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DETERMINANTS OF DIGITAL FINANCIAL INCLUSION AMONG LOW-INCOME HOUSEHOLDS: COMPARISON BETWEEN PENINSULAR AND EAST MALAYSIA

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ABSTRACT

Digital financial inclusion is a fundamental component in alleviating poverty and enhancing prosperity. A comprehensive financial system lays the foundation for a basis of robust and resilient households, enhancing the welfare of low-income groups. This research examines the determinants of digital financial inclusion among low-income families in Malaysia, specifically focusing on digital literacy, financial literacy, trust, infrastructure and financial service providers. Total of one thousand one hundred seventy-one respondents with income below the national poverty line were surveyed. The Partial Least Squares-Structural Equation Modelling (PLS-SEM) and the Multigroup Analysis (MGA) techniques were employed. This study separated the total sample into two groups, Peninsular Malaysia and East Malaysia. The results demonstrate that trust, digital literacy and infrastructure are positively and significantly related to digital financial inclusion for all the groups. The role of financial service providers is only supported for the complete sample set and Peninsular Malaysia. Surprisingly, this study found no association between financial literacy and digital financial inclusion. In addition, the MGA results further evidence significant differences between Peninsular Malaysia and East Malaysia in achieving digital financial inclusion. Peninsular Malaysia shows stronger digital literacy and infrastructure, while East Malaysia demonstrates more potents effects of financial service providers and trust in boosting digital financial inclusion. These findings provide practitioners valuable insights into fostering a digitally inclusive financial society. This research includes strengthening consumer protection regulations on digital financial services to address cyber threats, implementing digital

literacy campaigns to enhance awareness, and ensuring affordable and reliable internet access. These policy recommendations highlight the importance of formulating and designing tailored strategies to enhance digital financial inclusion among low-income households in Malaysia.

Keywords: Digital financial inclusion; low-income households; Peninsular Malaysia; East Malaysia; multigroup analysis.

INTRODUCTION

The financial sector is evolving at a rapid pace in this technological era. The deployment of financial technology has reshaping financial services. Digital financial services have the potential to lower costs by maximising economies of scale and increasing the speed of financial transactions (The World Bank, 2020). Digital inclusive finance plays significant role in poverty reduction (Zhou & Wang, 2021). Due to their lower economic status, the people with low incomes are more likely to be the underserved population. Digital financial services promote digital financial inclusion with more tailored financial services for low-income households.

Digital financial inclusion is a process of including those underserved and financially marginalised populations to access financial services through digital means at an affordable cost. Digital financial services have become the key driver and top priority in many countries' national agendas in achieving financial inclusion (Khera et al., 2021). The successful story of digital money M-PESA in Kenya which accelerated financial inclusion (Liu et al., 2021), shows the significant contribution of digital financial services in improving financial inclusion.

Despite Malaysia being a middle-to-high income economy that has experienced significant economic growth, poverty and income inequality remain persistent concerns for the Malaysian government (The World Bank, 2024). The latest 2022 poverty statistics reveal a contrast in poverty rates across states. Some states experiencing high poverty rates are Sabah (19.7%), Kelantan (13.2%), and Sarawak (10.8%). In contrast, more urbanised states such as Pulau Pinang (2%), Selangor (1.5%), Kuala Lumpur (1.4%), and Putrajaya (0.1%) have a low poverty rate. Other states, including Kedah (9%), Perak (7.5%), Pahang (6.3%), Terengganu (6.2%), Johor (4.5%), Negeri Sembilan (4.4%), Melaka (4.2%), Perlis (4%), and Labuan (2.5%) reported moderate poverty rates (DOSM, 28 July 2023). These disparities show uneven development, which leads to economic imbalances and income inequality.

The Malaysian government has formulated strategic development frameworks such as the Twelfth Malaysia Plan (RMK-12) 2021-2025 and the Malaysia financial sector blueprint 2022-2026 to address the issues. These strategic development frameworks aim to transform Malaysia into a prosperous, inclusive and sustainable country with improved financial well-being of households and advanced digitalisation of the financial sector. Hence, it is crucial to significantly change their lives, especially for low-income households whose income falls below the average national poverty line (PLI). This group, classified as absolute poverty in Malaysia (DOSM, 2023), can benefits from inclusion in the financial system, which provides them with tools, resources and opportunities to pursue financial security and a more promising future.

Although digital financial services offer significant benefits for achieving financial inclusion, many countries still face considerable challenges in using digital financial services to tackle poverty (Ozili, 2018). The reasons highlighted are the lack of trust and confidence (Malady, 2016), connectivity, financial literacy, and social awareness of digital financial services (Aziz & Naima, 2021).

While Malaysia has made significant progress in promoting digital financial services, low-income households continue to experience barriers, particularly in financial literacy, geographical accessibility, and conducting digital transactions (BNM, 2023). Malaysia lags in specific areas compared to neighbouring countries like Singapore and Thailand. For example, a report by OECD (2023) shows that Malaysia has lower fixed (12.4 subscriptions per 100 inhabitants) and mobile (127.4 subscriptions per 100 inhabitants) broadband penetration rate than Singapore (27.4 & 169.6 subscriptions) and Thailand (18.5 & 121.8 subscriptions), which may limit access to digital financial services. Additionally, a report on digital financial services for financial inclusion in Southeast Asia by Kim et al. (2022) highlights that Malaysia lacks a comprehensive cybersecurity law, unlike Singapore and Thailand, which have enacted the Cybersecurity Act, which may affect the trust and the security of digital financial transactions.

Additionally, the Hand Phone Users Survey 2021 (MCMC, 2021) shows that Malaysia has a high penetration rate of smartphones with more than 90% of individuals with income levels below RM3000 owning smartphones. However, accessing banking activities is among the lowest Internet activities. Furthermore, the survey also shows that 50% of the smartphone users in Malaysia do not use mobile payment apps. Hence, suggesting an opportunity to expand digital financial inclusion and empower low-income households with digital financial services.

Previous studies examined financial inclusion with traditional indicators such as outreach, penetration, availability, accessibility and technology (Bongomin & Ntayi, 2020; Morgan & Long, 2020; Vaid et al., 2020) and psychological factors such as financial literacy, trust and financial behaviour (Vaid et al., 2020; Toronto Centre, 2022). Another strand of the literature uses macroeconomic variables like the number of ATMs, the number of depositors, bank branches, deposits per capita, the age dependency ratio and inflation (Omar & Inaba, 2020; Nsiah et al., 2021) to explain financial inclusion. Other studies have also investigated the interaction between financial inclusion, income inequalities (Kling et al., 2020), and financial well-being (Nandru & Rentala, 2019).

