesses, the environmental investments can be seen as costs that are not transferable to customers (Simpson et al., 2004), and the small businesses working in the tangible sector and getting financial support are most likely to engage in environmental practices (Hoogendoorn et al., 2015). Participating in open sustainability can also advance these issues in terms of sharing knowledge, risks, and costs, as well as to co-invest and collaborate in the development of sustainable solutions.

8 Conclusions

8.1 Contribution to theory

The purpose of this study is to examine whether various sustainability factors are related to small- and medium-sized companies' intentions to exploit open sustainability. From a theoretical perspective, this study defines open sustainability as the systematic encouragement and exploration of a wide range of internal and external sources in the development of environmentally, socially and economically sustainable technologies, services, business models, and other initiatives. The sustainability factors that drive small businesses toward open sustainability initiatives are presented from the triple bottom-line perspective.

In the economic dimension, it is confirmed that the more important a company considers new business creation and cost reduction, the more likely the company is to exploit open sustainability. In the environmental dimension, the models show that the more important a company considers energy consumption and hygienic factors, the more likely the company is to exploit open sustainability. In the social dimension, it is confirmed that the more important a company considers ease of material handling and new job creation, the more likely the

company is to exploit open sustainability. The study also finds that, in the context of the horse industry, company size and operation type do not influence open sustainability initiatives.

Furthermore, the results of mediation analysis indicate that energy consumption, ease of material handling, and hygienic factors all influence the intention to exploit open sustainability in small businesses through their effects on new business creation and cost reduction. This indicates that environmental and social factors can also generate financial value. The intention of small businesses to exploit open sustainability can be considered significant when the drivers relate to some tangible resource, like capital. To make progress in energy consumption, ease of material handling, and hygienic factors, a variety of resources are needed that can be achieved and divided by exploiting open sustainability. The small businesses in horse industry, especially in the urban environment, operate in a tangible sector, and participation in open sustainability is a sensible option.

8.2 Managerial implications

Regarding managerial implications, this study increases understanding of how individual sustainability factors drive companies toward open sustainability. In practice, the study suggests that, from the triple bottom-line perspective, each sustainability dimension includes individual factors that drive companies toward open sustainability. Small businesses' movements toward open sustainability are therefore affected by more than economic or environmental reasons. Based on this understanding, practitioners and different stakeholder groups in the horse industry need to pay attention to all three sustainability dimensions when developing open sustainability initiatives. Based on the mediation analysis, it can be stated that energy consumption, ease of material handling, and hygienic factors are connected to cost reduction and new business creation, as well as the intention to exploit open sustainability. Practitioners can thus pay attention to these connections when developing and adapting open sustainability initiatives. From a practical point of view, small businesses in the horse industry (and other agricultural related industries) can find balance between different sustainability dimensions when adapting open sustainability initiatives, such as joint investments in biogas plants or services solving manure-handling problems. In this way, it is possible to generate new businesses and cost reduction while also reducing energy consumption, improving hygiene, and facilitating material handling.

8.3 Limitations and avenues for future research

Regarding limitations, data were gathered from one specific industry, so generalizing the results to other industries requires further research. One practical restriction was that the data had to be collected from a sample of 580 companies. Non-response biases were checked and the selected companies had good prerequisites to answer the survey. When considering these issues, it can be assumed that the results reflect the whole population quite well. The results were also gathered from one Northern Europe country, and the drivers of open sustainability

in other countries might differ. Thus, specific country characteristics need to be taken into account when applying the results in practice or in further research. The cross-sectional nature and use of perceptual data are other possible limitations of the research. Although perceptual data is extensively used in business studies, this can cause errors when a key informant approach is utilized. The key informant approach of this study creates the risk of potential limitations from common method bias. These biases were checked with both statistical and procedural techniques. In addition, these limitations were tempered by paying attention to theoretical arguments rationalizing the analyzed relationships. Future studies could address these limitations when developing theoretical and empirical understandings of the concept of open sustainability.

Overall, as a mainly unexplored research area, the concept of open sustainability requires further research. This study presents only one instance of the concept of open sustainability, indicating the need for more research on its elements or dimensions. In addition, future research could also examine other factors that might drive companies toward open sustainability initiatives. Many factors and dimensions of sustainability were not found to have a direct relationship with open sustainability, meaning there may be other factors that moderate or mediate the relationship. Further studies should identify these factors so they can be defined more precisely.

