Technological Forecasting & Social Change 185 (2022) 122096

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

journal homepage: www.elsevier.com/locate/techfore

An analysis of the sustainability goals of digital technology start-ups in Berlin

Thorsten Lammers [a,*], Lubna Rashid [b], Jan Kratzer [b], Alexey Voinov [c]

[a] Faculty of Engineering and IT, University of Technology Sydney, Broadway, Ultimo, NSW 2007, Australia[1]
[b] Centre for Entrepreneurship, Technical University of Berlin, Hardenbergstraße 38, 10623 Berlin, Germany
[c] Faculty of Engineering Technology, University of Twente, Drienerlolaan 5, 7522 NB Enschede, Netherlands

ARTICLE INFO

Keywords:
Sustainable development goals
Artificial intelligence
Entrepreneurship
Impact assessment
Triple bottom line, rational choice theory

ABSTRACT

New digital ventures play a very important role in the creation of new products and services and are a major driver of current economies. At the same time, there is growing awareness about sustainability and more interest in transformation towards a more sustainable future. This raises the question about rational choices of digital entrepreneurs and the subsequent contributions of new digital ventures in terms of sustainability. In times of rapid disruption through digital technologies, many new enterprises are driven by such new technologies. But to what extent do digital technology start-ups contribute to sustainability? An analysis of 320 start-ups from a large survey of entrepreneurial activities in the Berlin metropolitan region indicates that digital technology start-ups primarily focus on economic goals, with social and environmental goals being of lower importance or even ignored. This makes us question the priorities of current frameworks and incentive schemes.

1. Introduction

The world is navigating through global challenges such as poverty, inequality, environmental damage, climate change, and human rights. Humans must deal with these global challenges in an era of digital transformation, where tremendous advances are being made in areas such as artificial intelligence (AI), robotics, the internet of things, or blockchain. As ubiquitous technologies, they affect production, consumption, and our daily lives (Schwab, 2016). These new technologies also have the power to transform innovation and entrepreneurship and are therefore being exploited to create new business models, digital strategies, and customer experiences (Zaki, 2019; Nambisan et al., 2019), while carrying the potential to address the above-mentioned challenges (Stuermer and Abu-Tayeh, 2017; Rashid, 2019). These challenges are recognised by the Sustainable Development Goals (SDGs), which have recently celebrated their fifth anniversary (United Nations, 2020). Those 17 different goals together formulate a call to action to achieve a better and more sustainable future.

Digitalisation and entrepreneurship focussing on social impact have both been identified as pillars of national well-being (Torres and Augusto, 2020). Companies, however, have traditionally emphasised the economic benefit of their business and technology adaptation, with little or no attention paid to related ecological and social impacts and contributions (Sarasvathy, 2004). At first glance, this seems logical, as rational agents in an economic or, more specifically, an entrepreneurial environment could be expected to follow a path of lowest costs and highest profits (Scott, 2000). Traditionally, the pursuit of ecological and social goals came with higher transaction costs and lower profits and the argument was made that these would only be followed if they were aligned with customer benefits, possibly in higher echelons of the market (Belz and Binder, 2017). Since start-ups, particularly in their early stages, heavily depend on financial support and investments, their rationale is to prioritise economic value creation as public funding authorities and venture capital investors take this as a deciding factor for support and investments (Block et al., 2019; Cagarman et al., 2020).

However, over the past few years, social and ecological sustainability efforts have received increasingly more attention as contributors to economic success as well as being important standalone factors. Reasons for this might be found in generational shifts (Yamane and Kaneko, 2021), in perceived importance of and lived experiences in relation to social and ecological issues, and subsequently in a more proactive role of organisations (Schönborn et al., 2019; Hoffman, 2018). In the area of digital business, however, this shift is yet to fully emerge. The digital technology industry does not yet seem to be under much scrutiny in

* Corresponding author at: XU Exponential University of Applied Sciences, August-Bebel-Str. 26-53, 14482 Potsdam, Germany.
E-mail address: t.lammers@xu-university.de (T. Lammers).
[1] Sponsor.

https://doi.org/10.1016/j.techfore.2022.122096
Received 27 July 2021; Received in revised form 27 September 2022; Accepted 2 October 2022
Available online 12 October 2022

terms of their environmental or social impacts and efforts – an observation that is slowly being recognised by popular media (George, 2019; Jefferson, 2019). For new ventures in the digital space, entrepreneurs may consequently purely prioritise economic success, even more so than entrepreneurs in more conventional areas. This also holds in an international context in which digitalisation is a significant driver of activities and growth that may compete with sustainability goals (Denicolai et al., 2021). Meanwhile, one might expect that digital start-ups, as ones often led by highly educated individuals who are presumably aware of global challenges, would be promoting sustainability as much as possible.

Nevertheless, research regarding the contribution of entrepreneurship to sustainable development is, at this stage, still in its infancy (Anand et al., 2021). More empirical research into effects of digital entrepreneurship and its socioeconomic impacts and sustainability net benefits is needed (Zaheer et al., 2018; Satalkina and Steiner, 2020; Nicholls, 2010). This includes quantitative studies with large samples on the rapid evolution of digital entrepreneurship (Kraus et al., 2019). To be more specific, in entrepreneurship, "sustainability impacts as dependent variables remain hardly studied empirically" (Horne and Fichter, 2022).

Inspired by this, we focus on the sustainability impacts of digital technology start-ups by asking: *To what extent do digital technology start-ups contribute to sustainable transformation?* As this is an emerging field of research, empirical data is still very scarce. We aim to fill this gap by providing an empirical assessment from a survey of start-ups in the Berlin metropolitan area and their contributions to selected SDGs. The SGDs are clustered according to their primary alignment with economic, ecological, or social goals. Instead of defining what sustainability is, the SDGs describe what is needed to achieve sustainability (United Nations, 2020). Realising that a unique and generally accepted definition of sustainability is still missing and may never even emerge, we have deliberately chosen to use the SDGs in the context of our study as a proxy for what sustainability may imply, even though they sometimes appear not to sufficiently instigate real action and drive desirable human choices and preferences (Nilsson et al., 2016; Horne et al., 2020). We apply bounded rational choice theory and find evidence that digital start-ups are navigated by bounded awareness by ignoring pieces of information, and/or bounded ethicality by narrowing down the space of possible choices. As a result, the digital start-ups' prioritisation of financial returns over other sustainability goals is even more pronounced than that of other start-ups, despite the looming dangers of climate change and social issues.

The remainder of this article is structured as follows: In the next section, we provide an overview of the state-of-the-art of research at the nexus of sustainable and digital entrepreneurship drawing upon the rational choice theory and its boundaries in this context. We then develop hypotheses to support our research question. After that, we outline the materials and methods used in the empirical study and present the results of the analysis. Finally, we discuss those findings and their theoretical and practical implications.

2. Theoretical background and research hypotheses

2.1. Sustainable entrepreneurship

Business ventures of all kinds can play an important role in achieving SDGs. It is key to understand how incumbent firms and newly emerging, young ventures can create positive sustainability impacts (Horne, 2019). While large firms have been subject of extensive sustainability research, start-ups – being considered enablers of economic and social transformations – can also play a vital role (Parrish, 2010; Volkmann et al., 2019; Kratzer, 2020; Surana et al., 2020). Therefore, a start-up-specific understanding of sustainability is needed, which has only been researched for roughly a decade.

Katsikis and Kyrgidou (2007) define sustainable entrepreneurship as "the teleological process aiming at the achievement of sustainable development, by discovering, evaluating, and exploiting opportunities and creating value that produces economic prosperity, social cohesion and environmental protection". A study of the complex interplay between incumbent firms and new ventures with respect to sustainability has revealed differences in both ambition (higher for new ventures) and reach (higher for incumbents), confirming that a mixed approach is necessary for successful sustainability transformations of industries as a whole (Hockerts and Wüstenhagen, 2010).

Sustainability-driven approaches to entrepreneurship have been shown to exist in practice. However, they only work if an entrepreneur's ambition stretches beyond the primary goals of profit-seeking, and if they actively employ a set of skills and values which extends beyond the conventional principles of entrepreneurship to enable the active pursuit of a balance or trade-off between social, ecological, and economic goals (Parrish, 2010). Attempts to assess sustainability should therefore include "measures of social wealth that consider the economic, social, and environmental impacts of new ventures" (Cohen and Winn, 2007). This extension of the classical entrepreneurial ambition to holistically encompass sustainability has been shown to negatively correlate with an individual's business experience, which makes them focus more narrowly on profit (Kuckertz and Wagner, 2010). Interestingly, being profitable does not automatically imply lacking sustainability. On the contrary, investment in sustainability has been shown to result in significant gains in profits, even in low-resource environments (Haanaes et al., 2013). The 2020 leap of the Tesla stock is a good example of that. Nevertheless, while an individual's orientation towards sustainability drives sustainability-related opportunity in general, it does not necessarily foster their entrepreneurial intentions (Wagner, 2012).

