ADOPTION OF DIGITAL TECHNOLOGIES, BUSINESS MODEL INNOVATION, AND ENTREPRENEURIAL FIRM PERFORMANCE: EVIDENCE FROM ASEAN START-UPS

Donghyun Park
Yothin Jinjarak
Willem Smit
Kun Fu
Cynthia Petalcorin

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ABSTRACT

It is generally assumed that the adoption of digital technologies enables entrepreneurs to experiment more effectively. It is also assumed is that 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. However, both related assumptions have seldom been subjected to a direct empirical test. We surveyed 685 'digital entrepreneurs' in six Southeast Asian countries to test these assumptions in a cross-national and emerging market context. We measured the adoption of digital technologies in business models and business model experimentation and explored implications of these for business performance. Our analysis reveals that it is mainly the digital technology application in the business model by entrepreneurial businesses is a potent enabler of business model experimentation, which is a potent driver of business performance.

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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 re-organized to take advantage of digital technologies. This process has also transformed 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 re-think of how entrepreneurial businesses organize for the creation and delivery of customer value and capture this value as business profit (Bouwman, Nikou, & De Reuver, 2019; Massa & Tucci, 2013; Rachinger, Rauter, Müller, Vorraber, & 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, & Wright, 2018). Yet, surprisingly little is known about the performance effects of digital technology adoption by entrepreneurial businesses. We therefore 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; Blank, 2013; Ghezzi & Cavallo, 2020), 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). Due to 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 (Fossen & Sorgner, 2021). 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 (Bocken & Snihur, 2020; Contigiani & Levinthal, 2019). Such ideas have prompted a novel, iterative approach to entrepreneurial opportunity discovery and validation, often referred to as 'Lean Entrepreneurship' (Blank, 2013; 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, & Spina, 2019; Dimov, 2016; Kerr, Nanda, & Rhodes-Kropf, 2014; McMullen & Dimov, 2013; Romme & Reymen, 2018; Zellweger & Zenger, 2022). In the boundaryless and interconnected digital world, steady-state, independently existing and objectively discoverable 'market opportunities' have become less prevalent, and entrepreneurs are better off by harnessing digital technologies for an iterative and interactive process of opportunity development.

The above narrative rests on two important assumptions: first, that the adoption of digital technologies enables entrepreneurs to experiment more effectively, and second, that 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 seldom been 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 a few exceptions (Bouwman et al., 2019; Camuffo et al., 2019; Ferreira, Fernandes, & Ferreira, 2019; Liu, Liu, & Gu, 2021). The evidence regarding the impact of digitalization on entrepreneurial performance remains scarce particularly 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; Xiong, Wang, Yan, Xu, & Huang, 2021).

We address this gap by means of an interview survey of 'digital entrepreneurs' in six ASEAN countries: Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam. 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. We designed novel operationalizations of business-level digitalization and business model experimentation to test mediating relationships between digitalization, business model experimentation, and business performance. Our structural equation modelling reveals that digital technology adoption by entrepreneurial businesses is a potent enabler of business model experimentation, which is a potent driver of business performance. Our analysis also shows that the adoption of digital technologies also exercises a strong direct effect of business 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 five important contributions. First, this is one of the relatively few studies contributing insight on the relationships between business model digitalization, business model experimentation, and business 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, and digital technology adoption in business models, thereby facilitating further data collection in this domain. Finally, we contribute reflections and insights for entrepreneurship policy design.

DIGITALIZATION, BUSINESS MODEL INNOVATION, AND ENTREPRENEURSHIP

Transformative Properties of Digital Technologies and Infrastructures

Digital technologies possess several features that distinguish them from other advanced technologies and explain why they are exercising 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, & 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 electromagnetic 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, & 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 (Henfridsson, Nandhakumar, Scarbrough, & Panourgias, 2018). As generic technologies are adapted, they will inevitably precipitate changes in how the economy organizes, e.g., by enabling complex and knowledge-intensive functions that might not have been possible before (Yoo et al., 2012). This feature, then, is the key driver of digitalization, or the application of digital technologies in the society such that those technologies become infrastructural (Tilson et al., 2010). Because of digitalization, business firms are able organize the creation, delivery, and capture of economic and customer value in radically new ways. As digitalization has the effect of blurring product and industry boundaries, it opens opportunities for innovative combinations across product and sector boundaries, thereby challenging legacy business models (Henfridsson et al., 2018; Nambisan, 2017).

