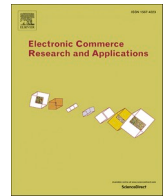




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## Can we classify cashless payment solution implementations at the country level?

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### ABSTRACT

This research commentary proposes a 3-D implementation classification framework to assist service providers and business leaders in understanding the kinds of contexts in which more or less successful cashless payment solutions are observed at point-of-sale (PoS) settings. Three constructs characterize the framework: the digitalization of the local implementation environment; the relative novelty of a given payment technology solution in a country at a specific point in time; and the development status of the national infrastructure. The framework is motivated by a need to support cross-country research in this domain. We analyze eight country mini-cases based on an eight-facet ( $2 \times 2 \times 2$ ) classification. A key insight is the distinction between local and national environments for solution implementations, and that there are no objective “low-tech” or “high-tech” payment solutions, but only those that must be calibrated by a country’s experience at the national or local implementation environment levels. Our analysis also revealed that implementing cashless payment solutions is complex, with each country and local context having its own set of challenges. Our proposed framework is a basis for policy-makers and payment service providers to developing insights related to the challenges of cashless payment solution implementation. Developing countries sometimes are able to leapfrog their legacy infrastructures by using mobile payment solutions, while developed countries need to appreciate the importance of barriers to implementation success, such as costs, settlement delays, and the habitual use of cash. We further note why business leaders should consider their approaches to payment solutions in view of the different degrees of local digitalization and national infrastructure development to support tech innovations in the digital economy.

### 1. Introduction

There has been increasing interest by many countries to implement more cashless payment solutions, for example, in Australia, Finland, South Korea, and the United Kingdom, among others (Global Data, 2020). We define *cashless payments* as payment transactions that are made using digital payment instruments and digital interfaces, typically involving telecommunication and the Internet, resulting in the diminished use or displacement of physical cash.<sup>1</sup> Countries are keen to

displace cash to meet the G20 countries’ financial inclusion goals to modernize their international financial architectures, as well as to reduce fraud and currency-related criminality. According to CapGemini. (2018, 2019), switching to cashless payments also can boost a country’s annual GDP by as much as 3% (see Table 1).

The financial services landscape has seen the rapid digitalization of payment solutions as a result of these and other forces. *Digitalization* is defined as:

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<sup>1</sup> The distinction between the terms *cashless payments* and *digital payments* is based on a technical consideration in how a payment transaction is made. With digital payments, the emphasis is on both the payment sender (*payer*) and payment recipient (*payee*) using a digital channel to send and receive value. Historically, the financial services industry referred to this category of payment transaction (as opposed to the use of physical cash) as *electronic payments*. Others give more care to the definition of digital payments. For example, the Better Than Cash Alliance (2020) of the United Nations distinguishes between: (1) “[the] nature of the payment instrument, [and] through which means – paper or digital – the instructions [are] carried”; and (2) the payer-payee interface, [and] whether the payee, payer or both use an electronic medium in a payment transaction.” In this work we use the terms digital payments and cashless payments interchangeably, prefer the latter, and do not use electronic payments.

**Table 1**  
Terms and Definitions.

TERM	DEFINITION
Implementation environment digitalization	The extent to which local business environment can effectively support innovative payment systems implementation. Also a function of the physical setting, its experience with payment technologies, the digitalization of the implementing vendor, and the merchants and consumers that will use it, as well as the training and educational levels of staff that will need to deal with novel technology implementations.
Payment technology solution novelty	The nature of the payment system solution that is to be supported, based on whether it involves complex and high-performance payment services, which are new and different for the country or the locality in which the implementation is being done. Emphasizes “relative newness” in a setting – typically a higher-technology solution vs. a lower-technology solution – that drives payment services at the PoS, and not used before.
National infrastructure development status	An indicator for the readiness of a country as a whole (not its local readiness or digitalization, which may be different) to successfully support innovative payment capabilities, based on its development level. National infrastructure is an operationally-definable basis in assessing global competitiveness, as an enabler of innovation and efficiency.

*a strategy or process that goes beyond the implementation of technology to imply a deeper, core change to the entire business model and the evolution of work. [It involves] the use of digital technologies and digitized data to impact how work gets done, transform how customers and companies engage and interact, and create new digital revenue streams.*<sup>2</sup>(Chapco-Wade, 2018)

Because it emphasizes an information-based transition that often causes business process disruption and industry transformation, moving toward cashless payments involves greater complexity for countries and firms that must undergo extensive changes – with no certainty of success (Clemons et al., 2017, Gomber et al., 2018, Kappelman et al., 2019).<sup>3</sup> This is what has been happening with cashless payments in many countries, for example, Kenya in the past (Christensen et al., 2015), and most notably, Sweden, which is forecast to become a cashless society by March 2023 (Arvidsson et al., 2017, Hedman, 2018).<sup>4</sup>

In addition, large technology companies, such as Ant Financial, Tencent, Facebook, Apple and Google, attracted by the potential for revenue growth, have entered the payment services market. Global payments services revenues, as a result of the widespread demand for innovative services, reached USD 1.5 trillion in 2019, and are expected

<sup>2</sup> Many professionals mistake the term *digitization* for *digitalization*. The former is narrower in scope: it means the process of converting analog content to computerized digital data. For additional background on the terms and their contrasts, see Brennen and Kreiss (2014). The knowledge on digitalization developed to date in research is discussed by Tallon et al. (2019), and current directions are showcased by ongoing special issue development at the *European Journal of Information Systems*, with the theme of “Digital-Enabled Strategic Agility: The Next Frontier” (Tallon et al., 2020, to appear in Spring 2022).

<sup>3</sup> The transformations that are underway are further discussed in terms of various issues by authors who have offered useful intellectual foundations for this research. They include coverage of macro-level issues: in the global digital economy (Tapscott, 1996); developing nations’ digital economy value creation and appropriation (UNCTAD, 2019), as well as in Asia (Li et al., 2020) and in global trade (OECD, 2020a, b); measurement of national digitalization via the Digital Economy and Society Index (DESI) (European Commission, 2019); and the impact of digitalization on national labor markets (DeGryse, 2016).

<sup>4</sup> The move toward a cashless society has been ongoing across the globe for a number of years. The earliest evidence is from Sweden. In 1919, a committee appointed by the king suggested that Sweden should start a postal giro business to decrease the use of cash (Sveriges Riksdag, 1919). Today, there is no such explicit aim expressed by the government. In fact, they have put new legislation in place to “protect cash,” but research shows that consumers (Riksbanken, 2019) and merchants (Arvidsson et al., 2017) are abandoning cash. Sweden, together with Finland, China, the U.K. and Australia, are top-ranked to become cashless societies. The path toward cashless is not uniform though. We can see both demand and supply-side paths. In Sweden, the demand side (consumers or merchants) is gone and digital payments, such as with payment cards and mobile payments, are the preferred choice. Similarly, in China people prefer embedded app payment solutions, like WeChat Pay or Alipay. In other countries, such as Singapore, it is the supply side – the government especially – that is pushing toward a cashless society. The supply-side arguments usually involve new value creation, financial inclusion by cutting out middlemen, and developing tools to the fight against corruption (Chakravorti et al., 2016).

to grow by 67% to USD 2.5 trillion by 2028. This will partly be driven by the move away from cash toward cashless payments around the world (Malhotra et al., 2019).

Developed countries often have to contend with the challenges of rolling out novel and high-tech payment solutions in locally low-digitalization implementation environments though. This is because typical retail settings such as shopping malls, supermarkets and restaurants have already been converted to cashless payment mechanisms through credit and debit cards (KPMG, 2016). Therefore, the focus for cashless payment implementation has shifted to locations where the purchase amounts are smaller in value and cash has been the predominant payment method, such as in outdoor food courts in Singapore where inexpensive meals are sold (Tung, 2016). In such places, business processes usually are not very digitalized. Such payment solution implementation settings resemble locations in developing countries like Kenya, with its dark and cramped shop spaces, cluttered store-front table-tops, itinerant retail staff with limited education, and the presence of only basic utilities (e.g., electricity, gas, water) (Ng and Tan, 2016).

Cashless payment implementation in such settings presents unique challenges though it also represents an opportunity: such locations are a final frontier for cashless payment solution implementation in a developed country’s effort to create a cashless society. Singapore is an example of a country that aims to go cashless (albeit not by 2025) – with an already well-developed national infrastructure. However, some of its local payment solution implementation environments are far less digitalized than what one may expect with the advanced infrastructure of a developed nation.

Similarly, developing countries such as Thailand and India have also been seeking to establish cashless payments capabilities (CGAP, 2019; Desai, 2019). How different are their experiences with specific cashless payment solution implementation initiatives compared to those of developed countries? We discuss a classification approach that is based on different levels of novelty for payment technology solutions that were implemented in the presence of different degrees of national technology infrastructure as well as contrasting levels of digitalization of the local retail implementation environment, and the novelty of the payment technologies and processes used. Consumers, meanwhile, have been turning to new technologies for greater convenience with money in their everyday lives. For example, 64% of Southeast Asian consumers have indicated that they are comfortable with going cashless for a day (Visa, 2019). This underlies the importance of cashless payment technologies in the countries’ drive toward a cashless society.

Novel payment technologies in an economy (even if they are not truly new in a global sense) also bring the need to operate them well, on both the consumer and merchant sides. Smaller merchants face unique hurdles as they go cashless (Boon, 2017b). There are economic hurdles (e.g., paying a merchant fee to accept e-transactions), but also the extra effort to operate any new payment technology due to the single-proprietor nature that is typical of their small businesses (Ahuja and Thatcher, 2005). More complex payment technologies bring with them challenges in merchant acceptance, especially for smaller merchants, due to their relatively high cost.

This research commentary is intended to address a set of high-level

questions of importance to industry practitioners and researchers who are interested in expanding the extent to which their country contexts can be studied, beyond the typical examples that are most often seen in existing industry and academic reports and articles:

- (RQ1) Can cashless payment solution implementations be classified using a framework that enables the identification of the primary descriptors of the setting and technologies for study in a country context?
- (RQ2) Can a framework be constructed that distinguishes between national and local infrastructures, based on commonly-accepted constructs and readily-available measures from leading government, business and university sources? Can such classification be done with authoritative measures?
- (RQ3) Is a 3-D framework useful that identifies key dimensions related to: the level of development of a country's infrastructure; the digitalization of the local implementation setting where a cashless payment solution occurs; and the degree of technological novelty associated with the payment solution at the time of its implementation in a country?

This commentary offers the following research contributions. (1) We offer new knowledge about payment technology solution implementations in different developing and developed nation settings. (2) A framework proposing the use of three new dimensions is presented. It offers a perspective to support assessing cashless and other kinds of payment technology implementation settings. It does so in terms of local *implementation environment digitalization*, *payment technology solution novelty*, and the *national infrastructure status of a country*, based on measures from the World Economic Forum (WEF).

The remainder of this article is laid out as follows. Section 2 presents the new 3-D framework for classifying cashless payment solution implementations at the country level.<sup>5</sup> Sections 3 and 4 then offer mini-case analyses for four developing country and four developed country cashless payment implementations. Section 5 interprets the findings about the mini-case implementation illustrations so the reader will understand the varied nature of the factors that are instrumental in influencing how successful they came to be. The mini-cases are not intended to be viewed as representative of all aspects of the individual countries' experiences and levels of success with cashless payments over the years though. Section 6 summarizes and concludes with some limitations.

## 2. Classifying country-level cashless payment implementations

We next introduce a three-dimensional (3-D) framework for the classification of the implementations of cashless payments at retail *point-of-sale* (PoS) locations for different countries around the world at different points in time over the years.<sup>6</sup> The first dimension, *payment solution implementation environment digitalization*, characterizes the extent to which the local business environment is able to effectively support innovative payment systems implementation. Local readiness is likely to be a function of the physical setting, its experience with

payment technologies, the digitalization of the implementing vendor, and the merchants and consumers that will use it, as well as the training and educational levels of staff that will need to deal with novel technology implementations. The second dimension, *payment technology solution novelty*, identifies the nature of the payment system solution that is to be supported, based on whether it involves complex and high-performance payment services, which are new and different for the country or the locality in which the implementation is being done. The third dimension is *national infrastructure development status*, which is an indicator for the readiness of a country as a whole (not its local readiness or digitalization, which may be different) to successfully support innovative payment capabilities, based on its development level. These constructs provide a way of looking at payment technology innovation deployment settings by grouping the opportunities into facets of a 3-D classification cube, whose dimensions we discuss and justify in greater detail.<sup>7</sup> (See Appendix Table A1 for a summary of the definitions of the terms.)

### 2.1. Implementation environment digitalization

*Implementation environment digitalization* is the nature of the business and technology deployment setting in which cashless payment purchase transactions will take place. This dimension is intended to represent the readiness of a cashless payment solution's implementation environment. So distinguishing between relatively less and more digitalized environments is a useful operationalization for whether payment technology solutions will be easier or more difficult to implement based on how well the environment will be able to support it. The degree of digitalization of the local implementation environment is typically affected by the physical and technical circumstances which, in turn, arise based on the nature of the business, the training of an organization's staff for payment transactions, and the year – or era – when the implementation occurred (including the 1990s, 2000s, 2010s and the upcoming 2020s decade).

