Article

Road to Sustainability: University–Start-Up Collaboration

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Abstract: Considerations on sustainability have growing attention not only for scholars and businesses, but also for almost everyone. However, accomplishing sustainable progress is complicated and cannot be completely reached by single individuals or organizations. Consequently, entrepreneurs striving for sustainable change might search for collaborations with universities to overcome their resource and technology constraints. A quantitative research method was employed to explore the value of such collaborations. Data were gathered via questionnaires, between February and March 2020, from entrepreneurs/start-ups that are spin-offs of the ten leading higher education institutions in Berlin and Brandenburg (Germany). Correlation and logistic regression disclosed that start-ups with different sustainability goals employed dissimilar formats of collaboration with universities. Ecological-oriented entrepreneurs tend to utilize all three forms of university–start-up collaboration. On the contrary, social-driven start-ups are not likely to adopt any kind of collaboration with universities. While ventures with economical SDGs are prone to employ product and prototype development along with support from professors. The study extends the knowledge about the search for collaborations of start-ups when pursuing different SDGs. In the practical domain, this research can encourage entrepreneurs to cooperate with universities in order to achieve their sustainable goals beyond incubation and acceleration. Additionally, it can also trigger universities to supply resources for supporting start-ups, especially social-driven ventures, to facilitate them to accomplish sustainability as well as to reach the third mission of universities in terms of supporting society.

Keywords: university–start-up collaboration; open innovation; cooperation; sustainability; sustainable development goals; SDGs

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1. Introduction

According to the Global Footprint Network, we require 1.6 Earths to support humanity's demand on Earth's ecosystem, which means one year and eight months are needed for the Earth to regenerate the natural resources that mankind consumes in a year. In other words, we utilize more environmental resources than nature can reproduce through overconsumption and more waste emission than the biological capacity available, which is not a sustainable way for our future. Consequently, sustainability and sustainable development are in the scholars' and practitioners' attentiveness [1–3] in order to use the resources without, or at least less, affecting the quality and well-being of future generations [4]. However, achieving sustainability is not as straightforward as a trading off between the positive impacts in one domain and the negative impacts in another. It requires simultaneous development in the following three dimensions: economic, social, and environmental, and these three areas are interlinked with each other. As such, the organizations that aim to pursue sustainability often experience a dearth of internal resources and capability, especially small- and medium-sized enterprises and start-ups [5–8]. Acquiring external knowledge and resources through open innovation is one possibility to bridge this gap. The companies that adopt open innovation practices not only overcome their constraints, but also enhance their innovativeness and competitive advantage.

Collaboration is one of the well-known approaches in the field of open innovation. Various forms of collaboration have been implemented, such as R&D consortia, strategic partnership, university–industry collaborations or more specifically university–start-up collaborations, and government–industry collaborations [6,9]. Considering universities as sources of knowledge [10,11] and technology capabilities [12], firms tend to cooperate with universities in order to fulfill their inadequate resources, enhancing the possibility to access novel technology and a broad array of research expertise [13], and acquiring talent [14] particularly towards solving sustainability challenges. Not only do companies obtain advantages from collaboration, but also universities. Academia gains benefits from expanding the practical implementation of knowledge, growing the number of contacts with the business world [15], accessing state-of-the-art equipment, and enlarging educational experiences, which in turn increases the reputation and recognition of the universities [16–18]. Nonetheless, the studies examining university–start-up collaboration as a pathway to sustainability are scarce, especially in large-sample quantitative research. Our research responds to the call from Nave and Franco [15] for investigating the quantitative data analysis of companies that formed cooperation relationships with universities as a result of aiming to implement sustainable practices. The purpose of this paper is to analyze the association of university–start-up collaboration in the context of pursuing sustainable development goals—SDGs. Our research revealed that entrepreneurs with different sustainability goals embraced different forms of collaboration with universities. Environmental-driven entrepreneurs tend to cooperate with universities in all three collaboration formats that the universities provide. This is in contrast with social-oriented entrepreneurs, who do not implement any collaboration approaches with universities. While start-ups focusing on economic sustainability tend to adopt product and prototype development as well as relying on support from professors in pursuing their sustainability. The study contributes to the literature regarding university–industry (start-up) collaboration and builds upon the theory of self-interest. From the theoretical aspect, the study enhanced the knowledge on university–industry collaborations by particularly focusing on start-ups and sustainability. From a practical perspective, the study might encourage entrepreneurs to collaborate with universities in order to achieve their sustainable goals besides incubation and acceleration. Universities can better contribute to regional and national socio-economic growth by sharing resources and knowledge with the industry, especially in the area of sustainability. Furthermore, the findings revealed the universities' opportunities to assist entrepreneurs to reach their goals, especially social-oriented start-ups, taking the university one step closer to achieving its third mission. The paper is outlined as follows: First, the literature review on sustainability and collaboration, the relation/impact of collaboration on each sustainability pillar as well as the theoretical background will be revealed from prior studies. After, the research method, data collection and analysis are demonstrated. Next, the findings are disclosed and discussed. The final conclusions, practical implications, limitations and areas of opportunities of future research are portrayed in the last part.