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 & Zott, 2001; Zott & Amin, 2016; Zott & Amit, 2010). 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 (Teece, 2010). Compared to conventional strategic management, which tended to emphasize the choice of where to compete, business model design emphasizes the operationalization of the firm's strategy through the design of its value-creating interaction system (Spieth & Schneider, 2016).

The practice of 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 & Zott, 2001; Osterwalder & Pigneur, 2010). A key application area for digital technologies has always been in business information systems, the design of which 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 relying external digital infrastructures, resources, and technologies for the performance of desired functions (Tilson et al., 2010; Yoo, Henfridsson, & Lyytinen, 2010). Where physical manufacturing activities have been conventionally organized along linear, upstream-branching value chains due to modular product architectures, digitalization tends to break such linear dependencies and re-organize value-creating processes around digital platforms characterized by horizontal relationships (Autio & Thomas, 2016; Baldwin & 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.

Digitalization and Entrepreneurship

Digitalization implies several consequences for opportunities for entrepreneurship and for the heuristics of entrepreneurial opportunity pursuit (Nambisan, 2017; Nambisan & Baron, 2013; Von Briel, Recker, & Davidsson, 2018; von Briel et al., 2021). First, digitalization expands the scope of entrepreneurial opportunities by blurring boundaries that surround products and services, those that define industry sectors, and those that define entrepreneurial opportunities themselves (Nambisan, 2017). With modularization and combinability, products and services evolve into open systems and platforms, around which entrepreneurial operators can offer innovative inputs (Nambisan, Siegel, & Kenney, 2018; Von Briel, Davidsson, & Recker, 2018). As different sectors increasingly rely on the shared digital infrastructure and digital resources accessible therein, this has the effect of making industry boundaries more transparent, as the shared digital infrastructure enables the creation of unanticipated combinations across sector boundaries (Yoo et al., 2012). This opens opportunities for entrepreneurs to compete with new business models that combine inputs from previously unconnected environments.

Entrepreneurial opportunities themselves are growing less bounded through digitalization (von Briel et al., 2021). 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 & Barney, 2007). With digitalization, opportunity creation becomes a collaborative process, as hierarchically independent actors test ideas and learn from one another (Autio et al., 2018; Nambisan et al., 2018). 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 (Ries, 2011). Because of reprogrammability, digital technologies can be cheaply and flexibly modified to test alternative product and service versions and different collaborative arrangements (West, Salter, Vanhaverbeke, & Chesbrough, 2014; Zellweger & Zenger, 2022). 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 resources can be flexibly harnessed to identify market niches that would have been impossible to identify and service in the pre-digital era. 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 (Camuffo et al., 2019). We next draw on these observations regarding digitalization, business model innovation, and the changing heuristics of entrepreneurial opportunity pursuit to build a theoretical model that outlines how digital technology adoption by entrepreneurial businesses drives business model experimentation, which mediates the effect of digital technology adoption on business performance.

THEORETICAL MODEL

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 three hypotheses, as elaborated below.

Digitalization shapes entrepreneurship by transforming entrepreneurial opportunity landscapes and the heuristics of entrepreneurial opportunity pursuit. In the interactive and dynamic digital world, where product boundaries are porous and different operators connect through non-hierarchical digital platforms, this discovery logic has been replaced by the logic of co-evolution and experimentation (Camuffo et al., 2019; Zellweger & Zenger, 2022). 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 (McMullen & Dimov, 2013). Small experiments solicit feedback, but they also prompt reactions from other stakeholders, thereby triggering a process of learning and co-evolution (Dimov, 2007). The insights from repeated experiments are gradually encoded 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.