Our reading of the literature suggested that there is no single measure or construct that functions in the exact way that our implementation environment digitalization construct is intended to. For example, one thread in the literature offers a theory of *organizational readiness* that emphasizes the effects of various underlying internal factors, such as the *implementation climate* and the perceptions of staff regarding the importance and feasibility of an implementation's likely success (Klein and Sorra, 1996). This is consistent with the changes that cashless payment solutions require the firms to deal with that implement them. Another thread is related to *environmental readiness* for evidence-based practice in healthcare organizations, but this still essentially applies to organizational readiness (Smith and Donze, 2010). A greater contrast is offered by research that has proposed the construct of *operational readiness*. It:

<sup>5</sup> It is not our purpose to identify representative mini-cases as a basis for classifying the countries that are discussed in this article. The available data from other published works in the industry and consulting literatures are not sufficient to permit a researcher to do that with a common basis of information for all of the different countries. We also do not delve deeply into the variety of payment technologies that have been used at different times in the different countries, since there is quite a bit of material from industry vendors, consulting firms and Computer Science researchers on this aspect of payments solutions.

<sup>6</sup> We do not wish to put forward a typology of PoS payments, since the main thrust of this thought leadership article is not about payment technologies and their variations over time. Instead, we mostly focus on the locations where digital payments, especially via cards but also online, can be made for mall store, restaurant, food court, and other public-setting purchases.

<sup>7</sup> An anonymous reviewer noted that our framework's dimensions do not emphasize existing national payment infrastructure, which is built upon the technology ecosystem in which its major stakeholders are involved. According to WePay.com (2020), in addition to customers and merchants, the payment ecosystem is comprised of acquiring banks that work most closely with the merchants, *payment service providers* (PSPs), payment facilitators, and payment aggregators – as well as fintech start-ups and other technology firms. Our framework for classification is not built based on an operationalization that includes them though. Instead, it assesses other aspects of payment solution settings (local digitalization, solution novelty, and the development of the broader national infrastructure). For an alternative perspective to ours, the interested should see Janis and Shah (2016) for their discussion of supply-side and demand-side drivers, policies and regulation issues that prompt the development of inclusive payment systems in developing countries, as well as the high costs associated with the move to new digital infrastructure for cashless payments (Massi et al., 2019).

ensures that the right people are in the right place at the right time, working with the right hardware according to the right procedures and management controls, and are functioning in a favourable physical and psychological environment. (Levovnik and Gerbec, 2018, p. 122)

## 2.2. Payment technology solution novelty

Our *payment technology solution novelty* construct is defined in terms of its relative newness and complexity in a setting – typically a higher-technology solution (Watkins et al., 2017) versus a lower-technology solution (GoCardless.com, 2020) that drives payment services at the PoS, and has not been used before.<sup>8</sup> We further recognize that solution novelty is time-specific and country-specific. Some countries are more advanced, while other are less advanced in technology deployment terms. Higher-tech applications such as contactless cards tend to support faster transactions, are more secure, and require less interface sophistication between the payment device and the PoS system, but they have appeared in different years in various countries in the world. So the reader should recognize that novelty truly is relative. For instance, a PayWave contactless transaction takes about 4 to 12s (RingitPlus, 2019), while a magnetic stripe credit card swipe transaction takes about 15s or more (Dwyer, 2019). They have brought convenience to consumers in many payment settings that were not previously available, and thus have been driving greater usage of cashless payments. But not all merchants and consumers in different countries around the world have had access to these tech innovations.<sup>9</sup>

Lower technology solution novelty, more generally, emphasizes the use of older, legacy technologies, such as magnetic stripe cards with EMV (Europay, Mastercard, Visa) credit card chips to produce unique transaction identifiers whenever a card is used. At various times in various countries in the world, they too have been viewed as novel solutions. Transactions, again, need to be authenticated with the cardholders' signatures. In developing countries, the use of manual *zip-zap card impression machines* that create receipts have typically been used where no telephone infrastructure was available (WorldPay Editorial Team, 2019). A payment application that offers online connectivity does not necessarily make it novel though. In online shopping, for example, low-tech payments are characterized by their use of postal *mail or telephone ordering* (MOTO) rules, plus the use of *card verification value* (CVV2) purchaser authentication, as an added form of transaction protection and security (Kortaccept Nordic (now Nets.eu), 2015).<sup>10</sup> But even they were viewed by the organizations that implemented them as being novel, when they were initially introduced in a country.

In contrast, higher technology solution novelty typically occurs as a by-product of the application of the latest technologies, especially when they have not been used heretofore in a country. They include *near-field communication* (NFC), *quick-response* (QR) machine-readable codes, *one-time passwords* (OTPs), mobile technologies, and contactless chips to store credit card information (U.S. Payments Forum, 2017). Higher-tech solutions typically require users to download mobile apps onto their

<sup>8</sup> An anonymous reviewer suggested that it makes sense to include *technological compatibility* as well (Kazan and Damsgaard, 2016). This is appropriate because compatibility with existing infrastructure, payment practices and store technologies is essential for feasibility success.

<sup>9</sup> In the U.K., for example, contactless payments now account for more than 40% of all transactions, and the payment limit of £14 for transactions in 2014 was raised to £30 in 2018 (Erenhouse, 2018, Gemalto, 2020). This is hardly true in Myanmar and Vietnam, however, which have lacked the infrastructure to make such payment solutions as the U.K.'s widely available. Lower-tech applications, in contrast, typically are less novel and slower due to their physical interfaces with PoS systems and the now antiquated requirement to support a payer's physical signatures (Infineon Technologies, 2017; Andriotis, 2018).

<sup>10</sup> In the U.S., a purchaser's home address is often used as part of the *cardholder authentication verification value* (CAVV) authentication protocol.

mobile phones, and they have been viewed as having novelty upon their introduction in many countries during the past decade. The apps allow consumers to update their personal information through their devices. And, they also allow them to scan the QR codes at checkout to wirelessly capture merchant information in many countries. The transactions occur with little or no physical contact resulting in purchases suitable for less-developed payments technology implementation environments. Also, it is possible to do such transactions with a mobile phone, which can share the payer's mobile phone number, without the involvement of a QR code.

## 2.3. National infrastructure status

There is no standard definition of *national infrastructure*, but according to the World Economic Forum (WEF, 2012), there is general agreement that it includes three types of sub-infrastructure:

- *Economic infrastructure* includes projects that drive economic growth and support the society, including transport facilities, utilities, flood protection, waste disposal, and telecom networks.
- *Social infrastructure* offers support for public services, such as public housing, hospitals, schools, parks and recreation to improve quality of life and biodiversity.
- *Soft infrastructure* consists of public institutions that enable society to function normally, with government buildings, rules for law and order, and education and public health systems.

*National infrastructure* is an operationally-definable basis, or *pillar*, in assessing global competitiveness, as it is a crucial enabler for innovation and efficiency. The availability of a cost-effective and reliable energy and communication networks do not guarantee economic growth though. Rather, they allow new technologies to support increased productivity and economic growth.

We provide the WEF's infrastructure rankings for fifteen representative countries. Among them are eight developing and developed countries for which we present mini-case analyses later. (See Table 2.)

The WEF ranks country-level combined *transport and utility infrastructure* and *information and communication technology* (ICT) *adoption* on a scale of 1 to 100. We used average rankings for the two measures as having more advanced, *developed infrastructure* (on the left) – in comparison to less advanced, *developing infrastructure* (on the right). To illustrate our framework, we set a ranking cut-off to define developing and developed countries for this research.

In payments settings, the areas of energy and telecom are particularly relevant as payments systems typically require electricity and telephone networks to function. More advanced forms of payments (e.g., those using mobile phones) require a dependable and pervasive mobile network, with relay towers covering the populated areas of a country. Payment innovations also need soft infrastructure in the form of proactive central bank regulations and civil and banking laws. Thus, infrastructure affects the performance of cashless payment solutions.

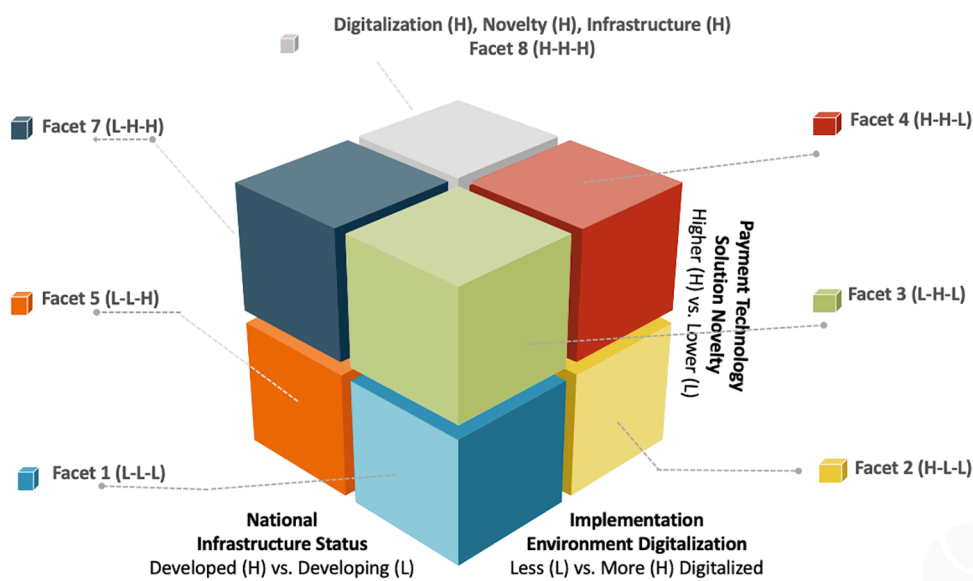
In countries with lower infrastructure rankings (e.g., Kenya and Vietnam), the less reliable infrastructures for supporting payments often translate into frequent electrical blackouts and fixed-line telephone disruptions that prevent PoS terminals from dialing up to obtain payment authorization when they need to work seamlessly. Good mobile phone network infrastructure, thus, can enable a country to leapfrog the constraints of poor land telecom or electricity infrastructure to reap m-payments efficiency.

The availability of m-payments also can allow a country to successfully enable millions of consumers to pay using their mobile phones. The lack of stable electricity, by the same token, will not be a critical constraint. The use of QR codes has done away with the need for an electrical connection at a merchant's location to power a PoS terminal. The consumer now can simply scan a QR code with his or her mobile phone – or use only the mobile phone – and payment will be effected

**Table 2**  
 WEF Infrastructure Development and ICT Adoption Rankings, 2018.

DEVELOPED COUNTRIES <sup>(a)</sup>	INFRASTRUCTURE DEVELOPMENT		ICT ADOPTION		DEVELOPING COUNTRIES <sup>(a)</sup>	INFRASTRUCTURE DEVELOPMENT		ICT ADOPTION	
	Score <sup>(b)</sup>	Rank <sup>(c)</sup>	Score <sup>(b)</sup>	Rank <sup>(c)</sup>		Score <sup>(b)</sup>	Rank <sup>(c)</sup>	Score <sup>(b)</sup>	Rank <sup>(c)</sup>
Singapore	95.4	1st	87.5	5th	Mexico	72.4	54th	55.4	74th
Netherlands	94.3	2nd	76.3	24th	India	68.1	70th	32.1	120th
Japan	93.2	5th	86.2	6th	Thailand	67.8	71th	60.1	62nd
Germany	90.2	8th	70.0	36th	Indonesia	67.1	72nd	55.4	72nd
U.K.	88.9	11th	73.0	30th	Vietnam	65.9	77th	69.0	41st
U.S.	87.9	13th	74.3	27th	Brazil	65.5	78th	58.1	67th
Denmark	87.1	15th	83.3	9th	Kenya	53.6	110th	35.7	116th
Sweden	84.0	19th	87.8	4th	-	-	-	-	-

Note. <sup>(a)</sup> The developed and developing countries in this table include all the eight countries we considered for the cashless payments mini-cases in later sections (shaded) – but not Brazil, Denmark, Mexico, the Netherlands, U.S., U.K. and Vietnam. <sup>(b, c)</sup> All scores and ranks were obtained from the WEF’s “Global Competitiveness Report 2019” (Schwab, 2020). We discuss alternative rankings later in this article. Note that the countries are ordered based on the extent to which their Infrastructure was developed. Also, ICT Adoption = strength of country’s deployed ICT. The assessments are for 2018, as reported in 2019.



**Fig. 1.** A 3-D classification framework for country-level cashless payment solution implementation. Note. We refer to the outward-facing sides of each *sub-cube* in the classification as *country facets*. This is what would be visible to a user if the related 2 × 2 matrix were extracted from that side of the cube. There are eight sub-cubes and facets (one per sub-cube). In addition, Facet 6 (H-L-H) is invisible in this drawing. It is hidden from view at the lower level, right-back side of the classification cube. The cube is drawn in a way that permits us to present all of the countries with developing infrastructures in the right-front side of the cube (the Light Blue, Yellow, Light Green, and Red sub-cubes), and the countries with developed infrastructures in the back-left side (the Orange, hidden, Dark Blue, Gray sub-cubes). The y-axis label is written vertically, with “H” indicating higher technology solution novelty (newness in a setting at some point in time) for the visible facets (or sub-cubes) 3, 4, 7 and 8. Per the request of an anonymous reviewer, we also include an “exploded version” of the classification so that the facets associated with the Developing National

Status and Developed National Status are presented separately. (See Appendix B.)

almost instantly without additional infrastructure support – a hallmark of a more-digitalized local implementation environment.<sup>11</sup>

**2.4. Proposed framework**

The main 3-D framework dimensions are: technology *implementation environment digitalization* – in the x-axis as cube length; *technology solution novelty* – in the y-axis as cube height; and *national infrastructure status*

<sup>11</sup> Other important constructs that come close to the mark of a country’s national infrastructure are *fintech readiness* and *diffusion in a country*. One index that has been proposed by the Asia-Pacific Economic Development Cooperation (APEC, 2016) organization is the “Fintech E-Payment Readiness Index.” Another is from consulting firm, EY (2019), which has released the “Global Fintech Adoption Index.” We discuss these in Sections 3 and 4 as alternative ways to understand how to distinguish between the extent of developed versus developing national infrastructure in contrast to local implementation environment digitalization.

for a country’s overall development – in the z-axis, cube depth. (See Fig. 1.) In presenting this framework, we also wish to signal to the reader that the analysis cube offers a generalizable artefact for use in other technology and business implementation settings outside the payments domain.