Despite the notable advancements in the financial industry, the literature on digital financial inclusion is still developing. Ozili (2018) presented a conceptual framework on digital financial inclusion, highlighting the role of government and financial service providers. Other studies focus on the issues such as adoption of digital financial services (Hossain et al., 2020; Yan et al., 2021), poverty reduction (Zhou & Wang, 2021) and financial inequalities (Demir et al., 2022).

This study aims to expand the existing literature by filling in the gaps related to digital financial inclusion among low-income households who earned below the poverty line (PLI). This study examines the determinants of digital financial inclusion among the low-income households in Malaysia. The investigation on this target population is important because being included in the financial system provides them with accessibility to financial tools that could help them better manage their finances and thus contribute to poverty alleviation in Malaysia. Furthermore, due to the development disparities between Peninsular and East Malaysia, there are significant differences in their economic development. Households experiencing absolute poverty were more prevalent in East Malaysia, whereas Peninsular Malaysia had comparatively lower incidences (DOSM, 2023). East Malaysia has lower access to basic facilities than Peninsular Malaysia (Wan Usamah, 2024). This study suggests that the two regions face different challenges in achieving digital financial inclusion. Hence, a multigroup analysis is conducted to provide a comprehensive view of digital financial inclusion in Malaysia. The study samples are segregated into two groups, Peninsular Malaysia and East Malaysia. It is important to understand the challenges and opportunities for digital financial inclusion in each region and to bridge the development

disparities between these regions. This investigation is crucial for narrowing income gaps and ensuring equitable access to financial services across these two regions. The findings provide valuable insights to practitioners, particularly policymakers, in formulating targeted financial inclusion policies and infrastructure development tailored to regional needs. Moreover, understanding the determinants of digital financial inclusion allows financial institutions to design more accessible and inclusive financial services, ensuring the participation of underserved populations in the digital economy. This reduces inequalities, fosters balanced economic development, and creates a more resilient, inclusive financial landscape in Malaysia.

This study makes several contributions. Unlike past studies, this study adopts a broader perspective by examining individual-level factors (digital literacy, financial literacy, and trust) and supporting factors (financial service providers and infrastructure) that facilitate digital financial inclusion. This study collects data from the demand side of the economy, particularly low-income households, to reveal their accessibility to digital financial inclusion and develop an evidence-based model that sheds light on the barriers they face. Furthermore, related studies on financial inclusion, such as Mahdzan et al. (2023) on financial well-being, examined across high-, middle-, and low-income groups, and Rahman et al. (2021) on the B40 group. This study extends the literature by focusing on a subset of the B40 group whose household income falls below the poverty line. Focusing on this group is essential, given their unique challenges in achieving financial stability. A multigroup analysis is conducted to further deepen the analysis by comparing the findings between Peninsular and East Malaysia to provide a comprehensive understanding of regional disparities in digital financial inclusion.

THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

The concept of digital financial inclusion is mainly based on the theories of financial inclusion. Kling et al. (2020) explain that financial exclusion can lead to persistent inequality from an economic theory perspective. The low initial wealth of the poor group faces barriers in the human and physical investment that limit their opportunity for social mobility and perpetuates inequality (Mehrotra & Yetman, 2014). This aligns with the financial inclusion theory that posits that access to affordable financial services is crucial to disadvantaged and low-income groups (Mahendra Dev, 2006). This is supported by Nsiah et al. (2021), who argued that financial inclusion is one of the panaceas to reduce poverty. Financial inclusion provides opportunities for people to benefit from financial services and thus is a key element in ending social exclusion (Mubiru, 2012). The financial sector plays a vital role in improving financial inclusion by providing financial services such as savings, credit, and insurance, thus narrowing income inequality (Park & Mercado, 2018). The financial inclusion indicators, such as the number of bank branches, deposit accounts, outstanding loans, and credit, are important in reducing income inequality over the long run (Verma & Giri, 2024). Omar and Inaba (2020) further highlight that the role of the financial sector, from the dimensions such as penetration, availability, and usage of financial services, influences the financial inclusion level. They found that financial inclusion significantly reduces poverty rates and income inequality, particularly in developing countries, by empowering low-income groups to build wealth and improve their financial stability.

The integration of digital technology into the financial sector enables poor groups to benefit from the formal financial services, contributing to the reduction of poverty (Lumsden, 2018) and income inequality (Yu & Wang, 2021). A study by Aziz and Naima (2021) demonstrated that digital financial inclusion is the interaction between financial inclusion (financial access and literacy), digital inclusion (accessibility, affordability and ability), and social inclusion (social networks and social capital). Ozili

(2018) also highlighted that to achieve the objective of financial inclusion and poverty reduction through digital financial services, a reliable digital financial service infrastructures and financial service providers who improve the delivery of the existing financial services are crucial elements.

The innovation diffusion theory developed by Rogers in 1962 provides an understanding of how an individual adopts new ideas and technology. Five constructs were established to explain the innovation adoption: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1962). The advantages of digital financial services, such as lower cost and broader outreach, compared to traditional financial services, foster digital financial inclusion. This is supported by the financial-led growth theory, which emphasizes the role of financial development in economic growth (Schumpeter, 1911). Schumpeter argued that an efficient financial system promotes growth by promoting efficient resource allocation and supporting key functions of financial services (mobilizing savings, managing risks and facilitating transactions). These are essential drivers of technological innovation and economic development. The financial development with digital innovation enhances financial accessibility. Studies such as Goldsmith (1969), McKinnon (1973), and Shaw (1973) found the positive impact of financial development on economic growth. Financial development, including the growth of financial institutions, expansion of financial services, and the advancements of financial infrastructure, are key to foster digital financial inclusion, as they encourage the widespread adoption of digital financial services.

To find out how to increase digital financial inclusion for households who earned below PLI in Malaysia, this study proposed five determinants (i.e., digital literacy, financial literacy, trust, digital financial service infrastructure, and the role of financial service providers) as explained.

