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DEVELOPING A MICRO-ENTERPRISE E-READINESS FRAMEWORK: A CASE STUDY FROM INDONESIA

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Abstract— *Micro-enterprises play a vital role in Indonesia's economy but continue to face persistent barriers in adopting information and communication technology (ICT). Understanding E-Readiness is essential for implementing effective digital interventions, especially for micro-enterprises. To address the lack of validated frameworks for assessing digital readiness at the micro-enterprise level, this study develops and empirically tests a novel E-Readiness Assessment Framework specifically designed for micro-enterprises. The proposed conceptual model consists of four dimensions: Technology, Organisation, External Environment, and Human Resources, which are derived from established e-readiness models. This study also proposed the measurement indicators that have been adapted to the characteristics of micro enterprises. Using quantitative data from 641 food and beverage (F&B) micro-enterprises in Batu City, Indonesia, exploratory factor analysis (EFA) was applied to evaluate construct validity. Despite the elimination of five indicators due to insufficient communality value, the overall model structure remained statistically valid. Subsequently, factor analysis was succeeded by the calculation of E-Readiness index using weighted aggregation and normalisation methods. The resulting E-Readiness Index for Batu City was 46.47, with 57.10% of enterprises classified as "Not Ready," primarily due to technological and infrastructural limitations. The proposed model in this study efficiently assesses e-readiness at the micro-enterprise level and is adaptable for application in different regions or business sectors. This model also provides valuable insights for policymakers in formulating targeted digital support initiatives. Future research may consider expanding the scope of indicators and validating the model using confirmatory analysis.*

Keywords: *E-Readiness, Exploratory Factor Analysis, F&B Sector, Micro Enterprises, Readiness Index..*

Intisari— *Usaha mikro sangat penting bagi perekonomian Indonesia. Namun, mereka menghadapi kendala yang signifikan dalam mengadopsi teknologi informasi dan komunikasi (TIK). Memahami kesiapan digital (E-Readiness) sangat penting untuk memberikan intervensi digital yang efektif, terutama pada usaha mikro. Penelitian ini mengusulkan model konseptual untuk menilai kesiapan digital (E-Readiness) bagi usaha mikro dan dan memvalidasi model tersebut dengan menerapkannya pada evaluasi e-readiness usaha mikro sektor makanan dan minuman (F&B) di Kota Batu, Indonesia. Metodologi kuantitatif digunakan dengan*

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memanfaatkan data yang dikumpulkan dari 641 usaha mikro makanan dan minuman. Model konseptual yang diusulkan pada penelitian ini terdiri dari empat dimensi: Teknologi, Organisasi, Lingkungan Eksternal, dan Sumber Daya Manusia. Penelitian ini juga mengusulkan indicator pengukuran untuk setiap dimensi yang telah disesuaikan dengan karakteristik usaha mikro. Analisis faktor eksploratori (EFA) dilakukan untuk menilai validitas konstruk dari keempat dimensi ini. Meskipun lima indikator dieliminasi karena nilai communality yang rendah, struktur model secara keseluruhan valid secara statistik. Analisis faktor kemudian dilanjutkan dengan pembentukan indeks kesiapan digital (e-readiness index) menggunakan teknik agregasi terbobot dan normalisasi. Skor indeks keseluruhan yang diperoleh untuk Kota Batu adalah 46,47, dengan 57,10% usaha diklasifikasikan sebagai "Belum Siap". Dimensi Teknologi memperoleh skor rata-rata terendah yang menunjukkan bahwa akses terhadap infrastruktur masih menjadi masalah utama pada usaha mikro di Kota Batu. Model yang diusulkan dalam penelitian ini efektif mengukur (E-Readiness) di tingkat usaha mikro dan dapat diadaptasi untuk digunakan di wilayah atau sektor usaha lainnya. Model ini juga menawarkan wawasan praktis bagi para pembuat kebijakan dalam merancang program dukungan digital yang tepat sasaran. Penelitian selanjutnya dapat mempertimbangkan perluasan cakupan indikator dan validasi model menggunakan analisis konfirmatori.