2. Literature Review

2.1. Sustainability: Sustainable Development Goals

The negative environmental and social consequences of economic growth and globalization impact the world's limited resources and people's well-being. Therefore, sustainability concerns are growing interest, not only for academia and business, but also around the globe [1,19]. Extant studies on sustainability are assorted in terms of topics, and they not only focus on environmental problems, for example, the definition of sustainability [20], sustainability transition [21], responsible production for sustainability [22], sustainability assessment [23,24], sustainability in e-commerce packaging [25], and sustainability innovations and firm competitiveness [26]. Even though the history of sustainability has been concerned alongside human history, the increase in the consideration of this concept appeared in the late 20th century [27]. Particularly, after the World Commission on

Environment and Development (WCED) published the “Our Common Future” report in 1987, which was aiming to guide the principles for sustainable development. According to the report, sustainable development is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [4] (p. 37), which highlights that society should not use the resources more than they can be reproduced. In 2015, the United Nation General Assembly emphasized the importance of this topic by approving the 17 sustainable development goals (SDGs) as the blueprint to achieve global sustainability. Thereafter, the amount of literature regarding sustainable development and sustainability grew exponentially [3]. Some studies utilized sustainability and sustainable development as interchangeable terms [27,28]. However, the authors follow Shaker [29], who stated that sustainability refers to the target of humanity to achieve homeostasis or human ecosystem equilibrium. Whereas sustainable development is an integrated approach and processes that ultimately contributes to sustainability.

Despite the fact that several organizations in both developed and developing countries are adopting the SDGs, accomplishing it faces various challenges in practice such as the scarcity of resources and financing, translating it into local contexts [3], different stakeholders’ expectations alignment, delineating and evaluating the sustainability performance [19]. These complex challenges cannot be overcome by a single organization. Thus, sustainable development requires collaboration from all stakeholders [3,30,31].

2.2. Open Innovation: Collaboration

In the fiercely competitive world, open innovation plays an essential role as the means to establish a competitive advantage for organizations [32–35]. Solely internal resources and internal innovations are not sufficient. The rapid changing of customer requirement, environmental turbulence, and market heterogeneity forces companies to pursue a flexibility and agility strategy apart from innovativeness. Nonetheless, companies may not possess all of the essential resources and knowledge. As a result, they are seeking external ideas and resources in order to complement their internal knowledge to outperform their competitors. There are several approaches for open innovation, and collaboration is one of them, which has been growing in scholars’ and practitioners’ attention for decades [36–38]. The ability to facilitate finding novel solutions by leveraging other organizations resources and competences, together with the internal capabilities to create customer value, leads to the enhancement of the organizational dynamic capabilities and to achieving a competitive advantage [38–41].

Researcher interests in collaboration have been diversified and divergently interpreted, which can be seen from various disciplines, for example, management [31,42], education [11,15,17], medicine [43,44], organizational behavior [45–47] and environmental science [8,11,48]. As well as across industries such as healthcare [49,50], tourism [51,52], agriculture [53,54], software [55,56] and automotive industry [57,58]. Moreover, the collaboration between firms and different participating units has been broadly studied, for instance, with the customer [59,60], supplier [46,61,62], multi-stakeholders [37,63–65], business [66–68], citizen [69–71], university [15,38], public sector/government [72–75], and even with their competitors [76,77]. As well as collaboration implementation in various aspects such as for new product development [61,78], technology [79,80] and knowledge transfer [11,81], as a means for sustainability [31,37,48,82], and as a pathway for competitive advantage and dynamic capability [38–41,60].

Although the term collaboration is widely utilized among researchers, an exact definition has not reached a consensus yet [39]. Collaboration is expansive in its application, varying from tangible to intangible depending on the level of participation, ranging from customer feedback to actively participating in the design and production process [83], as well as ranging from an informal agreement to a contract-based agreement [84]. Wood and Gray [85] summarized nine research-based articles and defined collaboration as “collaboration occurs when a group of autonomous stakeholders of a problem domain engage in an interactive process, using shared rules, norms, and structures, to act or decide on issues

related to that domain" [85] (p. 146). However, they argued that their definition still lacks some clarification, such as how many stakeholders should participate, the duration of the collaboration, and the nature of the outcome. Thomson et al. [86] followed the call of Wood and Gray [85] by using structural equation modeling analyzing a multidimensional model of collaboration, and they suggested that "Collaboration is a process in which autonomous or semi-autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together; it is a process involving shared norms and mutually beneficial interactions" [86] (p. 25). According to the commonality of the definitions, the authors adopt the broad definition of collaboration as an iterative and integrative process in which two or more entities actively and mutually participate in joint activities aiming to achieve common goals [39] by balancing the entities' self-interests and their mutual interests. This engagement benefits the organization in ways that cannot be accomplished by working alone.

2.3. Achieving Sustainable Development Goals through Collaboration

As stated in SDG 17, partnerships for the goals are encouraging collaboration across sectors as well as across countries. No single actor can perfectly achieve sustainable development goals, even within this particular SDG [31], because sustainable development is a complex task that requires joint force not only from internal capabilities, but also with external actors to overcome the organizational constraints. A growing body of extant research regarding collaboration as a factor to foster sustainable development has emphasized the importance of the cooperation approach. Johnson [6] mentioned that numerous patterns of collaborations contribute benefit to the creation and transfer of knowledge and expertise across cooperating partners on sustainable development [15]. Chaudhuri and Kendall [54] discovered collaborative practices among the Development Research Communication and Services Center (DRCSC), which is a non-governmental organization including small-holder farmers, and the information system technical experts that generate weather information systems in order to disseminate agrometeorology advisory such as the weather forecast and agricultural advice to small-holding farmers in West Bengal, India. This organization assists farmers to effectively utilize external expertise, convert and combine them with local relevant knowledge, and apply them in a new way in their everyday practices. These local capabilities are crucial to build a resilient agricultural system and pave the way for sustainable development goals. While Veleva and Bodkin [67] reported that the number of firms that cooperate with entrepreneurs to reduce waste and advance product reuse is increasing, despite the lack of federal mandates in the U.S. They suggested that in the collaboration between companies and entrepreneurs, knowledge, technology and strategic partnership are important factors to reduce financial costs, energy, time, environmental impacts and resources, which facilitate the creation of viable business models. Feng et al. [46] investigated 206 manufacturing companies in China and found out that by increasing the level of information sharing, the green supplier collaboration (GSC) positively affects the firm performance, both the financial and environmental performance. The study reveals that implementing GSC can assist firms to acquire more information and resources from the supplier for the collective environmental goal. The result from the study of Grekova et al. [87] confirms that inter-firm environmental collaboration increases the firms' performance. Environmental collaboration with suppliers is directly associated with cost savings, but is not related to the market gains of Dutch food and beverage processors. Conversely, environmental cooperation with customers provides an indirect effect on the firms' performance by implementing sustainable process improvements, which lead to cost savings and market gains.