Digital Financial Inclusion

Digital financial services provide alternative ways to address constraints such as physical accessibility of the financial system and transaction costs. Digital financial inclusion (DFIC) refers to digital access to and the use of financial services by the underserved population at an affordable cost (The CGAP, 2015). DFIC enhances the socio-economic wellbeing of the vulnerable groups, including the low-income group (Aziz & Naima, 2021) through digital financial services (Thathsarani et al., 2021). It is one of the tools to combat poverty (United Nations, 2016; Zhou & Wang, 2021). The inclusive digital finance helps the low-income group manage their finance.

The literature on digital financial inclusion is continuously evolving. The measurement of financial inclusion involves multiple indicators and different dimensions. Alliance for Financial Inclusion (AFI) proposed measuring financial inclusion using indicators from availability and usage of formal financial services from the demand side (AFI, 2011). Similarly, Peking University developed the digital inclusive finance index in 2011, which measures digital financial inclusion with dimensions of breadth of coverage, depth of usage, and the level of digitalization, focusing on financial inclusion in China (Guo et al., 2020). Later, the Global Partnership for Financial Inclusion (GPFI) expanded the measurement framework by including dimensions of availability, usage and quality of financial services (GPFI, 2012). Furthermore, the World Bank's Global Findex database was developed in 2012, covering four categories of financial inclusion indicators: account penetration, savings behaviour, borrowing behaviour, and insurance behaviour. In 2017, the Global Findex database refined its framework to measure financial inclusion and the fintech revolution, focusing on accessibility and usage of financial services, including savings, borrowing, and payments driven by digital technology (Demirgüç-Kunt et al., 2018).

Demirgüç-Kunt et al. (2018) highlighted that using digital financial services enhances financial inclusion. For example, the mobile money services allow users to store and transfer funds via a mobile phone. This improves their income-earning potential and reduces poverty. Furthermore, digital financial services make sending and receiving money over long distances easier, thereby improving financial risk management. Additionally, digital financial services lower transaction costs, such as eliminating the need for long-distance travel and reducing waiting times to access financial services. This study measures digital financial inclusion by adapting the Global Findex questionnaire 2017. Its coverage of access and usage of financial services driven by digital technology matches the objectives of this study.

Digital Literacy

Digital literacy (DIGL) refers to knowledge and competence to navigate digital content and use digital products and services (AFI, 2021). In the fast-paced growth of ~~the~~ digital financial services, DIGL is required to effectively and efficiently stimulate the usage of digital financial services (Lyons et al., 2021; Lyons & Kass-Hanna, 2021). Kass-Hana et al. (2021) measure DIGL with three dimensions: accessibility of technology, proficiency of mobile phone and mobile money. Individuals with good DIGL have greater confidence in using digital financial services, thus boosting DFIC (Jack & Suri, 2011; Mujeri & Azam, 2018). DIGL refers to the knowledge and skills to operate digital devices to complete financial transactions safely in this study.

Hypothesis (H1): The DIGL has a significant positive effect on DFIC.

Financial Literacy

Financial literacy (FINL) is knowledge, skills and attitude that make sound financial decisions (OECD, 2022). A literate individual possesses better financial knowledge and skills in managing their finances. They understand the features of financial products and services available in the market and know how to benefit from them, thus increasing their willingness to participate in the financial system (Ozili, 2020). Studies found FINL is positively related to financial inclusion (Vaid et al., 2020; Morgan & Long, 2020; Toronto Centre, 2022). However, Lyons et al. (2019) showed that low-income and low-education groups are less likely to benefit from FINL as they face barriers in utilising financial services. FINL is a set of knowledge and skills in financial management used in this study.

Hypothesis (H2): The FINL has a significant positive effect on DFIC.

Trust

Trust (TRU) is defined as individuals' confidence in their favourable expectations of what people will do based on their previous interactions (Gefen, 2000). TRU is needed in financial services because financial decisions are inherently risky (Oehler & Wendt, 2018). It is a significant predictor of digital financial services adoption (Khoa, 2020; Alnemer, 2022) and financial inclusion (Bongomin & Ntayi, 2020; Vaid et al., 2020), because digital services are exposed to digital crime (Shaikh et al., 2018). The lack of TRU is one reasons why individuals are not using digital financial services (Malady, 2016). TRU refers to the confidence in financial institutions and digital financial services in this study.

Hypothesis (H3): The TRU has a significant positive effect on DFIC.

Digital Financial Services Infrastructure (INFRA)

Digital financial services infrastructure (INFRA) refers to digital financial services platforms, interoperability, ID systems and reliable ICT connectivity that enable digital financial services to reach consumers reliably (Demirgüc-Kunt et al., 2017; D'Silva et al., 2019). INFRA is essential to support financial transactions and data transmission securely, authenticate and verify users' information, and prevent fraud. A well-established INFRA enables accessibility to financial services (Ozili, 2018) and reduces the gap of inclusion, particularly for low-income groups (Demirgüc-Kunt et al., 2017; D'Silva et al., 2019; Demir et al., 2022). Rewilak (2017) highlighted that a lack of INFRA hinders the poor group from benefitting from financial services, even in a well-developed financial sector. INFRA refers to digital devices, internet connectivity and the ID system to access digital financial services in this study.

Hypothesis (H4): The INFRA has significant positive effect on DFIC.

Financial Services Providers (FSP)

FSP comprises banks, financial institutions and fintech that are dominant in building an inclusive financial ecosystem. FSP is a special agent connecting clients to the financial system (Ozili, 2020). FSP is expected to understand the peculiarities of the excluded population and bring the population into financial services in an innovatively. Digital financial services provide immense opportunities for DFIC, predominantly low-income households. FSP is a factor that influences financial inclusion (Demirgüc-Kunt et al., 2017; Thathsarani et al., 2021). In this study, it refers to the role of financial service providers in providing financial services, financial information and affordable charges to low-income households through digital channels.

Hypothesis (H5): The FSP has a significant positive effect on DFIC.