As the mandate for sustainable development becomes more pressing, there are calls for entrepreneurship to not only focus on generating wealth (Teran-Yepez et al., 2020; Pankov et al., 2021; Welter et al., 2016; Rashid et al., 2020). In this context, a more targeted examination of the environmental impacts of entrepreneurs, leading to the term ecopreneuring, started a few decades ago – e.g. Blue (1990). Those ecopreneurs have the ambition of achieving market leadership while placing the solution to environmental problems at the core of their operations (Schaltegger, 2002). This form of sustainability-oriented entrepreneurial activity is highly ambitious for two reasons: First, it still supports the notion of economic growth as a key success factor while confronted with emerging debates on the necessity of "degrowth" to support sustainable development (Quilley, 2012; Schneider et al., 2010; Daly, 1999). Second, it highlights the necessity for political support to specifically target those sustainable start-ups (Hörisch, 2015; Isaak, 2002), while in reality, incentive systems are mostly of a competitive economic nature. Programs targeted at self-employment in Germany, for example, mostly focus on innovation and economic sustainability (Cagarman et al., 2020; Rashid and Cepeda-Garcia, 2021). Unsurprisingly, entrepreneurial ambition will then continue to mainly focus on economic success.

2.2. Sustainable entrepreneurship and rational choice

The rational choice theory may support explaining those phenomena. Accord to this theory, individuals act as motivated by their rational wants within a certain set of constraints (Scott, 2000). In the context of entrepreneurship, rational choice theory helps to frame problems around opportunity recognition. A key difference exists between the paradigms of rationality and bounded rationality. While contributors to the former "take their normative models to be predictive of actual behavior", the latter "provide evidence to contradict this claim" (Miller, 2007). Tech entrepreneurs acting as rational agents are choosing utility-maximising options within an incentive framework (Mole and Roper, 2012). Meanwhile, while it might also seem rational to "save the planet" and prioritise ecological and social goals, rationality is situational rather than bounded (Miller, 2007). Therefore, it remains to be seen if a

bounded interpretation of human rationality applies here, which might explain the more immediate and tangible focus on economic goals of the majority of actors in entrepreneurial incentive systems (Assuad, 2020).

The frame of bounded rational choice theory was extended to bounded ethicality and bounded awareness (Bazerman and Sezer, 2016). Bounded awareness refers to behavioural results of people making the wrong choice because they focus on their own thoughts and actions, ignoring key pieces of information, such as the consequences for society and environment (Schkade and Kahneman, 1998). Bounded ethicality refers to a psychological phenomenon that leads people to engage in ethically questionable behaviours that are inconsistent with their own preferred ethics (Chugh and Bazerman, 2007), resulting from limited reflection on or responsibility for their own choices and actions. There are many examples of such bounded effects; a recent and prominent one for bounded responsibility being "Dieselgate", the manipulation of car software in order to create an illusion of reduced emissions in the automotive industry (Parloff, 2018).

There is empirical evidence that bounded rationality affects start-ups differently than established enterprises. First, in order to identify opportunities, entrepreneurs show characteristics of bold decision-making based on perception and imagination, which goes beyond the paradigm of rational choice (Renko et al., 2012). Secondly, they profit more from reassessing perceived solutions to their problems based on intensive search for external information and consultation (Cohen et al., 2019). Entrepreneurs, while reporting a strong faith in initial intuition (Koudstaal et al., 2019), tend to make big, "pivotal", changes to their business models when new information deviates from their original beliefs, a fact that can negatively affect the relationship with key stakeholders and hence the availability of funding and resources (Flechas Chaparro and de Vasconcelos Gomes, 2021; Kirtley and O'Mahony, 2020).

Further empirical evidence shows that even for sustainability-oriented entrepreneurs, economic rationality leads to a prioritisation of profitability over a balance with socioecological goals so that the benefits of implemented sustainable practices are assessed based on their contribution to overall economic objectives (Spence et al., 2011). Causes for this could be, first, that founders of tech start-ups are unaware of the fact that they can be sustainable without compromising financial gain, as the common narrative portrays sustainability as an expense. Second, there is no unified and operationalised definition of sustainability that could help businesses understand what to do to become sustainable. People tend to define sustainability in ways that suit their particular biases, goals, priorities, and vested interests, and often use the term with no explicit evidence and recognition of the exact meaning being implied. This may often lead to confusion (Voinov, 2017). While a lack of a clear definition of sustainability is certainly a limitation of this study, as we discuss below, we chose to interpret sustainability in terms of the SDGs and use them to track the sustainability records of businesses. All in all, it remains to be seen to what extent a proposed paradigm shift from selfish and rational to a moral, social, and nature-based entrepreneurship is materialising (Hofstra, 2007).

2.3. Sustainable vs. digital entrepreneurship

How do these considerations specifically apply to new ventures in the digital area? Many new ventures attempt to exploit the opportunities of new digital technologies to create business value. The playing field of those so called "tech start-ups" is the digital entrepreneurial ecosystem – a merger of both the digital and entrepreneurial ecosystems in which digital innovation has a large influence on venture creation (Sussan and Acs, 2017; Elia et al., 2020). The imperative nature of digital technologies cannot be overstated as new ventures attempt to penetrate competitive markets. Not only do they support the development of new products and services, but they also operate with new business models as well as in new environmental conditions or markets (Cetindamar et al., 2020). As digitalisation is the enabler for both digital transformation and digital entrepreneurship, successful new ventures must be built on an understanding of their complex interrelationship (Antonizzi and Smuts, 2020). In that case, the unique properties of digital technologies around aspects like flexibility, generativity, and openness can be used by founders to fast-track the process of venture creation (Zaheer et al., 2022).

In the context of those concurring paradigm shifts of digital transformation and digital entrepreneurship, the role of sustainability impact assessments of new digital ventures is yet to become prominent. Predominant topics for new ventures using IT as their main value proposition emphasise their survival and their financial and funding performances (Steininger, 2019). Now emerging as a new field of research, and with gradually increasing acceptance of "the green concept" (Ye et al., 2020), optimistic views on the role of digital technology as an enabler for sustainable value creation in new ventures seem to gain traction (George et al., 2021; Bican and Brem, 2020; Wenzel, 2017).

However, there is also potential for a "dark side of innovation" emerging through adverse impacts of digital entrepreneurial activities on society and the environment (Coad et al., 2021). With respect to ecological sustainability, there is an increasing pressure to act on incumbent companies from a broad range of stakeholders (Coppola et al., 2019). Despite making progress towards sustainable transitions themselves, and despite emerging research comparing start-up and incumbent contributions towards green transformations, the public eye on ecological sustainability remains mainly focused on the incumbent "old" and "dirty" industries such as chemistry, energy, or mining (Palmié et al., 2021). New (digital technology) ventures are not under the same spotlight when more sustainability is demanded (Billing, 2020). This may be because their sustainability impacts are more indirect and the assessment of those "second order effects" (despite recently gaining increased attention) is harder to evaluate and criticise (Bisoyi et al., 2020; Rivera et al., 2014).

Additionally, the impacts of ecological threats such as climate change are superimposed on existing vulnerabilities of poor countries as they are both more exposed geographically and do not have the resources to respond as effectively (IPCC, 2007). This leads to the assumption that the vast majority of climate change consequences appear in the developing world and has already resulted in an increasing gap of economic inequality between wealthy and poor countries in the past half-century (Dar, 2012; Diffenbaugh and Burke, 2019). It similarly applies to issues of human rights and social inequality. Now, the digital technology industry is primarily led by highly privileged individuals in rich countries who might therefore not experience the negative impacts of the sustainability crisis to the same extent, hence not necessarily feel the need to take action. In combination with the previously mentioned lack of public scrutiny regarding their sustainability performances, this could lead industry leaders and entrepreneurs in this field to disregard holistic sustainability aspects of their businesses due to not being personally highly affected by it.

