BACKGROUND PAPER

Adoption of Digital Technologies, Business Model Innovation, and Financial and Sustainability Performance in Startup Firms

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DISCLAIMER

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I. Introduction

Over recent decades, advances in digital technologies have precipitated a major structural transformation in the organization of society and the economy. Ubiquitous digital connectivity has enabled economic and societal processes to be increasingly reorganized to take advantage of digital technologies. This process has transformed also the context within which entrepreneurs discover and pursue entrepreneurial opportunities and compete against established firms (Nambisan 2017). Arguably, the most important characteristic of digital technologies is their ability to enable business model innovation – i.e., a radical rethink of how entrepreneurial businesses organize for the creation and delivery of customer value and capture this value as business profit (Bouwman, Nikou, and De Reuver 2019; Massa and Tucci 2013; and Rachinger, Rauter, Müller, Vorraber, and Schirgi 2019). This is a particularly important opportunity driver for entrepreneurs, as established businesses tend to focus on optimizing their existing business models, which may hamper their ability to take advantage of the latest digital opportunities (Autio, Nambisan, Thomas, and Wright 2018). Yet, surprisingly little is known about the performance effects of digital technology adoption by entrepreneurial businesses. In this report, we explore such performance effects by means of a six-country survey of digital entrepreneurial businesses.

Although the importance of digitalization and its impact on entrepreneurship through business model innovation are widely recognized (Autio et al. 2018), surprisingly little is still known about the firm-level performance effects of the adoption of digital technologies in the business model (Bouwman et al. 2019). There is widespread acceptance that digitalization has a transformative effect on entrepreneurial opportunity landscapes in countries and on the optimal modes of entrepreneurial opportunity pursuit. Because of digitalization, entrepreneurial activities have become less constrained by spatial, temporal, and sectoral boundaries (Nambisan 2017). The digitally induced lifting of conventional constraints limiting entrepreneurial agency means that entrepreneurial opportunity pursuit has become a viable occupational option to larger audiences than ever before. At the same time and largely because of the same reasons, the effective means of pursuing entrepreneurial opportunities have been transformed, with entrepreneurs increasingly adopting innovation techniques and practices originally pioneered elsewhere, such as Design Thinking, Design Sprints, Growth Hacking, and Agile Development (Brown 2009, Kimbell 2009, Contigiani and Levinthal 2019, and Bocken and Snihur 2020). Such ideas have prompted a novel, iterative approach to entrepreneurial opportunity discovery and validation, often referred to as “lean entrepreneurship” (Blank 2013, and Ries 2011). The lean entrepreneurship approach builds on the insight that entrepreneurial opportunities seldom appear readily formed, in the “market”, ready to be exploited by entrepreneurs. Instead, opportunities need to be gradually created and shaped through entrepreneurial experiments by which the entrepreneur tests ideas and hunches, discarding those that do not appear to work, and retaining those that receive supportive feedback (Camuffo, Cordova, Gambardella, and Spina 2019; Dimov 2016; and Romme and Reymen 2018). In the boundaryless and interconnected digital world, steady-state, independently existing and objectively discoverable ”market opportunities” have become a rarity, and enterpreneurs are better off by harnessing digital technologies for an iterative process of opportunity development.

The above narrative rests on two important assumptions: (i) the adoption of digital technologies enables entrepreneurs to experiment more effectively; and (ii) the validated ideas are operationalized through their incorporation in the firm’s business model, or its operational architecture for the discovery, creation, delivery, and capture of customer value. These assumptions imply that both the adoption of digital technologies in themselves, and the iterative experimentation with these in the firm’s business model, should constitute important drivers of entrepreneurial firm performance in the digital age. If entrepreneurs shape and pursue opportunities more effectively through iterative experimentation, and if that experimentation is

enhanced by the adoption of digital technologies, both should support more effective opportunity development and, therefore, enhance the performance of entrepreneurial new businesses. However, these assumptions have been seldom subjected to a direct empirical test, and the few tests that have been conducted have mostly taken place in the context of high-income Western economies, with only rare exceptions (Bouwman et al. 2019; Camuffo et al. 2019; Ferreira, Fernandes, and Ferreira 2019; and Liu, Liu, and Gu 2021). The evidence regarding the impact of digitalization on entrepreneurial performance remains scarce in general and particularly so for emerging economies. This is an important gap, since emerging economies arguably stand to benefit the most from digitalization, as digital technologies offer the opportunity of catching up through leapfrogging steps conventionally required to advance economic development (Michelle 2009; and Xiong, Wang, Yan, Xu, and Huang 2021).

We address this gap by means of an interview survey of ”digital entrepreneurs” in six countries of the Association of Southeast Asian Nations (ASEAN): Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam. In a project sponsored and coordinated by the Asian Development Bank and conducted in collaboration with research teams from six leading academic institutions from the six ASEAN countries, we identified and interviewed a population of 685 digital entrepreneurs in these countries, focusing particularly on their adoption of digital technologies in their business models, their business model experimentation activities, and explored the implications of these processes for the business performance, and also for their performance in terms of conforming to and advancing the United Nations' Sustainable Development Goals. We designed novel operationalizations of business-level digitalization and business model experimentation in order to test mediating relationships between digitalization, business model experimentation, and business and sustainability performance. Our structural equation modelling analysis reveals that the adoption of digital technology by entrepreneurial businesses is a potent enabler of business model experimentation, which in turn is a potent driver of business and sustainability performance. Our analysis also shows that the adoption of digital technologies also exercises a strong direct effect of business and sustainability performance in addition to its mediating effect through business model experimentation, revealing that digital technologies have broad performance implications for entrepreneurial businesses.

Our analysis makes several important contributions. First, this is one of the relatively few studies the contribute insight on the relationships between business model digitalization, business model experimentation, and business and sustainability performance. The evidence contributed in this study should help inform the design of entrepreneurship and digitalization policies. Second, we contribute first-hand evidence on the effect of digitalization on the performance of entrepreneurial businesses in developing Asian economies, thereby addressing an important gap. Third, we provide a theory-grounded account of how and why digitalization should impact performance in entrepreneurial new businesses, thereby illuminating the mechanics of this important dynamic. Fourth, we contribute new and enhanced operationalizations of business model experimentation, digital technology adoption in business models, and sustainability performance, thereby facilitating further data collection in this domain. Finally, we contribute reflections and insights for entrepreneurship policy design.

This report is structured as follows. We next review theorizing on digitalization, business models, and entrepreneurship. This review introduces key features of digitalization, how it enables business model innovation, and how it shapes and transforms entrepreneurship and entrepreneurial opportunity pursuit. We then construct our theoretical model, which explicates relationships between business model digitalization, business model experimentation, and business and sustainability performance. We then describe our empirical design and present our methods, analysis, and findings. We conclude by discussing implications for policy and practice.

II. Digitalization, Business Model Innovation, and Entrepreneurship

A. Transformative Properties of Digital Technologies and Infrastructures

Digital technologies possess several features that distinguish them from other advanced technologies and explain why they are exercizing such a transformative impact on society. The key distinguishing feature of digital technologies is the very fact that they are digital and not physical, in the sense that digital technologies are defined by their digital and logical features and less by their physical characteristics (Yoo, Boland Jr, Lyytinen, and Majchrzak 2012). Digital technologies are Turing machines: they accept bits as input and produce bits as outputs. In other advanced technologies, the key properties of the technology – and therefore, the technological effect produced – are coded in physical arrangements of atoms in matter. A machine tool shapes physical objects with sharp blades that have themselves been machine tooled into desired form. An engine creates rotational movement by harnessing the power of burning fuel that is channeled to pistons that operate a rotating axis. A laser cutting device creates the desired cutting effect by concentrating large amounts of wave-synchronized electromagenetic radiation into a small space. In contrast to desired technical effects produced through manipulating physical arrangements of atoms in matter, digital devices manipulate information, as expressed in bits. Although those bits, too, are ultimately coded in physical media (e.g., electrons, photons), what matters for the operation of the digital device is the arrangement of those bits in the abstract, and the logical algorithms they can be designed to accomplish. As digital devices accept bits as inputs, and as the instruction sets that inform how to process inputs are themselves expressed as bits, digital devices can be flexibly reprogrammed to perform different functions with minimal cost and energy expenditure. In contrast, physical technologies are asset specific: they cannot be easily repurposed to perform different functions without significant loss of utility or significant expenditure of energy (Tilson, Lyytinen, and Sørensen 2010).

The reprogrammability and consequent flexibility of digital technologies means that digital technologies are generic technologies: they can be flexibily combined with other technologies and programmed to perform or enhance virtually any desired function in any sector. As generic technologies are adapted through the economy, they will inevitably precipitate changes in how the economy organizes its functions and open opportunities through their innovative application and through the enablement of new functionalities (Yoo et al. 2012). The impact of digital technologies is particularly pervasive, since digital programmability enables the coding of complex and knowledge-intensive functions that might not have been possible before. This feature, then, is the key driver of digitalization, or the application of digital technologies in the economy and society such that those technologies become infrastructural (Tilson et al. 2010). Through the process of digitalization, digial technologies and infrastructures become a core element of the context in which business firms organize for the creation, delivery, and capture of economic and customer value, allowing these to perform desired functions in radically new ways. A core aspect of the process of economic digitalization is that through their pervasive application, digital technologies open up new opportunities for innovative combination of existing functions and across product and sector boundaries. This makes digitalization a potent driver of combinatorial innovation – i.e., the creation of new functions and functionalities by combining existing functions (Henfridsson, Nandhakumar, Scarbrough, and Panourgias 2018). This dynamic drives digitally-induced structural transformation by breaking down barriers that used to separate conventional industry sectors. As all industry sectors increasingly rely on the pervasive digital infrastructure for their operation, opportunities to fundamentally re-think how the economy and society might work are

created and the prospect of novel combinatorial innovations enhanced, opening unprecedented opportunities for entrepreneurs to discover, invent, and advance new digital reality.

When considering the effects of digitalization on the organization of economic, innovative, and entrepreneurial activity, it is useful to distinguish between three manifestations of digital technologies: digital artifacts, digital platforms, and digital infrastructures (Nambisan, 2017). Digital artifacts are digital components, applications, or digital content and media (including data and machine learning algorithms) that offer specific functionalities or value to the end user (Kallinikos, Aaltonen, and Marton 2013). Many digital artifacts result from digitally-induced servitization by which existing, often physical services are encoded into digital form (e.g., fintech applications), on the one hand, or by which physical artifacts are servitized by wrapping them into a digital envelope (e.g., redefining conventional car ownership as a service offered as part of a digitally coordinated mobility service). Such artifacts exploit the ability of digital technologies to decouple physical form from related information (Cecez-Kecmanovic, Galliers, Henfridsson, Newell, and Vidgen 2014). This enhances combinatorial flexibility, as digital artifacts can be easily combined with one another and with digital platforms to enable new functionalities and applications, thereby boosting innovative experimentation with novel combinations.

Digital platforms are shared sets of services, architectures, interfaces, and technical standards that enable many hierarchically independent stakeholders to make their offerings available to wide audiences and combine their digital artifacts with those of others (Gawer 2020; Gawer and Cusumano 2008; Thomas, Autio, and Gann 2014; Van Alstyne, Parker, and Choudary 2016). Although digital platforms operate as an important medium for distributing and accessing digital artifacts, they also operate their own dynamic, as platform owners seek to harness generativity and network effects for the creation and capture of economic and user value through, e.g., data network effects (Gregory, Henfridsson, Kaganer, and Kyriakou 2020). By operating as venues that enable large, non-hierarchically related audiences to coordinate and combine their activities, digital platform ecosystems have emerged as an important novel form of economic organization in their own right, operating as hubs of wide-ranging activity systems (Thomas and Autio 2020). So doing, they have been transforming entrepreneurial opportunity landscapes and greatly expanding the reach of entrepreneurial opportunities to new audiences previously disconnected from them.