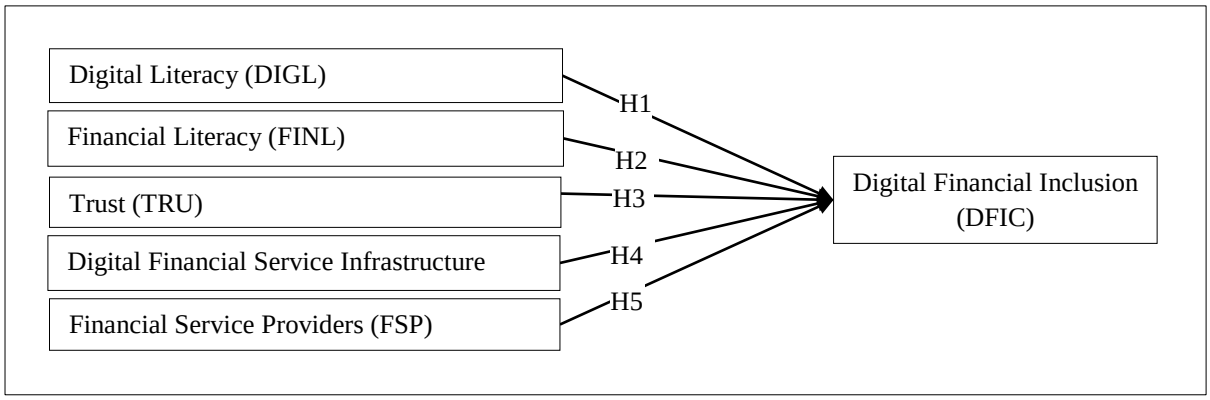
The problem of endogeneity has been acknowledged in previous studies. For example, Bucher-Koenen and Lusardi (2011) and Behrman et al. (2012) examined the causality problems of financial literacy. Bucher-Koenen and Lusardi (2011) highlighted the potential bidirectional relationship between financial literacy and financial retirement. They use financial knowledge as the instrumental variable and found that financial literacy has a positively and significantly impacts on financial retirement. Similarly, Behrman et al. (2012) explored whether financial literacy and education affect wealth accumulation. They showed evidence that financial literacy plays a crucial role in wealth accumulation. In the context of digital financial inclusion, Geng and He (2021) examined the impacts of digital financial inclusion on sustainable employment in China. They address the endogeneity problems by using internet penetration as an instrumental variable. The findings remained consistent, which suggests digital financial inclusion influences sustainable employment. Another study by Liu et al. (2024) investigated the relationship between digital financial inclusion and household financial vulnerability. They used the average value of the digital financial inclusion index from neighbouring areas within the same city as an instrumental variable and revealed that digital financial inclusion significantly reduces household financial vulnerability.

This study expands the literature on financial inclusion, with a specific focus on digital financial inclusion. Despite the growing body of literature, the literature on digital financial inclusion remains in its early stages, especially in the context of low-income households. It is observed that the existing literature essentially center around traditional indicators such as outreach, penetration, and accessibility

(Bongomin & Ntayi, 2020; Morgan & Long, 2020) and macroeconomic variables such as number of ATMs, number of depositors, bank branches, and deposits per capita (Omar & Inaba, 2020; Nsiah et al., 2021). However, as Malaysia transitions into a digital economy, achieving financial inclusion through digital financial services requires a deeper examination of individual-level (digital literacy, financial literacy, and trust) and supporting-level factors (digital financial service infrastructure and financial service providers). Furthermore, recognizing the uneven development between Peninsular and East Malaysia, comparing them is a crucial to provide insights to design targeted strategies to achieve the national goal outlined in the 12th Malaysia Plan (RMK-12) - building a prosperous, inclusive, and sustainable Malaysia.

Figure 1

The Research Framework of this Study



METHODOLOGY

Sampling and Data

Quantitative research is employed in this study. The simple random sampling technique was used to collect the responses from households that earned below the PLI. The PLI was RM2,208, and the number of households that fell below the PLI was 639,800 when this research was conducted (DOSM, August 6, 2021).

Based on the Krejcie & Morgan Table, considering the population of more than 1 million, with a 5% margin of error at a 95% confidence level, the minimum sample size required is 384 (Krejcie & Morgan, 1970). This study collected 1,171 completed responses, with 832 from Peninsular Malaysia and 339 from East Malaysia, from December 2022 to August 2023. Although the sample size for East Malaysia is slightly below the recommended size, it constitutes 88.28% of the required sample size. Given this small sample size, this study bootstrapped the samples 5,000 times to generate precise estimates.

The questionnaire was developed by adapting past studies. The face and content validity of the questionnaire was established through expert reviews from both industry and academia. The questionnaire consists of two sections: demographic information and structured questions related to all the constructs of this study. A Five-point Likert scale was used in this study. The enumerators distributed the self-administered questionnaires. The objective of the survey was informed, and the enumerators explained the questions before the target respondents answered them. The target respondents participated voluntarily in this survey.

Variables Measurement

The items for variables were adapted from the previous studies and adjusted, necessarily, to fit the context of this study. DFIC has seven items that are adapted from the Global Findex Questionnaire (2017), DIGL has seven items that are adapted from Kass-Hanna et al. (2021) and Kumar et al. (2022). FINL has six items that are adapted from OECD (2022), and TRU has four items that are adapted from Bongomin and Ntayi (2020). Lastly, the INFRA and FSP which were constructed with ten and six items, respectively, were adapted from Vaid et al. (2020). Respondents must indicate their agreement levels with statements for all variables from strongly disagree (1) to strongly agree (5). There were 33 respondents who participated in the pilot test. The Cronbach's alpha for all constructs is greater than 0.7, indicating the questionnaire's high internal consistency and reliability. The structure and sources of the questionnaire are presented in Table 1.

Table 1

Questionnaire Structure and Sources

Variables	Items	Descriptions	Cronbach's Alpha	Sources
DFIC	DFIC1	I can access digital financial services.	0.805	
	DFIC2	I can borrow money from digital financial service platform.		
	DFIC3	I can make payments through digital financial service platform.		Global Findex Questionnaire (2017)
	DFIC4	I can buy insurance plan through digital financial service platform.		
	DFIC5	I can make investment through digital financial service platform.		
	DFIC6	I use digital financial service at least once a month.		
	DFIC7	Digital financial service platform is user friendly.		
DIGL	DIGL1	Aware about the security of a website (https sites, safety logo or certificates) before making digital financial transactions.	0.818	
	DIGL2	Use smart phone to send or receive calls, sends or receives text messages, sends or receives photos.		
	DIGL3	Use smart phone browses or uses the Internet, downloads music, videos or games, makes financial transactions, or access social networking site.		Kass-Hanna et al. (2021), Kumar et al. (2022)
	DIGL4	Know how to open menu, finds the particular menu options, initiates a transaction, and complete digital financial transactions successfully.		
	DIGL5	Know how to correct an error or reverses or cancels a transaction successfully when doing transactions on digital financial service platform.		
	DIGL6	Have an experience to transfer/receive money using digital financial service platform.		
	DIGL7	Have an experience to check my account balance using digital financial service platform.		
FINL	FINL1	I know the importance to save money for the future.	0.818	OECD (2022)
	FINL2	I know the importance of financial planning for my future.		