The use of new digital technologies often enables the "creation, diffusion, and use of knowledge as part" of knowledge-intensive entrepreneurial ecosystems (Malerba and McKelvey, 2020), as can be seen for example in so-called green apps that lead to more ecologically conscious behaviours and consumption patterns – "Greenwallet"[2] and "Onesmallstep"[3] being good examples. While this technology-enabled sharing of knowledge performed by entrepreneurs living in urban, digitalised environments leads to new digital business models or start-ups, emerging research connects this to a strong economic (rather than social) orientation (Richter et al., 2017). Also, the creativity required in digital entrepreneurial ecosystems has been linked not only to the identification of opportunities and innovation, but also to the ability to disentangle from nature through moral disengagement, leading to an

[2] https://www.greenwallet.com.au
[3] https://www.onesmallstepapp.com

acceptance of negative impacts on the environment with higher disengagement from environmental values (Qin et al., 2022; Shepherd et al., 2013).

Furthermore, there is a notion that digitalisation intensifies consumption and satisfying this consumption can demand shorter product life cycles and the need for more rapid product development (Ritzer and Miles, 2018). While there can be positive sustainability effects of using digital technologies to meet this demand such as improved resource or energy efficiencies (for example in manufacturing or in information and communication technology), an increased resource use and waste generation might compromise on sustainability efforts for the sake of quickly creating newer and better products (Chen et al., 2020). A good example here is the ongoing discussion around Bitcoin's energy consumption (de Vries, 2020). The widely discussed potentially adverse effects of digitalisation on the workforce (e.g. through automation or labour standards in the gig-economy) are another example.

2.4. Hypotheses

Rational choices are therefore expected to drive digital entrepreneurs towards purely economically oriented business models and behaviour. The requirement to attract financial resources, to establish business value, and to maintain transaction costs and efforts as small and lean as possible might hinder investment in ecological and social sustainability. Social expectations towards digital start-ups gravitate towards financially successful role models such as Amazon, Google, or Facebook. For founders of digital technology start-ups (i.e., founders who consider their start-up to be primarily active in the digital technology industry, see Section 3.2), the societal value attributed to economic success predominates all other values. Therefore, we assume that entrepreneurs who are active in the digital technology industry would prioritise economic goals.

Hypothesis 1a. *(H1a): Digital technology start-ups prioritise economic over ecological and social SDGs (industry focus).*

Adopting technology alone does not make a technology company. Considering digital technology start-ups in H1a therefore comprises different aspects. Only the combination of technology application with a distinctive "restless change" mindset has made technology start-ups grow into some of the world's most valuable businesses (Bürkner et al., 2018). Narrowing down the specific employed technology therefore represents a more differentiated approach to address our research question. We choose artificial intelligence (AI) as a special use case. While showing characteristics similar to other digital technologies when it comes to deployment in digital transformation projects, AI is considerably one of the most prominent digital technologies in terms of both industry applicability and technical maturity (Corbo et al., 2021; Brock and von Wangenheim, 2019). This narrower exploration would help us to understand if all arguments raised above apply to AI start-ups (those who employ AI is a key aspect of their product/service, see Section 3.2) to the same extent.

By focusing on AI as driving technology rather than digital technology in general, some differences might be expected as well. Firstly, AI as an employed technology is seen by many as contributing the most to a firm's performance, calling for an above-average wage premium for hiring new talent, for example in the energy sector (Lyu and Liu, 2021). And secondly, AI application enables a reduction in human intervention when setting and governing rules in information systems and ultimately social and institutional norms (Ågerfalk, 2020). So, it remains to be seen whether when focusing on AI as an employed technology, the financial premise remains unchanged.

Hypothesis 1b. *(H1b): AI start-ups prioritise economic over ecological and social SDGs (technology focus).*

In this context, demographic differences might be of influence. Both gender equality and promoting migrant and ethnic-minority inclusion are explicit SDG targets, represented in SDGs 5 and 10 respectively. They may lead to an inclination of teams with women or migrant leadership to exhibit higher tendencies to address some non-economic SDGs. Additionally, both women and those with migrant backgrounds are (historically) faced with more institutional and societal pressures in comparison with native-born men. Those pressures could potentially drive them to behave more altruistically and pro-socially (Anderson, 2012; Rand et al., 2016; Brañas-Garza et al., 2018). In other words, women and migrants are more likely to be expected to behave as "good citizens", which may translate into higher tendencies to behave sustainably. Prior exposure to social problems seems to strengthen the social aspects of entrepreneurial intentions as well (Hockerts, 2017).

In Germany, women constitute <18 % of start-up founders whereas those with a migration background constitute about 21.6 % (Kollmann, 2021). The latter constitute about 26.7 % of the total population (Federal Agency for Civic Education, 2022). Inclusion of individuals from such underrepresented backgrounds within founding teams might therefore bring in perspectives on sustainability that would have traditionally been missed. Indeed, women generally show more positive attitudes towards sustainability aspects of entrepreneurship and are more likely to primarily have social or environmental, rather than economic value creation goals (Vuorio et al., 2018; Hechavarría et al., 2017; Rosca et al., 2020). This seems to become even more prominent in a post-materialistic society (Hechavarría et al., 2017). Likewise, having a migration background has been shown to correlate with an increased focus on social goals within entrepreneurial ecosystems, including in Germany (Meister and Mauer, 2019; Baron and Harima, 2019a).

Based on these prior findings, we will explore the potential moderation effects of those two aspects of demographic diversity on the previous hypotheses:

Hypothesis 2. *(H2): Diversity in gender or migration background moderates the prioritisation of economic over ecological and social SDGs.*

3. Materials and methods

In the following section, we describe the survey design, variables, and the statistical analysis.

3.1. Survey design

The study handles data from start-ups in the Berlin metropolitan region. Ranked in the global top 20 of start-up ecosystems with a high growth rate, Berlin shows specific strengths in the areas of financial technologies, AI, Big Data, and Analytics (Startup Genome, 2020). It is among the most diverse and inclusive ecosystems in the world, with a strong influence of migrants on entrepreneurial success (Trajkovska, 2018; Baron and Harima, 2019b). Of all German regions and states, Berlin has the highest share of green entrepreneurial activity and may therefore be deemed Germany's "Green Start-up Hub" (Olteanu and Fichter, 2020).

For this study, we use data collected through an online, anonymous, harmonised survey on start-up activities in connection to ten public universities in the Berlin-Brandenburg metropolitan region, which have been thoroughly and uniformly surveyed as part of a cross-university initiative. The survey was available in both English and German and included various questions on the founders and their companies, targeting self-employed individuals/start-up entrepreneurs with a connection to the participating universities (e.g., alumni, students, or scientific staff). The dataset is therefore comprised of self-reported data, which was preferred in this case following Heneman (1974) and Leenders et al. (2003), who indicate that self-reported measures may possess high objectivity in cases where anonymity is promised and that they may possess less restriction on range and leniency than methods such as supervisor ratings. In addition, a meta-analysis from Berry et al. (2012) shows first, that self- and other-ratings were moderately to

strongly correlated with each other. Second, with some notable exceptions, self- and other-reports exhibited very similar patterns and magnitudes of relationships with a set of common correlates. Third, other-reports generally accounted for little incremental variance in the common correlates beyond self-report. In addition, using self-reports to evaluate the start-ups contribution to the SDGs is the only way to achieve accuracy since only the founders of start-ups can report about their (often still intended) contribution to the SDGs.

The survey period was 01.02.2020–15.03.2020. The data was obtained prior to the outbreak of the coronavirus pandemic in Germany and refers mostly to 2019. The survey reached out to a total of 5120 individuals, of whom 750 participated (15 % response rate). A number of review studies on organisational research and response rates confirm that this response rate is acceptable (Baruch and Holtom, 2008; Pielsticker and Hiebl, 2020). The sample of 15 % is representative of the addressed population and no non-response biases are present. The data collection and analysis was coordinated by the Centre for Entrepreneurship at the Technical University of Berlin. Out of the 750 responses, the 320 start-ups that were founded in or after 2010 and are headquartered in Berlin have been included in this study. Therefore, potential age- and location-induced variability would be reduced. The maximum age of 10 years was chosen to be considered a start-up. Academic start-ups have a technology base >95 % of the time. Start-ups with a technology base usually require much more time to reach a mature stage compared to non-tech start-ups. In addition, research on business activities of start-ups usually considers start-ups within time periods of one decade (Balboni et al., 2019). An executed *t*-test shows that there are no statistically significant differences between 1 and 5 years old start-ups and those 6 to 10 years old with respect to their assessment of sustainability contributions along the SDGs.