Kata Kunci *E-Readiness, Analisis Faktor Eksploratori, Sektor F&B, Usaha Mikro, Indeks Kesiapan*

INTRODUCTION

Micro, small, and medium enterprises (MSMEs) constitute the backbone of the Indonesian economy. According to data from the Ministry of MSMEs, there were 65.47 million MSMEs in Indonesia in 2019 or around 99.99% of business sectors in Indonesia [1]. With 64.6 million firms (98.67%), micro enterprises (MEs) make up the greatest portion of the total. Following with totals of 798.68 thousand (1.22%) and 65.46 thousand (0.1%), respectively, were small and medium-sized businesses [1]. The contribution of MSMEs to Indonesia's Gross Domestic Product (GDP) accounted for 61.1% of Indonesia's total GDP in 2022 [1]. Specifically, micro enterprises account for 37.35% contribution to Indonesia's GDP, almost equal to the large enterprises [1].

Those data shows the significant contribution of MEs to the Indonesian economy and the potential of MEs as a strong national economic basis. MSMEs is also a significant driver of job development many of which can absorb a significant portion of the labor force, and a source of income for those from disadvantaged backgrounds, such as low-skilled laborers and low-income women [2]. Due to the low education levels of most populations, the business activities carried out as primary source of income in Indonesia are mostly through micro enterprises [3]. In terms of employment contribution, MSMEs in Indonesia can employ 119.56 million individuals [1]. Specifically, micro enterprises absorb around 97% of the total national workforce. Given the importance of MEs to the Indonesian economy, it is critical to boost their competitiveness to achieve long-term economic sustainability.

One way that has long been recognized to increase the competitiveness of enterprises is by using information and communication technology (ICT) [4]–[7]. Despite the numerous advantages that ICT offers to businesses, many MEs still do not use and leverage ICT to enhance their operations. Data from the Indonesia National Statistical Office (BPS) indicates that in 2023, 61.33 percent of micro and small enterprises sold goods/services via the internet [8]. This implies that around 38 percent or 24 million micro and small enterprises have not utilized the internet for their sales activities. MEs often face challenges in adopting ICT due to limited budgets for ICT investments, insufficient resources with ICT skills, and a lack of awareness among owners and managers about the potential benefits of ICT for enhancing competitiveness [4]–[7], [9]. According to [10], one of the reasons for the varied utilization and capability to implement and use ICT across enterprises is the difference in e-Readiness for ICT adoption.

E-readiness refers to the level of preparedness of an entity, whether a country, organization, or individual, to effectively use ICT [10]–[12]. E-Readiness encompasses a range of factors that collectively determine how prepared an entity is in key areas critical for ICT adoption [11]. It is the crucial initial stage or the beginning process of ICT adoption, before moving into the maturity phase [12]. By contrast, ICT adoption describes the actual process of integrating ICT tools and practices into business operations, ranging from basic computerization and internet use to advanced applications that enhance efficiency, productivity, and competitiveness [5], [9]. While ICT adoption captures the outcomes of digital integration, e-readiness focuses on the prerequisites that enable

enterprises to adopt ICT in the first place. Thus, understanding the e-readiness of micro-enterprises is essential for identifying barriers and designing interventions that facilitate successful ICT adoption. Therefore, before discussing the adoption of ICT among MEs, it is essential to focus on their readiness first.