Drawing on the above, we expect that digital technology adoption by entrepreneurial businesses drives business model experimentation in those businesses. 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. Furthermore, 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, & Whinston, 2010; Whitaker, Mithas, & Krishnan, 2010). Increasingly accessible to new and small ventures, this trends affords entrepreneurial ventures with greater flexibility in organizing their operations. A particularly notable trend is the standardization of offshoring services, as 'software-as-a-service' (SaaS) applications are increasingly available for new ventures (e.g., Basecamp or Trello for distributed project management; Infusionsoft for customer email management; or Freshbooks for accounting services) (Di Gregorio, Musteen, & 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:

Hypothesis 1 *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. 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 (Thomas, Autio, & Gann, 2014). 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:

Hypothesis 2 *Greater intensity of business model experimentation is associated with better business 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:

Hypothesis 3. *The effect of digital technology adoption on business performance is partially mediated through the effect of digital technology adoption on business model experimentation.*

METHODS

Sample and Data Collection

We tested the theoretical model with a questionnaire interview survey of 685 digital entrepreneurial businesses in six ASEAN countries: Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam. 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 interviewers were explained the purpose of the research, and we went through the entire questionnaire in detail to ensure that the interviewers understood exactly what kind of data we were looking for. Due to the COVID-19 situation, the interviews were carried out over zoom or by telephone. The interview records were then compiled and harmonized centrally before analysis.

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.

Control Variables. The main control variables included in the questionnaire were: (1) age of the business (years); (2) employee size of the business, specified as number of full-time equivalents; and (3) country dummies (1=yes) to indicate the home country of the business (Indonesia as base, other countries indicated as dummies).

***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 subsequently performed 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): 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, & Reim, 2019; Proksch, Rosin, Stubner, & 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 & 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); (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 Cronbach

alphas for each of the scales are higher than 0.738 indicating acceptable levels of reliability. The scale values were computed as weighted averages of individual statements, using factor loadings as weights. The scale compositions are shown in Table 1.

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To assess external validity for our Business Model Digitalization measures we looked for external objective performance measures. We found these in two sources. The first source is Semrush, a publicly-accessible SaaS platform that is widely reputed for its keyword research and online ranking data, including metrics such as search volume and cost per click (CPC). We drew a sample of 60 from our dataset. Thirty startups randomly drawn from the set of firms with lowest scores of Business Model digitalization (a sum of the four application areas) belonging to the lower quartile (25%). Another 30 were randomly drawn from the highest-scoring quartile of business model digitalization. We balanced the country-of-origin in each sample: 5 from each country. Table 2 shows that our self-reported measures are consistent with the five Semrush scores. Startups with high reported scores for digitalized business models have a higher Authority Score, higher Cost-Per-Click efficiency, more backlinks, and Advertising.[1] Only Organic Search scores on the number of top keywords generating traffic was not significantly higher. The second source is data from BuiltWith.com which is a website profiler specialized in identifying and monitoring which web-based technologies are applied into the websites it tracks. The webtech profiling tool covers over 300 website technologies organized in 28 categories. Our test focuses on the three largest technology sets: Analytics & Tracking (54 technologies), widgets (125), and Javascript Libraries (133). We find that the popular websites technologies are significantly more often used by the high-digitalized startups (more than 50%) than by the low-digitalized startups (20%).

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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; Spieth & Schneider, 2016; Zott & 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 3.

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Outcome Variables. We assessed three types of (related) firm-level performance variables in the study, 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. 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 tracking 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

[1] Note on the Semrush scores: Authority Score is the compound domain score that grades the overall quality of a website or a webpage. The higher the score, the more assumed weight a domain's or webpage's backlinks could have. The Organic Search score indicates the traffic generated organically to the website. The Backlinks refer to the number of links refering back to the entrepreneurial firm's website. The Display Advertising score is the number of times Display Advertising from the startup company was noticed.

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, as 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 4. As before, the scales were computed as weighted averages of the statements, using factor loadings as weights.

--- Table 4 here ---

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 5.

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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.

ANALYSIS AND FINDINGS

We performed a mediation model to test our hypotheses. 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 the correlation matrix. The mean age in the overall sample was 4.4 years and the mean employment size (full-time equivalents) was 38.6 employees. 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).

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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 shown in Table 7. The table shows effects for direct pathways.

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Table 7 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. 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 experimentation are shown in Table 8. 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 effects on business model experimentation: greater degrees of digitalization in the firm's activities were associated with greater likelihood of non-trivial 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 non-significant influence on business model experimentation. This is likely due to 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 Philippines and Vietnam 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 8 here ---

We next consider the effects of digitalization variables on performance. Table 9 shows the effects of the reliance of the business on Mobile and Web Applications and on Industrial Internet Applications on 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 9 here ---

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 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 financial 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.