Due to the development of concepts, existent studies of collaboration for sustainable development emerge in different sectors such as a public–private partnership, private–private collaboration, and academia–industry cooperation. Undoubtedly, the collaboration between the firms and universities is not a new topic. It has been in scholars' attention for

decades [17,38], in terms of considering universities as important sources of knowledge. In addition, both the firm and the university gain reciprocal benefits, enabling them to accelerate innovation [88] and promote knowledge to the community through knowledge and technology transfer [12]. From the firm's point of view, companies profit from several aspects such as novel knowledge transfer, licensing, and patents [89], which can be implemented into new product and service development, and overcome resource constraints. As a consequence, firms acquire a competitive advantage [38] that fosters business growth [16]. From the university perspective, universities benefit from external funding as complementary resources to fund academic staff, equipment, laboratories as well as students [13]. Moreover, universities improve the quality of teaching and research through utilization, gather new ideas for future research from application feedback, and ultimately enhance the institutions reputation and recognition [16–18].

A university–start-up collaboration can occur in several formats. Frølund, Murray and Riedel [90] provided the example of university–industry forms such as R&D cooperation, consortia membership, student hackathons, and collaboration on publicly funded research. Nsanzumuhire and Groot [91] reported, from their systematic literature review from the context perspective of university–industry collaborations, that the majority of the cooperation they found are publication, patent and license, R&D joint project, contract research, consultancy, students and staff training, conference and meetings, and spinoff. Furthermore, research from the EU experts disclosed that R&D collaboration, mobility of students, and consulting are the most frequent forms of collaboration between universities and industry from a business point of view [14]. The collaboration channels that organizations apply depends on the goals that they aim to accomplish. Contract research could be appropriate for firms that focus on short-term and gradual problem solving. While student-oriented activities, such as competitions, hackathons and internships, are suitable for companies targeted for talent search because these activities are an opportunity for them to identify highly qualified potential employees. In the case of major challenges, various forms are combining as the best practices, which can be acquired from the public call for research proposals [90]. De Fuentes and Dutrénit [92] discovered that while all four channels of academia–industry interaction, namely, information and training, R&D projects and consultancy, intellectual property rights, and human resources, are necessary for acquiring collaboration benefits, they have different effects on each type of benefit. The short-term benefits of companies are related to an improvement in quality whereas the long-term benefits are linked to the enhancement in knowledge, which contribute to the novel ideas for R&D projects, or are associated with the increase in the absorptive capabilities of firms. Contract R&D, joint R&D, and consultancy are essential for the R&D capability building benefits, followed by technology licenses, patents, and the recruiting of recent graduates, all of which improve the firms' innovativeness and productivity.

From a theoretical perspective, start-ups are inherently self-interested in pursuing their (sustainable) goals, such as their search for collaborations with actors that possess high levels of resources. Universities are actors that possess human resources by having very knowledgeable staff and students, and also technological resources. Moreover, universities also possess social capital, which can be defined as a “sum of the resources, actual or virtual, that accrue to an individual or group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition” [93] (p. 119). By using this social capital, entrepreneurs expect to get a return on their investment in the form of opportunities that they can exploit and benefit from [94]. In the case of a university–start-up collaboration, the theory of mutual interest and collective action might be applied in specific cases where a network of partners work together on an R&D project with clearly defined goals. The theory is based upon the assumption of “mutual interests and the possibility of benefits from coordinated action” [95] (p. 2) the network actors can get from the joined project. There are many joint university–start-up projects that underly this logic. In education, to bring practical knowledge to students, and in

research, to consortia from academics and practitioners, as stimulated from many political and science institutions.

The self-interest of start-ups in seeking sustainability can be classified into the following three groups based on the triple bottom line: economic, environmental and social. The economical-driven start-ups are mainly focusing on their financial gain and benefit in the economic domain. The entrepreneurs, who aim to pursue environmental sustainability, are centering around the ecological issues more than other aspects. While the social-oriented start-ups envision society as the prominence of their business besides the economic sustainability they try to achieve. As aforementioned, accomplishing those sustainable goals is complicated, no single entity can achieve it alone [31]. Therefore, an option is a collaboration with universities in order to search for external knowledge and resources to complement their capabilities. The universities provide several forms of collaboration [38,90,91]. However, the start-ups adopt collaboration patterns that are consistent with their interest, and facilitate them to achieve their goals. Consultancy with experts provides the firms with advice, information, or technical services that lead to novel ideas to overcome their constraints [38]. This cooperation could expand to a joint R&D project that enhances the firms competitive advantage by developing innovative solutions such as products, processes, and services, as well as increasing productivity [92]. Whereas, the mobility of students, such as doing a thesis and internship with a company, is an opportunity for start-ups to leverage talented people and an effective way for transferring knowledge [38].