E-readiness assessments are widely recognized as important tools for guiding ICT development, diagnosing challenges, and supporting digital transformation strategies. As mentioned in [13]–[15], a number of e-readiness assessments frameworks have been existed, such as the McConnell International (MI) Ready? Net.Go tool, Networked Readiness Index (NRM) by the World Economic Forum, and Technological Achievement Index (TAI) developed by the United Nations Development Program. However these models are generally used to assess e-readiness from a macro perspective or national level e-readiness measurement, and may not necessarily fit for micro level (sectors, enterprises, organizations level) assessments [10],[16]. Furthermore, findings from research [17] show that at the enterprise level of assessment, one model cannot fit all enterprise sizes. Due to substantial differences in characteristics between large, small, and medium enterprises, factors that influence e-readiness for these groups of enterprises also differ. Besides those mentioned previously, there are also many assessment frameworks or models proposed in previous research, like in [11], [18]–[21]. However, many of these proposed models were remained conceptual as they have not been empirically tested and validated on a number of samples of real enterprises, especially micro level enterprises. Therefore, based on those gaps, this paper aims to propose a conceptual model of e-readiness assessment designed specifically within the context of micro enterprises and examine the model by assessing e-readiness of MEs in a specific region of Indonesia.

Three new works on digital transformation have been added to the Indonesian regional literature by this research. First, e-readiness is assessed from a micro viewpoint in this study, while majority of the literature looks at e-readiness from a broader angle, such as studies by [10], [22], and [23]. Second, this study seeks to contribute to the growing body of knowledge on ICT adoption in the context of MEs by providing a nuanced understanding of e-readiness by offering both a theoretical foundation and practical insights. The proposed model integrates insights from existing literature, such as [11], [18], [20], [21], [23], [24]. Practically, this study shows how the theoretical framework can be used to assess e-readiness, identify gaps, and propose actionable strategies to increase ICT adoption among MEs. This study implements the framework on MEs in Batu City, East Java Province. Located inside the Greater Malang economic agglomeration, Batu City has emerged as one of Indonesia's most advanced tourism destinations. For the surrounding area, Batu City can serve as a positive model for the e-business diffusion. Third, this study uses primary data and significant data coverage, namely, 641 samples of households that own or manage food and beverage. Previous studies used smaller samples, such as studies [20] and [21].

MATERIAL AND METHODS

A. Proposed E-Readiness Assessment Model

Various e-readiness frameworks have been developed at both macro and organizational levels. At the macro level, global institutions have introduced models such as the Knowledge Assessment Methodology (KAM) developed by World Bank, Technology Achievement Index developed by the United Nations Development Program, or E-Business Readiness Ranking developed by IBM-EIU as discussed in [13]–[15]. While these models offer broad indicators like connectivity, regulation, and education, they are not designed for organization-level diagnostics, especially for MEs with distinct challenges such as limited funding, minimum IT infrastructurs, and low digital awareness.

For enterprises or organizations level e-readiness assessment, previous studies have proposed several models. One of the most widely referenced is the Technology Organization Environment (TOE) Framework. The framework is widely used to analyze the adoption of technological innovations within organizations, considering three contexts: technological, organizational, and environmental. The TOE framework has been used in various studies for e-readiness assessment, for example in [23], [24], and [25]. Extended from the TOE Framework, The STOPE framework covers additional two domains: Strategy and People. Research by [26] and [27] has previously used STOPE Framework for readiness assessment. Combining both internal and external perspective, TOE and STOPE are often praised for its balanced scope, but assume that organizations have formalized structures, which may not reflect the informal and home-based nature of most micro-enterprises.

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Another assessment model often used for micro level is Mutula-Brakel Integrated Information Rich E-readiness Assessment Tool [11][15]. The model aims to address the gap in earlier e-readiness assessments by emphasizing the importance of information access, which is often treated as a subset under the ICT dimension. In addition to the Mutula-Brakel framework, the Organizational E-readiness Assessment (OERA) framework was proposed by Hanafizadeh [28]. The OERA framework integrates multiple dimensions including technological infrastructure, human resources, application usage, and the external support environment. The Mutula-Brakel and OERA frameworks are conceptually rich as they were developed from a thorough literature review process. Both frameworks are detailed, providing measurement indicator information for each dimension, a feature rarely found in other frameworks. However, empirical applications of both frameworks remain scarce as limited research has reported its application in a real-world case study.