Digital infrastructures are defined as digital technology tools and systems that offer connectivity, communication, collaboration, and computing capabilities to support innovation, entrepreneurship, and other forms of economic activity (Nambisan, 2017). Digital infrastructures provide the fabric that underpins and enables modern societies. Because of mobile connectivity, edge computing, Internet of Things, cloud computing, and other connectivity technologies and digital resources, virtually anything anywhere can be connected to digital infrastructures at any time, thereby bringing all elements and operators of society into the realm of digitally-induced servitization and combinatorial innovation. A defining characteristic of digital infrastructures is exactly their ubiquitous connectivity and ease of access. They are distinguished from digital platforms in that most digital platforms tend to be proprietary and service a defined purpose, whereas the key function of digital infrastructures is to provide ubiquitous connectivity and access to digital resources and act as the enabler of digital society.

B. Digital Technologies and Business Model Innovation

Business models define the activity architecture of a given business for the creation, delivery, and capture of economic and social value (Amit and Zott 2001; Zott and Amin 2016; Zott and Amit 2010). In other words, they define the configuration of all aspects of the operations of a business firm, from partnerships to

production and manufacturing, to customer interactions, revenue generation, and cost structures. At the core of the business model is its value offering that defines which value the business creates and delivers for its different internal and external stakeholders. So doing they also describe the firm's business logic (Teece 2010). The literature typically identifies three major functions for business models: they describe the firm's 'way of doing business'; they describe how the firm facilitates opportunity development; and they describe how the firm commercializes new ideas and technologies (Spieth and Schneider 2016). While some conceptualizations of business models can be static (e.g., descriptions of the activity architecture of the business), most emphasize the dynamic aspects of innovation and value creation.

For our discussion, it is useful to emphasize the dynamic aspects of business models and consider them as interaction systems for the creation, delivery, and capture of economic and societal value. This conceptualization is consistent with the emerging reality of digitalization, which is blurring traditional industry boundaries and enabling new modes of connectivity among economic and societal actors. Compared to conventional strategic management, which tended to emphasize the choice of where to compete, the art of business model design very much emphasizes the operationalization of the firm's strategy through the design of its interaction system for value creation, delivery, and capture.

The concept and practice of business models and business model innovation has gained prominence in step with advances in digitalization in society – so much so that many of the influential early ideas were borrowed from information systems research and proposed by information systems researchers (Amit and Zott 2001; Osterwalder and Pigneur 2010). This intellectual inheritance is easy to understand when one considers that a key application area for digital technologies has always been in business information systems, and the design of business information systems entails the mapping and abstraction of all activities of a given business, so that these can be coded into algorithmic form. With the emergence of the Internet and particularly cloud computing technologies and infrastructures, previously closed and company-specific information systems have increasingly come to rely on external digital infrastructures, resources, and technologies for the performance of desired functions. Digitalization operates upon layered digital infrastructures, where lower-level layers (e.g., physical layer, transmission layer) enable and support user-facing functionalities at higher, user-facing layers (e.g., operating systems layer, application layer) (Tilson et al. 2010; Yoo, Henfridsson, and Lyytinen 2010). These infrastructures are characterized by upward and downward flexibility across layers. Upward flexibility means that the lower levels of the digital infrastructure can support the creation of virtually any application that makes use of the lower-level capabilities. Downward flexibility refers to the ability of any given application to draw potentially on a wide range of lower-level layers to generate the desired functionalities and generally enable novel ways of organize economic activity (Tilson et al. 2010). Where physical manufacturing activities tend to be organized along linear, upstream-branching value chains because of modular product architectures and co-specialization between given products and associated productive assets, digitalization tends to break such linear dependencies and re-organize value-creating processes around digital platforms characterized by horizontal relationships (Autio and Thomas 2016; Baldwin and Clark 1997; Yoo et al. 2012). Because of the sweeping impact of digitalization, business model innovation has arguably become the dominant form of innovation today.

C. Digitalization and Entrepreneurship

Before constructing our theoretical model, we briefly review the key consequences of digitalization on entrepreneurial agency and entrepreneurial opportunity pursuit. Two important effects are relevant for our discussion here. First, digitalization expands the scope of entrepreneurial opportunities by blurring various boundaries: (i) those that surround products and services, (ii) those that define industry sectors, and (iii)

those that define entrepreneurial opportunities themselves (Nambisan 2017). With digitalization, product systems have become increasingly modular, partly because of the general modularization of product structures, partly because of the inherent combinability of digital technologies (Baldwin and Clark, 1997). Modularization enhances openness, as standardized interfaces between modules enable more unconstrained innovation and production of new functionalities encoded in modules. With modularization and combinability, products and services evolve into open systems, where entrepreneurial operators can offer innovative, functionality-enhancing inputs. Earlier examples of the entrepreneurial opportunity-enhancing effects of this dynamic were visible in the PC industry. More recent well-known examples can be seen, for example, in the smartphone sector, where mobile app stores host innovative applications developed by thousands of independent developers. When it comes to industry sectors, the boundary-blurring effect of digital infrastructures was noted earlier. As different sectors increasingly rely on the shared digital infrastructure and digital resources accessible therein, opportunities for the creation of innovative, sector-spanning combinations grow exponentially. For example, running shoes could be equipped with a motion sensor that can be connected to the smartwatch, enabling the automatic sharing of running routes in online running communities, and perhaps even the creation of new life insurance products that charge lower premiums from those individuals who are more physically active. Finally, entrepreneurial opportunities themselves are growing less bounded through digitalization. As digitalization blurs the clean separation between ”products” and ”markets” as the result of the reorganization of economic activities around platform ecosystems, this development emphasizes the importance of opportunity creation and decreases the importance of opportunity discovery (Alvarez and Barney 2007). With digitalization, opportunity creation becomes a collaborative process, as hierarhically independent actors test ideas and learn from one another. Different actors active in platform ecosystems test new ideas and react to those presented by others. Opportunities for collaboration are actively pursued, often without having a clear idea of where the collaboration will lead. This dynamic embeds the logic of iterative opportunity creation in platform ecosystems, redefining how entrepreneurs can best pursue economic opportunities.

Finally, we note the facilitating effect of digitalization on entrepreneurial experimentation, which has contributed to the emergence of Lean Entrepreneurship heuristic. Because of reprogrammability, digital technologies can be cheaply and flexibly modified to test alternative product and service versions and different collaborative arrangements. Entrepreneurs can test different ideas very quickly and almost without cost by modifying their descriptions of their value offerings in their web pages and monitor the reactions of potential customers virtually real time. Social media platforms can be harnessed for quick feedback, and their data analytics resourecs can be flexibly harnessed to identify market niches that would have been impossible to identify and service in the pre-digital era. Therefore, the Lean Entrepreneurship heuristic is a product of an increasingly collaborative mode of opportunity creation facilitated by the migration of economic activity towards platform ecosystems, on the one hand, and of the increased ease, speed, and flexibility of entrepreneurial experimentation with different value offerings and organizational arrangements, on the other.

Concluding, digitalization is shaping entrepreneurship by transforming entrepreneurial opportunity landscapes and the heuristics of entrepreneurial opportunity pursuit. As a result of digitalization, entrepreneurship has been transformed from a planning discipline to a design discipline. Traditionally, entrepreneurs were expected to carefully study markets to spot market opportunities. Then, they were required to draft careful plans for addressing that opportunity, including team formation, investment plans, funding plans, and risk assessment. Armed with a business plan, they would raise funding with which they proceeded to executing the plan. The heuristic thus progressed from market research to opportunity discovery to business planning and, eventually, to execution. In the interactive, a dynamic digital world,

where product boundaries are porous and different operators connect through nonhierarhical digital platforms, this discovery logic has been replaced by the logic of co-evolution and experimentation. In this logic, instead of planning preceding action, action precedes planning. The process of entrepreneurial opportunity creation begins with action: small-scale experiments designed to get feedback and better understand the constantly evolving opportunity landscape. Small experiments solicit feedback, but they also prompt reactions from other stakeholders, thereby triggering a process of learning and co-evolution. The insights from repeated experiments are encoded gradually in the new venture's evolving business model, which not only defines its evolving value offering, but also the interaction system that ultimately creates and delivers that value offering to prospective customers. Essential to the success of this process is the speed and effectiveness with which the entrepreneur learns from their experiments and converts these into business model practices..

III. Theoretical Model of Digitalization, Business Model Experimentation, and Entrepreneurial Performance

With the preceding discussion of digitalization and its effects on business model innovation and entrepreneurship, we now present our theoretical model. The model builds on the premise that digitalization as an infrastructural process that shapes the context where all economic actors conduct their business. This means that the impact of digitalization is not limited to a specific category of 'digital' businesses only. Instead, the inferences encapsulated in the model should apply to any type of business firm, regardless of sector. Our model consolidates the insights from the preceding review into four hypotheses, as elaborated below.

First, we expect that digital technology adoption by entrepreneurial businesses drives business model experimentation in those businesses. As noted above, digital technologies are Turing technologies: they can be flexibly reprogrammed to perform different functions at low cost. Low-cost reprogrammability, which can take the simple form of modifying the firm's web page, makes it cheaper to experiment with alternative value offerings. Further, digitalization reduces asset specificity and enables the outsourcing of business activities that previously had to be built through in-house capability development (Afuah 2003; Mani, Barua, and Whinston 2010; and Whitaker, Mithas, and Krishnan 2010). By outsourcing, firms contract out activities previously performed in-house. Although the outsourcing of manufacturing activities has been a well-established and researched trend since the early 1990s, business process outsourcing has started to gather momentum only during this millennium, as functional service providers have become more sophisticated and multinational enterprises (MNEs) have become more adept at standardizing their business processes (Davenport 2005; Jean, Sinkovics, and Cavusgil 2010; Karmarkar 2004; Lahiri and Kedia 2011; and Lewin and Volberda 2011). Increasingly accessible to new and small ventures, these trends afford internationalizing ventures with greater flexibility in organizing their international operations. A particularly notable trend is the standardization of offshoring services, as "software-as-a-service" (SaaS) applications are increasingly available for internationalizing new ventures (e.g., Basecamp or Trello for distributed project management; Infusionsoft for customer email management; or Freshbooks for accounting services) (Di Gregorio, Musteen, and Thomas 2008). These developments enable entrepreneurial new businesses considerable latitude when configuring their business operations for value creation, delivery, and capture, including experimenting with alternative business model arrangements. We therefore predict:

H1 *Greater adoption of digital technologies by an entrepreneurial business is associated with greater propensity for business model experimentation.*

Second, we expect that business model experimentation is associated with enhanced business performance. With digitalization, the boundaries of products and services become increasingly blurred, enabling other operators to connect with them and potentially combine them with their own offerings – an activity that is quite common in digital platform ecosystems. Above, we noted the general trend towards co-evolutionary creation of entrepreneurial opportunities that is increasingly replacing conventional modes of entrepreneurial opportunity pursuit, which were based on the discovery of independently existing entrepreneurial opportunities, as set up by static market conditions. With platformization, economic activities are reorganized around platform ecosystems characterized by non-hierarchical relationships, as opposed to pre-defined, 1-to-1 supplier contracts that characterize conventional supply chains. As organic structures, platform ecosystems emphasize mutual adjustment. Digital technologies allow entrepreneurial businesses to flexibly experiment with different kinds of organizational arrangements for value creation, delivery, and capture. The low cost of experimentation enables entrepreneurial businesses to quickly

discover business model practices that work and discard those that do not. As business models define the firm's activity architecture for value creation, delivery, and capture, we predict:

H2 Greater intensity of business model experimentation is associated with better business performance.