Based on the research from Davey et al. [14], we focus our analysis on the following three resources of a university–industry collaboration, namely, (1) product/prototype development as an R&D collaboration; (2) expert advice from professors as a consulting service; and (3) student engagement as a student mobility option. The following section differentiates between the three pillars of sustainability, namely, social, economic and environmental as proposed by Cagarman et al. [96], and it describes collaboration as a means to achieve each of the pillars directing at the previously mentioned resources (see Figure 1).

Figure 1. Self-interest and university–start-up collaboration.

2.3.1. Collaboration for Economical SDGs

Economically motivated start-ups are primarily concerned with their financial gain and profit in the economic realm. To achieve economic goals, they require various determinants such as funding, innovative ideas and competitive advantages. Therefore, they tend to collaborate with external actors in order to reduce the R&D cost and risk as well as expedite innovation development. Collaboration with universities enables them to overcome their constraints, which can be seen from several studies. According to Dudkowski [38], the university–industry collaboration plays a crucial role in economic growth and innovation by facilitating the commercialization of novel research within companies [81]. Shi et al. [88] investigated 443 innovative firms in China from 2008 to 2011, and found that companies with more collaboration with universities are more likely to have more patents and new products. Motohashi and Tomozawa [97] analyzed the role of the university–industry cooperation in different phases of the technology life cycle (TLC) in order to develop the

innovation of solar cells. They found that companies can directly profit from the universities as the source of new technology in the primary phase of TLC. The patents in this phase are greater in the matter of newness of the invention. Whereas the quality of the patents in the later phase is higher. While Kafourous et al. [98] reported that companies benefit from collaboration with universities, concerning the improvement in competence after overwhelming engagement barriers. Research from Gretsche et al. [99] examined 166 heads of R&D groups from large international corporations, and they reported that university–industry collaboration contributes to a positive relationship with ideation and R&D processes, which in turn leads to more innovative research results; this is in harmony with the study from Wirsich et al. [89] and Mindruta [100]. Higuchi and Yamanaka [101] investigated knowledge sharing between academia and tourism practitioners and found that collaboration provides product, process, marketing, and managerial innovation outcomes to foster sustainable nature-based tourism in Tamamu, Japan. Mueller [102] revealed that the cooperation between the university and industry of the West German regions between 1992 and 2002 supports knowledge transfer in both directions and stimulates regional economic growth, which is in conformity with Lehmann and Menter [103]. From all of the study's results that are mentioned above, firms gain innovativeness, patents, knowledge transfer, new products, services and processes, which consequently contribute to the competitiveness and economic growth of businesses.

Even though the above studies also mentioned the potential downside of the collaboration between universities and firms, such as the engagement barrier [98], enhancing companies' administrative overhead [100], a lower innovative efficiency [88], information asymmetry [104], cultural differences, and sometimes conflicting targets [105], the benefits of adopting cooperation approaches seem to be more captivating for both universities and particularly start-ups. As such, we hypothesize as follows:

Hypothesis 1a (H1a). *Entrepreneurs/start-ups, who aim to pursue economical SDGs, are more likely to collaborate with the university for product/prototype development.*

Hypothesis 1b (H1b). *Entrepreneurs/start-ups, who aim to pursue economical SDGs, are more likely to collaborate with the university for expert support by a professor.*

Hypothesis 1c (H1c). *Entrepreneurs/start-ups, who aim to pursue economical SDGs, are more likely to collaborate with the university to work together with students in internships and theses.*

2.3.2. Collaboration for Environmental SDGs

Ecological considerations are more relevant to entrepreneurs who want to seek environmental sustainability rather than other factors. Environmental issues such as climate change, biodiversity loss, deforestation, and air and water pollution have been in scholars' awareness for decades. However, solving these problems is difficult as they are intricate and intertwined, not only among themselves, but also with economics and social issues. Universities are known as knowledge sources and, as such, the cooperation with universities accelerates innovative technology to solve environmental challenges. Song et al. [106] investigated the efficiency of the industry–university–research collaboration in 30 cities in mainland China from 2009 to 2017. They found that the overall collaborative efficiency has improved and this cooperation can effectively reduce carbon emissions. Hens et al. [107] examined the collaboration between the universities and the production industry, as well as the service sector, in Cienfuegos city, Cuba. The University of Cienfuegos set up a master program on cleaner production, which provided research targeted at several aspects of sustainable development, such as pollution inventory, energy production from local biomass, and sustainability indicators. Furthermore, a center for cleaner production has been established with the purpose to support its master program and research on cleaner production activities. As a result of the collaboration, the air and surface water quality in the province of Cienfuegos was improved. Moreover, the reduction in carbon emissions from a cement plant has been observed. Nave and Franco [15] suggested that a cooperative relationship

between the firm and university contributes to positive outcomes. The university was able to make scientific knowledge available to the business world, while the company found a solution for its environmental concern by transforming the wastewater into gas and utilizing it to heat the boiler. Bas-Bellver et al. [108] demonstrated the successful example of the collaboration between agri-food cooperative and universities to transform vegetable residues (carrot, leek, celery, and cabbage) from the fresh and ready-to-eat lines of the cooperative into functional ingredients by using pretreatment and drying stages. The vegetable waste powders obtained could be beneficial for the food industry as flavoring or coloring ingredients, natural preservatives, as well as improving the nutritional value of processed foods. The study contributes to SDG 12, to be more precise 12.3, in order to diminish food loss and waste, which ultimately reduces environmental pollution. Di Maria et al. [11] studied over 350 university–industry research and consultancy contracts, signed by professors at the University of Padova (Italy) for the period 2008–2012, and suggested that collaborations between academia and industry that are focused on knowledge transfer for environmental sustainability positively impact companies' financial performances. The greater the number of contracts signed, the better the economic performance. Furthermore, the study from Hansen et al. [109] manifested that the number of publications regarding sustainable production of the palm oil industry from 2004 to 2013 has enhanced from 11 to be 713, respectively. This exponential increase reflects the sustainability concern and the collective effort of academia and the palm oil industry. According to the above-mentioned studies, enterprises are solving their environmental problems by collaborating with universities. Hence, our hypotheses are as follow:

Hypothesis 2a (H2a). *Entrepreneurs/start-ups, who aim to pursue environmental SDGs, are more likely to collaborate with the university for product/prototype development.*

Hypothesis 2b (H2b). *Entrepreneurs/start-ups, who aim to pursue environmental SDGs, are more likely to collaborate with the university for expert support by a professor.*

Hypothesis 2c (H2c). *Entrepreneurs/start-ups, who aim to pursue environmental SDGs, are more likely to collaborate with the university to work together with students in internships and theses.*

2.3.3. Collaboration for Social SDGs

Social-oriented start-ups consider society to be the most important aspect of their mission, and they aim to enhance social wealth [110]. Hence, they tend to follow social SDGs. The overall purpose of social SDGs is with regard to people, their ability and willingness to sustain community well-being, and intergenerational justice and equity [111]. The social aspects of sustainability are convoluted by the economic and environmental aspects, due to a person's well-being depending on their economic status as well as the utilization of environmental resources and the environment that they live in. Firms surmount this complexity by implementing cooperation activities with academia. Liang et al. [53] reported that the collaboration of university and industry researchers in China contributes to technological innovations for rice breeding. The super hybrid rice not only provides higher yield and quality in the cultivation, but also resistance to both abiotic and biotic stresses. Moreover, hybrid rice breeding influences several improvements regarding agronomic traits, for example, resistance to lodging, reduced damage from pests and disease, and 15 panicles per plant and an average number of spikelets per panicle of more than 200. This innovation in rice production leads to food security in China, which is related to SDG 2, zero hunger. Another example is from the Department of Food Science and Technology at the Wayamba University of Sri Lanka. The university collaborated with the industrial partners in food industries through its innovation center, and utilized innovative technologies as the solutions for the food industry [112]. The study from Hansen et al. [109] suggested the holistic sustainability research framework on palm oil and mentioned that scholars play an important role in facilitating sustainable production in the palm oil industry by fulfilling knowledge gaps, and creating novel technical and policy-associated solutions. Anttila

and Jussila [113] provided several examples of university–industry cooperation regarding the smart city and university quality performance. Universities foster a transformation to smart cities by offering not only traditional educational means, but also new operational educational modes. The authors mentioned that the advantage of universities over other smart city actors is their involvement of several faculties, and research and development cooperation, which in turns enables them to offer various research teams in different disciplines for smart city projects. For instance, the University of Helsinki provided research and development, collaboration activities, and multidisciplinary knowledge, to the smart city projects, such as artificial intelligence; information technology; 5G mobile communication from the Faculty of Science, the Department of Computer Science; multidisciplinary urban research from the Faculty of Biological and Environmental Sciences; urban geography and regional studies from the Department of Geosciences and Geography; and narratives in urban planning, digital humanities from the Faculty of Arts, the Department of Modern Languages. Aalto University offered three factories, namely, the design factory, health factory and media factory to foster a new form of cooperation among researchers, students, firms and communities. Besides the practical interdisciplinary projects and research in various fields, for example, product development, marketing, intellectual property rights and innovations, Aalto University co-initiated a public–private co-working and co-creation platform called Urban Mill for urban innovations. Since 2013, there are more than 150,000 participants in over 3500 registered events on the platform, and more than 100 prototypes are generated. The authors also suggested guidance of quality management and performance measurement frameworks for the educational sector in order to maintain the high quality and performance excellence of universities. This research reflects SDG 11: sustainable cities and communities, as well as SDG 4: quality education. Taken together, collaborations with the university contribute to the accomplishment of social sustainability. Therefore, we propose the following:

Hypothesis 3a (H3a). *Entrepreneurs/start-ups, who aim to pursue social SDGs, are more likely to collaborate with the university for product/prototype development.*

Hypothesis 3b (H3b). *Entrepreneurs/start-ups, who aim to pursue social SDGs, are more likely to collaborate with the university for expert support by a professor.*

Hypothesis 3c (H3c). *Entrepreneurs/start-ups, who aim to pursue social SDGs, are more likely to collaborate with the university to work together with students in internships and theses.*

Figure 2 depicts a summary of all of the hypotheses.

Figure 2. Summary of all hypotheses.

3. Methodology

3.1. Data

For our analysis we used data from a harmonized start-up survey conducted between February and March 2020. The survey was sent out to entrepreneurs and self-employed individuals connected to one of the ten participating universities and universities of applied sciences in Berlin and Brandenburg (Germany). The online questionnaire was sent out to 5120 individuals. The 750 full responses were used for the aim of this study.

3.2. Measures

In the survey, start-ups were asked about the type of cooperation they had entered into with the university. Based on our hypotheses, we included the following three variables as dependent variables in our analysis: For the first dependent variable, the start-ups could indicate whether they had cooperated with the university for the development of a prototype. For the second variable, they were asked whether they had received professional support from a professor, and the third variable indicates whether the start-up had cooperated with students through internships or theses. All dependent variables are binary, indicating a value of quoted = 1 and not quoted = 0.