Besides the four models mentioned earlier, many other models have been proposed in other research. Previous studies related to e-readiness assessment generally proposed their own assessment models, depending on the needs of the case studies being measured. To synthesize, a summary is presented in Table 1 which highlights the most frequently identified dimensions across the models. As presented in Table 1, the most frequently identified domains or dimensions can be categorized into four key areas: Technology, Organizational, Environmental, and Human Resources. Technology Dimension focuses on assessing ICT infrastructure, including factors such as internet access, bandwidth, and network speed. Organizational encompasses Enterprise Readiness, Organization, and Strategy, which collectively evaluate an organization's preparedness for technology adoption. This includes aspects such as organizational structure, innovation levels, costs and policies that facilitate technology use, and challenges faced in technology adoption. Environmental examines the external factors that either promote or hinder e-business adoption, such as government regulations and economic infrastructure. Finally, the last domain or dimension highlights the competencies of human resources within an enterprise or organization in implementing and utilizing technology, such as skills, education, and training, that influence the effective use of ICT.

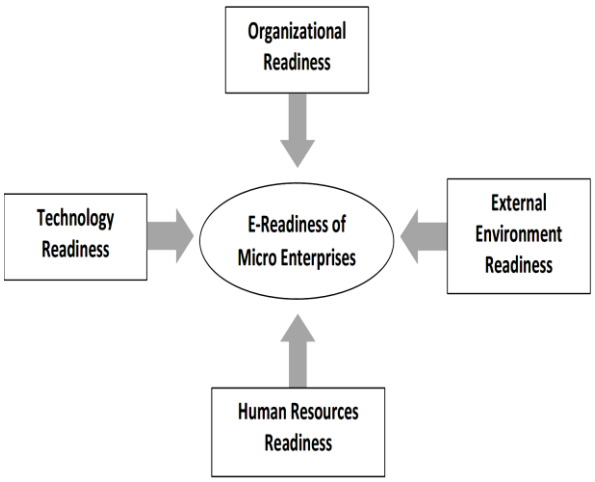
Table 1. Dimensions of E-Readiness Assessment and Proposed Measurement Indicators.

Dimension	Reference	Description	Proposed Measurement Indicators
Technology	[11], [18], [20], [23], [24]	Dimension that measures the availability of ICT infrastructure and the readiness of the enterprise to implement ICT infrastructure to improve business performance.	(T1) Internet access speed (T2) Number of digital devices owned (T3) Number of communication software used (T4) Condition of ICT infrastructure owned (T5) Technology use in recording business/financial transactions (T6) Technology use in payments (T7) Technology use in bills and invoices (T8) Technology use in promotion (T9) Technology use in sales (T10) Technology use in procurement of business unit needs (T11) Technology use in human resource management (T12) Technology use in budget planning for production activities
Organizational	[11], [18], [20], [21], [23], [24]	This dimension measures the readiness of the business unit from the perspective of management and organizational strategy in utilizing ICT	(O1) Strategy for information management capacity-building through learning and training in ICT utilization (O2) Strategy for information management capacity-building utilizing historical data (O3) Data security and confidentiality strategy to support electronic transactions (O4) Risk acceptance in business process changes (O5) Support for innovation in business processes (O6) Consumer protection policy strategy in electronic transactions (O7) Backup and recovery strategy
External Environment	[18], [23], [24]	Dimension related to the external environment outside the enterprise that drives or hinders e-business adoption, such	(EE1) Affordability of the cost to implement ICT (EE2) Financial aid from the government and banks (EE3) Accessibility of internet service providers (EE4) Environmental motivation (EE5) Sufficiency of electricity supply

		as government policies and customer demand.	(EE6) Number of customers or potential customers using ICT (EE7) Number of suppliers using ICT in their business transactions
Human Resources	[11], [18], [20], [23], [24]	This dimension provides an overview of the individual capabilities within the business unit in utilizing ICT, such as searching, accessing, managing, analyzing, and using information.	(HR1) Proportion of ICT workforce (HR2) Understanding of information-related laws (HR3) Ability to organize information (HR4) Ability to search, filter, and use information (HR5) Understanding of the benefits of well-organized and well-managed information in digital archives (HR6) Attitude toward the use of ICT for business transactions (HR7) Level of awareness about the benefits of ICT