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APPENDIX 1. Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Nutrient cycling	1.000															
2. Commitment to environmental causes	.832***	1.000														
3. Waste management	.737***	.805***	1.000													
4. Hygienic factors	.596***	.699***	.815***	1.000												
5. Energy consumption	.528***	.526***	.634***	.569***	1.000											
6. Land occupied	.713***	.683***	.695***	.631***	.670***	1.000										
7. Ease of material handling	.329***	.454***	.506***	.509***	.488***	.434***	1.000									
8. Social recognition	.515***	.618***	.578***	.596***	.579***	.560***	.436***	1.000								
9. Job creation	.481***	.506***	.561***	.526***	.504***	.430***	.408***	.573***	1.000							
10. Health and safety	.438***	.595***	.618***	.681***	.582***	.515***	.462***	.721***	.643***	1.000						
11. Human capital development	.584***	.599***	.618***	.546***	.511***	.518***	.365***	.698***	.684***	.674***	1.000					
12. Cost reduction	.171*	.219*	.295***	.413***	.400***	.345***	.516***	.321***	.285***	.359***	.150	1.000				
13. Income	.248**	.255**	.245**	.362***	.379***	.389***	.484***	.325***	.381***	.316***	.203*	.742***	1.000			
14. Indirect jobs	.385***	.420***	.474***	.485***	.476***	.429***	.360***	.541***	.757***	.560***	.561***	.361***	.576***	1.000		
15. New business	.421***	.420***	.466***	.417***	.529***	.433***	.322***	.526***	.670***	.550***	.549***	.292***	.502***	.794***	1.000	
16. Open sustainability	.126	.154	.214*	.323***	.362***	.214*	.369***	.289***	.373***	.333***	.265**	.412***	.407***	.377***	.436***	1.000

APPENDIX 2. Mediation analyses for energy consumption and open sustainability

	β	SE	St. β	t	R	R^2	Adj. R^2	SE	F
Dependent: open sustainability									
5. Constant	1,541	,968		1,592	,379	,144	,122	1,60894	6,600***
Size	,154	,267	,050	,575					
Type of operation	-,201	,274	-,064	-,731					
Energy consumption	,525	,119	,378	4,412***					
Dependent: new business									
6. Constant	2,355	,757		3,112	,478	,229	,210	1,29317	12,261***
Size	,200	,211	,077	,949					
Type of operation	-,208	,220	-,076	-,944					
Energy consumption	,548	,091	,479	6,021***					
Dependent: cost reduction									
7. Constant	3,564	,624		5,713	,462	,214	,194	1,06606	11,139***
Size	-,011	,174	-,005	-,061					
Type of operation	,074	,184	,033	,404					
Energy consumption	,432	,076	,459	5,695***					
Dependent: open sustainability									
8. Constant	-,745	1,044		-,714	,514	,264	,232	1,49329	8,267***
Size	,096	,249	,032	,387					
Type of operation	-,129	,260	-,041	-,495					
Energy consumption	,170	,136	,123	1,255					
New business	,287	,110	,244	2,623*					
Cost reduction	,445	,131	,299	3,399***					

APPENDIX 3. Mediation analyses for the ease of material handling and open sustainability

	β	SE	St. β	t	R	R^2	Adj. R^2	SE	F
Dependent: open sustainability									
9. Constant	1,156	1,052		1,098	,370	,137	,115	1,60873	6,293***
Size	,087	,265	,029	,330					
Type of operation	-,133	,274	-,042	-,486					
Ease of material handling	,563	,131	,367	4,305***					
Dependent: new business									
10. Constant	3,190	,857		3,723	,334	,112	,090	1,38275	5,237**
Size	,099	,223	,038	,444					
Type of operation	-,140	,235	-,051	-,596					
Ease of material handling	,402	,103	,331	3,907***					
Dependent: cost reduction									
11. Constant	2,628	,614		4,282	,564	,318	,301	,99008	19,270***
Size	-,051	,160	-,024	-,320					
Type of operation	,146	,171	,065	,857					
Ease of material handling	,556	,074	,559	7,521***					
Dependent: open sustainability									
12. Constant	-,855	1,073		-,797	,513	,263	,231	1,48863	8,275***
Size	,082	,245	,027	,334					
Type of operation	-,100	,258	-,032	-,389					
Ease of material handling	,184	,146	,121	1,263					
New business	,311	,102	,264	3,041**					
Cost reduction	,417	,138	,280	3,019**					

APPENDIX 4. Mediation analyses for the hygienic factors and open sustainability

	β	SE	St. β	t	R	R^2	Adj. R^2	SE	F
Dependent: open sustainability									
13. Constant	2,966	,797		3,722	,329	,108	,086	1,63541	4,806**
Size	-,011	,269	-,004	-,042					
Type of operation	-,153	,279	-,049	-,549					
Hygienic factors	,359	,096	,325	3,753***					
Dependent: new business									
14. Constant	3,976	,648		6,133	,388	,151	,130	1,35191	7,401***
Size	,026	,218	,010	,121					
Type of operation	-,160	,230	-,058	-,695					
Hygienic factors	,350	,075	,384	4,662***					
Dependent: cost reduction									
15. Constant	4,410	,505		8,731	,482	,232	,214	1,05052	12,497***
Size	-,149	,169	-,071	-,882					
Type of operation	,125	,181	,055	,688					
Hygienic factors	,353	,058	,475	6,032***					
Dependent: open sustainability									
16. Constant	-,385	,995		-,387	,508	,258	,226	1,49348	8,070***
Size	,055	,246	,018	,224					
Type of operation	-,108	,259	-,034	-,418					
Hygienic factors	,093	,102	,085	,913					
New business	,317	,104	,270	3,065**					
Cost reduction	,450	,133	,302	3,380***					