While we expect business performance to be the overriding goal of entrepreneurial businesses, we also note the trend towards a stakeholder orientation in business, by which entrepreneurial businesses and established businesses alike have begun to emphasize the responsibilities of the business towards societal and natural environmental stakeholders at large, along with their responsibilities towards their immediate shareholders. The increasing adoption of a "stakeholder thinking" (as opposed to the more narrow "shareholder thinking") means that, when new business firms optimize their activitity systems, they may have more goals in mind than simply increasing economic profitability. We expect that, alongside with business performance, entrepreneurial businesses are increasingly aware of their responsibilities towards their natural environments, their social communities, and their waried stakeholders. We, therefore, expect that when entrepreneurial businesses experiment to enhance their business performance, they will also seek to optimize their impact on their natural and social environments and their stakeholders at large. We, therefore, predict:

H3 Greater intensity of business model experimentation is associated with better sustainability performance.

Finally, we predict that at least some of the impact of digital technology adoption is mediated through the facilitating impact of digital technologies on business model experimentation:

H4 The effect of digital technology adoption on business and sustainability performance is partially mediated through the effect of digital technology adoption on business model experimentation.

We next elaborate on how we tested these hypotheses.

IV. Methods

A. Sample and Data Collection

We tested the theoretical model with a questionnaire interview survey of a total of 685 digital entrepreneurial businesses in six ASEAN countries: Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam. A ”digital entrepreneurial business” was defined as an independent business firm, which was owner-managed by an entrepreneur or team of entrepreneurs, and which applied digital technologies in its business model. The final criterion was intentionally defined quite loosely: we did not want to confine our analysis to select, ”digital” sector only. Instead, we wanted to capture the phenomenon of digitalization more broadly and its effect on new start-up firms in any sector, consistent with our portrayal of digitalization as an infrastructural process that affects all sectors in society and economy. We are also interested in sampling modern start-ups that were more likely to have been exposed to the digital start-up culture and compete with innovative business models and related offerings.

In identifying start-ups that belonged to our population of interest, several techniques were used. When possible, start-ups were catalogued by tracking tenants of new venture accelerators and co-working spaces. Where available, we referenced member catalogues of national start-up associations, software business associations, and similar. Policy agencies working with start-up companies were consulted for references. We also identified entrepreneurial start-ups from business press and start-up events. These leads were followed up by a snowballing technique, under which we asked the identified start-ups to name similar companies that they were aware of.

In each country, we had a team of researchers, led by a well-reputed academic from a highly regarded university. This team was in charge of identifying the target population and collecting the data. All data were collected by means of a closed-format interview questionnaire, which also included some open-ended questions. We used trained interviewers (typically, Masters-degree business students) to conduct the interviews. The purpose of the research was explained to the interviewers, and we went through the entire questionnaire in detail to ensure that the interviewers understood exactly what kind of data we were looking for. Because of the coronavirus disease (COVID—19) situation, the interviews were carried out over zoom or by telephone. The interview records were then compiled and harmonized centrally before analysis.

B. Questionnaire Design

The interview questionnaire was designed in English language by the study’s two lead authors and finalized in video meetings with all teams attending. The questionnaires were translated to local languages and back translated to English to check translation accuracy. The English-language questionnaire is provided in Appendix 2.

The questionnaire composed of five sections: (1) background of the business and entrepreneur; (2) description of the business; (3) business model and digitalization; (4) sustainability performance; and (5) business performance. Likert-style statement scales were designed to capture qualitative constructs, which comprised the main independent and outcome variables surveyed.

1. Control Variables

The **main control variables** included in the questionnaire were:

(i) age of the business in years (question: ’What year did your company start doing business?’)

(ii) employee size of the business, specified as number of full-time equivalents; and
(iii) country dummies (1=yes) to indicate the home country of the business (Indonesia as base, other countries indicated as dummies)

2. Independent Variables

The main independent variables in the questionnaire were: (1) reliance on digital technologies in the business (two scales), (2) application of digital technologies in the firm's business model (four scales), and (3) business model experimentation.

Reliance on digital technologies. The reliance of the business on digital technologies was measured with 12 items that queried the reliance of the business on different digital technologies. Five-step Likert scale was used, ranging from "not at all" (= 1) to "all the time" (= 5). The technologies queried ranged from mundane (e.g., company homepage and website, mobile phones and smartphones, fixed-line internet) to more sophisticated (e.g., our own mobile applications, machine learning, cloud computing, Internet of Things, distributed ledgers). A factor analysis (principal component analysis with Varimax rotation) was performed subsequently to check the loadings of individual items on different factors. Two factors emerged with Eigenvalues greater than 1 and clean loadings (i.e., no individual items loaded strongly on both factors):

(i) reliance on Mobile and Web applications (our business relies on (1) our own mobile applications, and (2) our own applications in the Internet); and
(ii) reliance on industrial internet technologies (our business relies on (1) Internet of Things (IOT), Industrial Internet of Things (IIOT); (2) Robotics, intelligent machinery; and (3) Blockchain, distributed ledgers).

The scale values were then computed as weighted averages of individual statements, using factor loadings as weights.

Application of digital technologies in the firm's business model. The application of digital technologies by the business queried how the businesses used digital technologies in different aspects of their business model. For these scales we sought inspiration from previous literature on digitalization and business models (e.g., Bouwman et al. 2019; Parida, Sjödin, and Reim 2019; Proksch, Rosin, Stubner, and Pinkwart 2021). Consistent with received conceptualizations, we defined a business model as the firm's architecture of activities for the creation, delivery, and capture of customer value (Zott and Amit 2007, 2010). Drawing on and inspired by received theory, previous empirical operations, and our own reasoning, we designed the questionnaire to incorporate a total of 23 statements querying the application of digital technologies in four aspects of the firm's business operations: (1) internal activities (8 items); (2) marketing, sales, and customer interactions (7 items); (3) products and services (3 items); and (4) partnerships (4 items). Principal component analyses yielded four factors with Eigenvalues greater than 1. After removing items with no strong loadings on any factor and items with strong loadings on more than one factor, a total of 17 individual items were retained: six for internal activities; six for marketing, sales, and customer interactions; three for products and services; and two for partnerships. The scale values were computed as weighted averages of individual statements, using factor loadings as weights. The scale compositions are shown in Table 1.

Table 1: Application of Digital Technologies in the Firm's Business Model: Scale Composition

We are interested in how you use digital technologies in your business. How well do the following statements describe your operations? (1=not at all … 5=perfectly)	
Scale	**Items**
Internal activities	Our human resource processes are fully digitalized (e.g., salary payments, recruitment, training…)
	Our customer management system and customer databases are fully digitalized
	Our accounting system is fully digitalized
	We use digital technologies and data to optimize our manufacturing, service, and logistics
	We use digital technologies for resource and inventory planning
	We are a fully data-driven company
Marketing, sales, customer interactions	We advertise our products and services primarily through digital channels
	We constantly use social media to interact with customers (e.g., Facebook, Instagram, TikToK, LinkedIn, Twitter, Line)
	We constantly monitor how our customers interact with our website and social media (e.g., clicks, views, etc)
	Our customers can order or pay online (or both)
	We actively monitor our online ratings and customer reviews online
	We operate our own online user community
Product and service	Our products and services are fully digital
	Our products and services are connected to a mobile app
	We use digital platforms to test new products and services and get user feedback
Partnerships	We actively work with partners to increase sales
	We collaborate with partners to create new services for our customers

Source: Authors.

Business model experimentation. In measuring business model experimentation, we wanted to capture the degree to which the firm had recently adjusted aspects of its business model. Any change in the business model was interpreted as an experiment to improve the business operation. Seeking inspiration from received empirical and theoretical literature (e.g., Parida et al. 2019; and Spieth and Schneider 2016; Zott and Amit 2007, 2010), we created 11 items that queried the degree to which the firm had changed any aspects of its business model over the past year (1=no change ... 5=complete re-think). A principal component analysis showed that all statements loaded cleanly on a single factor. The scale value was then computed as the weighted average of individual statements, using factor loadings as weights. The scale composition for the business model experimentation variable is shown in Table 2.

Table 2: Business Model Experimentation: Scale Composition

Over the past 12 months, have you changed any of the following elements of your business model? (1=no change … 5=complete re-think)	
Scale	**Items**
Business model experimentation	Our target customers and customer segment
	Our sales and marketing operations
	How we interact with our customers
	How we make and deliver our products and services
	Our partnerships (i.e., who we work with – other than suppliers)
	Our suppliers
	Our products and services
	What activities we do ourselves and what activities our partners do
	How we generate revenue (e.g., how we charge for our products)
	What business opportunities we address
	Our entire business model – i.e., how our company does business and organizes its operations

Source: Authors.

3. Outcome Variables

We assessed two sets of firm-level performance variables in the study: business performance and sustainability performance. The first set of outcome variables measured the firm's business performance and sought to capture any effects of firm-level digitalization on business performance, as mediated by the firm's digitally-enhanced ability to experiment with and adjust its business model to take the best possible advantage of the business opportunity. The second set of outcome variables focused on the sustainability performance of the business and sought to capture any effect of firm-level digitalization and business model experimentation for three dimensions of business sustainability: environmental sustainability, social sustainability, and stakeholder welfare.

In tracking the business performance of the firms, we faced a dilemma of choosing between coverage and data quality. Our target population was new, entrepreneurial businesses that used digital technologies. No readily available records existed that track their financial performance. The country teams also thought that if the survey were to inquire about financial details, this would likely push up non-response rate and make it difficult to sample a large enough number of companies. Therefore we opted for more qualitative proxies of business performance that did not require querying potentially sensitive information. Instead of measuring performance based on accounting data, we queried business performance in two different ways. First, we asked the company to assess how well their business had performed compared against the goals and expectations that they had had for their companies 12 months earlier. Six statements were developed, some of which focused more on financial performance (sales growth, profitability, and number of paying customers), and three focusing more on operational performance (new products and services, operational efficiency, and ability of the business to cope with the COVID-19 crisis). Second, we asked the respondents to compare the performance of their business against a typical competitor over the past 12 months. The same six scales were used.

As expected, the performance-against-own-expectations statements loaded on two factors, both of which had an Eigenvalue over 1. One set of statements captured financial performance and the other operational performance, as shown in Table 3. As before, the scales were computed as weighted averages of the statements, using factor loadings as weights.

Table 3: Business Performance against Entrepreneur's Expectations: Scale Composition

Comparing against your goals and expectations you had for the company one year ago, how well has your company performed during the past 12 months? (1=much worse … 5=much better)	
Scale	**Items**
Financial performance against expectations	Sales growth
	Profitability
	Number of paying customers
Operational performance against expectations	Development of new products and services
	Efficiency of our operations
	Our ability to cope with the coronavirus disease (COVID-19) crisis

Source: Authors.