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 signaled for 4 out of 6 possible mediating relationships. No statistically significant mediation is shown for the financial performance variable. 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, signaling 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.

Summarizing, the analysis in Table 9 to provides broad and quite consistent support to our key hypotheses: that business model experimentation is an important driver of business 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 with firm-level application of digital technologies is conducive to business 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 business performance 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. Due to the complexity of the models relative to sample size, and due to 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 10.

--- Table 10 here ---

In Table 10, 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 performance variables except for financial performance relative to entrepreneurs' own expectations. The speculated reasons for these remain the same. 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 financial performance. The coefficient sizes are shown as moderately strong for the digitalization of internal activities and marketing and sales for financial performance. Even though the digitalization of different aspects of the business model do not operate through business model experimentation, they nevertheless indicate non-trivial direct influence on this performance outcome variable.

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 observations 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 10 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. 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.

DISCUSSION AND CONCLUSIONS

We set out in this study 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[2] digital entrepreneurs in six rapidly digitalizing ASEAN economies.

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. Although in this study, 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 reported in this study 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 (Nambisan, 2017; Zellweger & Zenger, 2022). 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 (Autio et al., 2018). 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, and business performance.

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

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 subsequently positively associated with business performance; and assumingly (H3) a significant portion of the performance effect from adopting digital technologies is carried by the mediating effect of business model experimentation. We tested this model with interview survey data from 681 digital entrepreneurial businesses from Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam.

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 business 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 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 Total Factor Productivity 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 geographical 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 nevertheless believe that our findings should validated 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.

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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 (6 items, α = .841)	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 (6 items, α = .872)	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 (3 items, α = .738)	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 (2 items, α = .865)	We actively work with partners to increase sales
	We collaborate with partners to create new services for our customers

Table 2 Measurement Validation Test

Digitalization Scores	**Firms with LOW Business Model Digitalization (n=30)[1]**		**Firms with HIGH Business Model Digitalization (n=30)**		
(Semrush)	**Average**	**(sd)**	**Average**	**(sd)**	**p-value**
Authority Score	9.13	11.42	18.21	14.79	0.020**
Organic Search (SEO)	982.38	3558.69	34067.03	166518.44	0.201
Paid Search (CPC)	13.25	53.00	1.69	9.10	0.077*
Backlinks	3291.88	10809.30	61479.69	214031.59	0.099*
Display Advertising	2.19	4.49	25.93	72.95	0.061*
(BuiltWith)	**% Top 5 Adopted**	**Proportional Variance**	**% Top 5 Adopted**	**Proportional Variance**	**p-value**
Analytics & Tracking (54)	51.3	0.25	18.0	0.15	0.006***
Widgets (125)	50.7	0.25	20.7	0.16	0.015**
JavaScript Libraries (119)	53.3	0.25	20.7	.17	0.009***

sd =standard deviation.
[1]***note***: for 5 of the Lowly digitalized startups, we were unable to identify their websites.

Table 3 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 (11 items, α = .904)	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

Table 4 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 (3 items, α = .914)	Sales growth
	Profitability
	Number of paying customers
Operational Performance Against Expectations (3 items, α = .775)	Development of new products and services
	Efficiency of our operations
	Our ability to cope with the COVID-19 crisis

Table 5 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 (5 items, α = .893)	Sales growth
	Profitability
	Number of paying customers
	Development of new products and services
	Efficiency of our operations

Table 6 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 Financial Performance	0.07	-0.03	0.11*	0.16*	0.04	0.06	-0.02	1
9 Operational Performance	0.05	0.13*	0.29*	0.24*	0.19*	0.11*	0.17*	0.00
10 Performance (peer comparison)	0.11*	0.09*	0.33*	0.30*	0.14*	0.16*	0.13*	0.39*
11 Firm Age	0.18*	0.18*	0.10*	0.05	0.07	0.12*	-0.08*	0.09*
12 Firm Size (FTE)	0.24*	0.14*	0.06	-0.01	0.01	0.05	-0.02	0.01

n=681

Variables	9	10	11	12
9 Operational Performance	1			
10 Performance (peer comparison)	0.43*	1		
11 Firm Age	0.02	0.12*	1	
12 Firm Size (FTE)	0.04	0.09*	0.42*	1

n=681
IoT = internet of things, IIoT =industrial internet of things.
* p<.05 % significance