3.2. Variables

In this research, the contributions to economic, social, and ecological sustainability goals are the dependent variables. The classification of SDGs into those three categories was performed following Cagarman et al. (2020), see Fig. 1, bearing in mind that several other classifications exist with often contradictory and/or arbitrary grouping approaches (Dalampira and Nastis, 2020; Delli Paoli and Addeo, 2019; Khoshnava et al., 2019; Kostoska and Kocarev, 2019). The classification in this study is done based on an assessment from independent experts. In order to assess the main direction of the start-ups' activities, participants were asked: "to which of the 17 SDGs does your company contribute with its main activities?" and had the option to select zero to all SDGs. The dependent variables were constructed as binary variables (referring to either the presence or absence of contribution to SDGs in each category), with start-ups contributing to economic, social and ecological SDGs constituting 51 %, 62 % and 44 % of the sample, respectively.

The start-up type and branch are the independent variables. Corresponding to H1a, start-up founders were asked "in which industry is your company primarily active?" and multiple choices were given. Those that stated belonging to the branches "information and communication technology (ICT)", "electronics/electrical engineering/optic", and "software and ICT services" were labelled "digital technology start-ups". Those start-ups constituted 25 % of the sample (whereas the remaining non-digital-tech start-ups operate in industries such as manufacturing, pharmaceuticals, hardware, machinery, automotive, energy, hospitality, finance, and architecture, among a few others). As for addressing H1b, those labelled as "AI start-ups" are those that have answered yes to the question of whether they employ AI is a key aspect of their product/service (17 % of the sample). Both of those variables are of binary nature as well.

To address H2, the presence of individuals with an international background or identifying as female in the founding team (26 % and 42 %, respectively) have been considered, corresponding to questions on the number of individuals in the start-up founding team who identify as having an international background or being female respectively. Finally, the number of employees as well as sales volume have been set as control variables.

3.3. Statistical analysis

Logistic regression analysis was used to test the research hypotheses. Three models were built to test the relationship between digital technology start-ups and economic, social, and ecological sustainability, respectively. An additional three models were built to assess this relationship with the inclusion of moderating variables. The same strategy was undertaken with respect to AI start-ups. The results are summarised in Tables 1 and 2 below.

Additionally, Mann-Whitney-*U* Tests were conducted to further affirm the presence of differences in the sustainability contribution of digital technology versus non-digital technology and AI versus non-AI start-ups respectively. A non-parametric comparison was chosen due to its resilience against violation of normality assumptions (Field, 2009). Those results are summarised in Table 3.

4. Results

The results of the regression models for H1a and H1b are shown in Tables 1 and 2 respectively. The models show good validity as the

Fig. 1. Classification of SDGs.

Table 1
The sustainability contribution of digital technology start-ups.

	Economic goals				Social goals				Ecological goals			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
Variable	B	Exp (B)	B	Exp (B)	B	Exp (B)	B	Exp (B)	B	Exp (B)	B	Exp (B)
Control variables												
No. of employees	−0.070	0.932	−0.074	0.929	−0.002	0.998	−0.004	0.996	−0.066	0.936	−0.069	0.933
Sales volume	0.023	1024	0.017	1018	−0.037	0.964	−0.025	0.976	−0.094	0.910	−0.089	0.915
Independent variables												
Dig. tech. start-up	0.815**	2258	0.691*	1995	−0.800**	0.449	−0.667*	0.513	−0.611*	0.543	−0.597*	0.551
Moderating variables												
Migration background			−0.046	0.955			0.331	1392			0.166	1181
Female founder			−0.453	0.636			0.649*	1914			0.114	1121
Cox & Snell R^2	0.034		0.046		0.031		0.067		0.032		0.035	
Nagelkerke R^2	0.046		0.061		0.042		0.078		0.043		0.046	
Hosmer & Lemeshow Chi^2	2001		15,277		8190		9954		8837		15,031	

$n = 320$.
* $p \leq 0.05$.
** $p \leq 0.01$.

Table 2
The sustainability contribution of AI start-ups.

	Economic Goals				Social Goals				Ecological Goals			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
Variable	B	Exp (B)	B	Exp (B)	B	Exp (B)	B	Exp (B)	B	Exp (B)	B	Exp (B)
Control variables												
No. of employees	−0.079	0.924	−0.083	0.920	0.004	1004	0.003	1003	−0.061	0.940	−0.062	0.940
Sales volume	0.029	1029	0.022	1023	−0.040	0.961	−0.027	0.973	−0.096	0.908	−0.091	0.913
Independent variables												
AI start-up	0.821*	2273	0.732*	2079	−0.482	0.617	−0.376	0.686	−0.380	0.684	−0.347	0.707
Moderating variables												
Migration background			0.000	1000			0.248	1281			0.104	1110
Female founder			−0.541*	0.582			0.768**	2156			0.222	1248
Cox & Snell R^2	0.027		0.043		0.009		0.044		0.021		0.024	
Nagelkerke R^2	0.035		0.057		0.013		0.060		0.028		0.032	
Hosmer & Lemeshow Chi^2	1439		7893		4464		4110		5811		10,555	

n = 320.
* $p \leq 0.05$.
** $p \leq 0.01$.

Hosmer & Lemeshow tests are insignificant ($p > .05$) for all 12 models, indicating a reliable fit between the models and data (Field, 2009). As Hosmer-Lemeshow is a more useful evaluation indicator than the R2 indicators (Peng et al., 2002), we do not explicitly discuss the values of Cox and Snell R2 and Nagelkerke R2. Spearman correlation coefficients between all dependent and independent variables were calculated and all are <0.9, indicating the absence of multicollinearity (Chen and Rothschild, 2010; Doohoo et al., 1997).

The regression results show that being a digital technology start-up or an AI start-up has a significant and positive relationship with the likelihood of contributing to economic SDGs. Being a digital technology start-up significantly and negatively contributes to the likelihood of achieving social or ecological SDGs, while being an AI Start-up exhibits no significant relationship to those goals at all. Accordingly, H1a and H1b are confirmed. Further evidence to support H1a and H1b emerges from the non-parametric comparative analysis (Mann-Whitney *U* test), where significant differences in the probability of SDG contribution are shown across all SDG types for digital technology versus non-digital technology start-ups, and significant differences appear in economic and social SDG contribution for AI versus non-AI start-ups (see Table 3).

The regression models also provide partial support for H2. Although the presence of migrants in the founding team does not seem to have significant impact on any of the regression models, gender does. Having a gender-diverse founding team appears to have a significant and positive moderating impact on the contribution of both digital technology and AI start-ups to social sustainability, while it has a significant and negative moderating impact on the contribution of AI start-ups to economic goals.

5. Discussion and implications

The results obtained from our analysis can be interpreted from a few different angles, the most obvious of which would be from a societal perspective, seeing as the drive for pursuing social and environmental goals is still far less widespread than for the goals of economic success. The general public priorities still focus primarily on short-term growth, corporate turnovers, unicorns, and GDP, considerably more than on the transformation to sustainability and preservation or growth of natural capital. Motivated by a positive public attitude to economic success, all other goals receive less attention.

Table 3
Differences in SDG contribution across different start-up types.

Null hypothesis	Sig.	Decision
Mann-Whitney U Test (mean sustainability contribution for digital vs. non-digital start-ups)		
The probability of contribution to economic SDGs is the same across digital technology vs. non-digital-technology start-ups	0.017	Reject the null hypothesis.
The probability of contribution to social SDGs is the same across digital technology vs. non-digital-technology start-ups	0.000	Reject the null hypothesis.
The probability of contribution to environmental SDGs is the same across digital technology vs. non-digital-technology start-ups	0.000	Reject the null hypothesis.
Mann-Whitney U Test (mean sustainability contribution for AI vs. non-AI start-ups)		
The probability of contribution to economic SDGs is the same across AI vs. non-AI start-ups	0.001	Reject the null hypothesis.
The probability of contribution to social SDGs is the same across AI vs. non-AI start-ups	0.035	Reject the null hypothesis.
The probability of contribution to environmental SDGs is the same across AI vs. non-AI start-ups	0.159	Retain the null hypothesis.

Indeed, when founding a digital technology start-up, the entrepreneurial environment continues to frame the process along the lines of economic success. Only start-ups that can convincingly show that significant financial returns can be expected, have a chance of receiving public support or investments from (Corporate) Venture Capital models. Venture capitalists, by widening their roles to include sustainability at the core of their support, may promote the emergence of more sustainable business model innovation in the future (Bocken, 2015). However, for most start-ups that act rationally, it still seems to be difficult to escape the "green prison" in which all pay offs or rewards are set for economic success (Pacheco et al., 2010).

It might also be that digital technology start-ups perceive sustainability somewhat differently. These start-ups are often divorced from real direct impacts and have only second-order effects for environment and society. As a result, unlike many other industries, they also cannot immediately improve their performance to reduce the harm they are causing. And in turn, they also cannot declare doing less harm as a pursuit of social or environmental SDGs. In other words, digital technology start-ups may have less of an option to pursue social or environmental SDGs from their own perspective.