We will analyze why different real-world cashless payment implementations did better or worse after their implementation. We will do this based on publicly-available evidence for eight mini-cases – identified so that they map into the different 3-D cube country facets. Our research involved the following steps:

- (1) We searched business, academic and government press, research and policy articles, to identify the relevant intellectual foundations for the specification of the 3-D framework and so the cashless payments mini-cases that could be mapped to the

framework's facets. Industry professionals reminded us that the relative amount of available documentary evidence is slim for most cashless payment implementations, with some notable exceptions, as we learned in this research.<sup>12</sup>

- (2) We recognized the necessity of an *operationally-defined approach* to specifying the country facets based on the *measurement of the dimensions* to classify a country its implementation setting, national development and payment solution novelty based on the 3-D framework's facets, as described in two footnotes below.<sup>13,14</sup>
- (3) We extracted appropriate knowledge to inform our mini-case analyses by reading the content of all of the sources we identified. This is appropriate when there is material available to understand publicly-observable events commented on in the press (e.g., weather and earthquake disasters, or trade and interest rate policy announcements by policy-makers).
- (4) We chose not to use a specific set of standard strategy choices for cashless payment services providers to frame the implementations in each of the mini-case countries, nor was our intention to create a typology of payment service-provider strategies. Instead, our goal was to identify the strengths and weaknesses of the approaches that were observed to have been taken in the country facet mini-cases. There were not enough instances of mini-cases and sharp contrasts with respect to the payment services providers' strategies to support the approaches we chose not to apply though. Instead, we include quotations from the various interviews and publicly-available materials to which we had access.

We next offer additional details on the dimensions of the proposed 3-

<sup>12</sup> Among our mini-cases, not all have obtained global coverage of cashless payment solution implementations: Germany's card payments have been covered; and so has Kenya, for its success among developing countries with the M-PESA mobile phone-based money innovations; and Sweden for its impending 2023 move to the cashless society – as an exemplar for other Scandinavian nations. In contrast, Singapore's "Hawker Go Digital Initiative" has only gotten local press coverage. And the other countries with lower-profile digital payments efforts have received much sparser coverage. The written record is more difficult to uncover – and in some cases very limited. What led to the development of this research was a consulting project with a Singapore organization that permitted us to do interviews, collect relevant data and on-the-ground evidence on usage and success of cashless payments in hawker stalls and outdoor food courts. Other research that we have been involved with in different countries offered opportunities to interview executives, regulators, standards organizations and tech providers for payments – but with limitations on disclosure.

<sup>13</sup> A peer reviewer commented that there are no perfect *quantitative equivalents* for some of the dimensions. Our 3-D framework is a  $2 \times 2 \times 2$  composite representation, so that each of the sides of the cube has four sub-cube *facets* represented by their representative  $2 \times 2$  quadrants. There are three sides of each sub-cube that are the same among the eight sub-cubes in the  $2 \times 2 \times 2$  full cube. When we refer to *facets*, we are indicating *unique triples*, [(L or H) x (L or H) x (L or H)], based on the full cube's dimensions. The triples include: LLL, LLH, LHL, LHH, as well as HHH, HLL, HHL and HLH. From these, we operationalized definitions for facets with different national, local and solutions dimensions that are used by the classification cube.

<sup>14</sup> Further, based on the use of the dimensions, we defined countries based on how their dimensional assessments matched the eight triples (e.g., HHH, HLH, etc). Our approach, as we noted earlier, was to use the WEF Global Competitiveness Report's Infrastructure Development measure for the quantitative 3rd dimension. We used a ranking cut-off for Infrastructure Development of 25th place or higher and ranking cutoff for ICT Adoption of 40th place or higher. These two country-level measures were then averaged. For developing countries, our procedure was the same, though we set the Infrastructure Development and the ICT Adoption rankings to lower levels, both at 40th place. This enabled us to identify the countries as being generally representative of the various 3-D classification country facet triples. The identification of "higher" vs. "lower" assessments for the two qualitative dimensions was done on a more subjective basis, using the features that we described.

D classification framework. These additional details will highlight its application and use in a more straightforward manner for business analysis and researchers who may wish to use it for payments, or other business technologies for which it has broader applicability.

### 2.5. Additional details related to the classification framework dimensions

*Implementation environment digitalization* is assessed based on our scan of key features that characterize the implementation environment that suggest its relative digitalization readiness. This can indeed be different from the extent to which a country's national infrastructure development status suggests widespread digitalization overall, such as Sweden and Japan – or something less than that, such as Thailand and Indonesia. Some indicative features for local implementation settings include: the presence of electricity and water infrastructure; whether IT has been used in the setting before; whether there are telecom lines and data connections available; and whether the employees at a merchant's store have had sufficient training and experience with the use of cashless payment solutions, or if there is a merchants' association that acts as a clearinghouse for the sharing of technology-related implementation assistance and payment know-how.

*Payment technology solution novelty* can be assessed, as an anonymous reviewer appropriately pointed out, based on the relative newness of key features of the payment solution implementation in a country. Such features may include, but not be limited to: lower- vs. higher-speed payment transactions; lower or higher operational complexity; and less or more transaction and information security. Other things that add complexity to the process ought to be considered too. For example, some of them are the presence of QR or NFC card readers, fraud detection software, network connections that link a store to a larger company, intraday revenue data capture routines, etc.). These kinds of things can be assessed directly by analysts who work in specific national and local settings with relatively older or newer technologies. We must emphasize that *relative novelty* is better understood by people, and more rarely absolute and subjective interpretations of true novelty in the world. This is because payment technology solution novelty is almost always what people involved in implementing them know in a specific place (e.g., the locale and country) at a specific point in time (1980–1990s, 2000s, 2010s and beyond) for payment technologies. In addition, the solutions may be associated with different eras, such as for contact or contactless cards only, with or without mobile phone applications, and with or without smartphones and tablet computers.

*National infrastructure status*, in contrast, can be measured objectively and quantitatively based on the use of a variety of globally-available, non-governmental organization (NGO) metrics and agency reports. In this research, we chose to use the Infrastructure and Adoption Pillar indicators from the World Economic Forum's (WEF) "Global Competitiveness Report 2019," which we referenced above. This and other tools from other organizations that are closely tied to specific regions of the world (e.g., for Europe, the Middle East, Africa Asia and the Americas), or to sub-sectors (e.g., fintech firms, tech start-ups and firms in the global banking sub-sector), may be helpful for an analyst's use based on the scope of the country classification that needs to be done. WEF's report is especially useful since there are other pillars that go beyond infrastructure and ICT adoption.

We now shift to the presentation of the main findings of the mini-case analyses in this research, separated into Section 3 for developing countries and Section 4 for developed countries based on their WEF-assessed infrastructures.

## 3. Developing country cashless payment solution implementations

We begin our mini-case analyses to explore a variety of cashless payment solutions that have been implemented in countries with developing national infrastructures, involving Facets 1 to 4 in the framework. The

countries all vary in terms of their local retail implementation environment digitalization, as well as the novelty and advanced technical nature of the cashless payment solutions they have sought to implement. We further contemplate the factors that precipitate implementation failure and success across four countries in South Asia, Southeast Asia and Africa: India, Thailand, Kenya, and Indonesia. We also discuss the Infrastructure Development and ICT Adoption pillars of the WEF's "Global Competitiveness Report 2019," as a basis for tagging the nations as developing countries due to the nature of their infrastructures.

### 3.1. Facet 1 (L-L-L): India – Kirana, ItzCards and the human element for customer centricity

Facet 1 represents countries with a developing national infrastructure (low) like India. In these countries there are also retail environments which exhibit low levels of local digitalization and low payment technology novelty. One example is *kirana stores* in India: neighborhood convenience stores located around the corner from where everyone lives – for which we review the success of the Mumbai-based DCB Bank's ItzCash Card initiative.

Kirana stores are typically multi-generation, family-owned businesses with close to 12 million spread around India (Bureau, 2020) and sales representing 96% of the retail grocery business (VezaBlogAdmin, 2020). They appear to be resistant to basic digitalization, despite the widespread move of digital technology into the retail spaces of developed and developing nations. Their social relevance and sustainable intermediation in the distribution of goods and food have been due to their proprietors' knowledge of how to sell a locally-relevant selection of items in their neighborhoods. An article in YourStory.com, the multi-lingual sub-continent e-zine, explains the great appeal of the "humble kiranas" that leads to their business sustainability:

*Their accessibility, convenience and the variety of local relevant goods they stock makes these seemingly small stores popular. They are better tuned in to the requirements of their regular customers than several larger players. If you are looking for Maharastrian Chivada or lonche; Guntur chili Karnataka's Mankattu chili, you are more likely to find it in a kirana store just around the corner than on the shelves of some fancy supermarket. Their intimate knowledge of the local consumer community helps them with smarter utilization of their limited store space, since stock only what they need to while using the wholesaler as a warehouse. In addition, they also tend to provide free delivery in less than an hour with a handy credit facility for regular customers. (Mediratta, 2018)*

Ninad Sheth (2020), a Nikkei Asian Review journalist, explained why the kiranas are so effective: even in a market with large online commerce players that offer similar goods, food and delivery services, the kiranas come out on top in customer centricity due to the high degree of informedness they possess about their business and its customers – and because the online stores only make deliveries in five-days (Li et al., 2014a, 2014b). Another reason they are able to withstand the onslaught, especially against the larger, branded supermarkets is because they can keep their real estate costs to a minimum. This is a major challenge for large supermarkets though. Small kiranas also manage fewer stock keeping units (SKUs) in a smaller space, which is critical in a country where food preferences change every 100 kilometers. Thus, since most of their sales transactions are in cash, kirana shops offer high potential for cash displacement, in spite of the low digitalization of their retail environments.<sup>15</sup>

The Mumbai-based DCB Bank's ItzCash Card initiative, a prepaid card launched in 2006 (ItzCash, 2020), has been sold at 20,000-plus kirana shops during the past decade (The Economic Times, 2011). The

ItzCash Card is a low-novelty e-payment card that is also low-cost for the kiranas: it uses older and simpler mag-stripe technology with a low-cost card reader. This allows the bank issuer to price ItzCash card services at the low end (say, at –50 rupees or –70 U.S. cents). Sometimes, they are even given away for free in small denominations, so more consumers will be able to hold a card and top it up later. Currently, the ItzCash's prepaid card has one million users. However, Ravi Singh, Chief Business Officer at ItzCash, indicated:

*Earlier, many small merchants would discourage customers to use plastic money for payment. However, post-demonetization, we have seen a massive behavioral change in the mind set of traditional brick and mortar retail merchants towards digital payment movement. Furthermore, as per RBI [Reserve Bank of India] data, we have only 1.5 million PoS machines in India; which together underline the existing huge opportunity in the POS payments segment. (Finextra, 2017)*

Because it is a domestic-use only card, however, the ItzCard cannot be used outside India. This circumvents issues with the international pricing structure of the related card associations, since the ItzCash Card is also a Visa card. It also allows for lower local interchange fees, thus leading to a lower merchant-discount rate. This also permits the card to circumvent the need for an embedded EMV chip, which further lowers the cost for consumers. The real challenge, though, is the cost of PoS terminals to be deployed at so many kirana shops. Since they work with mag-stripe cards though, this payment solution is ill-suited for faster-paced convenience-store retailing, as installing NFC-capable terminals in them would be cost-prohibitive. Terminalization, thus, is restricted to the higher-volume outlets that can achieve some criterion scale size to be cost-effective (Finextra, 2017).

In the past, the view has been offered that this segment can be profitable for banks if they achieve a cost-effective scale size with respect to prepaid cards. Thus, it has made sense for them to explore other lower-cost payment technologies like QR-code payments. This is now allowing more merchants in India to accept cashless transactions without the need for investments in more costly PoS terminals (Allirajan, 2017). Payment systems tech sophistication for these merchants can also occur as part of a larger retailing process digitalization effort. For example, India's Reliance Group was courting the kiranas the year we wrote this article, with a proposal to convert them to a B2B2C model in partnership with Facebook, using Reliance's JioMart platform (LiveMint, 2020). If successful, this will subsume the terminalization costs within a larger, more strategic retailing digitalization initiative.

The kirana example shows that there is a good possibility to implement cashless payments even in L-L-L settings, but cost of the technology and sales volumes are currently challenges for wider adoption.