Source: (Research Results, 2024)

This study acknowledges the conceptual contributions of the existing frameworks. Therefore, this study proposes a model that combines the core dimensions from the existing frameworks to integrates their core strengths while addressing their limitations. Based on the synthesis on Table 1, four core dimensions are identified as most relevant for micro-enterprise digital readiness. Hence, this study proposes a model to evaluate the e-readiness of micro-enterprises which consists of four readiness dimensions: Technology Readiness, Organizational Readiness, External Environment Readiness, and Human Resources Readiness, as illustrated in Fig. 1.



Source: (Research Results, 2024)
Figure 1 Proposed E-Readiness Assessment Model for Micro Enterprises.

However, the specific measurement indicators within each dimension were not directly adopted from prior models. Instead, this study proposed carefully tailored measurement indicators to reflect the unique characteristics and barriers faced by micro enterprises, as supported by empirical findings from previous studies on ICT adoption among SMEs. As studies in SMEs have shown, such as [4]–[7], [9], common barriers include financial constraints, limited infrastructure access, low exposure to digital tools, and resistance due to demographic factors, or inadequate training or support. Thus, while the structural foundation draws from established frameworks, the indicator-level adaptation ensures contextual relevance and practical applicability for evaluating e-readiness in micro-enterprises. The relationship between each domain and its corresponding measurement indicators is detailed in Table 1.

B. Application of the E-Readiness Assessment Model

To evaluate the proposed research model, e-readiness assessment was conducted by collecting data from several micro-enterprises operating in Batu City, East Java Province, Indonesia. In Indonesia, various regulations define MSMEs, as established by the Ministry of Cooperatives and MSMEs, National Statistical Office, and the Ministry of Finance. Each regulation classifies MSMEs differently, using criteria such as net assets, annual revenue, or the number of employees. This study adopts the definition provided by National Statistical Office, which identifies an industrial enterprise as a micro-enterprise if it employs 1–4 individuals. Additionally, the study focuses exclusively on micro-enterprises within the food and beverage sector.

The sampling process employed a two-stage approach known as Two-Stage Sampling. During the first stage, specific sample areas or census blocks within Batu City were selected using the Probability Proportional to Size with Replacement (PPS WR) method. The measure of size (MoS) for this process was based on the number of micro-enterprises recorded in the 2016 Economic Census for each census block. This method ensured that census blocks with a higher concentration of micro-enterprises had a proportionally higher likelihood of being included in the sample. Out of 623 census

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blocks identified in Batu City, 150 were selected for this study.

In the second stage, every household within the 150 sampled census blocks was then visited individually. Households with members who owned or managed micro-enterprises in the food and beverage sector were identified as potential candidates for further sampling. From this pool, systematic sampling, a method where population elements are selected at regular intervals, was used to finalize the sample.

This process resulted in the selection of 641 households. Direct interviews were conducted with the micro-enterprise owners or managers from these households using Computer-Assisted Personal Interviewing (CAPI) technology. Data collection was completed over a ten-day period, from January 23 to February 3, 2024. All respondents participated voluntarily in the study and provided informed consent prior to data collection. They were clearly informed about the purpose of the research, the nature of the questions, their right to withdraw at any time, and the assurance of data confidentiality. Personal identifiers were removed or anonymized during the data processing and analysis stages.