Another factor which might make it difficult for digital technology start-ups to see themselves in the process of sustainable transformation, is the fact that the digital technology industry is primarily led by developed countries. Individuals in those countries may not themselves experience the negative impacts of lack of sustainability as much (Middermann et al., 2020). Most digital innovations are inherently based on demands and wishes from users and customers and subsequently take account of issues in wealthy countries, which are less affected by negative effects of, say, climate change such as flooding, poverty, and migration.

5.1. Practical implications

There are certainly many more explanations for the abovementioned findings that could be discussed here, and when synthesised, the following practical and theoretical implications can be drawn. From the practice side, the results indicate the necessity to increase efforts in all educational levels. The urgent need to change our economic and social lives towards more sustainable ones should be realised in a more holistic way. The message should be clear: Everyone causes negative externalities, both as individual or as enterprise. Effects of bounded awareness and bounded ethicality should be addressed. Education does not only mean direct awareness of sustainability challenges and goals and their means of assessment, but also psychology, decision-making skills, emotional intelligence, and empathy – vital yet often overlooked assets needed to guide the transition of mindsets and behaviours, and the translation of good intentions into collaborative and inclusive sustainable actions (Rashid, 2022).

Second, the entrepreneurial environment needs to change towards more "sustainability"-friendly conditions. The changes can start with public support and incentive programs, which should focus on socially and environmentally oriented start-ups and the incubation and acceleration processes from private and commercial sides as well as the academic services that should integrate sustainable solutions much more strongly. In addition, the ratings of enterprises, and particularly start-ups, should be based on sustainable return on investment judgements rather than pure economic success, and with such investments be redirected.

Finally, young digital technology start-ups should be exposed to role models and examples different than purely profit-oriented Silicon Valley approaches and business plans. Indeed, there is a growing movement towards alternative business models focused on more 'purposeful capitalism', rethinking the whole goal of profitability as the main driver of economic activity (Deutsche Welle, 2021). Moreover, the findings indicate that diversity (in this case gender diversity) moderates the process and might contribute towards more sustainable start-ups, which adds to current debates on the necessity to bridge the gender gap in (technology) entrepreneurship as well as emphasise female role models.

5.2. Theoretical implications

From the theoretical side, our research adds to the discussion about the relevance of the Friedman doctrine for the 21st century, which has been fundamental for business over the last half century and defined increasing the shareholder value as the only social responsibility of an organisation (Mayer, 2018). Considering the two opposing research paradigms of rationality and bounded rationality, our study supports the latter, highlighting that the immediate and tangible focus on economic goals is the logical consequence.

The cost of an opportunity within an incentive framework determines if it will be sought out by an entrepreneur (Mole and Roper, 2012). As rational choice theory suggests, material, non-material and institutional incentives are important to inform entrepreneurs' decision-making (Hopkins, 2016). Here, the public, institutional, and regulatory frameworks in place do not seem to allow making other decisions, given the prevailing knowledge, values, and preferences. In addition, prominent digital technology start-ups may not even sense any demand or pressure to follow social or environmental SDGs, as from their own perspective, they are harmless. Digital technology start-ups might be particularly in danger of suffering from behavioural effects of bounded awareness and bounded ethicality. Assuming bounded rationality here provides a good framework to extend and deepen the theoretical perspective in further research, as our findings indicate that digital start-ups indeed follow a rational path and ignore obvious information about the urgent need for sustainable transformation, hence limit their frame to act accordingly.

The study exposes the current existing framework conditions of a societal and economic system which does not sanction unsustainable choices, but rather approves them. This creates payoff structures and behaviours, which are detrimental to sustainable change. By creating and extended the framework of bounded rational choice theory to sustainable behaviours of start-ups, our study contributes to an increasing field of studies which attempt to explain the obvious contradictions between formulated societal and economic goals and business reality. Other theoretical approaches, such as "collective good" theories, might be considered as well as they are also based on the assumptions of bounded rational behaviour of individuals, in addition to groups of individuals such as start-ups.

5.3. Limitations and future research

In the context of our study, the definitions, operationalisation, and measurement of sustainability remain quite vague. This is also seen in the context of digital entrepreneurial ecosystems, where the term sustainability has been adapted to cover aspects such as user privacy, platform efficiency and security, and free market competition (Song, 2019). Sometimes, the SDGs are even used as a measure of long-term economic viability without considering ecological or social aspects at all (Al Omoush et al., 2018). We have chosen to apply the broadly defined SDGs as a general set of indicators to classify the goals of start-ups. The contradictions embedded in the SDGs make it difficult to apply them in general, and their understanding and interpretation among the start-ups in this study might be diverse. Future research may address this issue in two ways. First, experimental settings could inform how different start-ups interpret and recognise the SDGs differently across a variety of settings (e.g. industry branches, locations, etc.). Secondly, researchers could attempt to operationalise the SDGs with measurable indicators. Admittedly, the latter would require tremendous effort in order to establish generally accepted metrics.

Moreover, the limitations of self-assessments should be mentioned. As research shows, self-assessments may be biased towards socially desirable answers and/or missing or wrong information (Nederhof, 1985). However, as there are currently no accepted metrics to measure sustainability of start-ups in different phases of development objectively, the method of self-assessment is the most feasible viable choice. Another limitation is the sample used in this study, as it represents "typical" start-ups in a resource-rich, urban environment. So, for many points raised in the discussion above, it might be difficult to generalise the results to all digital technology start-ups in other economies and settings. In order to answer the research question more broadly, a global sample of digital technology start-ups would be required.

Our results should be interpreted as highly explorative in nature. It is observed in academic incubators/accelerators that start-ups develop from having a broad range of sustainability goals towards a prioritisation of economic goals after entering the real entrepreneurial environment (Hayter, 2011). To address this issue, longitudinal research designs would be required to unravel the entire complex of reasons and factors for the development of business plans and strategies more precisely. Finally, the impact of (gender) diversity should be on the agenda of future research to further understand the reasons and implications of founder demographics on start-up sustainability behaviours.

5.4. Conclusion

For digital start-up founders, "passion for their field matters more than the project" (Zaheer et al., 2022). This passion, however, does not always seem to include a sufficient consideration of sustainability aspects. We find that digital technology start-ups demonstrate a statistically significant positive attitude to pursuing SDGs that are economically oriented and a negative attitude to SDGs that are socially or environmentally oriented. Similarly, start-ups that employ AI technology also show a statistically significant and positive attitude to economically oriented SDGs, while preference for socially or environmentally oriented SDGs remains statistically insignificant. These preferences are somewhat moderated by gender-diversity with more social orientation in digital technology start-ups led by females. Thus, digital and AI technology start-ups may be far from being drivers of a transformation to sustainability. We hope that our findings support entrepreneurs, practitioners, and researchers alike in pursuing urgently needed sustainable behaviours to fulfil the full potential of 21st century technology.

CRediT authorship contribution statement

Thorsten Lammers: Conceptualization, Writing – original draft, Writing – review & editing, Project administration. **Lubna Rashid:** Methodology, Investigation, Data curation, Project administration, Writing – review & editing, Validation, Formal analysis. **Jan Kratzer:** Conceptualization, Investigation, Supervision, Writing – review & editing. **Alexey Voinov:** Writing – review & editing.

Declaration of competing interest

The authors have no competing interests to declare.

Data availability

Data will be made available on request.

References

Ågerfalk, P.J., 2020. Artificial intelligence as digital agency. Eur. J. Inf. Syst. 29, 1–8.

Al Omoush, K.S., Al-Qirem, R.M., Al Hawatmah, Z.M., 2018. The degree of e-business entrepreneurship and long-term sustainability: an institutional perspective. IseB 16, 29–56.

Anand, A., Argade, P., Barkemeyer, R., Salignac, F., 2021. Trends and patterns in sustainable entrepreneurship research: a bibliometric review and research agenda. J. Bus. Ventur. 36, 106092.

Anderson, B., 2012. What Does "The Migrant" Tell Us About the (Good) Citizen?. COMPAS Communications (Working Paper), Volume WP-12-94. University of Oxford.

Antonizzi, J., Smuts, H., 2020. The characteristics of digital entrepreneurship and digital transformation: a systematic literature review. In: Hattingh, M. (Ed.), Responsible Design, Implementation and Use of Information and Communication Technology. I3E 2020. Lecture Notes in Computer Science, vol 12066. Springer, Cham.

Assuad, C.S., 2020. Understanding rationality in sustainable development decision-making: unfolding the motivations for action. J. Knowl. Econ. 11, 1086–1119.