### 3.2. Facet 2 (H-L-L): Thailand and the deployment of electronic data capture (EDC) machines

Facet 2 represents countries with a national infrastructure like that of a developing country (low). We illustrate this facet with Thailand, where there are retail stores which exhibit considerable levels of local implementation environment digitalization (high), but use payment solutions with less payment technology novelty (low). According to the pillars of the WEF's "Global Competitiveness Report 2019" (Schwab, 2020), Thailand's Infrastructure Development capabilities score (67.8) ranked it 71st in the world, while on ICT Adoption (60.1), it ranked 62nd.

An example of the Facet 2 scenario occurs with urban shopping malls in Bangkok, such as The Mall, Emporium, Siam Paragon, Paradise Park, and MBK Center (Iverson, 2017), as well as the King Power Duty-Free

<sup>15</sup> Cash displacement occurs when cashless payments replace the use of cash, making it unnecessary. For additional background on cash displacement, see A. T. Kearney (2013).

stores in [Suvannabhumi Airport \(2020\)](#).<sup>16</sup> These shops serve the middle class of society and the tourist market. Thailand's shopping industry generated THB 3.42 billion (Thai baht) in revenues in 2016, of which 81% was associated with tourist spending ([PATA, 2018](#)).

Each Thai mall typically has an anchor tenant which operates a department store. Often the mall owner will also be the operator of the department store, taking up major space in the mall, while subletting the other store spaces to smaller shops. Due to high tourism spending in Thailand, a majority of retail shops naturally focus on the tourist market ([Krungsri Research, 2019](#)). The level of digitalization in the smaller shops typically is limited, and cash is the main form of payment for consumer purchases. Because of the leisurely nature of retail shopping, there is no expressed need by consumers for faster (more novel) payment technology.

In 2016, however, the Bank of Thailand promoted the use of e-card usage through its Card Usage Expansion Project as part of the national drive to go cashless. The aim of this project was to displace cash at smaller retailers' PoS, so that the 54 million debit cards in Thailand could be used to make everyday purchases. Previously, the cards had mostly been used for cash withdrawals at ATMs. The government funded the installation of *electronic data capture* (EDC) machines at smaller retail shops' PoS, with a goal to reach an installed base of 550,000 EDCs by March 2018 ([Chantanusornsiri, 2018](#)). The retailers enjoyed free rental of EDC machines, a lower merchant discount rate of 0.55% (compared to the usual 1.5–2.5%), plus inclusion in a "lucky winner" draw for participating merchants ([Payment System Committee, 2018](#)). In spite of the incentives in their favor, Shoke Na Ranong, Chairman of the Thai Payment Network, noted a major limitation of the overall initiative:

*Debit card transactions account for only 2% of the total value of cash withdrawals from ATMs. Merchants have been discouraged from accepting debit cards due to the high transaction fees, while cardholders are not confident about using them and have concerns about the security of the magnetic stripe. (Banchongduang, 2016)*

Beyond the EDC Expansion Project, the Thai government also organized various marketing initiatives to increase tourism spending. For example, the Thailand Shopping and Dining Paradise campaign was launched in 2017 by the Tourism Authority of Thailand ([PATA, 2018](#)). It promoted less popular destinations, such as Mae Sot in Tak Province, the Kueang District in Khon Kaen Province, the Aranyaprathet District in Sa Kaeo Province and the Hat Yai District in Songkhla Province. Despite these initiatives, merchants nevertheless were slow to adopt the EDC machines ([Banchongduang, 2017](#)). Merchants, meanwhile, were fearful that their use of cashless payments would allow the tax authorities to audit their revenues and earnings. The actual rollout of the EDC machines also fell behind schedule with only 140,000 merchants enabled out of the targeted 560,000. Merchants also complained that the merchant discount rate was too high. As a result, more than half of smaller retailers still use cash. This is because they had fewer full-time employees, and instead, had to rely mostly on daily hires who were more familiar with cash. Due to these factors and the increasing popularity of QR codes in other countries like China, the Bank of Thailand introduced PromptPay, an m-payment system using a standard PoS QR code to encourage more use of cashless payments. This also was intended to overcome the cost challenges associated with EDC machines ([SCB Research, 2017](#)).

Nikhil Reddy, a payments analyst, summed up "Thailand Cards & Payments: Opportunities and Risks to 2022," the report of his firm, with these things in mind:

*[T]he share of cash in the overall payment volume is expected to decline from 85.6% in 2018 to 77.8% [by] 2022. During the same period, the total card payment value is expected to increase from THB 1.8 trillion (USD 56.1 bn) to THB 2.7 trillion (USD83.8bn). ... Though cash will continue to remain dominant in Thailand, these measures will certainly propel electronic payments, thereby further reduce the usage of cash over the next five years. (Global Data, 2019b)*

We can see from this example that, even with high local digitalization and strong government initiatives, if the merchants themselves are disadvantaged by transaction costs and concerned by factors such as tax audits then implementation can be negatively impacted.

### 3.3. Facet 3 (L-H-L): Kenya and the success of the M-PESA payment wallet

Facet 3 represents countries with a developing national infrastructure like Kenya, where most local retail environments typically have insufficient digitalization of their payment solution implementation environments (low), making it difficult to adopt and operate advanced cashless payment systems. Based on the WEF Global Competitiveness 2019 pillars, Kenya's Infrastructure Development (53.6) ranked 110th in the world, while its ICT Adoption (35.7) was 116th. With such weak national infrastructure in the country, many observers surely would have questioned the logic of implementing an advanced, mobile phone and SMS-based payment system – a solution that clearly had high novelty, was technically advanced in its time, and challenging to operate successfully in view of the country's unbanked population. It was under these circumstances that Safaricom Ltd. launched the M-PESA money remit project in 2007, and ever since, it has been viewed as a successful SMS-based cashless payment initiative in a developing country that was novel in its time ([Hughes and Lonie, 2007](#); [IFC, 2009](#)).

Topping up to add value in the M-PESA wallet required customers to visit the network of agents. These involved small convenience stores in wooden huts scattered across rural Kenya with only the most basic utilities, low retail digitalization, and a severe lack of space. M-PESA agents from that time were often categorized as being at the *bottom-of-the-pyramid* (BoP), with annual income less than USD 2000. In the late 2000s, only 19% of the population had access to formal financial services. So, while Kenyans were familiar with making a call using their mobile phones, they were less familiar with using it for making payments ([Pralhad and Hammond, 2002](#)). The usual practice was to send money with someone, possibly a stranger travelling back to their village. This could take days though. So there was a clear and high-value proposition in meeting the public's need for swifter payment exchanges. Using a mobile phone to make payments was a novel, disruptive and high-tech application, given the socioeconomic background of Kenya in 2007, when M-PESA was launched ([Christensen et al., 2015](#)).

This led one of the consultants on the project, Susie Lonie, to assert in an interview with a journalist:

*From very early in the project I felt certain that we were onto something pretty big with M-PESA. However, I would never have predicted anything like the growth we experienced. I remember a month after the Kenyan launch the Safaricom CEO called us to his office and said he wanted us to triple our year one target. We thought he was joking but in fact we achieved this new target in the first eight months. (Maritz, 2010)*

Within four months of the official launch, customer sign-up for the service reached 268,499 users. In the interview, Lonie vocalized the

<sup>16</sup> The main government documents that have been guiding Thailand's national cashless payments efforts are the "National E-Payment Plan" ([Global Data, 2019a](#), [Suwanprateer, 2016](#)) and "Payment Systems Roadmap, 2019–2021" ([Bank of Thailand, 2019](#)).



CEO's Safaricom's realization that:

*... with M-PESA ... anyone with a ten-dollar mobile phone [could] participate in financial services, even if they [had] never set foot inside a bank.*

And, by July 2007, monthly transactions amounted to KSH 1.065 billion (Kenyan shillings) or USD 14.2 million (Kimenyi and Ndung'u, 2009). Within two years of the launch, six million customers had registered with the service, representing nearly half the customer base of Safaricom, M-PESA's creator. During that period the P2P dollar-equivalent transfer volume for the service was over USD 1.6 billion (Mas and Morawczynski, 2009).

Various authors examined a number of issues: funding, sponsorship, needs and alternatives, the core value proposition, the service provider's market size estimate, the complexity of M-PESA's retail service agents, and the potential impacts of government regulation.<sup>17</sup> In particular, new entrants had to be able to secure funding to last through the slow uptake in the early years due to the huge investments in banking technology required. Also, resources needed to be allocated so the timelines for commercialization could be strictly followed. Significant attention was devoted to ensuring that the presence of other success factors would not make a difference unless the M-PESA product met a real need in the market and the less attractive alternatives could be clearly understood too.

Acceptance and diffusion also was dependent on the extent to which the value proposition could be understood by M-PESA's agents and their customers, as well as other institutional stakeholders (Kingiri and Fu, 2020). Further, understanding the dominant size of the competing market incumbent's customer base was critical, because M-PESA sought to cross-sell the new product to its own customers. Also, its physical agents were deployed on the ground to strengthen M-PESA's acceptance and diffusion. They also sought to understand the watchful, proactive role of the Central Bank of Kenya, which amended the country's banking regulations to ensure they did not hold back the growth of new payment service and product innovations. Beyond its role as a central cashless money transfer service, the M-PESA platform also supported virtual savings accounts and a menu of financial services that could be accessed in customers' homes, without a trip to a bank.

M-PESA thus created a strong push for financial inclusion in Kenya (Ndung'u, 2018). But, on the other hand, we were reminded that:

*Agents must process a certain volume of transactions each day to make a profit, which has kept the average M-PESA transaction as high as USD 27. This means serving low-income rural areas is just not economical for them, and they go where the money is. Not great news if you're living on a few dollars a day and wish to make sub-USD 2 transactions. ... All this is not to say that mobile money hasn't been a resounding success in Africa, an innovation that has brought millions of people within the reach of formal financial services. It undoubtedly has been. But it has evident limitations, which mean that the true potential of mobile money remains as yet unfulfilled. (Jackson, 2016)*

This mini-case shows that even with a low local environment of

<sup>17</sup> Some have focused on the reasons for M-PESA's success. Hughes and Lonie (2007), for example, investigated senior management's relationship with its vendor, Vodafone, as well as M-PESA's focus, and the fight with the obstacles of day-to-day project management to ensure effective delivery of a commercial service. Mas and Ng'Weno (2010) studied the operational aspects of M-PESA, including its branding, channel management and retail pricing, customer registration process, retail service agent activity monitoring, and scalable distribution structure for liquidity management. IFC (2009) reported on the business case and model for a mobile phone and SMS-based payment capability, and the retail aggregator model for involving M-PESA's many agents. It also explored the core challenges that top management had to overcome, and the technical, cultural, operational, financial, marketing and strategic lessons to be learned.

digitalization, a low level of national infrastructure development and a high novelty implementation can be successful as long as the consumer need is strong, there is a good value model for the agents, and a proactive regulator. This is also an example where mobile payments can be used to leapfrog the legacy infrastructure in a country.

#### 3.4. Facet 4 (H-H-L): Indonesia's luxury tourism and the migration to EMV chip cards

Facet 4 represents countries with a developing national infrastructure like Indonesia (low), yet also with retail establishments that have substantially digitalized technology implementation environments (high) that potentially can handle novel (high) cashless payment system solutions. From the WEF's "Global Competitiveness Report 2019" perspective, the country has an Infrastructure Development score (67.1) which ranked it 72nd globally, and an ICT Adoption score (55.4), that placed it 72nd also. Its transport and utility services infrastructure were weaker than the ICT diffusion that its digitalization capabilities built on.<sup>18</sup>

There are local retail environments in Indonesia that exhibit advanced levels of digitalization and use highly novel payment technologies for the country. One example is the luxury malls in downtown Jakarta – such as Pacific Place, Plaza Indonesia and Grand Indonesia. Indonesia's revenue in the luxury goods market was forecast to be equivalent to USD 2.04 billion in 2020, according to Statista (2020). The boutiques in Jakarta's luxury malls cater to the upper income segments of Indonesian society and foreign tourists. Like most other developing countries, Indonesia is critically dependent on tourists for foreign exchange revenue. Bali is a popular destination for tourists with many luxury resorts including, the Bvlgari Resort, the Four Seasons Resort, the St. Regis Bali Resort and the Banyan Tree Resort. As the head of Indonesia's Central Statistics Agency (BPS) Suharyanto, asserted, China is the top country for arriving tourists, who made up 15% of the total in 2016. Further:

*The [Chinese tourist] surge is not happening in Indonesia alone, but also in other countries, supported by [tourists'] higher earning per capita as China's economy grows. ... We have prepared a separate, special breakfast called [a] Chinese breakfast in which we provide bread, porridge and dim sum. (Susanti and Wirayani, 2016)*

Chinese tourists spend generously, averaging purchases of USD 1000 per visit (Antara News, 2018).

The luxury malls around Jakarta offer global brand names, including Louis Vuitton, Cartier, Bvlgari and other companies in the LVMH Group. Due to their up-market image and global operations, these shops operate with high levels of digitalization in their retail processes. They also are required to support the payment choices preferred by their local high net-worth customers, as well as inbound tourists. The range of payment support, then, must include not just chip cards, but also contactless and NFC payments – such as ApplePay, GooglePay, WeChat Pay and AliPay.<sup>19</sup> The focus for the tourism industry is on three things: providing payment infrastructure to accommodate tourist needs; expanding the non-cash payment ecosystem in the tourist destinations; and the digitalization of tourist transactions to boost the overall volume of non-cash, digital transactions.