C. Data Analysis Method

To verify the structural validity of the proposed research model, a factor analysis approach was employed to examine the relationships among indicators within each dimension, using 641 data of food and beverage micro-enterprises from Batu City, East Java Province, Indonesia. Factor analysis assumes that the indicators within a given dimension are sufficiently correlated and share common variance, allowing them to be grouped under a single latent construct. All indicators listed in Table 1 were first grouped into their respective dimensions: Technology, Organizational, External Environment, and Human Resources. After that, several statistical tests were conducted as prerequisites for performing factor analysis, including Bartlett's Test of Sphericity, the Kaiser-Meyer-Olkin (KMO) statistic, and the Measure of Sampling Adequacy (MSA).

The Bartlett's Test of Sphericity were applied to evaluate the the correlation among indicators. Since the data consist of ordinal and mixed types, polychoric and polyserial correlation approaches were used to achieve more accurate results. This step was then followed by checking the sample adequacy using the Kaiser-Mayer-Olkin (KMO) statistic and Measure of Sampling Adequacy (MSA). The threshold value for KMO MSA used was 0.5. If the KMO MSA for an indicator was less than 0.5, that indicator would be removed from the relevant dimension [29].

After all these checking steps were completed, further factor analysis was conducted. Factor extraction was performed based on the eigenvalues. Factors or dimensions were retained if their eigenvalues were greater than 1 [29]. The factor rotation method used was Varimax, as it was assumed that each indicator should load exclusively on a single factor, allowing for a clearer and more interpretable factor structure. In addition, the factor loadings of each indicator were examined to determine how strongly each item was associated with the underlying factor.

The communalities were also assessed to evaluate how much of each item's variance was explained by the extracted factors. The threshold used for communality values was 0.20, following [29]. Therefore, any indicator with a communality value below 0.20 was eliminated from the model, as it indicated a weak contribution to the factor structure. This elimination process ensured that the retained indicators had sufficient shared variance with other items within the same dimension and contributed meaningfully to the overall factor model.

Based on the factor structure established, this study proceeded to construct a composite index called the E-Readiness Index. This index aims to quantify the level of e- readiness among micro food and beverage enterprises operating in Batu City, East Java Province, Indonesia. The E-Readiness Index was developed by aggregating the scores of indicators that were grouped under each dimension. Each dimension score was computed using a weighted aggregation method, where indicator weights were derived from their respective factor loadings. This approach ensures that indicators with stronger associations to their dimensions contribute more significantly to the final index.

The aggregated scores were normalized using the min-max method to produce a standardized E-Readiness Index for each enterprise, enabling comparability across districts and dimensions. To obtain the E-Readiness score at the district level or for Batu City as a whole, the index values of individual micro enterprises were aggregated by calculating the average E-Readiness Index within each district or across the entire city. The following steps summarize the index construction process:

1. Perform factor analysis to identify valid factors and indicators
2. Retain only indicators with:
   i. KMO-MSA value > 0.50
   ii. Communality ≥ 0.20
3. Retain only factors with eigenvalues > 1
4. For each dimension:
   i. Multiply each indicator score by its loading weight
   ii. Sum the weighted scores to compute the dimension score
5. Normalize each dimension score using the min-max method so that each dimension has ranges from 0 to 100:

$$\text{NormalizedScore} = \frac{(\text{Score} - \text{Min})}{(\text{Max} - \text{Min})} x\ 100$$

6. Aggregate normalized scores across dimensions to form the E-Readiness Index for beach enterprise
7. To obtain district-level E-Readiness: Compute the average E-Readiness Index of all enterprises in that district
8. To obtain city-level E-Readiness: Compute the average E-Readiness Index across all enterprises in Batu City

Once the E-Readiness Index has been calculated for each dimension and for the overall composite index, the results can be interpreted by classifying them into three readiness levels: "Not Ready", "Moderately Ready", and "Ready". As presented in Table 2, the classification criteria are defined using three unequal-interval categories based on the Village Development Index issued by Indonesia National Statistical Office.