In contrast to performance against own expectations, the statements inquiring the companies' self-assessed performance against typical competitors all loaded on a single factor with an Eigenvalue over 1. This probably reflects the fact that the entrepreneurs might not have had a detailed understanding of the different aspects of the performance of their competitors. In addition, the statement concerning ability to cope with the COVID-19 pandemic did not load strongly on the factor and was excluded from the final composite variable. The statements measuring self-assessed performance against peers are shown in Table 4.

Table 4: Business Performance against Peers: Scale Composition

How does your company's performance compare against your typical competitor over the past 12 months? (1=much worse … 5=much better)	
Scale	**Items**
Performance against peers	Sales growth
	Profitability
	Number of paying customers
	Development of new products and services
	Efficiency of our operations

Source: Authors.

Our business performance measures being qualitative self-assessments, our analysis does not provide "hard" data on financial performance. However, qualitative performance metrics also have advantages, especially when measuring the performance of new, entrepreneurial businesses that are still evolving rapidly. Generally speaking, financial performance metrics apply best to going concerns, who are fully developed and established as a steady-state business operation. It usually takes roughly a decade for an entrepreneurial business to reach that stage. Because different entrepreneurial businesses might be going through different stages in their development, measures of performance against the owner's reasonable expectations may be less susceptible to bias resulting from that fact. In addition, our measure of operational performance also

captures some aspect of the resilience of the business in the face of the COVID-19 pandemic, which would have impacted the surveyed businesses during the period of study. Finally, performance expectations are calibrated by general performance expectations in a given sector, which is helpful given the cross-sector nature of our sample.

Finally, we measured the self-assessed sustainability performance of the businesses. Consistent with United Nations Sustainable Development Goals and related literature, we sought self-assessments of three aspects of business sustainability: environmental sustainability, social sustainability, and stakeholder sustainability (Fiksel, 2012; Lüdeke-Freund, Carroux, Joyce, Massa, and Breuer 2018; Muhmad and Muhamad 2020; Nikolaou, Tsalis, and Evangelinos 2019; Parida et al. 2019; and Roberts and Tribe 2008). Environmental sustainability approximates the impact the business operation has on its natural environment, or the size of its 'environmental footprint'. A business with a large environmental footprint would generate a large negative externality on its natural environment. Social sustainability measures the impact the business operation has on its local community at large. A socially sustainable business would create a positive externality on its local social community. Stakeholder sustainability measures how well the business treats its key stakeholders, such as employees, suppliers, and business partners. A stakeholder sustainable business would treat its stakeholders fairly and equitably.

Drawing on received literature, we designed a total of 21 statements to measure different aspects of business sustainability performance. Nine of these measured environmental sustainability, six statements measured social sustainability, and six statements measured stakeholder sustainability. The principal-components factor analysis (orthogonal varimax rotation) revealed that all statements measuring social sustainability loaded on a single factor with an Eigenvalue greater than 1. Four of the five statements measuring stakeholder sustainability also loaded on a single factor. However, the statements measuring environmental sustainability loaded on two separate factors, each with an Eigenvalue over 1. A closer inspection revealed that three of the statements measured the environmental sustainability, as practiced in the internal operations of the business. Six of the statements measured externally-oriented environmental sustainability, as reflected in the sustainability mission of the business. The statement composition of the four measures of sustainability performance are shown in Table 5.

Table 5: Business Sustainability Measures: Scale Composition

We are interested in any actions you may have taken to enhance the environmental and social sustainability of your business. How well do the following describe your company? (1=not at all … 5=perfectly)	
Scale	**Items**
Environmental sustainability (internal)	We go well beyond the minimum required by legal authorities to minimize any negative impact of our business on the environment (e.g., waste, recycling, etc).
	We take great effort to use renewable and environment-friendly materials in our products and operations.
	We recycle all our waste.
Environmental sustainability (external)	We have applied for or been awarded a green label or certification.
	We monitor our suppliers closely to ensure that they are environmentally sustainable.
	We often donate to environmental causes.
	We have a clearly defined mission to help save the environment and planet.
	We are widely recognized as an environmental-friendly company.
	We have a system in place to ensure that we keep focused on environmental friendliness.
Social sustainability	We go well beyond the minimum required by legal authorities to minimize any negative impact of our business on our local community.
	We take great effort to make a positive contribution to the social community where we operate.
	We have a clearly defined social mission in addition to our business mission.
	We often donate to those in need.
	It is very important for us to be a good corporate citizen in our community.
	We have a system in place to ensure that we keep focused on our social mission.
Stakeholder sustainability	We take extra effort to treat our employees well, like family.
	It is very important for us to treat our suppliers and partners fairly and not take unfair advantage over them.
	We pay close attention to workplace safety..
	It is important for us to treat all our employees equally regardless of gender, age, ethnicity, or religion.

Source: Authors.

V. Analysis and Findings

We tested two mediation models to verify our hypotheses. These were: H1 Digital Technology Adoption enables Business Model Experimentation; H2 Business Model Experimentation drives Business Performance; H3 Business Model Experimentation Drives Sustainability Performance; and H4 Business Model Experimentation mediates the impact of Digital Technology Adoption on Business and Sustainability Performance.

All hypothesis tests were carried out with structural equation modelling, using the "sem" command of Stata 12. Structural equation modelling offers the benefit of allowing to estimate the share of the mediated influence of independent variables on the outcome variable relative to the direct influence of these on the outcome variable. In other words, it permits the estimation of the relative strength of mediation in the model.

Table 6 shows sample descriptives by country. The mean age in the overall sample was 4,4 years and the mean employment size (full-time equivalents) was 38,6 employees.

Table 6: Sample Descriptives by Country

Country	n	Mean (age)	Min (age)	Max (age)	Mean (size)	Min (size)	Max (size)
Indonesia	114	5,5	0	38	57,1	0	588
Malaysia	139	3,5	0	8	22,0	1	500
Philippines	109	3,0	1	10	13,1	0	350
Singapore	124	3,0	0	20	12,5	0	150
Thailand	100	4,1	0	12	39,8	0	588
Viet Nam	100	7,6	1	57	102,2	3	588

Employment size was winsorized at 1%, hence max(size) of 588

n=686

Max. = maximum, Min. = minimum, n = number of observations.
Source: Authors.

Table 7 shows the correlation matrix. We can see significant correlations among digitalization variables, as expected. Firm age exhibits a negative bivariate correlation with business model experimentation, indicating that the frequency of business model experimentation tends to attenuate over time. Interestingly, the firm's reliance on mobile and web applications is not correlated with its reliance on industrial internet applications (IoT, IIoT, Robotics, Blockchain).

Table 7 Correlation Matrix

Variables	1	2	3	4	5	6	7	8
1 Mobile and Web application	1							
2 IOT, IIOT, Robotics, Blockchain	0.00	1						
3 Internal activities	0.17*	0.23*	1					
4 Marketing, sales, customer interactions	-0.01	0.10*	0.42*	1				
5 Products and services	0.11*	0.48*	0.46*	0.27*	1			
6 Partnerships	0.15*	0.21*	0.39*	0.23*	0.40*	1		
7 Business model experimentation	0.03	0.14*	0.13*	0.10*	0.20*	0.27*	1	
8 Environmental sustainability (internal)	0.19*	0.14*	0.08*	0.10*	0.09*	0.12*	0.09*	1
9 Environmental sustainability (external)	0.09*	0.05	0.13*	0.09*	0.07	0.13*	-0.02	0.00
10 Social sustainability	0.08*	0.15*	0.29*	0.31*	0.24*	0.28*	0.18*	0.40*
11 Stakeholder sustainability	0.07	-0.07	0.17*	0.17*	0.00	0.15*	0.04	-0.05
12 Financial performance	0.07	-0.03	0.11*	0.16*	0.04	0.06	-0.02	0.02
13 Operational performance	0.05	0.13*	0.29*	0.24*	0.19*	0.11*	0.17*	-0.05
14 Performance (peer comparison)	0.11*	0.09*	0.33*	0.30*	0.14*	0.16*	0.13*	0.11*
15 Firm age	0.18*	0.18*	0.10*	0.05	0.07	0.12*	-0.08*	0.20*
16 Firm size (FTE)	0.24*	0.14*	0.06	-0.01	0.01	0.05	-0.02	0.18*

n=681

Variables	9	10	11	12	13	14	15	16
9 Environmental sustainability (external)	1							
10 Social sustainability	0.38*	1						
11 Stakeholder sustainability	0.23*	0.26*	1					
12 Financial performance	0.00	0.03	0.05	1				
13 Operational performance	0.10*	0.16*	0.12*	0.00	1			
14 Performance (peer comparison)	0.07	0.21*	0.14*	0.39*	0.43*	1		
15 Firm age	0.03	0.10*	0.01	0.09*	0.02	0.12*	1	
16 Firm size (FTE)	-0.02	0.07	-0.01	0.01	0.04	0.09*	0.42*	1

n=681

FTE= full-time equivalent, n = number of observations.
Source: Authors.

Before conducting the mediation analysis, we first consider the influence of the reliance on mobile and fixed-line internet applications on the propensity of the firm to experiment with its business model. The results of this structural equation modelling analysis are shown in Table 8. The table shows effects for direct pathways.

Table 8 confirms the basic effect of digital technologies on business model experimentation: greater reliance on mobile and web applications was strongly associated with the likelihood of the business introducing non-trivial changes in its business model over the past 12 months ($p<0.01$**). Similarly, the reliance of the business on industrial internet applications was also strongly associated with introductions of non-trivial changes in the firm's business model over the past 12 months ($p<0.001$***). Both these associations were consistent with hypothesis H1.

Table 8: Influence of Reliance on Digital Tech Applications on Business Model Experimentation (Direct Pathways)

Business Model Experimentation	Coef.	Std. Err.
Reliance on mobile and web applications	0.1148**	0.040
Reliance on industrial internet applications	0.1715***	0.040
Controls		
Firm age	Included	
Employees (FTE)	Included*	
Malaysia	Included	
Philippines	Included	
Singapore	Included	
Thailand	Included	
Vietnam	Included	

n = 681, 1-tailed significances
Coef. = coefficient, FTE = full-time equivalent, n = number of observations, Std. Err. = standard error
Source: Authors.

Regarding control variables, firm size was negatively associated with business model experimentation: businesses with a greater number of full-time equivalent employees were less likely to have introduced non-trivial changes in their business models over the past 12 months. However, although statistically significant, the effect size was minor. As such, this association is not surprising, as larger businesses tend to be more mature and more likely to be in the scale-up phase, where the business model is more likely to be set and the need for business model experimentation will gradually grow smaller.

The effects of digitalization of different aspects of the firm's business model are shown in Table 9. We show the direct effects of each of the digitalization variables separately, i.e., for internal activities, marketing and sales, products and services, and for partnerships. As can be seen in the table, all digitalization variables exhibited strong and statistically significant effets on business model experimentation: greater degrees of digitalization in the firm's activities were associated with greater likelihood of nontrivial business model changes during the past 12 months. These findings further reinforce support for our first hypothesis (H1): that the application of digital technologies in the firm's business model enhances the firm's ability to make changes to its business model and, therefore, experiment with alternative business model configurations. Note that, when entered together, the digitalization of internal activities is shown as a nonsignificant influence on business model experimentation. This is likely because of strong correlations between the digitalization variables, which may be confounding the structural equation modelling results. Regarding control variables, firm size in full-time employees exhibits a mild negative effect on the likelihood of business model experimentation. Of the country dummies, those for the Philippines and Viet Nam show significant negative effects, indicating that the interviewed firms in these countries were less likely to report business model changes over the past 12 months.