(continued)

Variables	Items	Descriptions	Cronbach's Alpha	Sources
	FINL3	I know the importance of recording my expenses.		
	FINL4	I think carefully before deciding to buy something.		
	FINL5	I have adequate awareness about the financial products and services offered.		
	FINL6	I have adequate awareness about the interest rates charged on financial products and services.		
TRU	TRU1	Financial institutions are reliable for availing digital financial services.	0.855	
	TRU2	Feel safe when using digital financial services.		Bongomin & Ntayi (2020)
	TRU3	Digital financial service platform is trustworthy.		
	TRU4	I am confident in using digital financial service platform.		
INFRA	INFRA1	I have a device (laptop, smartphone, tablet) to access to the digital financial service.	0.868	Vaid et al. (2020)
	INFRA2	My living area has stable internet connection.		
	INFRA3	I can afford to buy data or subscribe internet line.		
	INFRA4	Opening financial accounts through digital financial service platform is easy.		
	INFRA5	Applying a loan through digital financial service platform is easy.		
	INFRA6	Transferring/receiving money through digital financial service platform is easy.		
	INFRA7	Doing investment and getting wealth management/financial advisory services through digital financial service platform is easy.		
	INFRA8	Purchasing/renewing life/health/general insurance through digital financial service platform is easy.		
	INFRA9	FaceID/TouchID/digital authentication that linked to financial services accounts for transaction authentication is convenient.		
	INFRA10	It is easy to reach financial institutions through call center or LiveChat on digital financial service platform.		
FSP	FSP1	Financial service providers provide necessary information about digital financial products and services.	0.751	Vaid et al. (2020)
	FSP2	Financial service providers offer digital financial products and services that meet my needs.		
	FSP3	Formal financial service providers charge lower lending rate than informal financial services (main kutu/Ah Long/Biaohui/illegal pawnshop).		
	FSP4	Financial service providers charges lower lending rate than other moneylenders (e-wallet, pawnshop, credit community etc.).		
	FSP5	It is convenient to access digital financial service.		
	FSP6	Using digital financial services save my effort of going to bank/physical store.		

Notes. DFIC=Digital financial inclusion; DIGL=Digital literacy; FINL=Financial literacy; TRU=Trust; INFRA=Digital financial service infrastructure; FSP=Financial service providers.

Data Analysis

This study uses partial least squares-structural equation modelling (PLS-SEM) for hypothesis testing. PLS-SEM is suitable for explanatory studies (Sarstedt et al., 2017), which matches this study. It also does not require normally distributed data and excels in handling models with multiple interrelated latent constructs (Hair & Alamer, 2022). A two-step approach of PLS-SEM was executed, where the measurement model was used to assess the validity and reliability of the constructs prior to the structural model that was used to assess the relationship between the variables (Anderson & Gerbing, 1988). Additionally, multigroup analysis (MGA) techniques were employed to compare the data between Peninsular and East Malaysia. The sample data was segregated into two groups (i.e., Peninsular and East Malaysia). The three-step process of measurement invariance of composites (MICOM) was conducted to determine measurement invariance before the multigroup analysis examining the variations between the two regions (Cheah et al., 2023).

The following model is designed to examine the objective of this study.

$$DFIC = \alpha + \beta_1 DIGL + \beta_2 FINL + \beta_3 TRU + \beta_4 INFRA + \beta_5 FSP + \varepsilon \qquad (1)$$

Where DFIC (digital financial inclusion) is the dependent variable, and a set of independent variables include DIGL (Digital Literacy), FINL (Financial Literacy), TRU (Trust), INFRA (Infrastructure) and FSP (Financial Service Providers).

RESULTS

Respondent's Demographic Analysis

Table 2

Demographic Profile (n=1,171)

Particulars		n	%	Particulars		n	%
Gender	Male	229	19.56	Age	18-24	150	12.81
	Female	942	80.44		25-34	326	27.84
					35-44	325	27.75
Race	Malay	977	83.43		45-54	219	18.70
	Chinese	52	4.44		55-60	108	9.22
	Indian	42	3.59		>60	43	3.67
	Iban	56	4.78				
	Melanau	9	0.77	Residential	Rural	805	68.74
	Bidayuh	8	0.68	Area	Urban	366	31.26
	Bajau	6	0.51				
	Kadazan	5	0.43	State	Sabah	182	15.54
	Others	16	1.37		Kelantan	108	9.22
					Sarawak	157	13.41

(continued)

Particulars		n	%	Particulars		n	%
Marital	Single	293	25.02		Kedah	147	12.55
Status	Married	785	67.04		Perak	135	11.53
	Divorced	30	2.56		Perlis	97	8.28
	Widowed	63	5.38		Terengganu	79	6.75
					Pahang	29	2.48
Education	No formal education	24	2.05		Negeri Sembilan	53	4.53
Level	Primary	72	6.15		Melaka	48	4.10
	Secondary	623	53.20		Johor	47	4.01
	Diploma	306	26.13		W.P. Labuan	65	5.55
	Bachelor's degree	138	11.78		Pulau Pinang	18	1.54
	Master Degree/Ph.D	8	0.68		Selangor	4	0.34
					W.P. Kuala Lumpur	2	0.17
Monthly	<500	122	10.42				
Income	500-1,000	156	13.32				
(RM)	1,001-1,500	276	23.57				
	1,501-2,208	617	52.69				

Table 2 presents the demographic profile of the respondents. Most respondents were females (80.44%) and Malays (83.43%). About 67.04% of the respondents were married, completed secondary school (53.2%), aged 25-34 years (27.84%), lived in rural areas (68.74%), and earned RM1,501 to RM2,208 (52.69%). The majority of the respondents were from Sabah (15.54%), followed by Sarawak (13.41%), Kedah (12.55%), Perak (11.53%), Kelantan (9.22%), Perlis (8.28%), and Terengganu (6.75%). This data represents the population of households whose income falls below the average national poverty line (PLI).