Despite the high levels of digitalization in Indonesia's tourism industry, the rest of the retail sector is more traditional in its operations. Over 99% of all transaction volume still takes place on a cash basis

<sup>18</sup> Overall, on WEF's nine-pillar evaluation index, Indonesia ranks 50th, suggesting that it is in the 2nd quartile of the 195 countries that are members.

<sup>19</sup> The "2025 Indonesian Payment System Blueprint" (Bank Indonesia, 2019) lays out the country's game plan to move toward greater financial inclusion. It also discusses Indonesia's cashless economy target initiatives to reduce fraud, by moving away from mag-stripe to EMV chip cards, and pursuing digitalization in nine leading tourism destinations.

(CGAP, 2014). Analysts estimate there are between just two to four PoS devices per 1000 people. By comparison, there are 34 PoS devices per 1000 people in the U.S. and only one per 1000 people in India. The ATM and debit cards in circulation remain largely magnetic stripe-based. And, due to high level of money-related fraud, the government has mandated that all ATM and debit cards must migrate to EMV chips with a six-digit PIN by the end 2021. As a result, achieving this mandated shift to a higher payment technology solution has been the focus of the country's banking industry over the past five years.

The high degree of payment solution novelty in the tourism industry stands in stark contrast to the rest of the country. This problem is further compounded by the growth of increasingly wealthy Chinese tourists coming into the country who bring along their own preferences for different ways-to-pay. The Indonesian tourism industry also has moved to Weibo and WeChat to attract more high-spending Chinese tourists to Bali for their next vacation (Valentina, 2016). And there has been a growing trend for luxury brands like Cartier and Bulgari to flock to WeChat to attract wealthy Chinese to their high-end products (Liao, 2019). Since most Chinese prefer to pay using the China-based WeChat Pay, the industry has upgraded its payment capabilities to allow the use of WeChat Pay at many tourism destinations. Pablo Mauron, a partner at the global Digital Luxury Group offered a related opinion about Indonesia, showing the broad opportunity it has to pursue cashless payments:

*I think WeChat is finally becoming what it's supposed to be for luxury brands, which is not just a social media app. One [function] could be for customers to buy the product. Another could be for brands to build a loyalty program. Customers can pre-order a product or set up an appointment with the [offline] store. (Liao, 2019)*

Related to this, in early 2020 the Central Bank of Indonesia officially granted WeChatPay a permit to operate in the country (The Jakarta Post, 2020). Indonesia clearly is pursuing an *outside-in strategy*, that seeks to leverage cashless payments inside the country to make it a more attractive destination for others to visit and spread their wealth far and wide across the nation's economy.

This example shows that, as might be expected, high novelty solutions work well in highly digitalized environments even in countries with low national infrastructures. However, while technology novelty continues to grow in the main setting, it does not have effects that project across the entire country.

### 3.5. Related observations

Across the "developing national infrastructure" mini-cases, common issues related to needs, choices, alternatives, mandates and scale size pertain to the overall desire that industry participants and governments have toward cashless payment systems implementation. For example, with the neighborhood kirana stores in India, the owners have clear-cut needs to be able to handle customer checkouts faster, but only so far as they are cost-effective in their low-digitalization retail store environments. The result is that the choices they have for the payment solutions that are offered are relatively limited, due to their lack of scale size. In contrast, Indonesia has been operating with a desire to make purchase transactions more attractive and digitalized to suit the expectations of the shopping experiences of luxury goods shoppers, while mandating the shift to cashless payments due to the high occurrence of cash fraud.

Kenya's M-PESA implementation, in contrast, has been a run-away success, And yet it too illustrates the common issues that we noted for the countries' initiatives. In Kenya, the needs of its many BoP consumers were clearly framed, and there was a lack of national coverage with branch banking and ATM services infrastructure. Due to the costs associated with M-PESA's retail agent service network, as well as the agents' critical need to achieve a modest return, the country still experienced severe limits to growth in its m-payments transaction base. And

yet, for other reasons – adopting a truly-workable, mobile phone-based alternative, while avoiding government payment-related mandates, building a harmonious working relationship between the solution vendor and the service provider, and carefully architecting the distribution structure scale size – contributed to its eventual success.

Thailand did not fare quite as well due to scale and usage challenges, specifically the difficulty to effectively deploy the technology related to supporting the goals of its Card Usage and Electronic Data Capture Expansion Projects, as a way of following the government's "National e-Payment Plan" and "Payment Systems Roadmap, 2019–2021."

## 4. Developed country cashless payment solution implementations

We next discuss four additional mini-cases that illustrate problems that cashless payment solutions face, in spite of there being a developed national infrastructure in the country where they are locally implemented. The countries all vary in terms of their local retail implementation environments' digitalization, and the technological novelty of their cashless payment solutions. We identify drivers of failure and success for solution implementations that occurred in Japan, Germany, Singapore and Sweden. And we continue to consider the WEF's "2019 Global Competition Report's" Infrastructure Development and ICT Adoption Pillars, and to assert that our cashless payment mini-cases represent novel technical innovations in developed countries when they were implemented.

### 4.1. Facet 5 (L-L-H): Japan's lagged implementation of EMV chip cards

Facet 5 represents countries with a well-developed national infrastructure (high), like all the mini-cases in this section. Japan has weaker implementation environment digitalization (low) in many local settings though. We will explore a typical retail setting, in restaurants, retail shops, small eateries and convenience stores, which requires fast purchase checkouts, but often they still are using slower and relatively less advanced payment technology solutions – in comparison to some of the country's major downtown areas in larger cities, and to the world overall. Thus, the level of technology solution novelty that we investigate is not nearly as advanced as what you may observe in Japan with respect to factory robotics, mobile phones, and applications of natural language processing (NLP).

As evaluated by the "Global Competitiveness Report 2019" (Schwab, 2020), Japan is ranked 93.2 on Infrastructure (5th) and 86.2 in ICT Adoption (6th).<sup>20</sup> Thus, Japan is an exemplar of a country with a highly-developed infrastructure, and yet it has been slow to adopt advanced payment technology solutions which can enable speedy payments, including NFC-based and contactless payments. Surprisingly, Japan's mandate to implement EMV chip cards lagged behind other countries, too. The primary reason was the unique and highly complex domestic market, language issues, and challenges to comply with local chip standards (Kadoyama, 2017).

But the increasing level of credit card fraud related to merchants' unprotected PoS payment processes, and the Tokyo 2020 Summer Olympic Games (postponed to 2021 due to COVID-19) created some urgency for the government to move more quickly. The official website of the country's central bank, the Bank of Japan, has elaborated on its "Action Plan 2017 for the Consolidation of Security Measures for Credit Card Transactions":

*Meanwhile, in recent years, Japan has been facing an increase in the number of incidents involving leaks of personal credit card information by*

<sup>20</sup> An alternative approach, the EY Global Fintech Readiness Index (EY, 2019), reported that Japan's rate of consumer fintech adoption was 34%, the lowest across 27 markets. The average adoption among the 27 markets was 64%.

unauthorized access targeting the computers of credit-card merchants with insufficient security measures. These leaks also trigger an increase in the number of victims involved in unauthorized use of credit cards, including transactions by forged credit cards and spoofing online transactions. ... Looking overseas, the United States, like Japan, had lagged behind in terms of introducing IC (EMV) card payment systems and saw a concentration of damage due to unauthorized use of credit cards from around the world, but the country has been dramatically advancing the introduction of IC (EMV) card payment systems. As this trend in the introduction of IC (EMV) card payment system continues, Japan is facing the growing risk of becoming a credit card security hole among global society and a country prone to the concentration of international crime. In May 2016, an incident of unauthorized cash withdrawal transactions occurred in Japan using forged cards originally issued by a bank in South Africa. In just three hours or so, over 1.8 billion yen in total was simultaneously withdrawn from ATMs in convenience stores nationwide, causing huge damage. ... To prevent further damage due to unauthorized credit-card transactions, in March 2015, the JCA and the Ministry of Economy, Trade and Industry (METI) proactively established the Credit Transaction Security Council, aiming to develop an international-level security environment for credit-card transactions with an eye on 2020. (METI, 2017).

The image of Japan from the outside is of a uniformly high-tech country. But in reality the use of lower-tech approaches is more common than many think. A professional comic book writer, for instance, has written:

*As a British person living in Japan, I regularly get comments from people back home like: "Wow, Japan! What a high-tech world you must live in. ... Well, no. In fact, I will hazard a claim: The U.K. is a considerably more high-tech country than Japan. And please, before anyone mistakes this for just another attack on Japan, I urge you to read right to the end of the article. Walk into almost any post office, bank or estate agent and the non-Japanese visitor may be taken aback by the extensive use of paper-based and labor-intensive systems, and the relatively low level of computer usage. (Wilson, 2015)*

While the government has plans to speed up irrevocable funds movement via more contemporary approaches, cashless payments currently still make up only 20% of all transactions – far lower than world-leader Sweden, and lower than many other western as well as Asian countries (Höglind, 2019). The reasons for this are many. First, the Japanese market is unique and highly complex, requiring coordination with and interaction among many stakeholders for EMV certification and testing. These stakeholders (again surprisingly) also do not have the necessary technical expertise. Second, compliance with the local standard, FeliCa (felicanetworks.co.jp), is a complicated process. Third, EMV specifications are in English, which is not understood by many in Japan.

While contactless payments are ubiquitous within Japan's public transport industry, the merchants accepting the card for payment tend to be mostly those around train stations and only for smaller amounts. The larger retailers, on the other hand, resist new payment technologies (Milne, 2015) thus making Japan also known as a country where "cash is king" (Reuters Staff, 2019). Thus, even with a highly-developed national infrastructure there can be low-novelty technical solutions in use and low local digitization environments caused by environment complexity alongside consumer, merchant and government reluctance to change.

#### 4.2. Facet 6 (H-L-H): Germany's EK-Carte and the slow move toward cashless payments

Facet 6 represents countries with a developed national infrastructure (high) that attempt to implement a less-novel payment solution (low) in a highly-digitalized implementation environment (high). Germany is one such country. According to the "Global Competitiveness Report 2019" (Schwab, 2020), Germany had a strong Infrastructure score (90.2), ranking it 8th in the world, while for ICT Adoption (70.0), it

ranked 36th. Despite its highly-developed infrastructure, the German people are known to be heavy cash users. In 2017, for example, 74% of purchases were carried out with cash (Handelsblatt, 2019). When they do not make cash transactions, the closest alternative is the ubiquitous "girocard," a national network for PIN-based debit cards. It received six billion transactions in 2017, and is often used in the retail sector (Mai, 2018). The overall use of card transactions among the various payment methods in Germany in 2018 was only 22.8% with cash payments at an astonishingly very high 76.1%. (See Fig. 2.)

The girocard – known as the EC-Karte in Germany – had a 14.3% overall payments share, and achieved 15.9% of purchases in the clothing and sporting goods sector in Germany in 2017 (Korella, 2017). This occurred despite the sector's previously having implemented relatively high levels of retail digitalization. The EC-Karte is a PIN-based bank debit card, which allows consumers to withdraw cash from ATMs and make purchases at retail establishments across many medium to large retailers, so long as they have a valid PIN. It is known for the payment problems that it creates for some consumers.

A foreign blogger based in Berlin, for example, incensed by the need to resort to using cash, wrote:

*On Thursday I will need to buy some furniture in IKEA and, as confirmed on their website, again credit cards are not allowed. So, because it takes some time to get all the information together to open a German bank account, again I will be off to the cash machine and drawing out a bunch of notes. ... Most of the rest of Europe has fixed this, and long ago. In U.K., Denmark or Sweden I can pay more or less anywhere with a U.K. Visa or Mastercard. Even in Belgium it works most of the time, and even SNCB [National Railway Company of Belgium] now accepts Visa. But for IKEA, that very symbol of globalisation, to not accept global payment cards? That's absurd. (JonWorth Euroblog, 2013)*

More novel and faster forms of payments, such as contactless and m-payments, have not become popular, with only 5–7% of Germans using smartphones to pay in 2018 (Mai, 2018). So, it is nothing like Singapore, South Korea, China, Denmark and Sweden.

In fact, Germany is an extreme case in our mini-cases related to cashless implementation (Deutsche Bank, 2020). Despite its developed infrastructure, the Germans seem to have a strong disdain toward using plastic (DW.com, 2018), and instead, have been registering strong cash use across all categories of payments. It is particularly vexing that this occurs in Germany's retail sector, though many other developed countries with highly-digitalized retail store implementation environments have consumers who exhibit higher levels of cashless payments use. This often occurs through the implementation of more novel NFC and contactless payment solutions – and especially so, since the cost of these technologies has fallen considerably.<sup>21</sup> The reasons for the slower diffusion of cashless payments in Germany's case are worth considering: (1) consumers there, according to a Bundesbank Executive Board member, perceive cash transactions ... as a secure and simple way to pay; and (2) Visa CEO, Alfred Kelly, has also asserted that "the Germans are very sensitive about their data, perhaps even more than in other parts of the world," and there are data and security concerns that come with shifting to cashless payments (Handelsblatt, 2019). This seems likely to continue given the country's cultural traits of debt aversion, household frugality and saving money. It is interesting that the "German word for 'debt,' after

<sup>21</sup> An anonymous reviewer suggested that NFC cards were launched by the German savings banks (Sparkassen-Finanzgruppe members) in 2018, but the terminals to accept them were not enabled then.