Table 9: Effect of Digital Technology Application in the Firm's Business Model on Business Model Experimentation (Direct Pathways)

Business Model Experimentation				
Digitalization Variables	Model 1	Model 2	Model 3	Model 4
Digitalization of internal activities	0.1395 ***			
Digitalization of marketing and sales		0.1707 ***		
Digitalization of products and services			0.1930 ***	
Digitalization of partnerships				0.2823 ***
Control Variables				
Firm age	n.s.	n.s.	n.s.	n.s.
Employees (FTE)	+	+	+	*
Malaysia	n.s.	n.s.	n.s.	+
Philippines	**	***	*	***
Singapore	n.s.	n.s.	n.s.	n.s.
Thailand	n.s.	n.s.	n.s.	n.s.
Viet Nam	***	***	***	***

n = 681
FTE = full-time equivalent, n = number of observations
Source: Authors.

We next consider the effects of digitalization variables on performance. Table 10 shows the effects of the reliance of the business on Mobile and Web Applications and on Industrial Internet Applications, respectively, on sustainability performance and business performance. The "Direct Effect" column shows the direct effects of the predictor variables on performance only. The "Indirect Effect" column shows only the effects of the reliance of digital applications on performance, as mediated through their effect on business model experimentation. The "Total Effect" column shows the combined direct and mediated effects. The "% Med." column shows the proportion of the effect of the independent variables that were mediated through their effect on business model experimentation. For simplicity, we do not show the effects of control variables, although these were included in all equations.

Table 10 Effects of Reliance on Digital Technologies on Sustainability and Business Performance

	Direct Effect		Indirect Effect		Total Effect		% Med.
Environmental Sustainability (internal)	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,1125***	0,0325		(no path)	0,1125***	0,0325	
Reliance on Mobile and Web Applications	0,1538***	0,0341	0,0129*	0,0058	0,1667***	0,0342	7,7%
Reliance on Industrial Internet Applications	0,0442+	0,0345	0,0193**	0,0072	0,0635*	0,0343	30,4%
Environmental Sustainability (external)	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,0127	0,0382		(no path)	0,0127***	0,0382	
Reliance on Mobile and Web Applications	0,1026**	0,0401	0,0015	0,0044	0,1041***	0,0398	n.s.
Reliance on Industrial Internet Applications	0,0758*	0,0405	0,0022	0,0066	0,078***	0,04	n.s.
Social Sustainability	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,2163***	0,0372		(no path)	0,2163***	0,0372	
Reliance on Mobile and Web Applications	0,0489	0,039	0,0248**	0,0096	0,0737***	0,0397	33,7%
Reliance on Industrial Internet Applications	0,0946**	0,0394	0,0371***	0,0108	0,1317***	0,0399	28,2%
Stakeholder Sustainability	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,092**	0,0375		(no path)	0,092***	0,0375	
Reliance on Mobile and Web Applications	0,0269	0,0394	0,0106*	0,0057	0,0374***	0,0393	28,2%
Reliance on Industrial Internet Applications	-0,0239	0,0398	0,0158*	0,0074	-0,0082***	0,0394	n.s.
Financial Performance (vs expectations)	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	-0,0089	0,0394		(no path)	-0,0089***	0,0394	
Reliance on Mobile and Web Applications	0,0705*	0,0414	-0,001	0,0045	0,0695***	0,0411	n.s.
Reliance on Industrial Internet Applications	0,0039	0,0418	-0,0015	0,0068	0,0023***	0,0413	n.s.
Operational Performance (vs expectations)	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,1442***	0,0374		(no path)	0,1442***	0,0374	
Reliance on Mobile and Web Applications	0,0627+	0,0393	0,0166*	0,0072	0,0792***	0,0394	20,9%
Reliance on Industrial Internet Applications	0,1585***	0,0397	0,0247**	0,0086	0,1832***	0,0396	13,5%
Performance vs Peers	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,1295***	0,038		(no path)	0,1295***	0,038	
Reliance on Mobile and Web Applications	0,102**	0,0399	0,0149*	0,0068	0,1168***	0,04	12,7%
Reliance on Industrial Internet Applications	0,0843*	0,0403	0,0222**	0,0083	0,1066***	0,0401	20,8%
Controls							
Firm Age	included		included		included		
Employees (FTE)	included		included		included		
Malaysia	included		included		included		
Philippines	included		included		included		
Singapore	included		included		included		
Thailand	included		included		included		
Vietnam	included		included		included		

*** = p<0,001; ** = p<0,01; * = p< 0,05; + = p < 0,1. Two-tailed significances shown

Coef. = coefficient, FTE = full-time equivalent, Med. = mediation, n.s. = not statistically significant, Std. Err. = standard error.
Source: Authors.

We first consider the effect of business model experimentation on performance. Looking at the ”Total Effect” column, we can see that all associations between the business model experimentation variable and the different outcome variables are statistically highly significant, confirming the basic thesis that business model experimentation is an important driver of both sustainability and business performance. However, for one performance variable—the firm’s realized financial performance relative to the entrepreneur’s own expectations—this association is shown to be negative: higher levels of business model experimentation

were associated with poorer finacial performance when compared to the expectations of the entrepreneur(s). We speculate that this negative association may signal the sensitivity of entrepreneurial businesses to the failure to meet financial performance expectations, to which they then react with more frequent and sweeping business model changes. In other words, we speculate that, in this case, the correlation operates in reverse, from lagging financial performance to greater business model experimentation. Therefore, although we continue to believe that business model experimentation will ultimately help entrepreneurial businesses to discover more effective business models and improve their financial performance, this effect may be masked in our sample by the simple fact that many businesses remain in very early stages of their development, where sub-standard financial performance is likely to trigger more frequent business model experiments.

For operational performance and performance relative to similar peers, poor performance may be less likely to trigger intensive business model experimentation, and the positive association observed is likely to signal the true facilitating effect of business model experimentation on performance.

Considering the effect of business model experimentation on sustainability performance, we can observe statistically strongly significant associations for all four sustainability performance variables (i.e., internal environmental sustainability, external environmental sustainability, social sustainability, and stakeholder sustainability). The coefficients are strongest for social sustainability, internal environmental sustainability, and stakeholder sustainability. This suggests that business model experimentation is a particularly strong driver of social sustainability, but perhaps less so for external environmental sustainability. With a closer look at the content of the external environmental sustainability variable, this pattern appears to make sense. The external environmental sustainability tends to be more heavily influenced by the firm's chosen environmental mission than it is by more immediate operational considerations. This variable is composed of statements, such as: "we have applied for or been awarded a green label"; "we often donate to environmental causes"; "we have a clearly defined mission to help save the environment". These are all statements of mission that may not trigger immediate feedback from business operations regarding the accomplishment of the stated mission. In the absence of immediate performance feedback, business model experiments are less likely to be triggered. Such feedback will be more readily available from the social community of the business, from its internal operations, and from its stakeholders, and this feedback, therefore, could be more easily fed back to business model experimentation.

We next consider the mediating effects of the firm's reliance on digital technologies (notably, mobile and web applications and industrial internet applications) on business model experimentation and subsequently to performance. Looking at the "% Med." column, we can see that some degree of mediation is signalled for 9 out of 14 possible mediating relationships. For external environmental sustainability, no statistically significant mediation effect is shown for the reliance variables, business model experimentation, and performance. Instead, only statistically significant direct effects are shown, as indicated in the "Total Effect" column. Given that business model experimentation does not exercise statistically significant direct influence on external environmental sustainability performance, this is not surprising. As such, the coefficient sizes suggest a reasonably powerful association.

No statistically significant mediation is shown for the financial performance variable either. As noted above, this effect is likely masked by the possible reverse causality that might be operating from lagging financial performance to more intensive business model experimentation in response.For operational performance (relative to expectations) and performance, as compared to peers, statistically significant mediating influences are shown. In both cases, the Total Effect of the reliance variables is shown as highly statistically significant, with reasonably strong correlation coefficients, signalling a non-trivial relationship. The "% Med."

column indicates partial mediation for both outcomes, with the strength of mediation (through business model experimentation) ranging from 12.7% to 20.9%. This suggest that although reliance on digital technologies advances operational and peer-calibrated performance through its facilitating effect on business model experimentation, both Mobile and Web Applications and Industrial Internet Applications also exercise a direct influence on performance, which might operate, for example, through increased agility, ability to create more customer value, cost savings, or similar.

For the other three sustainability performance variables, we can also detect partial mediation in most cases. For internal environmental sustainability, a particularly strong mediation is shown for the reliance on industrial internet applications. This seems understandable, given that internal environmental sustainability performance is strongly influenced by operational efficiency. A stronger coefficient, however, although weaker mediation is shown for the reliance on mobile and web applications, perhaps testifying of the ability of these applications to directly help entrepreneurial businesses to reduce their environmental footprint.

The strongest mediation effects are shown for the effect of the reliance on digital applications on social sustainability performance. Both mediation pathways indicate roughly 30% mediation through the facilitating effect of mobile, web, and industrial internet applications on business model experimentation.

Finally, for stakeholder sustainability, mediation is only signalled for the reliance of mobile and web applications. It should be observed that the coefficient size for this variable is small (see ”Total Effect” column), indicating a small effect overall. For the reliance on industrial internet applications, the coefficient size is even smaller and negative – although highlighted as statistically significant. The ”Total Effect” size is so small that this relationship does not appear to warrant closer inspection.

Summarizing, the analysis in Table 10 seems to provide broad and consistent support to our key hypotheses: that business model experimentation is an important driver of both business and sustainability performance, and that the firm’s reliance on digital technology applications is an important enabler of business model experimentation. The table further shows that in addition to this mediating effect, digital technology applications generate an even more important performance impact through their direct effect on performance outcome variables. This is an important reminder that although important, enhanced ability for business model experimentation is only one of the ways through which firm-level application of digital technologies is conducive to both business and sustainability performance. Many additional mechanisms are at play, which we have not been able to explore in more detail here. The overall signal is nevertheless clear, and perhaps also encouraging: the adoption of digital technology applications is likely to have a positive effect on both business performance and business-level sustainability outcomes in the context of the six ASEAN countries included in the sample.

We next move to consider the digitalization of various activities of the firm’s business model and its potential impact on performance, both directly and through the mediation of business model experimentation. Beacuse of the complexity of the models relative to sample size, and because of the relatively strong intercorrelations among digitalization variables, we only show individual path effects for each of the digitalization variables separately and not as a group. The results are shown in Table 11.