Partial Least Square-Structural Equation Modelling (PLS-SEM)

Measurement Model

The measurement model was executed to assess internal consistency reliability (loadings, Cronbach's alpha, and composite reliability (CR)), convergent reliability (Average Variance Extracted (AVE) and discriminant validity (Heterotrait-Monotrait (HTMT) ratio) as presented in Table 3 and 4.

Table 3 shows that the Cronbach's alpha, CR and AVE are larger than the threshold value of 0.7, 0.7 and 0.5, respectively (Hair et al., 2019). The loadings for the constructs were higher than 0.5 (Hair et al., 2019), except for items DIGL1, INFRA2, INFRA4 and INFRA5. Moreover, Table 4 showed that the HTMT values for all constructs were below 0.85, indicating that discriminant validity was established (Henseler et al., 2015). In addition, there is no multicollinearity issues in this study as the variance inflation factor (VIF) for all constructs was well below 3.3 (Kock & Lynn, 2012).

Table 3

Measurement Model

	Complete				Peninsular				East			
	Loading	Cronbach's Alpha	CR	AVE	Loading	Cronbach's Alpha	CR	AVE	Loading	Cronbach's Alpha	CR	AVE
Digital Financial Inclusion		0.885	0.910	0.593		0.870	0.899	0.563		0.907	0.926	0.643
DFIC1	0.813				0.808				0.829			
DFIC2	0.591				0.572				0.611			
DFIC3	0.845				0.846				0.847			
DFIC4	0.745				0.676				0.842			
DFIC5	0.767				0.741				0.805			
DFIC6	0.776				0.776				0.777			
DFIC7	0.825				0.797				0.874			
Digital Literacy		0.909	0.931	0.695		0.905	0.928	0.686		0.917	0.937	0.714
DIGL2	0.610				0.61				0.630			
DIGL3	0.879				0.878				0.880			
DIGL4	0.804				0.798				0.813			
DIGL5	0.895				0.885				0.910			
DIGL6	0.900				0.888				0.921			
DIGL7	0.877				0.875				0.882			
Financial Literacy						0.857	0.891	0.587		0.887	0.913	0.637
FINL1	0.827	0.870	0.902	0.609	0.859				0.751			
FINL2	0.860				0.876				0.831			
FINL3	0.871				0.879				0.850			
FINL4	0.775				0.807				0.701			
FINL5	0.663				0.549				0.824			
FINL6	0.655				0.540				0.820			

(continued)

	Complete				Peninsular				East			
	Loading	Cronbach's Alpha	CR	AVE	Loading	Cronbach's Alpha	CR	AVE	Loading	Cronbach's Alpha	CR	AVE
Financial Service Providers		0.845	0.884	0.562		0.816	0.865	0.519		0.881	0.909	0.628
FSP1	0.735				0.654				0.838			
FSP2	0.809				0.782				0.841			
FSP3	0.658				0.634				0.687			
FSP4	0.670				0.651				0.701			
FSP5	0.816				0.795				0.854			
FSP6	0.794				0.787				0.815			
Infrastructure		0.867	0.898	0.558		0.849	0.885	0.526		0.888	0.912	0.599
INFRA1	0.688				0.697				0.679			
INFRA10	0.707				0.692				0.721			
INFRA3	0.700				0.673				0.742			
INFRA6	0.809				0.783				0.845			
INFRA7	0.738				0.675				0.810			
INFRA8	0.780				0.744				0.820			
INFRA9	0.795				0.800				0.790			
Trust		0.899	0.930	0.768		0.903	0.932	0.775		0.893	0.925	0.757
TRU1	0.828				0.835				0.815			
TRU2	0.899				0.916				0.866			
TRU3	0.912				0.918				0.901			
TRU4	0.865				0.848				0.895			

Notes. DFIC=Digital financial inclusion; DIGL=Digital literacy; FINL=Financial literacy; TRU=Trust; INFRA=Digital financial service infrastructure; FSP=Financial service providers.

Table 4

Discriminant Analysis

	1	2	3	4	5	6
Complete						
DFIC						
DIGL	0.709					
FINL	0.417	0.504				
FSP	0.685	0.596	0.473			
INFRA	0.718	0.676	0.413	0.785		
TRU	0.723	0.604	0.392	0.624	0.577	
Peninsular						
DFIC						
DIGL	0.728					
FINL	0.457	0.508				
FSP	0.702	0.59	0.54			
INFRA	0.734	0.651	0.513	0.819		
TRU	0.718	0.584	0.398	0.613	0.562	
East						
DFIC						
DIGL	0.683					
FINL	0.394	0.527				
FSP	0.665	0.608	0.418			
INFRA	0.696	0.717	0.322	0.747		
TRU	0.735	0.642	0.418	0.653	0.607	

Notes. DFIC=Digital financial inclusion; DIGL=Digital literacy; FINL=Financial literacy; TRU=Trust; INFRA=Digital financial service infrastructure; FSP=Financial service providers.

Structural Model

Table 5

Hypothesis Testing

Path	Std. Beta	Std. Error	t-value	p-value	BCI LL	BCI UL	f^2	R^2	Q^2
Complete								0.716	0.615
H1: DIGL -> DFIC	0.283	0.044	6.453	0.000	0.212	0.357	0.123		
H2: FINL -> DFIC	-0.006	0.031	0.184	0.427	-0.056	0.045	0.000		
H3: FSP -> DFIC	0.138	0.054	2.561	0.005	0.048	0.227	0.021		
H4: INFRA -> DFIC	0.223	0.052	4.289	0.000	0.137	0.310	0.054		
H5: TRU -> DFIC	0.349	0.037	9.417	0.000	0.289	0.410	0.225		
Peninsular								0.743	0.624
H1: DIGL -> DFIC	0.318	0.049	6.491	0.000	0.238	0.399	0.187		
H2: FINL -> DFIC	-0.021	0.037	0.573	0.283	-0.082	0.040	0.001		
H3: FSP -> DFIC	0.136	0.077	1.764	0.039	0.004	0.259	0.020		
H4: INFRA -> DFIC	0.242	0.073	3.297	0.000	0.123	0.366	0.064		
H5: TRU -> DFIC	0.330	0.041	7.970	0.000	0.262	0.399	0.233		

(continued)

Path	Std. Beta	Std. Error	t-value	p-value	BCI LL	BCI UL	f^2	R^2	Q^2
East								0.684	0.590
H1: DIGL -> DFIC	0.201	0.086	2.352	0.009	0.063	0.341	0.047		
H2: FINL -> DFIC	0.032	0.053	0.593	0.277	-0.052	0.121	0.002		
H3: FSP -> DFIC	0.120	0.079	1.517	0.065	-0.011	0.249	0.016		
H4: INFRA -> DFIC	0.232	0.082	2.829	0.002	0.100	0.369	0.053		
H5: TRU -> DFIC	0.381	0.072	5.259	0.000	0.261	0.499	0.220		

Notes. 5,000 bootstrapping procedure, DFIC=Digital financial inclusion; DIGL=Digital literacy; FINL=Financial literacy; TRU=Trust; INFRA=Digital financial service infrastructure; FSP=Financial service providers.