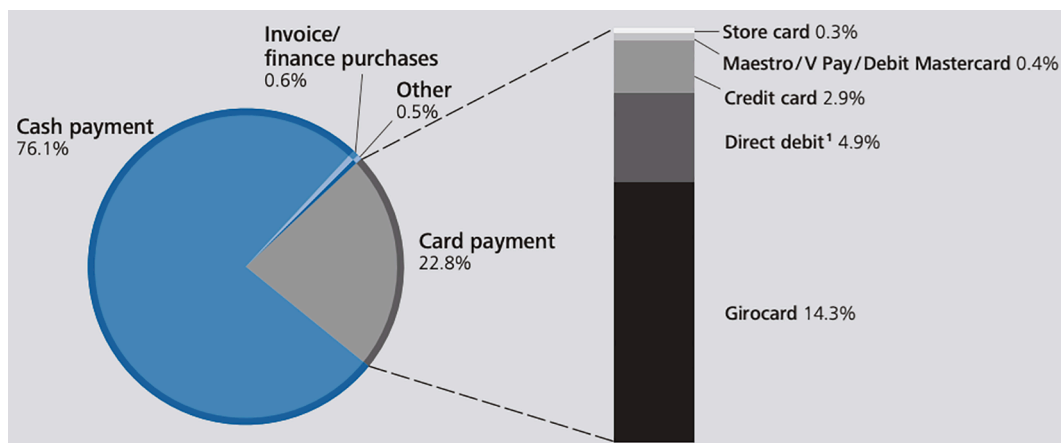


Fig. 2. Transactions in the German retail sector in 2018, by payment method (%). Source. Data and image are in the public domain via Deutsche Bundesbank (2019), and EHI Retail Institute (2019) in German. Percentages are based on 20 billion total payment transactions.

*all – schuld – also means guilt* (DW.com, 2018). So no wonder the author characterizes the situation as “No cards please, we’re German!”<sup>22</sup>

This example shows that despite a highly-developed infrastructure and highly-digitalized local environments, solution novelty can remain low due to consumers’ contentment with cash and concerns with cashless solutions such as with data privacy.

#### 4.3. Facet 7 (L-H-H): The Singapore Government’s “Hawker Go Digital Initiative” at food courts

Facet 7 represents countries with a well-developed national infrastructure (high) like Singapore, but with low implementation environment digitalization in some locales outside the city center and the malls. As evaluated by the WEF’s “Global Competitiveness Report 2019” (Schwab, 2020), Singapore ranked 1st in Infrastructure score (95.4) and 5th in ICT Adoption (87.5), reflecting its strong role as a competitive, top economy.<sup>23</sup> Singapore also has many novel cashless payment systems in use across the country.

Open-air food courts, also known as *hawker centres* in Singapore and elsewhere in Southeast Asia, house 10 to 70 stalls that sell a wide variety of affordably-priced foods, with prices averaging SGD 4 per meal (about USD 3) (Tung, 2016). Hawker centres were highlighted in a consulting report commissioned by the Monetary Authority of Singapore (MAS), its central bank, entitled “Singapore Payments Roadmap: Enabling the Future of Payments 2020 and Beyond” (KPMG, 2016). The report pointed out that hawker centres topped the list of places where cash payments predominate, in many instances exceeding 90% of the total value of transactions, thus offering an opportunity for cash

<sup>22</sup> An inappropriate conclusion for the German context is to argue that the preference for cash are somehow culture predispositions for holding cash. The populations of numerous countries share this characteristic, but it has been mostly firms in the financial service sector whose practices have shaped their customers approach over the years, based on the services that have been offered.

<sup>23</sup> In another study, the 2018 Asian Digital Transformation Index (ADTI), by the Economist Intelligence Unit, Singapore ranked 1st in Digital Infrastructure (82.5), with Hong Kong (63.6), Japan (58.9), South Korea (54.3) and Taiwan (47.6) rounding out the top 5 in Asia, and India (36.1), China (35.7), and Thailand (26.4) scoring lower in 7th, 8th and 9th place, respectively (EDB, 2019). We decided not to use this index because there is no comparable Economist Intelligence Unit study for Europe and North America. The European Commission (2019) releases the Digital Economy and Society Index (DESI) with somewhat different measures which makes direct comparisons difficult.

displacement. The Singapore government initiated the “Hawker Go Digital Initiative” (The New Paper, 2020), emphasizing the digitalization of the payment process for hawkers, food courts and fast food outlets, extending its high-tech approach to less digitalized implementation environments. The program included subsidized PoS terminals for hawker centre merchants to support contemporary payment solutions, including contactless cards and m-payment devices. Such devices were intended to meet the needs of hawkers for speedy payments, while creating next-level convenience for consumers and reducing the use of cash in local implementation environments like outdoor food courts. They had relatively low infrastructure digitalization and weak ICT penetration compared to elsewhere in Singapore.

Hawker centre food stalls are characterized by congested working spaces that are not conducive to the use of cashless payments solutions, including debit and credit cards. Due to their small size and low-value transactions, cash has been the main form of consumer payment. Recent government initiatives that placed novel cashless payment technologies at hawker stalls are akin to the “last mile in the cashless journey” for developed countries though. They may exist as a small segment of an otherwise developed economy that enjoys developed national infrastructure, with most other retail environments already accepting cashless payments (e.g., stores, theaters, restaurants, etc.).

About 500 hawkers became involved in the first 18 months (Wong and Heng, 2019), but the Cashless Payments Initiative, according to media reports, was suggested to have a less-than-successful rate of implementation. For example, a 57-year old hawker was quoted as having said:

*No one used the cashless system for most days in the first one to two years, at most there were one to three customers. I also had to pay a monthly fee of SGD 28 for the device, and the payment options were limited. (The New Paper, 2020)*

And most hawker stall operators continued to rely on cash as the main form of payment, with some expressing concerns about the barriers to cashless payments implementation success (Ha and Lin, 2018). Consumers did not exhibit a strongly positive response – even with the “free drink” incentives offered.

Our research points to several factors in Singapore’s developed infrastructure that posed unique challenges to success with cashless payments in outdoor food courts. First, the presence in the nation of a mature and well-developed financial infrastructure meant that the likelihood of counterfeit currency was low (MAS, 2020). So there was no push to use cashless payments to reduce fraud from paper currency, which is a much more common problem in developing countries such as

**Table 3**  
Mini-Case Findings.

FACET	SECTION	3-D	COUNTRY	FINDINGS
<i>Developing National Infrastructure</i>				
1	3.1	L-L-L	India	(a) Even though India generally scores low on all three dimensions of our classification framework, the country has received remarkably high ratings for its faster payments readiness. (b) Kirana stores are especially worthwhile settings in which to explore prepaid card novelty for faster PoS payments. (c) Implement of cashless payments is possible, even in L-L-L settings, but technology costs and sales volumes pose challenges for wider adoption.
2	3.2	H-L-L	Thailand	(a) Thailand has focused its payments efforts on shopping in large urban shopping malls with developed capabilities, especially for tourism payments. (b) It also has sought to deploy e-data capture technology at smaller shops to encourage the use of payments cards more often. (c) But 50% of smaller retailers still require cash transactions.
3	3.3	L-H-L	Kenya	(a) Kenya's M-PESA, which involves use of mobile phones and involvement of many human agents to facilitate value exchanges has been surprisingly successful, so it has achieved global notoriety. (b) It supported the government's strong push for financial inclusion of its population, and it has often been used in people's homes. (c) Since it created service capabilities for people and communities with banking access, M-PESA proved to be transformative for the sector and country.
4	3.4	H-H-L	Indonesia	(a) Indonesia's focus in payments has primarily been to build infrastructure to serve the tourism market, a major revenue sector. (b) Expansion has occurred in the non-cash payment ecosystem in tourist destinations; and the digitalization of tourist transactions. (c) Payment solution novelty is very visible in the country's tourist areas, but this is in stark contrast to non-tourist destinations.
<i>Developed National Infrastructure</i>				
5	4.1	L-L-H	Japan	(a) Japan has exhibited lagged adoption of EMV chip cards, like the U.S., with problems of limited expertise and complex processes. (b) Compliance for cashless payments with the FeliCa card has been hard, and English EMV specifications have added roadblocks. (c) The result has been that the uptake of EMV chip cards has not been rapid, and more often occurred in public transit and stores nearby train stations.
6	4.2	H-L-H	Germany	(a) In Germany, contactless and non-cash payments have lagged in growth due to dominance of the EC-Karte, which has less tech novelty, but is seen as safer and fast enough for domestic retailing. (b) Slower non-cash payment method diffusion has also been held up by the limited trust in cash and disdain for digital ID sharing among Germans. (c) High digitalization stores lead in consumer cashless payments.
7	4.3	L-H-H	Singapore	(a) Singapore's government offered subsidies for cashless payments implementation in locally less-digitalized hawker centres. (b) Contactless cards, m-payments were expected to gain acceptance, but large-scale rollout has met with low enthusiasm. (c) Low crime rates and a lack of money fraud, and customers' cash habits have made cashless payments less urgent, unless popular stores forced adoption.
8	4.4	H-H-H	Sweden	(a) Sweden's 2012 rollout of Swish struck a chord with consumers, leading to rapid uptake, and to successful usage for P2P payment capabilities. (b) The tap-and-pay experience has been delivered via a bluetooth module tethered to Swish, and for contactless communication with a bluetooth box connected to a merchant's PoS terminal. (c) Simultaneous penetration of contactless cards into retail stores provided further impetus for the expansion of use of Swish among the population.

Thailand, Indonesia, Kenya and China. Second, ATMs and cashback services are conveniently available across Singapore (MAS, 2019), such as at POSB (2020) kiosks and store locations. The country also has one of the lowest crime rates in the world, which makes withdrawing and carrying cash much safer for consumers (Low, 2018).

Third, Singaporean consumers are known to have a habit of using cash at hawker centres (Chia, 2017) – like many adults and senior citizens in other Asian nations, who make their purchases in cash. But this is common in many countries around the world, and is not a unique cultural difference. By participating in the observation of hawker centre consumer purchases, we found that many instinctively reached into their pockets for cash – despite display signs that cashless payment options were available. Fourth, our research in Singapore also has shown how another segment of retail outlets, which began requiring faster cashless payments in the past three or four years, can succeed. It is the fast food chain, McDonald's. Although consumers previously used credit and debit cards at the cashier's window, more recently, most order their food via a self-service kiosk, in lieu of standing in a slow-moving queue with an over-worked counter staffer. So, practically speaking, the only acceptable means of payment is cashless now (Pucci, 2019). Thus, cash displacement appears to be more successful when customers have no real choice. The requirement for merchants is hefty investments in self-service technology (similar to what is often observed in airport food courts now), and the end-to-end ordering process – including payment – is digitalized. The business policy of mandating a “no-choice-for-customers” policy is critical, but it may only be possible with a global brand that relies on ample financial strength and kiosk-use incentives. In this context, Singapore's prime minister, Lee Hsien Loong, encouraged additional effort:

*From the point of view of users, and if you compare with other countries, there is a lot more we have to learn. We have not gone as far as we need in order to do cashless payments in hawker centres, in shops, between people. (Boon, 2017a)*

Again we see that even with strong government initiatives, highly technical infrastructure and novel solutions available, it is the consumer and merchant habits and concerns that drive the success of the cashless payment solutions.

#### 4.4. Facet 8 (H-H-H): Sweden and its Swish cashless payment system

Facet 8 represents countries with a developed national infrastructure (high), local retail implementation environments with high levels of digitalization (high), and relatively novel payment technology deployment (high). According to WEF's “Global Competitiveness Report 2019” (Schwab, 2020), Sweden's national Infrastructure Development score (84.0) puts it in 19th place globally, and its ICT Adoption ranking is even stronger (87.8) at 4th place overall. It is a country with a highly-developed infrastructure among nations is closest to achieving a totally cashless society – targeted for March 2023. Currently, cash transactions represent only 1% of the country's GDP, making it a world leader (European Payments Council, 2019).

A driving force behind this was the 2012 rollout of Swish (swish.nu), a service to support account-to-account (P2P) payments between private users. Its conceptualization is described in the firm's online materials:

*Once upon a time, though not so long ago, there was a country high up in Northern Europe where people tried to pay for their share of the joint dinner. It was tedious for the poor citizens who really wanted to live a little more spontaneously and southern-like – where someone could take the*

*whole bill without making a scene having to count coins or running to the nearest ATM. That was the birth of an idea that came to be a natural part of more than seven million Swedes' everyday lives: Swish” (Swish, 2020a, 2020b)*

Related to this, a London-based blogger, wondering why Swish wasn't available in the U.K., where he lived in 2017, wrote about his interaction with a Swede, who told him:

*Just Swish it to me. It is easier and safer than having cash.” That's what a Swedish friend told me after having dinner when I recently visited Stockholm. When I told him that I did not know what Swish was, he was shocked. “Everyone uses Swish nowadays. No one uses cash anymore.” Swish is a free and instant mobile app payment. You should check it out. (Etienne, 2017)*

In fact, more than two-thirds of Swedish residents use Swish (Fawthrop, 2019), with nearly 7.5 million people sending and receiving money, as of the 3rd quarter of 2020 (Swish, 2020a, 2020b). On September 25, Swish processed over three million transactions (over one million business transactions and two million P2P transactions). Swish is jointly-owned and operated by seven of Sweden's largest banks: Danske Bank, Handelsbanken, Länsförsäkringar, Nordea, SEB, Swedbank and Sparbankerna. The country's Mobile Payments Working Group has been led by the Swedish Bankers Association, and its participation in the 2012 founding of Swish was crucial. While P2P payments grew in popularity due to the rise in demand for them, the app's functionality has been expanding, enabling it to penetrate into the retail and service sectors. Retail consumers appreciated the “tap-and-pay” experience using a bluetooth module tethered to Swish. This module communicated in a contactless manner with a bluetooth box that is connected to a merchant's PoS terminal. Scanning a product's QR code at a merchant was also available for Swish. Implementation of novel payments technologies such as these was assisted by the Nordic Council of Shopping Centres (NCSC, 2016), which collaborated with United Minds and the Institute of Management of Innovation and Technology to put on a series of implementation readiness workshops held in 2015 and 2016 to support the digitalization of retail spaces.