Table 11: Activity Digitalization and Business and Sustainability Performance (individual path effects shown for digitalization variables)

	Direct Effect		Indirect Effect		Total Effect		% Med.
Environmental Sustainability (internal)	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,1227***	0,033	(no path)		0,1227***	0,033	
Dig'n of Internal Activities	0,0698*	0,033	0,0171**	0,007	0,0869**	0,033	19,7%
Dig'n of Marketing and Sales	0,0896**	0,034	0,0201**	0,007	0,1097***	0,034	18,3%
Dig'n of Product and Service	-0,0033	0,033	0,0256***	0,008	0,0223	0,033	n.s.
Dig'n of Partnerships	0,0708*	0,033	0,0316***	0,010	0,1024***	0,032	30,8%
Environmental Sustainability (external)	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,0098	0,038	(no path)		0,0098	0,038	
Dig'n of Internal Activities	0,1615***	0,038	0,0014	0,005	0,1629***	0,038	n.s.
Dig'n of Marketing and Sales	0,0955**	0,039	0,0028	0,007	0,0984**	0,039	n.s.
Dig'n of Product and Service	0,092**	0,038	0,0029	0,007	0,0949**	0,038	n.s.
Dig'n of Partnerships	0,1257***	0,039	-0,0012	0,011	0,1245***	0,037	n.s.
Social Sustainability	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,1975***	0,036	(no path)		0,1975***	0,036	
Dig'n of Internal Activities	0,269***	0,036	0,0276***	0,009	0,2965***	0,036	9,3%
Dig'n of Marketing and Sales	0,2965***	0,037	0,0319***	0,009	0,3284***	0,037	9,7%
Dig'n of Product and Service	0,1861***	0,037	0,0383***	0,010	0,2245***	0,037	17,1%
Dig'n of Partnerships	0,2345***	0,037	0,0471***	0,012	0,2816***	0,036	16,7%
Stakeholder Sustainability	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,0714*	0,037	(no path)		0,0714*	0,037	
Dig'n of Internal Activities	0,1475***	0,037	0,01*	0,006	0,1574***	0,037	6,3%
Dig'n of Marketing and Sales	0,0876*	0,038	0,0132*	0,007	0,1008**	0,038	13,1%
Dig'n of Product and Service	0,0412	0,038	0,016*	0,008	0,0573+	0,037	28,0%
Dig'n of Partnerships	0,1582***	0,038	0,013	0,011	0,1712***	0,036	n.s.
Financial Performance (vs expectations)	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	-0,0171	0,039	(no path)		-0,0171	0,039	
Dig'n of Internal Activities	0,1102**	0,039	-0,0024	0,005	0,1078**	0,039	n.s.
Dig'n of Marketing and Sales	0,1331***	0,040	-0,004	0,007	0,1291***	0,040	n.s.
Dig'n of Product and Service	0,0592+	0,040	-0,0026	0,008	0,0566+	0,039	n.s.
Dig'n of Partnerships	0,0792*	0,040	-0,007	0,011	0,0722*	0,038	n.s.
Operational Performance (vs expectations)	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,1374***	0,036	(no path)		0,1374***	0,036	
Dig'n of Internal Activities	0,2443***	0,037	0,0192**	0,007	0,2635***	0,037	7,3%
Dig'n of Marketing and Sales	0,1872***	0,038	0,024**	0,008	0,2113***	0,038	11,4%
Dig'n of Product and Service	0,1781***	0,038	0,0267**	0,009	0,2048***	0,037	13,0%
Dig'n of Partnerships	0,0692*	0,038	0,0426***	0,012	0,1118**	0,037	38,1%
Performance vs Peers	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
Business Model Experimentation	0,1098**	0,036	(no path)		0,1098**	0,036	
Dig'n of Internal Activities	0,2904***	0,037	0,0153**	0,007	0,3057***	0,037	5,0%
Dig'n of Marketing and Sales	0,2487***	0,038	0,0187**	0,008	0,2674***	0,038	7,0%
Dig'n of Product and Service	0,1111**	0,038	0,0249**	0,009	0,136***	0,038	18,3%
Dig'n of Partnerships	0,1373***	0,038	0,0311**	0,012	0,1684***	0,037	18,5%

*** = p<0,001; ** = p<0,01; * = p< 0,05; + = p < 0,1. One-tailed significances. Controls included but not shown

Coef. = coefficient, FTE = full-time equivalent, Med. = mediation, n.s. = not statistically significant, Std. Err. = standard error.
Source: Authors.

In Table 11, we can see many of the patterns confirmed, as previously discussed for the reliance of digital technology application variables. First, as already discussed, business model experimentation is shown as a strong and statistically significant influence for most business and sustainability performance variables except for external environmental sustainability performance and financial performance relative to entrepreneurs' own expectations. The speculated reasons for these remain the same. For external environmental sustainability performance, the feedback mechanism from performance outcomes (i.e., accomplishment of external environmental sustainability mission) back to business model experimentation is likely too weak to provide meaningful guidance for business model experimentation. For financial performance relative to entrepreneurs' own expectations, there is a strong likelihood of reverse causality, with weaker-than-expected financial performance triggering business model adjustments. Because of the lacking effect of business model experimentation on these performance variables, no mediating effects are shown for any of the four digitalization variables for either of these two outcome variables (i.e., for digitalization of internal activities; marketing and sales; products and services; and partnerships, respectively). However, business model experimentation disregarded, an examination of the "Total Effect" column highlights all four digitalization variables as statistically significant direct influences upon both external environmental sustainability and financial performance. The coefficient sizes are shown as moderately strong for the digitalization of internal activities and marketing and sales for financial performance; and for the digitalization of internal activities and partnerships for external environmental performance, respectively. Even though the digitalization of different aspects of the business model does not operate through business model experimentation, it nevertheless indicate non-trivial direct influence on these two performance outcome variables.

Looking at coefficient sizes ("Total Effect"column), the impact of digitalizing different aspects of the business model appears the strongest for social sustainability performance: the coefficient sizes for the digitalization of different business model activities range from 0.2245*** to 0.3284***. Some of this influence operates through business model experimentation, as the mediated share of the influence ranges from 9.3% to 17.1%. This strong impact of digitalization on social sustainability performance is interesting and would appear to merit further examination. We speculate that part of the influence might be because of the prevailing COVID-19 pandemic, which is inflicting severe strain on social communities all across the ASEAN countries. Elsewhere, we have seen that many entrepreneurial businesses have responded to this challenge by taking on or expanding social missions alongside with their profit missions. The findings reported in Table 11 suggest that digitalization of the entrepreneurial firm's business model may enable it to take on social impact missions more easily alongside its for-profit business mission, or alternatively, they may help to amplify the impact of the social mission. Further inquiry into this issue is needed, but the signal regarding the close link between business model digitalization and social sustainability performance appears to be a strong one and merit closer inspection.

Still looking at coefficient sizes ("Total Effect" column), the impact of digitalizing different aspects of the business model appears the second strongest for performance, as measured against closely comparable peers: the coefficient sizes range from 0.136*** (digitalization of products and services) to 0.3057*** (digitalization of internal activities). These observation suggest that in the ASEAN country contexts at least, new, entrepreneurial start-ups are likely to gain a performance advantage over their peers by digitalizing virtually any aspect of their business models. In the context of ASEAN countries, at least, digitalization appears to represent an important constituent element of entrepreneurial advantage over peers. This observation sends another important message: investment in digitalization can be crucial for new, entrepreneurial businesses to get their noses ahead of peers, and thus, increase their chances of survival and success. Again, while some of this effect operates through business model experimentation, the findings in

Table 11 underscore the general importance of business model digitalization for competitive advantage in entrepreneurial businesses.

Alongside these performance effects, digitalization of different aspects of the firm's business model also exhibited strong influences on operational performance, stakeholder sustainability, and internal environmental sustainability. The statistics show that while a part of this effect operates through the impact of business model digitalization on business model experimentation, important direct effects remain at play and merit further attention.

Summarizing, the analysis of the impact of business model digitalization on business and sustainability performance shows consistent support for the general theoretical framework that we set out to test in this study: greater degrees of business model digitalization are associated with greater business and sustainability performance, either directly or through the facilitating impact of these upon business model experimentation. The total effects are both statistically highly significant and consequential in practice. The overarching message is that investment in digitalization benefits entrepreneurial businesses, and it also benefits society at large through enhanced environmental, social, and stakeholder sustainability of entrepreneurial businesses. Therefore, as a general conclusion, we note that our theoretical hypotheses receive strong and consistent support in empirical data. Adoption of digital applications and the digitalization of different business model activities exercise strong and consistent effect on business performance and sustainability performance, both directly and through their facilitating impact on business model experimentation.

VI. Discussion and Conclusions

We set out in this report to explore firm-level performance effects of firm-level digitalization – i.e., the application of digital technologies in different aspects of the firm's business model. In spite of digitalization being arguably the most fundamental transformative force shaping business-level productivity and performance today, there have been few empirical explorations into firm-level performance effects of digitalization, and even more surprisingly, of the effect of firm-level digitalization on business model experimentation. This dearth is particularly acute for Asian developing countries. We addressed this gap with an interview survey of 681[1] digital entrepreneurs in six ASEAN countries.

Digitalization— the application of digital technologies in society and economy such that these become infrastructural—is a complex socio-technical phenomenon that is transforming societies. Because digital technologies are infrastructural and embedded in the fabric of the society, advances in digital technologies create opportunities and challenges for all businesses and not only those deemed to operate in "digital" sectors. In this study, although we have sampled "'digital entrepreneurs", using the loose criterion that the entrepreneurial business relies on digital technologies in its business model, this has been for the purpose of gaining a clearer window upon the phenomenon of interest. As such, we consider the findings recorded in this report to apply more widely to entrepreneurial businesses in all sectors.

Our literature review identified several transformative impacts of digitalization on economies at large and on entrepreneurial businesses in particular. Because digital infrastructures are shared by all industry sectors, all of whom increasingly rely on these infrastructures for their value-creating activities, digitalization tends to blur conventional sector boundaries and open the opportunity to create novel combinations across these. Digitalization has also the tendency of reorganizing value-creating activities around digital platform ecosystems, in the process converting traditional hierarchical relationships based on formal 1-to-1 supplier contracts into non-hierarchical horizontal relationships organized around digital platforms. This blurring tends to change the nature of entrepreneurial opportunities. As the traditionally clear-cut separation between producers and products, on the one hand, and "markets", on the other is becoming increasingly blurred, the conventional "linear planning" approach to entrepreneurial opportunity discovery is being transformed into an experimentation-driven dynamic of co-evolutionary opportunity development within non-hierarchical ecosystem structures. As this dynamic often involves "on-the-fly" reorganization of stakeholder relationships and interactions within the firm's value co-creating activity system, this trend tends to shift the focus of innovative activities away from conventional product and service innovation towards more comprehensive business model innovation, where all elements of the business model (the firm's value proposition, its productive activities, its customer-facing activities, and its revenue model) are iteratively experimented with and adjusted to one another. Because of its tendency to drive business model innovation, digitalization opens many opportunities for entrepreneurial businesses, as they are less constrained by legacy investment in legacy business models. Because digitalization significantly reduces the cost of business model experimentation, the adoption of digital technologies should be a potent driver of business model experimentation, business performance, and sustainability performance.

Drawing on the above reasoning, we developed and empirically tested a theoretical model that suggested that: (H1) the adoption of digital technologies in the entrepreneurial firm's business model has a positive influence on business model experimentation, (H2) business model experimentation is positively associated with business performance, (H3) business model experimentation is positively associated with sustainability performance,and (H4) the effect of digital technology adoption on business and sustainability performance is

[1] A total of 685 entrepreneurs were interviewed, but we only had complete responses from 681 entrepreneurs

partially mediated by the effect of these upon business model experimentation. We tested this model with interview survey data from 681 digital entrepreneurial businesses from Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam.

Our analysis provided broad and consistent support to our theoretical model: the reliance of the business on select digital applications and the digitalization of different aspects of the firm's business models were found to be potent drivers of business model experimentation in entrepreneurial businesses. Business model experimentation was found to be a potent predictor of both business performance and sustainability performance. We also observed consistent mediation effects of digitalization variables on performance through their effect on business model experimentation, although the digitalization variables also exhibited strong direct effects on performance. This last observation signals that the adoption of digital technologies by entrepreneurial businesses has more wide-ranging beneficial impacts than their facilitating effect on business model experimentation.