Balboni, B., Bortoluzzi, G., Pugliese, R., Tracogna, A., 2019. Business model evolution, contextual ambidexterity and the growth performance of high-tech start-ups. J. Bus. Res. 99, 115–124.

Baron, T., Harima, A., 2019. The role of diaspora entrepreneurs in start-up ecosystem development – a Berlin case study. Int. J. Entrep. Small Bus. 36 (1/2), 74–102.

Baron, T., Harima, A., 2019. The role of diaspora entrepreneurs in start-up ecosystem development - a Berlin case study. Int. J. Entrep. Small Bus. 36 (1/2), 74–102.

Baruch, Y., Holtom, B.C., 2008. Survey response rate levels and trends in organizational research. Hum. Relat. 61 (8), 1139–1160.

Bazerman, M.H., Sezer, O., 2016. Bounded awareness: implications for ethical decision making. Organ. Behav. Hum. Decis. Process. 136, 96–105.

Belz, F.M., Binder, J.K., 2017. Sustainable entrepreneurship: a convergent process model. Bus. Strateg. Environ. 26 (1), 1–17.

Berry, C.M., Carpenter, N.C., Barratt, C.L., 2012. Do other-reports of counterproductive work behavior provide an incremental contribution over self-reports? A meta-analytic comparison. J. Appl. Psychol. 97 (3), 613–636.

Bican, P.M., Brem, A., 2020. Digital business model, digital transformation, digital entrepreneurship: is there a sustainable, "Digital"? Sustainability 12 (13), 5239.

Billing, M., 2020. Why Start-ups are More Likely to Dodge Greenwashing Label. Financial Times.

Bisoyi, B., Das, D., Das, B., 2020. Assessing global environmental sustainability: second-order effect of information and communication technology. In: Satapathy, S., Bhateja, V., Mohanty, J., Udgata, S. (Eds.), Smart Intelligent Computing and Applications. Smart Innovation, Systems and Technologies. Springer, SIngapore, pp. 145–153.

Block, J., Fisch, C., Vismara, S., Andres, R., 2019. Private equity investment criteria: an experimental conjoint analysis of venture capital, business ANgels, and family offices. J. Corp. Finan. 58 (19), 329–352.

Blue, J., 1990. Ecopreneuring: Managing For Results. Scott Foresman, London.

Bocken, N.M.P., 2015. Sustainable venture capital – catalyst for sustainable start-up success? J. Clean. Prod. 108 (A), 647–658.

Brañas-Garza, P., Capraro, V., Rascón-Ramírez, E., 2018. Gender differences in altruism on mechanical turk: expectations and actual behaviour. Econ. Lett. 170, 19–23.

Brock, J.K.U., von Wangenheim, F., 2019. Demystifying AI: what digital transformation leaders can teach you about realistic artificial intelligence. Calif. Manag. Rev. 61 (4), 110–134.

Bürkner, H.P., Tripathi, S., Utama, E.Y., 2018. It takes more than technology to be like a tech company (Boston Consulting Group). [Online]. https://www.bcg.com/publications/2018/takes-more-than-technology-to-be-like-tech-company. (Accessed 16 March 2022).

Cagarman, K., et al., 2020. Social entrepreneurship on its way to significance: the case of Germany. Sustainability 12 (21), 8954.

Cetindamar, D., Lammers, T., Sick, N., 2020. Understanding the relationship between smart cities and entrepreneurial ecosystems: the case of Sydney. In: Biloria, N. (Ed.), Data-Driven Multivalence in the Built Environment. Cham, Springer Nature, pp. 301–315.

Chen, C.-F., Rothschild, R., 2010. An application of hedonic pricing analysis to the case of hotel rooms in Taipei. Tour. Econ. 16 (3), 685–694.