While Swish was moving from P2P payments into the retail space, retailers had already begun accepting contactless cards for payment for some time (Staykova and Damsgaard, 2015a, 2015b). In 2019, Swish began moving to in-store payments, again with bluetooth checkout technology (Finextra, 2019). Pär Ekroth, a marketing manager at Swish in Stockholm, noted that:

*Seven million Swedes walk around with the Swish app in their pocket, and it's clear that the demand for easier in-store payments is increasing. As such, we are pleased to offer mobile payments functionality to our customers. (Finextra, 2019)*

Swish also provides extra functionality that supports store sales, including loyalty program management and real-time geo-tagging of offers, as well as real-time processing of funds. While other payment systems like credit and debit cards required a few days to credit a merchant with sale, Swish transactions disrupted and transformed the usual cycle of retail payments, enabling the credit to occur almost immediately. This removed one of the major challenges of going cashless – cashflow problems (Insights Nordea, 2019).

Though Swish m-payments were likely to succeed – based on the fresh approach they took with payment services functionality, there were other strategic initiatives that led to success on the ground and how far Sweden has advanced in its journey toward a cashless society. One is

the framework regarding contract law. In Sweden, contract documents take precedence over banking and payment law documents. So, a sign on a shop window indicating that it does not accept cash implies that there is a contract between that store and a customer that the store will not accept cash. Several other drivers include the early implementation of payment cards in the 1950s in Sweden, the extent of the nation's Internet infrastructure in the 1990s, and the central bank, Sverige Riksbank's decision to outsource the printing and distribution of cash, which made cash more expensive to use (Arvidsson et al., 2017). More shops started to display signs that said they do not accept cash. There is expectation that mobile and Internet payment will pick up in retail and overtake card payments soon (Hedman, 2018).

This example shows that with a developed national infrastructure, local retail environments with high levels of digitalization can be successful with relatively novel payment technology deployment that consumers find useful and convenient.

#### 4.5. Related observations

The commonalities that we discussed earlier also seem to apply to the "developed national infrastructure status" mini-cases as well, though the national settings and payment solution contexts are different. This suggests the usefulness of the 3-D framework for analyzing the range of cashless payment initiatives that we examined and highlighted the factors that drive their success and failure. On the other hand, we did not acquire evidence to suggest that different national cultures created a basis for identifying differences in the novelty or success of cashless payment solutions – with the exception of Germany to some extent.

Knowledgeable observers of the issues faced over the years with respect to payment systems recognize that, in spite of a country's e-commerce and fintech cultures of innovation, there are still vexing problems that slow the rollout of more effective, higher-tech solutions as long as other cost-effective solutions are still available. The lagging implementation of EMV chip cards and readers is a case in point in Japan. Singapore's experience, in contrast, touches on the issue of consumer and merchant needs, as well as the choices and alternatives that have been available to the key stakeholders of payment systems solutions (including the commercial banks). Germany's slow cashless payments uptake situation is interesting, in spite of its strong national infrastructure and ICT penetration, so the extent of the digitalization of its payment processes is less than one may expect. Although it has a number of choices and alternatives, and a large enough population to ensure high scale size (similar to Swish in Sweden), it turns out that the German people, who are very sensitive about their personal data, have not adopted new payment innovations – while the government has not mandated change in this domain.<sup>24</sup>

Singapore offers a number of contrasts to some of the other countries, especially with respect to the typical "succeed to the greatest extent possible in the national interest" attitude the government typically has in its technology initiatives.<sup>25</sup> In the "Hawker Go Digital Initiative" food court context, however, having a highly-developed national infrastructure was not a sufficient condition to ensure success in light of the much

less-digitalized, meal-service outdoor hawker centres (Deogawanka, 2019). Although there clearly are numerous advantages and future gains to be reaped, the first several years of the initiative did not produce very positive results. Instead, it demonstrated the range of barriers to cashless payment implementation, including consumer and vendor willingness to work beyond their habits with cash, and to understand that the incentives that were put into place for consumer use were insufficient to encourage change. During the same timeframe, McDonald's, a leading branded restaurant there, rolled out kiosk-based ordering and cashless payment at its restaurants. The program ended up being a resounding success, reducing queues and wait times, while steering customers much more effectively to forgo the use of cash.

The Swedish mini-case involving Swish is perhaps the most straightforward success story of the group of initiatives that we analyzed. The solution it offered in the early 2010s was compelling in terms of what people needed for P2P payments, simple in terms of implementation since they already had mobile phones, and high early in scale size on its road to successful national penetration. Paving its way was the long-standing experience that consumer banking, its payments association and people had with highly-effective, networked retail banking services. So the widespread penetration in Sweden since Swish's inception resulted in collateral innovation, broadening platform envelopment (Parker et al., 2016).

## 5. Summary of findings and discussion

We first offer a summary of the mini-case findings from Sections 3 and 4. (See Table 3 for an overview.) Then, immediately after, we offer a broader interpretation of what has been learned in this research, including our thoughts on strategies in the area of cashless payments.

The analysis of the strategies undertaken by organizations in the various countries for achieving success with the implementation of cashless payments solutions is different than what we see with firms that compete directly with one another in the same or overlapping markets. In the domain of building effective cashless payment solutions, the emphasis is on improving the competitiveness of a country's overall infrastructure at an acceptable cost, so that the country's technological base is strengthened in support of its participation in the international economy, related to its capabilities for globalization. A policy analysis report from the United Nations Conference on Technology and Development (UNCTAD) explains this general perspective in terms of divergence in industrial performance, the speed of innovation, and the capacity to reduce transaction and information costs in economic exchange:

*Industrial countries worry greatly about competitiveness, about maintaining their competitive lead over new entrants, and their concerns are revealed by the steady stream of productivity and competitiveness analyses. The process is more difficult, and the stresses correspondingly greater, for developing countries, although a large body of theory suggests that with their wage cost advantages all they should do is open up to global trade and investment flows. The evidence shows that this is too simple a view, and that it is leading to growing divergence [in] industrial performance rather than convergence. The main reasons for the growing importance of international competitiveness are technological. The rapid pace of innovation – and the resulting promise of productivity increase – makes it more costly to insulate economies from international trade and investment. Since new technologies benefit all activities, traded and non-traded, rapid access to such technologies in the form of new products, equipment and knowledge becomes vital for national welfare. Insulation from global markets and technologies is no longer a viable option for any developing country. Then there is the shrinking of "economic distance" – a consequence of technological change in communications and transport – that reduces transaction and information costs and so forces economies together. The growing ability of firms to network far-flung activities, also a consequence of shrinking economic distance, allows production chains to*

<sup>24</sup> There is a great contrast with the importance that Germany has placed on a number of sub-initiatives of the overall national effort to achieve highly-digitalized Industry 4.0 capabilities in support of manufacturing, services, distribution and logistics, process and technology standards, and other activities that are critical for its creation of high GDP (European Commission, 2017).

<sup>25</sup> Examples of Singapore government and research agency funding programs include, for example: the National Cybersecurity R&D Programme (National Research Foundation); the International Research Centre @ Singapore Funding Initiative and the IDM Programme Office, Media Development Authority (National Research Foundation); and The 100 Experiments to address Singaporean industries' AI problems and help them build their own AI teams (AI Singapore 2020).

be spread over longer distances, thus leading to closer integration of activities, processes or even specific functions (UNCTAD, 2003).

Payment systems have the properties of public goods: non-excludability of use by one consumer over another; non-rivalrous consumption so that use by one consumer does not prevent others from accessing it; and they are often consumable at no cost. With their globalization, cashless payments have become more important and are now viewed as part of a country's *critical national infrastructure of IT networks* (CPNI, 2020). The surge in online shopping during the COVID-19 pandemic has further highlighted the importance of cashless payments, as opposed to payments with cash. There is also increasing impetus around the world for sustainable, faster payments and immediate settlement – even though the typical interpretation of sustainability is more often related to affordable clean water, a healthy living environment, the availability of healthcare, and access to knowledge. *Social sustainability* and the inclusion goals of countries today include focusing on people who may be excluded from economic and social opportunities, including access to cashless payments.<sup>26</sup> This suggests another aspect of the digital divide that has been the subject of so much attention over the years.

And yet, even though countries are not subject to the same competitive dynamics as firms are, there still are useful aspects of how to think about strategy at the level of industry sectors and societies. It is at this level where technology investment decisions must be gauged as feasible or infeasible in terms of producing desired outcomes, and harmonizing with existing national and local infrastructure, and organizational interests (Kauffman, 2020a). Thus, just as firms must consider the access they have to strategic resources to achieve sustainable competitive advantage in a crowded marketplace, so must countries consider what unique resources they have access to in order to make the deployment of new cashless payment solutions beneficial for those who seek to obtain the desired outcomes. Thus, the *resource-based view of the firm* (Clemons, 1991; Peteraf, 1993) also applies in a general way to countries, although the benefits of valuable, rare, difficult to imitate and non-substitutable resources need to be understood more as *enablers of implementation and payment solution success* than as longer-term differentiators for their *competitive sustainability*.

The creation of cost-appropriate, high-functionality and forward-looking cashless payment capabilities is akin to the purchase of a future *growth option* for a country and its industry sectors to be able to do things in the future that would not be possible in the absence of the advanced digitalization of payments (Dai and Kauffman, 2005; Kauffman and Li, 2005). Cashless payments capabilities are advanced telecom-related services, so it is important to think of building such capabilities as “hook-up-or-lose-out” decisions (Clemons and McFarlan, 1986). This is true in a country related to reduction of its transaction costs and economic growth, and in its external relations, so it becomes a more attractive destination for global connectivity and foreign direct investment. This is especially true among nations in light of the European Community's decision to implement the Payment Systems Directive 2 (PSD2) in 2018 (Románova et al., 2018). And, in today's COVID-19 context, contactless and mobile payments have become critical approaches to reduce infections from viral contagion.

In addition, cashless payments capabilities act as a future-oriented platform for nations. This way, consumers, intermediaries and producers can do better in the *co-creation of value* in their regional economy through advanced network services – which is essentially a “Smart Nation” capability, too (Kauffman et al., 2010). The development of cashless payment platforms is especially interesting since they create

<sup>26</sup> For example, this has been happening in the U.S. as Amazon builds cashless, no-staff convenience stores. And also for the public policy problems in Europe associated with population migration-related payment solutions for refugees, where school lunches for children whose families don't have bank account access, medical services, and disabled / elderly people must be provided.

opportunities for building collateral services on top of them to benefit many kinds of stakeholders.<sup>27</sup>

Our framework yielded useful observations to help others understand the strategic, tactical and operational approaches that have been used to enable cashless payments success (e.g., Indonesia, India and Singapore), even if things did not always work out as expected there and elsewhere. Further, we presented evidence for network-based business and social value creation, as well as the critical importance of scale size. The extent to which cashless payment intermediaries are subject to sustainability issues for their businesses also has proven to be important, as we observed for Indonesia and Kenya. Further, individuals' responses to initiatives can make or break cashless payment efforts. An example is Germany, where a fear of data privacy has been an enormous obstacle and, conversely, in Singapore, where McDonald's “no-choice-but-cashless” local strategy helped with consumer acceptance.

It is important to recognize the growing dominance of platforms for digital banking as well, similar to what has been observed for music, movies, loyalty and consumer affinity services, and many supply chain applications. Indeed, digital platforms are the *essence of the new fintech capabilities* (Kauffman, 2020b). Shevlin (2019) has argued that “digital platforms are eating banking,” as other articles in this special issue generally suggest to be the case. Thus, the reader should recognize that most contemporary payments digitalization projects are essentially *platformification initiatives*. And not everything works out as expected for nations in the process (Mas and Rothman, 2008).