Table 5 presents the results of the significance of the hypothesis developed. TRU is found as the most significant factors to determine the DFIC among the low-income households in Malaysia ($\beta_{complete}$=0.349, p<0.000; $\beta_{Peninsular}$=0.330, p<0.000; β_{East}=0.381, p<0.000), followed by DIGL ($\beta_{complete}$=0.283, p<0.000; $\beta_{Peninsular}$=0.318, p<0.000; β_{East}=0.201, p<0.009) and INFRA ($\beta_{complete}$=0.223, p<0.000; $\beta_{Peninsular}$=0.242, p<0.000; β_{East}=0.232, p<0.002). Thus, H1, H4, and H5 are supported for all the sample sets. However, different findings were observed for the two sub-sample sets, where FSP only showed a positive effect on the DFIC for the complete and Peninsular samples ($\beta_{complete}$=0.138, p<0.005; $\beta_{Peninsular}$=0.136, p<0.039), while no association was found for the East Malaysia sample. Hence, H3 only supported for complete and Peninsular Malaysia sample sets. Surprisingly, this study found results that contradicted from the majority of the past studies that showed a positive relationship between FINL and DFIC. Hence, H2 is not supported.

Additionally, f^2, R^2 and Q^2 evaluate the model's predictive power. The results in Table 5 showed that TRU-> DFIC showed moderate level of practical significance ($f^2_{complete}$=0.225; $f^2_{Peninsular}$=0.233; f^2_{East}=0.220), while DIGL-> DFIC and INFRA-> DFIC are found smaller effect size ($0.02 \leq f^2 \leq 0.15$) for all the sample sets (Cohen, 1988). The FSP-> DFIC resulted smaller effect size only for complete and Peninsular sample sets ($f^2_{complete}$=0.021; $f^2_{Peninsular}$=0.020. No effect size is found for FINL-> DFIC for all sample sets. Accordingly, TRU is a key determinant in predicting DFIC. The results also showed that the model has moderate explanatory power where $0.5 \leq R^2 \leq 0.78$ for all the sample sets ($R^2_{complete}$=0.716; $R^2_{Peninsular}$=0.743; R^2_{East}=0.684). The findings also imply that the five independent constructs of this study have strong degree of predictive accuracy on DFIC ($Q^2_{complete}$=0.615; $Q^2_{Peninsular}$=0.624; Q^2_{East}=0.590), where $Q^2 \geq 0.35$ (Hair et al., 2013).

Multigroup Analysis

Before conducting Multigroup Analysis (MGA), the measurement invariance of composite (MICOM) is required (Henseler et al., 2016). There are three steps involved in MICOM through permutation. Table 6 shows that the configural invariance and compositional tests were established as all the constructs are identical and the *c* for all constructs are greater than 5% quantile of C_u. The measurement invariance was partially established as not all the composite mean values and variances were equal (Cheah et al., 2023). This suggests that the items for both groups of samples are invariant and the subsequent multigroup analysis can proceed.

Table 7 presents the results of multigroup analysis to compare the significant differences between Peninsular and East Malaysia. The significant differences for the path coefficient of DIGL→DFIC, FSP→DFIC, INFRA→DFIC and TRU→DFIC were found. The path of DIGL→DFIC and INFRA→DFIC were weaker for East Malaysia, whereas the Peninsular Malaysia was weaker for the path of FSP→DFIC and TRU→DFIC. The findings suggest that increasing the DIGL level and a well-established INFRA are essential to boosting the DFIC in Peninsular Malaysia. Meanwhile, the DFIC in East Malaysia can efficiently increase with the enhancement of the role played by the FSP and increase the TRU in utilising digital financial services.

DISCUSSION

The results confirm the hypothesis developed in this study. TRU is the most significant factor in determining the DFIC among low-income households in Malaysia. This finding is corroborated by Bongomin and Ntayi (2020) and Setiawan et al. (2024). TRU is an essential factor affecting DFIC. When conducting digital financial transactions, users are exposed to financial risks such as scams and identity theft. A higher level of TRU in digital financial services can lead to greater utilization of these services and, therefore, enhance greater DFIC. Next, DIGL was found to influence DFIC positively. This is supported by previous studies of Jack and Suri (2011), Mujeri and Azam (2018), Lyons et al. (2021) and Lyons and Kass-Hanna (2021) who demonstrated that DIGL increases the usage of digital financial services. When low-income households are equipped with DIGL, they can access digital financial services effectively and are able to take preventive steps against online financial fraud, which boosts DFIC. Furthermore, INFRA is found to be positively associated with DFIC. Studies by Demirgüc-Kunt et al. (2017), D'Silva et al. (2019) and Demir et al. (2022) demonstrated consistent findings where a well-established INFRA increases financial inclusion. The INFRA, which provides reliable internet connectivity and interoperability of digital financial services platforms, facilitates low-income households in conducting digital financial transactions. Meanwhile, FSP only positively affected the DFIC for the complete and Peninsular samples. Demirgüc-Kunt et al. (2017) and Thathsarani et al. (2021) found that FSP that provides innovative digital financial services that meets low-income households' needs pave the way to DFIC. However, FINL is not found to be associated with DFIC. Bongomin et al. (2016) argued that FINL indirectly influences DFIC. They explained that the absence of social capital hinders the effectiveness of FINL initiatives of poor households in Uganda to access financial services and thus fails to enhance DFIC.