Furthermore, start-ups were asked “To which of the 17 SDGs does your company contribute with its main activities?”. They were then asked to select those objectives pursued by their business activities. To create the three independent variables, we adapted the classification of Cagarman et al. [96] measuring the contribution to economic, social, and environmental SDGs as illustrated in Figure 3. The first independent variable, economic SDGs, encompasses those SDGs that aim towards financial aspects, and consists of SDG 8 (decent work and economic growth) and SDG 9 (industry, innovation, and infrastructure). Second, all SDGs with regard to people, their ability and willingness to sustain community well-being, intergenerational justice and equity [111] were clustered as social SDGs and include the following SDGs: SDG 1 (no poverty), SDG 2 (zero hunger), SDG 3 (good health and well-being), SDG 4 (quality education), SDG 5 (gender equality), SDG 10 (reduced inequalities), SDG 11 (sustainable cities and communities), SDG 16 (peace, justice and strong institutions) and SDG 17 (partnerships for the goals). Initially, all SDGs focusing on ecological environment were considered as environmental SDGs, and they consist of SDG 6 (clean water and sanitation), SDG 7 (affordable and clean energy), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (life below water), and SDG 15 (life on land). Additionally, employee number and sales volume were applied as control variables.

Figure 3. Sustainable development goals classification.

4. Results

The descriptive statistics and correlations are presented in Table 1, and they show that 6% of the respondents collaborated with a university for prototype and new product development, 17% got professional support by a professor, and 13% collaborated with students in their internships and theses. To maintain statistical accuracy and ensure that multicollinearity is not biasing our model, we analyzed the correlation coefficients and the variation inflation factors. Since the correlation matrix does not show values above 0.360, and the variation inflation factors are below 10 with a tolerance greater 0.1, we can assume that our variables are not affected by multicollinearity [114].

Table 1. Descriptive Statistics and Correlations.

Variables	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Dependent variables</i>										
(1) Prototype development	0.06	0.24	1							
(2) Support of a professor	0.17	0.38	0.360 ***	1						
(3) Student collaboration	0.13	0.34	0.134 ***	0.295 ***	1					
<i>Control variables</i>										
(4) Number employees	2.18	2.19	−0.053	−0.077 *	−0.033	1				
(5) Sales volume	3.87	2.24	−0.045	−0.057	−0.007	0.309 ***	1			
<i>Independent variables</i>										
(6) Economical SDGs	0.67	0.74	0.073	0.107 **	0.043	0.036	0.061	1		
(7) Environmental SDGs	0.68	1.36	0.101 **	0.108 **	0.157 ***	−0.021	−0.021	0.063	1	
(8) Social SDGs	1.44	1.04	0.026	0.052	0.038	−0.004	0.010	0.042	0.182 ***	1

Note: n = 636; *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$; n.s. $p > 0.05$ (two-tailed-test).

Due to the binary nature of the dependent variable, we applied logistic regression [114]. Therefore, in order to measure the influence of the independent variables on the dependent variables, a total of three logistic regression models were created, one for each dependent variable (Table 2).

Table 2. Logistic Regression Models.

Variables	Prototype Development		Support of a Professor		Student Collaboration	
	ß	Exp(ß)	ß	Exp(ß)	ß	Exp(ß)
<i>Controls</i>						
No. Of employees	−0.103	0.902	−0.112	0.894	−0.034	0.967
Sales Volume	−0.058	0.943	−0.064	0.938	0.010	1.010
<i>Independent variables</i>						
Economical SDGs	0.366 *	1.422	0.385 **	1.469	0.117	1.124
Environmental SDGs	0.251 *	1.285	0.215 **	1.240	0.344 ***	1.410
Social SDGs	−0.015	0.986	0.041	1.042	0.005	1.005
<i>Model evaluation</i>						
Wald test	273.536 ***		224.291 ***		2753.632 ***	
<i>Goodness-of-fit test</i>						
Hosmer & Lemeshow	6.44 (n.s.)		13.81 (n.s.)		4.88 (n.s.)	
Cox and Snell R ²	0.014		0.031		0.022	
Nagelkerke R ²	0.037		0.052		0.040	

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$; n.s. $p > 0.05$ (one-tailed-test).

Our empirical results show that economical SDGs have positive and significant effects on collaboration with universities, in terms of the prototype development and expert support of a professor. Therefore, entrepreneurs/start-ups, who aim to pursue economical SDGs, are more likely ($\text{Exp}(B) = 1.422$) to collaborate with the university for product/prototype development and to get professional support from a professor

(Exp(B) = 1.469). Thus, hypotheses H1a and H1b are supported. However, we could not find any effect of the pursuit of economical SDGs on the likelihood to collaborate with students. Consequently, hypothesis H1c is rejected.

For environmental SDGs, we could find significant and positive effects on all three of the outcome variables. Thus, entrepreneurs/start-ups, who aim to pursue environmental SDGs, are more likely to collaborate with the university for product/prototype development (Exp(B) = 1.285), for expert support by a professor (Exp(B) = 1.240), and are more likely work together with students in internships and theses (Exp(B) = 1.410). Therefore, hypotheses H2a, H2b and H2c are supported. However, we could not find any significant effects related to social SDGs. Thus, the entrepreneurs who aim to pursue social SDGs are not more likely to follow collaboration with the university. Consequently, hypotheses H3a, H3b and H3c were rejected.