We consider the findings reported here to be of significant value for the design of entrepreneurial and digitalization policies in Asian developing economies and in emerging economies more widely. Our analysis points to important performance implications of digital technology adoption by entrepreneurial businesses. Because a non-trivial part of this dynamic operates through business model experimentation, this makes digital entrepreneurial businesses potent drivers of digital transformation in the economy. Unconstrained by legacy investment in legacy business models, entrepreneurial businesses are free to explore ways to take advantage in their business models of advances in digital technologies and infrastructures. So doing, they challenge established industry incumbents who compete with legacy business models, forcing these to re-structure their operations in response. This dynamic should help drive TFP in the digital economy. As digitalization offers promise for developing economies to leapfrog stages in development, this dynamic means that facilitating the digitalization of entrepreneurial businesses should be a high priority for governments in such economies. In practice this means investing in digital infrastructures, extending the geogrpahical coverage of these infrastructures, and making sure that those infrastructures can be accessed at an affordable cost. It is important to develop the digital literacy of entrepreneurs such that these will be better positioned to benefit from advances in digital technologies and infrastructures. Governments should also invest in facilitating regional entrepreneurial ecosystems, as these tend to operate as important hubs of business model experimentation and innovation. Finally, because digitalization tends to make entrepreneurial opportunity pursuit a viable and accessible career option for increasingly large audiences, governments should make sure that educational systems develop entrepreneurial skills such as opportunity recognition, action orientation, experimentation, teamwork, and collaboration.

Although reporting important evidence, this study is not without limitations. In order to secure a large enough respondent sample, we did not ask for financial accounting data from the businesses. Instead, we used qualitative performance measures, as self-reported by the interviewed entrepreneurs. Although qualitative performance measures have their own advantages as reported in the method section, and although we believe our findings to remain valid for alternative performance measures, we believe nevertheless that our findings should be validated by using various alternative performance measures, such as sales growth and profitability. Another limitation is that we are performing our analyses in cross-sectional data in the absence of longitudinal databases recording data on pertinent variables. Therefore, our causal inferences are based on theoretical reasoning rather than direct empirical testing. Future studies should implement longitudinal designs to validate the findings reported here. These limitations acknowledged, we hope nevertheless that policy-makers in regional member countries of the Asian Development Bank will find our findings inspiring and useful background material for entrepreneurship and digitalization policy design.

Appendix 1: Factor Loadings for Variables

	Factor	Survey Item	Factor Loading	Unique-ness
Reliance on digital applications	**Mobile and web applications**	Our own mobile applications	0.89	0.20
		Our own applications in the internet	0.85	0.23
	IOT, IIOT, Robotics, Blockchain	Internet of Things (IOT), Industrial Int...	0.80	0.34
		Robotics, intelligent machinery	0.84	0.28
		Blockchain, distributed ledgers	0.70	0.47
Application of digital technologies in business model	**Internal activities**	Our human resource processes are fully d...	0.74	0.46
		Our customer management system and custo...	0.81	0.34
		Our accounting system is fully digitaliz...	0.78	0.40
		We use digital technologies and data to ...	0.71	0.50
		We use digital technologies for resource...	0.74	0.45
		We are a fully data-driven company	0.71	0.50
	Marketing, sales, customer interactions	We advertise our products and services p...	0.77	0.41
		We constantly use social media to intera...	0.81	0.34
		We constantly monitor how our customers ...	0.83	0.31
		Our customers can order or pay online (o...	0.76	0.43
		We actively monitor our online ratings a...	0.85	0.28
		We operate our own online user community	0.70	0.51
	Products and services	Our products and services are fully digi...	0.81	0.35
		Our products and services are connected ...	0.80	0.37
		We use digital platforms to test new pro...	0.83	0.31
	Partnerships	We actively work with partners to increa...	0.94	0.12
		We collaborate with partners to create n...	0.94	0.12
Business model experimentation	**Business model experimentation**	Our target customers and customer segmen...	0.67	0.55
		Our sales and marketing operations	0.72	0.48
		How we interact with our customers	0.63	0.60
		How we make and deliver our products and...	0.71	0.49
		Our partnerships (i.e., who we work with...	0.69	0.53
		Our suppliers	0.62	0.61
		Our products and services	0.73	047
		What activities we do ourselves and what...	0.76	0.43
		How we generate revenue (e.g., how we ch...	0.77	0.41
		What business opportunities we address	0.75	0.44
		Our entire business model, i.e., how ou...	0.80	0.37

	Factor	Survey Item	Factor Loading	Unique-ness
Sustainability performance	**Environment sustainability performance (internal)**	We go well beyond the minimum required b...	0.82	0.27
		We take great effort to use renewable an...	0.82	0.20
		We recycle all our waste	0.80	0.28
	Environment sustainability performance (external)	We have applied for or been awarded a gr...	0.75	0.41
		We monitor our suppliers closely to ensu...	0.74	0.29
		We often donate to environmental causes	0.77	0.37
		We have a clearly defined mission to hel...	0.75	0.26
		We are widely recognized as an environme...	0.84	0.19
		We have a system in place to ensure that we k...	0.80	0.21
	Social sustainability performance	We go well beyond the minimum required b...	0.76	0.42
		We take great effort to make a positive ...	0.85	0.28
		We have a clearly defined social mission...	0.86	0.26
		We often donate to those in need	0.67	0.55
		It is very important for us to be a good...	0.71	0.50
		We have a system in place to ensure we k...	0.85	0.28
	Stakeholder sustainability performance	We take extra effort to treat our employ...	0.79	0.38
		It is very important for us to treat our...	0.81	0.35
		We pay close attention to workplace safe...	0.78	0.40
		It is important for us to treat all our ...	0.80	0.36
Business performance (compared against peers)	**Financial performance (against own expectations)**	Sales growth	0.92	0.11
		Profitability	0.91	0.13
		Number of paying customers	0.85	0.20
	Operational performance (against own expectations)	Development of new products and services	0.79	0.32
		Efficiency of our operations	0.84	0.25
		Our ability to cope with the coronavirus disease (COVID-19) cr...	0.72	0.34
	Performance Sales growth			
		0.88	0.23	
		Profitability	0.85	0.28
		Number of paying customers	0.86	0.26
		Development of new products and services	0.77	0.40
		Efficiency of our operations	0.80	0.37
Controls		Our ability to cope with the COVID-19 cr...	0.81	0.35
	Firm age	2021 - (year business started) +1		
	Firm size (FTE)	Total number of employees (FTE)		

FTE = full-time equivalent.
Source: Authors.

Appendix 2 Survey Questionnaire

Digitalization, Start-ups and Sustainability

We are studying how start-up businesses leverage digital technologies to innovate their business models and speed up their growth. With this survey we are collecting feedback from start-ups in Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam.

The study is a collaboration between the Asian Development Bank, leading business schools in the Association of Southeast Asian Nations (Asia School of Business, De La Salle University, Padjadjaran University Indonesia, Sasin School of Management, Singapore Management University, and Thu Dau Mot University) and Imperial College Business School, United Kingdom. The contact person for this study in **[CITY/COUNTRY]** is xx.xx@xx.xx.xx with cell phone number +nn– nn nnn nn nn

This survey is confidential. Identifiable data concerning individual businesses will not be published. The data will be stored in a secure server, and only the research team will be able to access it for research purposes only.

We will publish a report of our findings, including implications for policy and entrepreneurial practice. If you wish to receive a copy of the report, please tick the box below.

We will also organize a webinar to elaborate the implications of our findings for entrepreneurs and how entrepreneurs can best harness digital technologies to boost their business. If you wish to attend such a webinar, please tick the box below.

- ❑ Yes, I want a copy of the report
- ❑ Yes, I want to attend a webinar discussing implications for entrepreneurs

[Use the space below to provide instructions for interviewers]

Part 1 Background

1.1 Information about the business **(NOTE: This needs to be recorded before the interview and only checked during the interview for correctness)**	
Company name	
Respondent name	
Respondent position (also indicate if respondent is co-founder)	
Respondent's ownership share of the company	Respondent owns _____ % of the business (0 – 100%)
[PREFILLED] Respondent's LinkedIn profile URL (if any)	
1.2 Please describe in your own words what your business does – its products and services and its main customers	
1.3 How many people currently work for this business? **NOTE: If the company has part-time employees, ask the respondent to indicate full-time equivalents**	**Number of employees**
The number of employees **in total**	
The number of employees primarily working in **product development**	
The number of employees primarily working in **sales and marketing**	
The number of employees primarily working in **production and operations**	
1.4 What year did your company start doing business?	
1.5 Please estimate the number of customers to which your company has sold products and services during the previous 12 months	(Indicate number)
1.5.1 How many of these are business customers (i.e., companies and similar)?	(Indicate number)
1.5.2 Please estimate what percentage of your sales revenue comes from sales of <u>products</u> rather than services!	(Indicate %)
1.6 Please estimate the number of SUPPLIERS your company has done business with during the previous 12 months	(Indicate number)

1.7 We would like to know more about you. What is your highest level of education (modify by country)?	**Tick (X) the option that applies best**
Primary or secondary school [COUNTRY SPECIFIC]	
Vocational or college degree [COUNTRY SPECIFIC]	
Bachelor's degree [COUNTRY SPECIFIC]	
Master's degree [COUNTRY SPECIFIC]	
Doctoral degree (PhD) [COUNTRY SPECIFIC]	
1.8 Have you ever studied outside [country] for longer than four months?	(Indicate 'yes' or 'no')
1.9 Are you currently a citizen of [country] (that is, do you own or could own a passport of [country])?	(Indicate 'yes' or 'no')
1.10 Were you born in [country]?	(Indicate 'yes' or 'no')
1.11 How many years of work experience did you have prior to starting this business?	(Indicate number of years)
1.12 How many years of this work experience were gained outside [country]?	(Indicate number of years)
1.13 How many businesses have you or your team started before this one, if any?	(Indicate number)
1.14 How many businesses have you or your team started before this one, if any?	(Indicate number)
1.15 How many people actively participate in managing this business as members of your entrepreneurial team?	(Indicate number)
1.16 How regularly do you exchange ideas and experiences with others in your entrepreneurial community?	**1 = never, 2 = a few times per year, 3 = monthly, 4 = weekly, 5 = daily**
Other start-ups and digital entrepreneurs	1 2 3 4 5
New business incubators, new venture accelerators, co-working spaces	1 2 3 4 5

Part 2 Business

2.1 Which of the following best describes your company's current revenue status?	**Tick (X) the option that applies BEST (1 only)**
Pre-revenue: We are not yet generating regular sales revenue	
Pre-profit: We have sales revenue but not yet sufficient to cover our costs	
Profit: We have regular sales revenue and are making a profit	
Has the covid crisis affected your company's performance? (1 = very negative impact, 3 = no effect, 5 = very positive impact)	1 2 3 4 5
2.2 Your business model describes what products and services you offer, how you interact with your customers, who you work with to create and deliver your products and services, what your key resources and activities are, and how you make money. Which of the following best describes your business model at the moment?	**Tick (X) the option that applies best**
We only just started to experiment with different product ideas	
We have a pretty good product or service idea but are still experimenting with other aspects of our business model	
Our business model is set, and we are operating in a steady state	
Our business model is set, and we are seeking to grow our business rapidly	
2.3 How is your business funded? Please rate the importance of the following funding sources for your business. (Select '1' if the funding form is not used)	**1 = not at all important 5 = very important**
Founders' family and personal savings	1 2 3 4 5
Loans from financial institutions such as banks	1 2 3 4 5
Government grants	1 2 3 4 5
External investors	1 2 3 4 5
2.4 In the past 12 months, have you sold products or services to customers who are located outside your home country? If yes, what year did you first receive sales revenue from abroad?	(Indicate either 'NO' or year of first foreign sales)
2.5 (ASK ONLY IF THEY HAVE INTERNATIONAL SALES) What percentage of your total sales revenue did you generate outside your home country during the past 12 months? (Mark '0' if no sales outside country!)	(Indicate %)

Part 3 Business Model and Digitalization

Remember, your business model describes how <u>your company</u> does business and organizes its business operations with suppliers, customers, and partners!