Lastly, the multigroup analysis revealed that DIGL level and a well-established INFRA are essential to boosting the DFIC in Peninsular Malaysia at the same time, the enhancement of the role played by the FSP and increasing the TRU in utilizing digital financial service can efficiently increase the DFIC in East Malaysia. Although DIGL and INFRA are important to both Peninsular and East Malaysia in achieving DFIC, they faced different challenges due to disparities in development. The economy is generally more developed and dynamic, and there are more digital financial activities in Peninsular Malaysia. As a result, low-income households in Peninsular Malaysia are exposed to various forms of digital crimes. Well-equipped with DIGL and a well-established INFRA are crucial for the low-income households in Peninsular Malaysia to protect their online personal and financial information and conduct digital financial transactions effectively and efficiently. On the other hand, the geographical factors of East Malaysia, particularly in remote areas, could present barriers to DFIC among low-income households. FSP may not complete financial services and customer service support in certain areas, which lowers the confidence in utilising digital financial services. The role of FSP is prominent in providing digital financial services with an innovative approach and increasing their TRU to be included in the financial system so that they can fully benefit from the digital financial services.

This study enhances the theoretical understanding of digital financial inclusion by integrating individual-level factors (digital literacy, financial literacy, and trust) and supporting-level factors (digital financial service infrastructure and financial service providers) in predicting digital financial inclusion. This is supported by theories of financial inclusion, such as vulnerable group theory, system theory, and financial literacy theory, as discussed by Ozili (2018) as foundations for understanding financial inclusion. Additionally, few studies in the field compare the differences between Peninsular and East Malaysia. This study reveals significant regional differences between Peninsular and East Malaysia, which are crucial for policymakers and practitioners in developing strategies to improve digital financial inclusion in Malaysia.

The implications are derived from the findings of this study. Enhancing digital financial inclusion among low-income households in Malaysia requires a focus on building trust in digital financial services. Digital financial services expose users to cybersecurity risks such as fraud and data breaches, potentially leading to financial loss. Practitioners must establish cybersecurity and financial regulations and measures to protect users from cyber threats. When users have confidence in the security and reliability of digital financial services, it encourages wider adoption among low-income households, thereby increasing digital financial inclusion.

Furthermore, individuals with digital literacy use digital financial services more effectively. Digital literacy provides people with the knowledge and skills to operate digital devices and engage in secure digital practices. They become aware of cyber threats, understand how to protect their information, and conduct digital financial transactions securely. To enhance digital literacy, practitioners should implement a digital literacy campaign and program to increase awareness and provide resources to enhance digital literacy. Platforms such as broadcast media and social media can effectively spread information and improve digital literacy.

Moreover, a well-established digital financial service infrastructure is crucial to digital financial inclusion. Key components of digital financial service infrastructure include a user-friendly interface and stable, reliable internet connectivity, which are prerequisites for effectively and efficiently accessing and conducting digital financial transactions. Practitioners like the government and telecommunication companies should work together to develop and provide affordable and reliable internet connectivity. Meanwhile, financial service providers can enhance the features of their digital financial service platform to ensure they are user-friendly, secure and accessible. These efforts would contribute to increasing digital financial inclusion.

CONCLUSION

DFIC is important for economic development, poverty reduction, and eliminating inequality in a nation. This study aims to examine factors determining DFIC among low-income households in Malaysia. Our first findings show that, of the five factors, TRU, DIGL and INFRA affected DFIC among low-income households in Malaysia for the total sample. However, FSP only significantly impacts DFIC for the complete and Peninsular Malaysia samples. Interestingly, FINL is the only construct that is not related to DFIC. Instead, FINL might influence DFIC indirectly, particularly low-income households, as they are more likely to rely on informal networks, such as family or friends, to meet their financial needs rather than engage with the formal financial system, even if they possess financial knowledge.

Moreover, the PLS-MGA analysis demonstrated that all the constructs, except FINL, were significantly different between Peninsular and East Malaysia. We found that DIGL and INFRA are more important in increasing the DFIC among low-income households in Peninsular Malaysia, while the role of FSP and TRU is more effective in increasing DFIC in East Malaysia.

Several limitations are present in this study. This study examined the direct relationship between the variables without considering other factors such as financial behaviour and financial attitude that might mediate or moderate the relationships. This could lead to an incomplete understanding of how other factors interact with these relationships. Furthermore, this study focused only on households that earned below the poverty line in Malaysia. The investigation on different income level groups could offer a more comprehensive view of how digital financial inclusion in Malaysia varies across different socio-economic statuses.

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Table 6

MICOM

Construct	Configural invariance	Compositional Invariance			Equal Mean			Equal Variance			
		c = 1	5% quantile of C_u	Permutation p-value	Compositional invariance	Differences	95% confidence interval	Permutation p-value	Differences	95% confidence interval	Permutation p-value	Measurement Invariance
DFIC	Yes	1.000	0.999	0.311	Yes	0.117	[-0.103; 0.102]	0.027	-0.317	[-0.158; 0.173]	0.000	Partial
DIGL	Yes	1.000	1.000	0.956	Yes	0.059	[-0.099; 0.105]	0.160	-0.234	[-0.132; 0.141]	0.002	Partial
FINL	Yes	1.000	0.999	0.141	Yes	-0.229	[-0.097; 0.096]	0.000	0.191	[-0.125; 0.134]	0.012	Partial
FSP	Yes	0.999	0.996	0.837	Yes	0.055	[-0.098; 0.108]	0.076	-0.341	[-0.149; 0.164]	0.000	Partial
INFRA	Yes	0.999	0.996	0.882	Yes	0.150	[-0.091; 0.111]	0.000	-0.273	[-0.144; 0.157]	0.001	Partial
TRU	Yes	1.000	1.000	0.196	Yes	0.112	[-0.095; 0.099]	0.032	-0.031	[-0.145; 0.151]	0.372	Partial

Table 7

Multigroup Analysis Results

Hypothesis	Path Coefficient (Peninsular)	p-value (Peninsular)	Path Coefficient (East)	p-value (East)	Supported?
DIGL -> DFIC	0.316	0.000	0.254	0.001	Yes
FINL -> DFIC	0.034	0.130	0.011	0.399	No
FSP -> DFIC	0.154	0.000	0.178	0.005	Yes
INFRA -> DFIC	0.160	0.000	0.139	0.000	Yes
TRU -> DFIC	0.320	0.000	0.354	0.000	Yes

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