All logistic regression models show good validity. The Wald tests ($p < 0.001$) are significant and provide a better fit to the data than the basis model [115], and the Hosmer and Lemeshow tests are insignificant ($p > 0.05$), indicating a reliable fit between the model and data [114]. As Hosmer–Lemeshow is a more useful evaluation mark than the R^2 indicators, we do not explicitly discuss the values of Cox and Snell R^2 and Nagelkerke R^2 [115].

The results of the hypotheses are summarized in Table 3.

Table 3. Summary of results.

Hypotheses	Results
Collaboration for Economical SDGs	
Hypothesis 1a (H1a). <i>Entrepreneurs/start-ups, who aim to pursue economical SDGs, are more likely to collaborate with the university for product/prototype development.</i>	supported
Hypothesis 1b (H1b). <i>Entrepreneurs/start-ups, who aim to pursue economical SDGs, are more likely to collaborate with the university for expert support by a professor.</i>	supported
Hypothesis 1c (H1c). <i>Entrepreneurs/start-ups, who aim to pursue economical SDGs, are more likely to collaborate with the university to work together with students in internships and theses.</i>	rejected
Collaboration for Environmental SDGs	
Hypothesis 2a (H2a). <i>Entrepreneurs/start-ups, who aim to pursue environmental SDGs, are more likely to collaborate with the university for product/prototype development.</i>	supported
Hypothesis 2b (H2b). <i>Entrepreneurs/start-ups, who aim to pursue environmental SDGs, are more likely to collaborate with the university for expert support by a professor.</i>	supported
Hypothesis 2c (H2c). <i>Entrepreneurs/start-ups, who aim to pursue environmental SDGs, are more likely to collaborate with the university to work together with students in internships and theses.</i>	supported
Collaboration for Social SDGs	
Hypothesis 3a (H3a). <i>Entrepreneurs/start-ups, who aim to pursue social SDGs, are more likely to collaborate with the university for product/prototype development.</i>	rejected
Hypothesis 3b (H3b). <i>Entrepreneurs/start-ups, who aim to pursue social SDGs, are more likely to collaborate with the university for expert support by a professor.</i>	rejected
Hypothesis 3c (H3c). <i>Entrepreneurs/start-ups, who aim to pursue social SDGs, are more likely to collaborate with the university to work together with students in internships and theses.</i>	rejected

5. Discussion

Our results confirm that economically driven entrepreneurs tend to collaborate with universities in terms of product and prototype development, as well as tending to make use of expert knowledge from professors. This is in line with the study of Davey et al. [14], Dudkowski [38], and De Fuentes and Dutrénit [92] regarding the essential role R&D collaboration and consultancy play in enhancing the firms' capabilities and innovative activities. The start-ups gain a competitive advantage and benefit from several economic aspects such as cost savings, quality enhancement, and innovativeness, which contribute to the firm and regional economic growth. As a result, it can be concluded that cooperation with universities, in the form of joint R&D projects and expert consultancy, assists economically motivated ventures to achieve their economic SDGs. However, entrepreneurs that pursue economic goals are not likely to make use of students in terms of internships or theses

writing. Our findings contradict the results of the study done by Jones and de Zubielqui [7], which revealed that knowledge accessed through human resource mobility, such as co-operation in the education of graduate students and recruiting new graduates, benefits SMEs' innovativeness, which ultimately contributes to productivity and sale growth. This could be explained by the timing and the early phase the start-ups are in. In the early stage of a start-up, entrepreneurs are usually focusing on expert knowledge provided by the professors that can contribute to a more innovative product or service or support them with the resources to develop their product to bring it to the market, and they do not have the capacity to supervise or employ interns.

Compared to economically driven entrepreneurs, entrepreneurs focusing on environmental goals do tend to take support not only for their product or prototype development and expert knowledge from professors, but also support from students. This may be caused by the topic and its importance, as well as its explorational nature and the question of which way a technology can be used to improve our environment. Furthermore, we assume that ecological projects usually rely on technological solutions, and consequently need more collaboration and are more dependent on support from other parties [11]. In the realm of green innovation in particular, firms are more likely to rely on universities as their knowledge is greater [5]. Therefore, environmental entrepreneurs who partner with universities can overcome their resource constraints and gain advanced knowledge input through R&D collaboration, professors support, and student engagement, which could facilitate them to reach their ecological SDGs.

Our hypotheses for socially oriented entrepreneurs were not supported. Based on our findings, social-driven start-ups seem not to perceive collaboration with universities as a means to accomplish their social SDGs. The explanation is three-fold. First of all, the concept of social entrepreneurship is a rather new phenomenon and still fuzzy, and consequently not well defined. Social entrepreneurship is still causing confusion, especially due to its intertwined nature with the welfare and charitable sector. All this can be justified by the different developments influenced by policy and culture in each country [116]. Secondly, when trying to solve a social problem, social entrepreneurs do not see founding a business as a possible solution for their endeavor. Instead, in most of the cases social entrepreneurs turn to organizational forms that are charitable and not economically driven. Thirdly, there is no infrastructure to support social ideas within universities as compared to economic start-ups, and there might be not many collaboration options for social start-ups. Therefore, social entrepreneurs cannot and do not make use of the resources a university has to offer. In its place, social entrepreneurs turn to other sources of support such as specific governmental programs, non-governmental organizations, or alike.

In conclusion, it can be said that entrepreneurs make use of the support provided by universities. However, they tend to participate in cooperation as a fit-for-purpose practice. Engaging in one type of collaboration does not imply that they will engage in another, which is in line with the research of Davey et al. [14]. It seems like universities are well-equipped and knowledgeable on how to support economic and environmentally driven start-ups, but an infrastructure for social entrepreneurship still needs to be developed. Furthermore, universities have to find a way to show students and alumni that social entrepreneurship is a possible future.