Chen, X., Despeisse, M., Johansson, B., 2020. Environmental sustainability of digitalization inmanufacturing: a review. Sustainability 12.
Chugh, D., Bazerman, M.H., 2007. Bounded awareness: what you fail to see can hurt you. Mind & Society 6 (1), 1–18.
Coad, A., Nightingale, P., Stilgoe, J., Vezzani, A., 2021. Editorial: the dark side of innovation. Ind. Innov. 28 (1), 102–112.
Cohen, B., Winn, M.I., 2007. Market imperfections, opportunity and sustainable entrepreneurship. J. Bus. Ventur. 22 (1), 29–49.
Cohen, S.L., Bingham, C.B., Hallen, B.L., 2019. The role of accelerator designs in mitigating bounded rationality in new ventures. Adm. Sci. Q. 64 (4), 810–854.
Coppola, M., Krick, T., Blohmke, J., 2019. Feeling the heat? - Companies are under pressure on climate change and need to do more. In: s.l.: The Deloitte Sustainability Services.
Corbo, J., Henke, N., Ostojic, I., 2021. The top trends in tech (McKinsey Insights) [Online] Available at: https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the-top-trends-in-tech. (Accessed 16 March 2022).
Dalampira, E.-S., Nastis, S.A., 2020. Mapping sustainable development goals: a network analysis framework. Sustain. Dev. 28 (1), 46–55.
Daly, H.E., 1999. Steady-state economics: avoiding uneconomic growth. In: van den Bergh, J.C.J.M. (Ed.), Handbook of Environmental and Resource Economics. Edward Elgar, Cheltenham, UK; Northampton, USA, pp. 635–642.
Dar, W., 2012. A hypothesis of hope for the developing world. UN Chron. 46 (4), 16–20.
Delli Paoli, A., Addeo, F., 2019. Assessing SDGs: a methodology to measure sustainability. Athens J. Soc. Sci. 6 (3), 229–250.
Denicolai, S., Zucchella, A., Magnani, G., 2021. Internationalization, digitalization, and sustainability: are SMEs ready? A survey on synergies and substituting effects among growth paths. Technol. Forecast. Soc. Chang. 166, 120650.
Deutsche Welle, 2021. Rethinking capitalism [Online] Available at: https://www.youtube.com/watch?v=rp6cqaRZ-oQ. (Accessed 30 June 2021).
Diffenbaugh, N.S., Burke, M., 2019. Global warming has increased global economic inequality. Sustain. Sci. 116 (20).
Doohoo, I.R., et al., 1997. An overview of techniques for dealing with large numbers of independent variables in epidemiologic studies. Prev. Vet. Med. 29 (3), 221–239.
Elia, G., Margherita, A., Passiante, G., 2020. Digital entrepreneurship ecosystem: how digital technologies and collective intelligence are reshaping the entrepreneurial process. Technol. Forecast. Soc. Chang. 150, 119791.
Federal Agency for Civic Education, 2022. Bevölkerung mit Migrationshintergrund [Online] Available at. https://www.bpb.de/kurz-knapp/zahlen-und-fakten/soziale-situation-in-deutschland/61646/bevoelkerung-mit-migrationshintergrund/. (Accessed 28 March 2022).
Field, A., 2009. Discovering Statistics Using SPSS, 3 ed. Sage, New York.
Flechas Chaparro, X.A., de Vasconcelos Gomes, L.A., 2021. Pivot decisions in startups: a systematic literature review. Int. J. Entrep. Behav. Res. 27 (4), 884–910.
George, G., Merrill, R.K., Schillebeeckx, S.J.D, 2021. Digital sustainability and entrepreneurship: how digital innovations are helping tackle climate change and sustainable development. Enterp. Theory Pract. 45 (5), 999–1027. https://doi.org/10.1177/1042258719899425.
George, K., 2019. The tech industry has a serious sustainability problem. https://www.huckmag.com/art-and-culture/tech/the-tech-industry-has-a-serious-sustainability-problem/. (Accessed 26 January 2020).
Haanaes, K., Michael, D., Jurgens, J., Rangan, S., 2013. Making sustainability profitable. Harv. Bus. Rev. (03).
Hayter, C.S., 2011. In search of the profit-maximizing actor: motivations and definitions of success from nascent academic entrepreneurs. J. Technol. Transf. 36, 340–352.
Hechavarría, D.M., et al., 2017. Taking care of business: the impact of culture and gender on entrepreneurs' blended value creation goals. Small Bus. Econ. 48 (1), 225–257.
Heneman, H.G., 1974. Comparisons of self- and superior ratings of managerial performance. J. Appl. Psychol. 59 (5), 638–642.
Hockerts, K., 2017. Determinants of social entrepreneurial intentions. Enterp. Theory Pract. 41 (1), 105–130.
Hockerts, K., Wüstenhagen, R., 2010. Greening goliaths versus emerging davids — theorizing about the role of incumbents and new entrants in sustainable entrepreneurship. J. Bus. Ventur. 25 (5), 481–492.
Hoffman, A.J., 2018. The next phase of business sustainability. Stanf. Soc. Innov. Rev. 16 (2), 34–39.
Hofstra, N., 2007. Sustainable entrepreneurship in dialogue. Prog. Ind. Ecol. 4 (6), 495–514.
Hopkins, V., 2016. Institutions, incentives, and policy entrepreneurship. Policy Stud. J. 44 (3), 332–348.
Hörisch, J., 2015. The role of sustainable entrepreneurship in sustainability transitions: a conceptual synthesis against the background of the multi-level perspective. Adm. Sci. 5 (4), 286–300.
Horne, J., 2019. The Sustainability Impact of New Ventures: Measuring and Managing Entrepreneurial Contributions to Sustainable Development. Technische Universität Berlin, Berlin.
Horne, J., Fichter, K., 2022. Growing for sustainability: enablers for the growth of impact startups – a conceptual framework, taxonomy, and systematic literature review. J. Clean. Prod. 349, 131163.
Horne, J., et al., 2020. Exploring entrepreneurship related to the sustainable development goals - mapping new venture activities with semi-automated content analysis. J. Clean. Prod. 242, 118052.
IPCC, 2007. Climate Change 2007, Synthesis Report, s.l.: Intergovernmental Panel on Climate Change.
Isaak, R., 2002. The making of the ecopreneur. Greener Manag. Int. (38), 81–92..
Jefferson, B., 2019. Tech companies still lagging on sustainability leadership [Online] Available at: https://www.triplepundit.com/story/2019/tech-companies-still-lagging-sustainability-leadership/85511. (Accessed 26 January 2020).
Katsikis, I.N., Kyrgidou, L.P., 2007. The concept of sustainable entrepreneurship: a conceptual framework and empirical analysis. Acad. Manag. Ann. Meet. Proc. 8 (1), 1–6.
Khoshnava, S.M., et al., 2019. Aligning the criteria of green economy (GE) and sustainable development goals (SDGs) to implement sustainable development. Sustainability 11 (17), 4615.
Kirtley, J., O'Mahony, S., 2020. What is a pivot? Explaining when and how entrepreneurial firms decide to make strategic change and pivot. Strat. Mgmt. J. 1–34. https://doi.org/10.1002/smj.3131.
Kollmann, T., 2021. Deutscher Startup Monitor, s.l.: Bundesverband Deutsche Startups e. V.
Kostoska, O., Kocarev, L., 2019. A novel ICT framework for sustainable development goals. Sustainability 11 (7), 1961.
Koudstaal, M., Sloof, R., van Praag, M., 2019. Entrepreneurs: intuitive or contemplative decision-makers. Small Bus. Econ. 53, 901–920.
Kratzer, J., 2020. Starting up in the age of sustainability. Curr. Opin. Green Sustain. Chem. 21, 89–92.
Kraus, S., et al., 2019. Digital entrepreneurship: a research agenda on new business models for the twenty-first century. Int. J. Entrep. Behav. Res. 25 (2), 353–375.
Kuckertz, A., Wagner, M., 2010. The influence of sustainability orientation on entrepreneurial intentions — investigating the role of business experience. J. Bus. Ventur. 25 (5), 524–539.
Leenders, R.T.A.J., van Engelen, J.M.L., Kratzer, J., 2003. Virtuality, communication, and new product team creativity: a social network perspective. J. Eng. Technol. Manag. 20 (1–2), 69–92.
Lyu, W., Liu, J., 2021. Artificial intelligence and emerging digital technologies in the energy sector. Appl. Energy 303, 117615.
Malerba, F., McKelvey, M., 2020. Knowledge-intensive innovative entrepreneurship integrating schumpeter, evolutionary economics, and innovation systems. Small Bus. Econ. 54 (2), 503–522.
Mayer, C., 2018. Prosperity : Better Business Makes the Greater Good. Oxford University Press, Oxford.
Meister, A.D., Mauer, R., 2019. Understanding refugee entrepreneurship incubation – an embeddedness perspective. Int. J. Entrep. Behav. Res. 25 (5), 1065–1092.
Middermann, L.H., Kratzer, J., Perner, S., 2020. The impact of environmental risk exposure on the determinants of sustainable entrepreneurship. Sustainability 12, 1534.
Miller, K.D., 2007. Risk and rationality in entrepreneurial processes. Strateg. Entrep. J. 1, 57–74.
Mole, K., Roper, S., 2012. The rational choice approach to entrepreneurship. In: Mole, K., Ram, M. (Eds.), Perspectives in Entrepreneurship: A Critical Approach. Springer Nature, London, pp. 13–26.
Nambisan, S., Wright, M., Feldman, M., 2019. The digital transformation of innovation and entrepreneurship: progress, challenges and key themes. Res. Policy 48 (8).
Nederhof, A.J., 1985. Methods of coping with social desirability bias: a review. Eur. J. Soc. Psychol. 15 (3), 263–280.
Nicholls, A., 2010. The legitimacy of social entrepreneurship: reflexive isomorphism in a pre-paradigmatic field. Enterp. Theory Pract. 34 (4), 611–633.
Nilsson, M., Griggs, D., Visbeck, M., 2016. Policy: map the interactions between sustainable development goals. Nature 534, 320–322.
Olteanu, Y., Fichter, K., 2020. Green Startup Monitor 2020. Borderstep Institut, Bundesverband Deutsche Startups e.V, Berlin.
Pacheco, D.F., Dean, T., Payne, D.S., 2010. Escaping the green prison: entrepreneurship and the creation of opportunities for sustainable development. J. Bus. Ventur. 25, 464–480.
Palmié, M., et al., 2021. Startups versus incumbents in 'green' industry transformations: a comparative study of business model archetypes in the electrical power sector. Ind. Mark. Manag. 96, 35–49.
Pankov, S., Velamuri, V.K., Schneckenberg, D., 2021. Towards sustainable entrepreneurial ecosystems: examining the effect of contextual factors on sustainable entrepreneurial activities in the sharing economy. Small Bus. Econ. 56, 1073–1095.
Parloff, R., 2018. How VW paid $25 billion for 'Dieselgate' — and got off easy. Fortune.
Parrish, B.D., 2010. Sustainability-driven entrepreneurship: principles of organization design. J. Bus. Ventur. 25, 510–523.
Peng, C.-Y.J., Lee, K.L., Ingersoll, G.M., 2002. An introduction to logistic regression analysis and reporting. Educ. Res. 96, 3–14.
Pielsticker, D.I., Hiebl, M.R.W., 2020. Survey response rates in family business research. Eur. Manag. Rev. 17 (1), 327–346.
Qin, X., Shepherd, D.A., Lin, D., Xie, S., Liang, X., Lin, S., 2022. The dark side of entrepreneurs' creativity: investigating how and when entrepreneurs' creativity increases the favorability of potential opportunities that harm nature. Enterp. Theory Pract. 46 (4), 857–883. https://doi.org/10.1177/1042258720915582.
Quilley, S., 2012. System innovation and a new 'Great Transformation': re-embedding economic life in the context of 'De-growth'. J. Soc. Entrep. 3 (2), 206–229.
Rand, D.G., et al., 2016. Social heuristics and social roles: intuition favors altruism for women but not for men. J. Exp. Psychol. Gen. 145 (4), 389–396.
Rashid, L., 2019. Entrepreneurship education and sustainable development goals: a literature review and a closer look at fragile states and technology-enabled approaches. Sustainability 11 (19), 5343.
Rashid, L., 2022. Bursting the bubble: why sustainability initiatives often lack adequate intention to action translation. Small Bus. Econ. 59, 1–9.
Rashid, L., Cepeda-Garcia, S., 2021. Self-categorising and othering in migrant integration: the case of entrepreneurs in Berlin. Sustainability 13 (4), 2145.