Table *7* Influence of Reliance on Digital Tech Applications on Business Model Experimentation (Direct Pathways)

Business Model Experimentation	**Coefficient**	**Standard Error**
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

* = % significance, ** =% significance, *** =% significance

Table 8 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 ***			
Dig'n of Marketing and Sales		0,1707 ***		
Dig'n of Products and Services			0,1930 ***	
Dig'n 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.
Vietnam	***	***	***	***

n = 681

* = % significance, ** =% significance, *** =% significance ,+ = _____, n.s. = not significant

Table 9 OLS Regression of Digital on Business Performance

	(1) **Financial Performance**	(2) **Operational Performance**	(3) **Competitive Performance (Peer comparison)**	(4) **Business Model Experimentation**
Variables				
Constant	46.46***	29.46***	31.04***	33.65***

	(3.617)	(3.367)	(3.401)	(3.189)
Digital Technology Adoption Index	0.211	0.530	0.515	0.605*
	(0.356)	(0.331)	(0.334)	(0.338)
Digital Technology Application	2.532***	4.892***	5.134***	4.953***
	(0.887)	(0.826)	(0.834)	(0.822)
Business Model Experimentation	-0.0448	0.0927**	0.0669*	
	(0.0405)	(0.0377)	(0.0381)	
Controls				
Firm Age	-0.0623	0.285*	0.285*	0.201
	(0.173)	(0.161)	(0.162)	(0.164)
Firm size (employees)	0.00189	-0.000907	-0.000533	-0.00433*
	(0.00248)	(0.00231)	(0.00234)	(0.00236)
Country_Vietnam	-4.243*	-9.554***	-7.276***	-10.48***
	(2.185)	(2.034)	(2.054)	(2.040)
Country_Thailand	-3.422	-5.884***	-3.166	-2.365
	(2.104)	(1.959)	(1.979)	(2.001)
Country_Malaysia	-4.562**	0.561	-3.988**	-2.557
	(1.950)	(1.815)	(1.833)	(1.854)
Country_Philippines	1.766	1.392	-1.124	-4.561**
	(2.105)	(1.960)	(1.979)	(1.997)
Country_Singapore	-4.775**	-7.360***	-10.07***	2.449
	(2.035)	(1.894)	(1.913)	(1.935)
Observations	682	682	682	682
Adjusted R-squared	0.026	0.155	0.141	0.120