The pursuit of SDGs is surveyed through self-reporting, which comes with the problem of respondents somewhat glossing over the answer choices or overstating themselves. However, this happens mostly when collecting sensitive data, and therefore we are confident that our results are not biased [117]. Another limitation is the variety of interpretations of SDGs caused by their generic definition [3]. Furthermore, the three identified pillars overlap in some cases and make it difficult to have a clear separation. An additional limitation can be the nested structure [114] since the data were derived from a sample in Berlin and Brandenburg. This means that entrepreneurs belonging to the same start-up, incubator, region, or city are more alike to each other than to other entrepreneurs [118].

Future studies could repeat the study for different regions of Germany and, above all, in a further step, investigate whether there are country differences caused by the structural differences. Thus, care needs to be taken in generalizing the results [119]. Moreover, we postulate longitudinal studies for direct observation of if the independent variables influence university collaboration in the long term, as well as taking the firms' outcomes/performances into account in order to examine the firms' sustainability through their cooperation with universities. In addition, qualitative follow-up studies, such as in-depth interviews with the entrepreneurs to explain the results of this study, are required. Since this article focuses mainly on the start-up/entrepreneur, future studies should analyze the self-interest of universities. Finally, gaining more insight into the social perspective, research to answer what the needs of social entrepreneurs are and how universities could support them should be conducted in terms of achieving the third mission of the university.

6. Conclusions

Overconsumption, negative environmental impact, social inequality, and constant economic growth and globalization impact the Earth's finite resources and human wellbeing. Therefore, increasing concern regarding sustainability can be observed from academia and practitioners around the world. Nonetheless, achieving sustainable results cannot be resolved by a single firm. As the result, entrepreneurs seek collaboration with universities to complement their resources and knowledge scarcity in an effort to pursue sustainability.

In this paper, we have presented the quantitative data analysis of the collaboration between academia and start-ups as a means for sustainability in each pillar, namely, economic, environmental and social. Our analyses are based on a sample of entrepreneurs/start-ups who resulted as spin-off of the ten most prominent higher education institutions in the Berlin-Brandenburg metropolitan region (Germany). The findings revealed that start-ups pursuing different sustainable goals implemented dissimilar formats of cooperation with universities. The entrepreneurs who aim to pursue environmental SDGs are prone to cooperate with universities in all of the three most often found in university-start-up collaboration forms. While economical-oriented start-ups tend to collaborate in the product and prototype development as well as support from professors, but not with student engagement. Whereas, social-driven ventures are not utilizing all three of the collaboration channels with universities.

This study contributes to theory and practice in the following ways. From a theoretical perspective, the research advanced the knowledge on university-industry collaborations, particularly in terms of start-ups and sustainability. From a practical perspective, the study can promote university-start-up cooperation as a means to sustainability further incubation and acceleration. Since most academics and companies do not engage in university-industry collaborations, even though universities are increasingly being recognized as a source of talent, an incubator for entrepreneurship, and a key player in regional development [14], this study could raise awareness regarding how universities and start-ups can collaborate to achieve various SDGs. Universities contribute to regional and national socio-economic growth more effectively by sharing resources and expertise with the business world, especially in the field of sustainability. Moreover, the findings disclosed the opportunities of universities to support entrepreneurs, especially social-oriented ventures, bringing the university one step closer to fulfilling its third mission. Additionally, the government, universities and businesses should further promote the benefits of university-business collaborations by organizing conferences and workshops, as well as distributing information of best practice case studies to businesspeople about how partnering with universities offers the business a competitive advantage in terms of obtaining qualified employees, innovativeness and building a reputation. These can be published through the local press and institutional websites, focusing more on media to promote the positive impact of the collaboration between universities and businesses, especially for the social-driven entrepreneurs because they do not seem to be aware of the benefits from cooperation with universities.

For greater efficiency, apart from university–industry partnering, collaboration with other actors such as government and societal stakeholders should be considered.

In terms of future research, we postulate longitudinal studies for the direct observation of whether the independent variables influence university collaboration in the long term. Furthermore, qualitative follow-up studies (e.g., in-depth interviews with entrepreneurs) are required to explain the findings of this study, and furthermore to identify the goals of both sides, the university and the start-up. This could be done by starting with a closer look at the needs of the three different types of entrepreneurs, followed by an investigation of the required support systems compared to the reality. This is of particularly high importance in the case of social entrepreneurship. By doing that, other forms of collaboration should be included in the observation, such as patent and licensing, hackathons and ideation contests, as well as living lab approaches among many more. Moreover, future research should investigate how other actors, such as the government and societal stakeholders, affect university–start-up collaborations. The present study consists of entrepreneurs/start-ups based in the Berlin/Brandenburg region. Future studies could repeat the study for different regions of Germany and, above all, in a further step, investigate whether there are country differences caused by the structural differences. Thus, care needs to be taken in generalizing the results [119]. Future studies could also focus on the firm age, industry sector or education level of the entrepreneur. In addition, a large step still has to be made in conceptualizing and operationalizing sustainability, particularly in the early start-up phases. The SDGs, as a common base, might be a good take off. However, there are still many issues around SDGs that have to be conceptualized, just as some contradictions and debates concerning growth and de-growth, the consideration of greenwashing and greenscamming, and the different perspectives from diverse groups along socio-economic status, wealth, culture, gender and many more. Finally, the status of the academic institutions, including universities, differs tremendously among countries from purely private and commercial-acting organizations via public institutions to charities. This status certainly determines the collaboration between universities and start-ups and should be part of future research.

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