3.1 To what extent does your business rely on the following digital technologies?	**Not relevant**	**Not at all ←←**				**All the time →→**
Company homepage and website	0	1	2	3	4	5
Mobile phones and smartphones	0	1	2	3	4	5
Fixed line Internet (cable, optical cable, copper line)	0	1	2	3	4	5
Our own mobile applications	0	1	2	3	4	5
Our own applications in the Internet	0	1	2	3	4	5
Machine learning, AI technologies (artificial intelligence)	0	1	2	3	4	5
Cloud computing and cloud services	0	1	2	3	4	5
Internet of Things (IoT), Industrial Internet of Things (IIoT)	0	1	2	3	4	5
Robotics, intelligent machinery	0	1	2	3	4	5
Blockchain, distributed ledgers	0	1	2	3	4	5
Augmented Reality, Virtual Reality (AR, VR)	0	1	2	3	4	5
Internet resources such as bit.ly, Trello, Slack, FB business suite, Creator studio, Discord, Xero, Google Analytics…	0	1	2	3	4	5
[**INTERVIEWER ASSESSMENT**] How knowledgeable was the respondent and how reliable were their answers in your opinion? 1 = not at all reliable; 5 = extremely knowledgeable and reliable		1	2	3	4	5

3.2 We are interested in how you use digital technologies in your business. How well do the following statements describe your operations?						
3.2.1 Internal Activities	**Not at all ←←**				**Perfectly →→**	
Our human resource processes are fully digitalized (e.g., salary payments, recruitment, training…)	1	2	3	4	5	
Our customer management system and customer databases are fully digitalized	1	2	3	4	5	
Our accounting system is fully digitalized	1	2	3	4	5	
We use suppliers to manufacture products under our own brand	1	2	3	4	5	
We use digital technologies and data to optimize our manufacturing, service, and logistics	1	2	3	4	5	
We use digital technologies for resource and inventory planning	1	2	3	4	5	
Our staff often work from home with a digital connection	1	2	3	4	5	
We are a fully data-driven company	1	2	3	4	5	

3.2.2 Marketing, Sales, and Customer Interactions	**Not at all** ←←				**Perfectly** →→
We advertise our products and services primarily through digital channels	1	2	3	4	5
We constantly update our web page to promote and run our business	1	2	3	4	5
We constantly use social media to interact with customers (e.g., Facebook, Instagram, TikToK, LinkedIn, Twitter, Line)	1	2	3	4	5
We constantly monitor how our customers interact with our website and social media (e.g., clicks, views, etc)	1	2	3	4	5
Our customers can order or pay online (or both)	1	2	3	4	5
We actively monitor our online ratings and customer reviews online	1	2	3	4	5
We operate our own online user community	1	2	3	4	5
3.2.3 Product and Service	**Not at all** ←←				**Perfectly** →→
Our products and services are fully digital	1	2	3	4	5
Our products and services are connected to a mobile app	1	2	3	4	5
We use digital platforms to test new products and services and get user feedback	1	2	3	4	5
3.2.4 Partnerships	**Not at all** ←←				**Perfectly** →→
We use online coordination resources such as Trello, Slack, and similar to collaborate with our partners	1	2	3	4	5
We share data with our partners	1	2	3	4	5
We actively work with partners to increase sales	1	2	3	4	5
We collaborate with partners to create new services for our customers	1	2	3	4	5
[**INTERVIEWER ASSESSMENT**] How knowledgeable was the respondent and how reliable were their answers in sections 3.2.1 – 3.2.4 in your opinion? 1 = not at all reliable; 5 = extremely knowledgeable and reliable	1	2	3	4	5

3.3 Over the past 12 months, have you changed any of the following elements of your business model?	**1 = no change 2 = minor changes 3 = moderate changes 4 = major changes 5 = complete re-think**				
Our target customers and customer segment	1	2	3	4	5
Our sales and marketing operations	1	2	3	4	5
How we interact with our customers	1	2	3	4	5
How we make and deliver our products and services	1	2	3	4	5
Our partnerships (i.e., who we work with – other than suppliers)	1	2	3	4	5
Our suppliers	1	2	3	4	5
Our products and services	1	2	3	4	5
What activities we do ourselves and what activities our partners do	1	2	3	4	5
How we generate revenue (e.g., how we charge for our products)	1	2	3	4	5
What business opportunities we address	1	2	3	4	5
Our entire business model – i.e., how our company does business and organizes its operations	1	2	3	4	5
[**INTERVIEWER ASSESSMENT**] How knowledgeable was the respondent and how reliable were their answers to 3.3 in your opinion? 1 = not at all reliable; 5 = extremely knowledgeable and reliable	1	2	3	4	5
3.4 To what extent can the changes in your Business Model, as mentioned above, be regarded as innovative?	**1 = disagree 2 = somewhat disagree 3 = neither agree nor disagree 4 = somewhat agree 5 = agree**				
Many of the changes in our business model are already widely practiced by our competitors	1	2	3	4	5
Many of the changes our business model so new that no other company in our country has done similar things before	1	2	3	4	5
Many of the changes our business model so new that no other company has anything like it anywhere in the world	1	2	3	4	5
[**INTERVIEWER ASSESSMENT**] How knowledgeable was the respondent and how reliable were their answers to 3.4 in your opinion? 1 = not at all reliable; 5 = extremely knowledgeable and reliable	1	2	3	4	5

Part 4 Sustainability

4.1 We are interested in any actions you may have taken to enhance the environmental and social sustainability of your business. How well do the following describe your company?

Please remember that there is no 'right' or 'wrong' answer! For some businesses, environmental and social sustainability can be more important than for others for natural reasons. Try to answer these questions objectively and truthfully!

Environmental sustainability (i.e., how much our business operations impact the natural environment)	**Not at all ←←**				**Perfectly →→**
We go well beyond the minimum required by legal authorities to minimize any negative impact of our business on the environment (e.g., waste, recycling, etc)	1	2	3	4	5
We take great effort to use renewable and environmentally friendly materials in our products and operations	1	2	3	4	5
We recycle all our waste	1	2	3	4	5
We have applied for or been awarded a green label or certification	1	2	3	4	5
We monitor our suppliers closely to ensure they are environmentally sustainable	1	2	3	4	5
We often donate to environmental causes	1	2	3	4	5
We have a clearly defined mission to help save the environment and planet	1	2	3	4	5
We are widely recognized as an environmentally friendly company	1	2	3	4	5
We have a system in place to ensure we keep focused on environmental friendliness	1	2	3	4	5
Social sustainability	**Not at all ←←**				**Perfectly →→**
We go well beyond the minimum required by legal authorities to minimize any negative impact of our business on our local community	1	2	3	4	5
We take great effort to make a positive contribution to the social community where we operate	1	2	3	4	5
We have a clearly defined social mission in addition to our business mission	1	2	3	4	5
We often donate to those in need	1	2	3	4	5
It is very important for us to be a good corporate citizen in our community	1	2	3	4	5
We have a system in place to ensure we keep focused on our social mission	1	2	3	4	5

How we treat our employees, suppliers, and business partners	Not at all ←←				Perfectly →→
We go well beyond the minimum required by legal authorities in treating our employees, partners, and suppliers	1	2	3	4	5
We take extra effort to treat our employees well, like family	1	2	3	4	5
It is very important for us to treat our suppliers and partners fairly and not take unfair advantage over them	1	2	3	4	5
We pay close attention to workplace safety	1	2	3	4	5
It is important for us to treat all our employees equally regardless of gender, age, ethnicity, or religion	1	2	3	4	5
As a business, we are widely recognized as a great employer who treats their employees well	1	2	3	4	5
[INTERVIEWER ASSESSMENT] How knowledgeable was the respondent and how reliable were their answers in section 4.1 in your opinion? 1 = not at all reliable; 5 = extremely knowledgeable and reliable	1	2	3	4	5

4.2 We are interested in how your business emphasizes alternative goals. Please indicate below how you prioritize the following pairs of goals.
(For example, in the first question below, 'a' would mean that you give complete priority for financial profit and zero priority to environmental sustainability; 'c' would mean that you give equal weight to both; and 'e' would mean that you always prioritize sustainability over profit).

Financial profit regardless of our impact on the environment	a	b	c	d e	Environmental sustainability even if this would mean we make no profit at all
Financial profit regardless of our impact on our local community	a	b	c	d e	Social mission even if this would mean we make no profit at all
Financial profit regardless of the needs of our suppliers and employees	a	b	c	d e	The welfare of our employees and suppliers even if we would have to sacrifice profit

Part 5 Performance

5.1 Comparing against your goals and expectations you had for the company one year ago, how well has your company performed during the past 12 months?	**Much worse ←←**				**Much better →→**
Sales growth	1	2	3	4	5
Profitability	1	2	3	4	5
Number of paying customers	1	2	3	4	5
Development of new products and services	1	2	3	4	5
Efficiency of our operations	1	2	3	4	5
Our ability to cope with the covid-19 crisis	1	2	3	4	5
5.2 How does your company's performance compare against your <u>typical</u> competitor over the past 12 months? (If you do not have any local competitors, please think about a foreign equivalent)	**Much worse ←←**				**Much better →→**
Interviewer note: Mark 'X' if company did not have local competitors in the country					
Sales growth	1	2	3	4	5
Profitability	1	2	3	4	5
Number of paying customers	1	2	3	4	5
Development of new products and services	1	2	3	4	5
Efficiency of our operations	1	2	3	4	5
Our ability to cope with the covid-19 crisis	1	2	3	4	5
5.3 Thinking about your company's environmental and social sustainability, how does your company compare against <u>a typical close competitor</u>? (If you do not have any local competitors, please think about a foreign equivalent)	**Much worse ←←**				**Much better →→**
Interviewer note: Mark 'X' if company did not have local competitors in the country					
Environmental sustainability	1	2	3	4	5
Social sustainability	1	2	3	4	5
The welfare of our employees and suppliers	1	2	3	4	5

5.4 How many new products, services, and business model ideas you have introduced during the past 12 months? (Indicate number in the box)	
Number of changes to existing products and services	
Number of completely new products and services that we did not sell before	
Number of smaller adjustments in our business model (i.e., in how we do business – other than products and services)	
Number of major changes in our business model (i.e., how we do business – other than products and services)	
[INTERVIEWER ASSESSMENT] How knowledgeable was the respondent and how reliable were their answers to 5.1 – 5.4 in your opinion? 1 = not at all reliable; 5 = extremely knowledgeable and reliable	1 2 3 4 5
5.5 What percentage of your sales came from products and services that were introduced during the past 12 months?	
	%
5.6 Finally, how good was your financial performance during the latest full accounting year?	
Sales turnover [indicate currency!]	
Profit margin as % of sales (profit as % of sales before interest, taxes, depreciations and amortizations EBITDA, roughly the same as gross profit)	

EBITDA = earnings before interest, taxes, depreciation, and amortization.

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