These developments are tied to other issues that have arisen with mass personalization and consumer prediction analytics, due to the ubiquitous access that firms today have to big data from their customers. How else can a financial services firm better understand consumer behavior than through its customers' digital payment records? Five critical factors are at work that affect collective social values and the nature of organizational commitments related to consumers, as noted by Law, Ethics and Informatics researcher, Yeung (2018), at Birmingham University:

*The first three fears are largely concerned [with] the values of fairness and justice, and which can ultimately be attributed to the systematic use of digital profiling techniques that apply machine learning algorithms to merged sets of data collected from the digital traces generated from continuously tracking users' online behaviour to make calculated predictions about individuals across a population. The remaining two fears coalesce around concerns for social solidarity and loss of community that may be associated with the increasing personalisation of services and offerings, which is both fuelling and being fuelled by, an increasingly narcissistic mindset that mass personalisation makes possible.*

Other recent research is clarion in its call for consumers, business executives and government regulators to treat the many different moves that are underway around the globe related to platform services, machine algorithms, and potentially invasive predictive intelligence that has become increasingly possible with the information-drive

<sup>27</sup> This happened in the past with Philadelphia National Bank's strategic venture with its MAC ATM network (Clemons, 1990) to create “icon services” that other financial firms could add to the offerings at its PLUS Network services – a leading example of a growth option (Dai et al., 2007) that also enabled the banks' *payment platform envelopment* (Parker et al., 2016) to expand and support *partnering for service perfection* (Dai and Kauffman, 2005; Dai et al., 2007) with other leading financial services firms (e.g., the Safaricom-Vodafone alliance and eventually joint ownership of M-PESA in Kenya discussed earlier). More recently, we have seen this with other instances of fintech innovations (e.g., with the platform extension of Swish in Sweden to include in-store purchases (also noted earlier), and *cloud services brokerage* (CSB) *intermediation* in the U.S., a form of *corporate service aggregation infomediation* (Shang and Kauffman, 2020).



transformation of processes, industries and society (Clemons et al., 2017).<sup>28</sup>

## 6. Conclusion

Today, we are increasingly witnessing the use of technology to create new opportunities for cashless payments, as well as a critical reckoning in global industry on the importance of firm-level, local-environmental and national-level infrastructure digitalization strategies – especially access to borderless markets (Wald et al., 2019). Mobile and contactless technologies have supported convenience and speed for consumers and merchants in payment transaction-making. Together with effective national infrastructures, these technologies have allowed developing countries to reach the unbanked segments of their populations – thus addressing the issue of *inclusive finance* in the United Nations Sustainable Development Goals for 2030 (Citigroup, 2017; United Nations, 2020). They also have permitted developed countries to begin to convert low-value transactions in less-digitalized environments to cashless ones.

We have addressed our set of high-level research questions to signal the importance of this work to industry practitioners and researchers, with the following outcomes of this research commentary article:

- (RQ1) We classified cashless payment solution implementations using a framework that identifies the extent of the development of the national infrastructure, the level of digitalization of local retail payment implementation environments, and the relative novelty of payment technology solutions that are implemented in a country.
- (RQ2) Our framework was constructed in three dimensions that distinguish between national and local-level infrastructure, based on commonly-accepted constructs and readily-available measures from leading government, business and university sources, with classification metrics from authoritative sources such as the WEF's infrastructure rankings.
- (RQ3) The 3-D framework identifies dimensions related to: the level of development of a country's infrastructure; the digitalization of the local implementation setting where a cashless payment solution occurs; and the degree of technological novelty associated with the payment solution at the time of its implementation in a country. We argued that these are useful for beginning to more fully understand the success factors and problem areas across the country facets – even though not all implementation environments in a country will be representative of the country overall.

### 6.1. Summary of contributions

Governments and PSPs need to gain a better understanding of the challenges involved in cashless payment implementations. Our research has highlighted many challenges in the country facets of our 3-D classification framework for both developed and developing nations. Forward-looking payment solution approaches, it appears, must be applied to overcome the inevitable barriers to successful implementation. Our proposed framework can help to offer new insights as countries and payment providers seek clarity on their cashless payment technology-related strategies in the classification facets, and should be a useful contribution for other practitioners and researchers who are

<sup>28</sup> A valuable source of knowledge in this respect is the multi-decade research program of Clemons (2019), for the variety of ways that firms have been empowered by the technological bases and sociotechnical infrastructures that are available to implement strategy.

studying the mechanics of technology innovation uptake and implementation related to the “Fintech Revolution” (Gomber et al., 2018; Gozman et al., 2018).<sup>29</sup>

This research, more broadly, contributes to our knowledge about technology implementation in different kinds of developing and developed nation settings. The primary actionable insight that we offer for others – researchers and practice managers alike – is the analytical distinction between the local and national environments, and why this is needed to identify appropriate success strategies for implementation. The standard interpretation in most university research is more of an “either-or” dichotomy. Either the goal is to understand what drives technology innovation and diffusion at the national level, or the goal is to understand what makes success possible at the local level. Rarely have we seen research center studies, agency reports, and consulting white papers on technology implementation guides that attempt to bring together both of those levels.

So, in a sense, our research in this project has been an effort to bridge the gap that remains in how business leaders should reconsider their approach to cashless payment solution implementation in view of the potentially different degrees of local digitalization and national infrastructure development to support new technology innovations in the digital economy. Indeed, there seems to have been more effort in disparate disciplines. These include: the local and national energy policy arena (Batel and Devine-Wright, 2015; Kostika and Hobbs, 2012; Wu et al., 2017); the lending, risk management and regulatory practices of regional and national banks (BIS, 2017; World Bank Group, 2019); rural and urban healthcare services, including the recent COVID-19 pandemic (Haggstrom et al., 2019; OECD, 2020b); and local and national telecom services effects (Philip et al., 2017; Sandu and Raja, 2017). These all are in areas of research and policy interest.

Other insights from this study highlight the common obstacles. They include issues in attempting to displace currently acceptable solutions, extra costs involved in cashless payments, and a range of user needs whether the user is a consumer, vendor or merchant. First, if the current solution is very convenient, fast and accessible, as with accessible and fast-delivering Indian stores, and due to the low crime rate and secure bank notes in Singapore, then there is less likelihood of success. Second, costs from many sides can prohibit implementation, such as the cost of payment technology, transaction fees and high merchant discount rates, as in Thailand and Japan. The needs of any stakeholder can also impact success. Consumers may have data privacy and security concerns, but need faster checkouts or have cultural sensitivities to seeing non-cash alternatives such as debt in Germany, for example. Merchants also have concerns including tax audits, finding space for the hardware and training on new technology, such as in Thailand and Singapore. Vendors clearly need a solid value proposition for implementing and maintaining the cashless systems.

In addition, it is valuable for this research to have offered a 3-D framework. Although it is visually complex, it also has the potential to be more analytically inclusive, while offering its users the opportunities to create multiple  $2 \times 2$  (2-D) analysis matrices as they are needed, by holding the third dimension fixed. (Again, see Appendix B for exploded views of the developed and developing country infrastructure status, which can be used for separate and fuller analysis.) With this in mind, it becomes possible to examine technology acceptance issues when the local implementation digitalization environment is held fixed – or when technology solution novelty is held constant. Our choice in the present work was to focus on holding the national infrastructure status of a country fixed – either developing or developed – so it was possible to examine

<sup>29</sup> Fintech innovations that are on the “global radar” related to payments include digital currencies (e.g., Bitcoin and Ethereum) (BIS, 2015), *distributed ledger technology* (DLT) and digital assets (Arner et al., 2019), and fintech remittance services (World Bank and IMF, 2018).

cases that are related to the other two dimensions of the analysis cube.

6.2. Limitations

In closing, it is important to discuss possible limitations of this research for both our audiences. First, the issue of *framework robustness* is a well-known concern in the research literature of many disciplines in Social Science. The main idea is that a classification should be relatively *complete* – in the sense that it should be hard to add to or adjust for different classificatory dimensions to address other kinds of case settings beyond those that have been presented. Yet, the reader should recognize that it is possible to add or consider other dimensions to change the overall nature of the country classification.

A natural addition, for example, is to consider cashless payment solution implementations in high versus low financial-regulation economies. Most countries, such as China, Kenya, Singapore, and the European countries (among others we selected), are all subject to extensive financial regulation. Thus, close regulation seems to be the dominant force at work almost everywhere, prompted by central banks’ view that national payment systems are essential as publicly-available networks, and the benefits they yield for society – even if some have private ownership, like the large international branded card networks of Visa and Mastercard, among others (Weinberg, 1996; Carstens, 2019).

Second, we should point out that the amount of source material and interview opportunities for the mini-cases available was more limited for some countries than for others. As a result, we brought a deeper level of research informedness to this project for some regions and countries (e.g., more for Western Europe, all of Asia and the Americas, but less for Africa and the Middle East). And yet, our goal was not to develop full individual case studies or perform advanced quantitative analysis. So, the information access that we obtained was typically sufficient, although not uniform in terms of the amount of information available. Further, machine-based methods are often used to conduct co-citation analyses of the relevant literature for a study based on the validation of their content-consistency – in terms of constructs, variables, moderating drivers, and so on. For example, text analytics can be applied to identify underlying theme-frequency in written source material, among other things. It was not possible for us to do this in this research though.

Appendix A. Classification framework terms

Table A1  
Terms and Definitions.

TERM	DEFINITION
Implementation environment digitalization	The extent to which local business environment can effectively support innovative payment systems implementation. Also a function of the physical setting, its experience with payment technologies, the digitalization of the implementing vendor, and the merchants and consumers that will use it, as well as the training and educational levels of staff that will need to deal with novel technology implementations.
Payment technology solution novelty	The nature of the payment system solution that is to be supported, based on whether it involves complex and high-performance payment services, which are new and different for the country or the locality in which the implementation is being done. Emphasizes “relative newness” in a setting – typically a higher-technology solution vs. a lower-technology solution – that drives payment services at the PoS, and not used before.
National infrastructure development status	An indicator for the readiness of a country as a whole (not its local readiness or digitalization, which may be different) to successfully support innovative payment capabilities, based on its development level. National infrastructure is an operationally-definable basis in assessing global competitiveness, as an enabler of innovation and efficiency.

We lacked sufficient materials to make this effective and worthwhile.

Finally, it is important in comparative analysis to consider cultural similarities and differences across nations (Au and Kauffman, 2008; Takada and Jain, 1991), geospatial connectedness (Techatassanasoontorn and Kauffman, 2005; Kauffman and Techatassanasoontorn, 2009), influences of different socio-technical set-ups (Geels, 2002) and political regimes. They include, for example, the effects of democratic, constitutional-oligarchic, electoral-autocratic, and authoritarian governments (Wigell, 2007), as well as Alt-Right political thought on fintech innovations (Mavadiya, 2017). Other issues are: varying entrepreneurship support (Andrews et al., 2018); incentives for new technology investment and economic development (Mies, 2019); and intertemporal differences in value flows (Banerjee et al., 2007; Kauffman and Wang, 2008). We will leave these things for others to explore further.

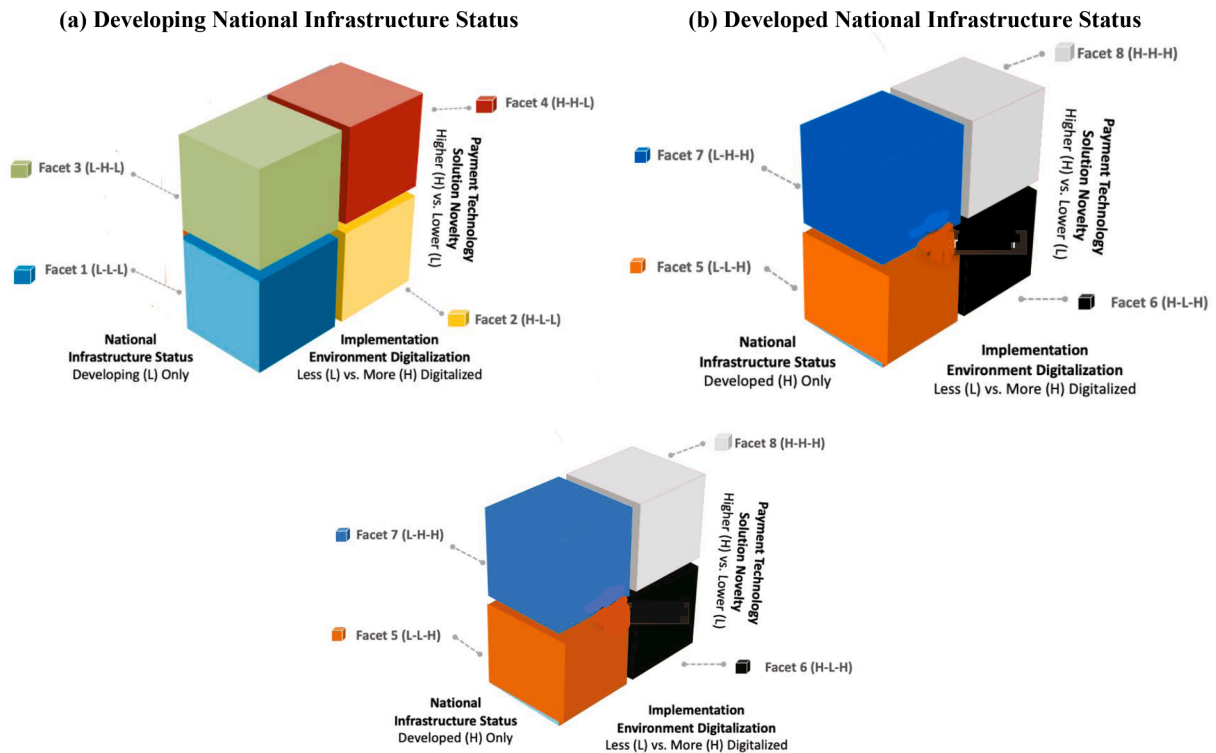
Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix B. Exploded views to show the slices for national infrastructure development status



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