Rashid, L., Alzafari, K., Kratzer, J., 2020. Founder personalities, behaviors and new venture success in sub-saharan Africa. Technol. Forecast. Soc. Chang. 151, 119766.
Renko, M., Shrader, R.C., Simon, M., 2012. Perception of entrepreneurial opportunity: a general framework. Manag. Decis. 50 (7), 1233–1251.
Richter, C., et al., 2017. Digital entrepreneurship: innovative business models for the sharing economy. Creat. Innov. Manag. 26 (3), 300–310.
Ritzer, G., Miles, S., 2018. The changing nature of consumption and the intensification of McDonaldization in the digital age. J. Consum. Cult. 19, 3–20.
Rivera, M.B., Håkansson, C., Svenfelt, A., Finnveden, G., 2014. Including second order effects in environmental assessments of ICT. Environ. Model Softw. 56, 105–115.
Rosca, E., Agarwal, N., Brem, A., 2020. Women entrepreneurs as agents of change: a comparative analysis of social entrepreneurship processes in emerging markets. Technol. Forecast. Soc. Chang. 157, 120067.
Sarasvathy, S.D., 2004. Making it happen: beyond theories of the firm to theories of firm design. Enterp. Theory Pract. 28 (6), 519–531.
Satalkina, L., Steiner, G., 2020. Digital entrepreneurship and its role in innovation systems: a systematic literature review as a basis for future research avenues for sustainable transitions. Sustainability 12 (7), 2764.
Schaltegger, S., 2002. A framework for ecopreneurship: leading bioneers and environmental managers to ecopreneurship. Greener Manag. Int. 38, 45–58.
Schkade, D.A., Kahneman, D., 1998. Does living in California make people happy? A focusing illusion in judgments of life satisfaction. Psychol. Sci. 9 (5), 340–346.
Schneider, F., Kallis, G., Martinez-Alier, J., 2010. Crisis or opportunity? Economic degrowth for social equity and ecological sustainability. Clean. Prod. 11, 511–518.
Schönborn, G., et al., 2019. Why social sustainability counts: the impact of corporate social sustainability culture on financial success. Sustain. Prod. Consum. 17, 1–10.
Schwab, K., 2016. The Fourth Industrial Revolution. World Economic Forum, Geneva.
Scott, J., 2000. Rational choice theory. In: Browning, G., Halci, A., Webster, F. (Eds.), Understanding Contemporary Society: Theories of the Present. Sage, London, pp. 126–138.
Shepherd, D.A., Patzelt, H., Baron, R.A., 2013. "I care about nature, but …": disengaging values in assessing opportunities that cause harm. Acad. Manag. J. 56 (5), 1251–1273.
Song, A.K., 2019. The digital entrepreneurial ecosystem—a critique and reconfiguration. Small Bus. Econ. 53 (3), 569–590.
Spence, M., Ben Boubaker Gherib, J., Ondoua Biwolé, V., 2011. Sustainable entrepreneurship: is entrepreneurial will enough? A North–South comparison. J. Bus. Ethics 99, 335–367.
Startup Genome, 2020. Global Startup Ecosystem Report 2020. s.l.: Startup Genome.
Steininger, D., 2019. Linking information systems and entrepreneurship: a review and agenda for IT-associated and digital entrepreneurship research. Inf. Syst. J. 29 (2), 363–407.
Stuermer, M., Abu-Tayeh, G., 2017. Digital sustainability: basic conditions for sustainable digital artifacts and their ecosystems. Sustain. Sci. 2 (247–262), 12.
Surana, K., Singh, A., Sagar, A.D., 2020. Strengthening science, technology, and innovation-based incubators to help achieve sustainable development goals: lessons from India. Technol. Forecast. Soc. Chang. 157, 120057.
Sussan, F., Acs, Z.J., 2017. The digital entrepreneurial ecosystem. Small Bus. Econ. 49, 55–73.
Teran-Yepez, E., Marin-Camillo, G.M., Casado-Belmonte, M.P., Capobianco-Uriarte, M., 2020. Sustainable entrepreneurship: review of its evolution and new trends. J. Clean. Prod. 252.
Torres, P., Augusto, M., 2020. Digitalisation, social entrepreneurship and national well-being. Technol. Forecast. Soc. Chang. 161, 120279.
Trajkovska, B., 2018. Berlin's startup ecosystem at a glance [Online] Available at: https://www.eu-startups.com/2018/12/berlins-startup-ecosystem-at-a-glance/. (Accessed 17 February 2021).
United Nations, 2020. United Nations releases special 2020 broadcast calling for collective action [Online] Available at: https://www.un.org/sustainabledevelopment/blog/2020/09/united-nations-releases-special-2020-broadcast-calling-for-collective-action/. (Accessed 11 April 2020).
Voinov, A., 2017. In: Participatory Modeling for Sustainability. Encyclopedia of Sustainable Technologies, pp. 33–39.
Volkmann, C., Fichter, K., Klofsten, M., Ausdretsch, D.B., 2019. Sustainable entrepreneurial ecosystems: an emerging field of research. Small Bus. Econ. 1–9.
de Vries, A., 2020. Bitcoin's energy consumption is underestimated: a market dynamics approach. Energy Res. Soc. Sci. 70, 101721.
Vuorio, A.M., Puumalainen, K., Fellnhofer, K., 2018. Drivers of entrepreneurial intentions in sustainable entrepreneurship. Int. J. Entrep. Behav. Res. 24 (2), 359–381.
Wagner, M., 2012. Ventures for the public good and entrepreneurial intentions: an empirical analysis of sustainability orientation as a determining factor. J. Small Bus. Entrep. 25 (4), 519–531.
Welter, F., Baker, T., Audretsch, D.B., Gartner, W.B., 2016. Everyday entrepreneurship—a call for entrepreneurship research to embrace entrepreneurial diversity. Enterp. Theory Pract. 41 (3), 311–321.
Wenzel, F., 2017. Sustainable digital business: crucial success factor for small and medium-sized enterprises and start-ups. In: Osburg, T., Lohrmann, C. (Eds.), Sustainability in a Digital World. Springer, Cham, pp. 131–144.
Yamane, T., Kaneko, S., 2021. Is the younger generation a driving force toward achieving the sustainable development goals? Survey experiments. J. Clean. Prod. 292 (125932).
Ye, Q., et al., 2020. Entrepreneurs and environmental sustainability in the digital era: regional and institutional perspectives. Int. J. Environ. Res. Public Health 17 (4), 1355.
Zaheer, H., Breyer, Y., Dumay, J., 2018. Digital entrepreneurship: an interdisciplinary structured literature review and research agenda. Technol. Forecast. Soc. Chang. 148.
Zaheer, H., Breyer, Y., Dumay, J., Enjeti, M., 2022. The entrepreneurial journeys of digital start-up founders. Technol. Forecast. Soc. Chang. 179, 121638.
Zaki, M., 2019. Digital transformation: harnessing digital technologies for the next generation of services. J. Serv. Mark. 33 (4), 429–435.

Prof. Dr. Thorsten Lammers is Professor for Deep Tech Entrepreneurship at XU Exponential University of Applied Sciences in Potsdam and Adjunct Associate Professor at the University of Technology Sydney. He focusses on wider societal implications of digital transformation, such as sustainability impacts and knowledge spillovers in deep tech startup ecosystems. Thorsten designs and teaches classes in the areas of digital and AI strategy, smart operations management and complex systems modeling. Before that, he worked as a consultant in the fields of technology and operations management. Thorsten holds a doctorate in business administration and a postgraduate degree in Physics.

Dr. Lubna Rashid is a postdoctoral researcher at the TU Berlin's Chair of Entrepreneurship and Innovation Management, conducting research at the intersection of entrepreneurship, digitalization, and sustainability, particularly in contexts of fragility and crisis. She is also affiliated with the Humboldt Institute for Internet and Society in Berlin. Lubna is primarily a quantitative researcher with academic backgrounds in genetics, health systems, and management of technology. She was born in Iraq and has previously worked with several activist groups, consultancies and social entrepreneurs across the USA, Europe and the Arab world.

Prof. Dr. Jan Kratzer is Chaired Professor for Entrepreneurship and Innovation Management and Founder/Academic Director of Centre for Entrepreneurship (CfE) at Technische Universität Berlin, Germany. He is in the editorial board of "Creativity and Innovation Management" (CIM), "Journal of Product Innovation Management" (J-PIM), "Sustainability" and "Highlights of Sustainability". His research is mainly on factors that drive sustainable entrepreneurial and innovation activities, online and offline social networks and the human side of innovations. His work has appeared among more in Journal of Cleaner Production, Journal of Consumer Research, Research Policy, Journal of Product Innovation Management and Technological Forecasting and Social Change.

Alexey Voinov is Professor of Persuasive Systems Modeling for Sustainability Science in the Department of Water Management, Faculty of Engineering Technology (FET). Earlier he was a Distinguished Professor and director of the Center on Persuasive Systems for Wise Adaptive Living (PERSWADE) at the Faculty of Engineering and IT at University of Technology Sydney, Australia. Before he was professor at ITC, University of Twente. Prior to that he was coordinating the Chesapeake Research Consortium Community Modeling Program, and was also Principal Research Scientist at John's Hopkins University, USA. He has spent one year with the AAAS Science and Technology Fellowship program working with the US Army Corps of Engineers. For over ten years he was with the Institute for Ecological Economics, Univ. of Maryland and Vermont. He has his MSc and PhD from Moscow State University, Russia.