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10 Mediation Test

Variable	Direct Effect (Full stats)						Indirect Effect (Full stats)						Total E			
	Coefficient	OIM Std. Error	z	P> |z|	95% Confidence Interval		Coefficient	OIM Std. Error	z	P> |z|	95% Confidence Interval		Coefficient	OIM Std. Error	z	P> |z|
financial performance																
BM experimentation	-0.045	0.040	-1.120	0.265	-0.124	0.034	0.000	(no path)					-0.045	0.040	-1.120	0.265
Technology Index	0.211	0.353	0.600	0.551	-0.481	0.902	-0.027	0.029	-0.950	0.343	-0.083	0.029	0.184	0.352	0.520	0.602
Digital Tech Application	2.532	0.880	2.880	0.004	0.808	4.256	-0.222	0.202	-1.100	0.273	-0.619	0.175	2.310	0.858	2.690	0.007
Firm Age	-0.062	0.171	-0.360	0.716	-0.398	0.274	-0.009	0.011	-0.830	0.408	-0.030	0.012	-0.071	0.171	-0.420	0.677
Firm Size	0.002	0.002	0.770	0.443	-0.003	0.007	0.000	0.000	0.950	0.340	0.000	0.001	0.002	0.002	0.850	0.396
Country_VNM	-4.243	2.167	-1.960	0.050	-8.490	0.004	0.470	0.431	1.090	0.276	-0.375	1.314	-3.774	2.128	-1.770	0.076
Country_THA	-3.422	2.087	-1.640	0.101	-7.513	0.670	0.106	0.130	0.810	0.416	-0.149	0.361	-3.316	2.087	-1.590	0.112
Country_MAL	-4.562	1.934	-2.360	0.018	-8.352	-0.771	0.115	0.132	0.870	0.384	-0.144	0.373	-4.447	1.933	-2.300	0.021
Country_PHI	1.766	2.088	0.850	0.398	-2.327	5.859	0.204	0.204	1.000	0.316	-0.195	0.604	1.971	2.082	0.950	0.344
Country_SIN	-4.775	2.018	-2.370	0.018	-8.730	-0.819	-0.110	0.131	-0.840	0.401	-0.366	0.147	-4.884	2.018	-2.420	0.015
Operational performance																
BM experimentation	0.093	0.037	2.480	0.013	0.019	0.166	0.000	(no path)					0.093	0.037	2.480	0.013
Technology Index	0.530	0.328	1.610	0.106	-0.113	1.174	0.056	0.038	1.460	0.145	-0.019	0.131	0.586	0.329	1.780	0.075
Digital Tech Application	4.892	0.819	5.970	0.000	3.287	6.497	0.459	0.200	2.290	0.022	0.067	0.851	5.351	0.801	6.680	0.000
Firm Age	0.285	0.159	1.780	0.074	-0.028	0.597	0.019	0.017	1.110	0.269	-0.014	0.052	0.303	0.160	1.900	0.058
Firm Size	-0.001	0.002	-0.400	0.693	-0.005	0.004	0.000	0.000	-1.480	0.138	-0.001	0.000	-0.001	0.002	-0.570	0.569
Country_VNM	-9.554	2.017	-4.740	0.000	-13.508	-5.601	-0.972	0.435	-2.240	0.025	-1.824	-0.120	-10.526	1.987	-5.300	0.000
Country_THA	-5.884	1.943	-3.030	0.002	-9.692	-2.075	-0.219	0.204	-1.070	0.283	-0.620	0.181	-6.103	1.950	-3.130	0.002
Country_MAL	0.561	1.800	0.310	0.755	-2.967	4.089	-0.237	0.196	-1.210	0.225	-0.620	0.146	0.324	1.806	0.180	0.858
Country_PHI	1.392	1.944	0.720	0.474	-2.418	5.201	-0.423	0.251	-1.690	0.092	-0.914	0.069	0.969	1.945	0.500	0.618
Country_SIN	-7.360	1.879	-3.920	0.000	-11.042	-3.677	0.227	0.200	1.130	0.257	-0.165	0.620	-7.132	1.885	-3.780	0.000
Competitiive performance																
BM experimentation	0.067	0.038	1.770	0.077	-0.007	0.141	0.000	(no path)					0.067	0.038	1.770	0.077

Technology Index	0.515	0.332	1.550	0.121	-0.135	1.165	0.040	0.032	1.260	0.206	-0.022	0.103	0.555	0.332	1.670	0.094
Digital Tech Application	5.134	0.827	6.210	0.000	3.513	6.755	0.331	0.195	1.700	0.089	-0.051	0.714	5.466	0.808	6.770	0.000
Firm Age	0.285	0.161	1.770	0.077	-0.031	0.600	0.013	0.013	1.010	0.311	-0.013	0.040	0.298	0.161	1.850	0.065
Firm Size	-0.001	0.002	-0.230	0.818	-0.005	0.004	0.000	0.000	-1.280	0.201	-0.001	0.000	-0.001	0.002	-0.360	0.723
Country_VNM	-7.276	2.037	-3.570	0.000	-11.269	-3.282	-0.701	0.419	-1.680	0.094	-1.522	0.119	-7.977	2.003	-3.980	0.000
Country_THA	-3.166	1.963	-1.610	0.107	-7.013	0.681	-0.158	0.160	-0.990	0.323	-0.472	0.156	-3.324	1.965	-1.690	0.091
Country_MAL	-3.988	1.818	-2.190	0.028	-7.552	-0.424	-0.171	0.157	-1.090	0.274	-0.478	0.136	-4.159	1.820	-2.280	0.022
Country_PHI	-1.124	1.963	-0.570	0.567	-4.973	2.724	-0.305	0.217	-1.400	0.160	-0.731	0.121	-1.430	1.960	-0.730	0.466
Country_SIN	-10.074	1.898	-5.310	0.000	-13.794	-6.355	0.164	0.158	1.030	0.301	-0.147	0.474	-9.911	1.900	-5.220	0.000