Table 2. Readiness Level Classification based on E-Readiness Index Score

Range	Readiness Level
0 ≤ Index ≤ 50	Not Ready
51 ≤ Index ≤ 75	Moderately Ready
76 ≤ Index ≤ 100	Ready

Source: (Research Results, 2024)

RESULTS AND DISCUSSION

A. Statistical Analysis of Proposed Model

Ensuring that each proposed item accurately represents its intended dimension in the research model, factor analysis was conducted using the 641-record data of micro food and beverage (F&B) enterprises in Batu City to statistically examine the structure and interrelationships among indicators. The fundamental basis of factor analysis is the presence of correlation among indicators. If the indicators within the same dimension have weak correlations, then they are not suitable to be grouped under the same dimension. Therefore, to ensure that each group of indicators is interrelated and suitable for further analysis, we conducted Bartlett's Test of Sphericity on the four main dimensions: Technology, Organizational, External Environment, and Human Resources. The test results in Table 3 showed that all dimensions had a significance value (p-value) of 0.0000, indicating a highly significant result. In other words, the indicators within each dimension in the proposed research model are indeed interrelated and not independent of one another.

Table 3. Result of Bartlett's Test of Sphericity

Dimension	Test Statistic	Degrees of Freedom	P-Value
Technology	3613,7730	45	0,0000
Organizational	1592,3670	21	0,0000
External Environment	323,1882	10	0,0000
Human Resources	2111,1190	15	0,0000
Technology	3613,7730	45	0,0000

Source: (Research Results, 2024)

In addition, the Kaiser-Meyer-Olkin (KMO) and Measure of Sampling Adequacy (MSA) values were assessed to determine whether the indicators within each dimension have a sufficient level of common variance, indicating their appropriateness for combined analysis within the same dimension. The minimum acceptable KMO and MSA value for factor analysis is 0.50. Higher KMO and MSA values indicate better common variance and stronger suitability for factor analysis. The results, in Table 4, show that all dimensions have KMO values with the following details: Technology (0.86), Organizational (0.80), External Environment (0.64), and Human Resources (0.85). These values suggest that the indicators within the same dimension measure the same underlying construct and are suitable to be analyzed together within the same dimension. Additionally, the Measure of Sampling Adequacy (MSA) for individual indicators in all dimensions yielded values ≥ 0.5, indicating that all indicators are appropriate to retain. The highest MSA scores were found in the Technology and Human Resources dimensions (e.g., 0.93), demonstrating strong contributions to the factor structure.

The Bartlett's Test of Sphericity and the KMO and MSA results confirm that the dataset meets the criteria for conducting further factor analysis. An exploratory factor analysis (EFA) was conducted using a fixed number of factors based on the theoretical model: Technology, Organizational, External Environment, and Human Resources. The number of factors was determined using the

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eigenvalue > 1 criterion and supported by scree plot observations. The results show that the indicators within the Technology, Organizational, and Human Resources dimensions each loaded strongly onto a single factor, confirming the internal coherence and conceptual integrity of these dimensions as initially proposed in the research model. The Technology dimension extracted a dominant factor with an eigenvalue of 5.19, explaining 47% of the total variance. Indicators such as digital payment adoption (loading = 0.85) and digital sales (0.81) showed strong contributions. The Organizational dimension formed one major factor (eigenvalue = 3.50), explaining 42% of the variance. Items like support for business innovation (0.74) and data security strategy (0.64) had substantial loadings. The Human Resources dimension extracted a strong single factor (eigenvalue = 3.71), explaining 55% of the variance. Indicators such as ability to organize information (0.90) and use of information (0.89) showed high coherence.

Table 4. Kaiser-Meyer-Olkin (KMO) and Measure of Sampling Adequacy (MSA) Values

Dimension	Indicators	MSA
Technology	T3	0,0645833
(KMO = 0.86)	T4	0,0625
	T5	0,0569444
	T6	0,0583333
	T7	0,0590278
	T8	0,0618056
	T9	0,0611111
	T10	0,0645833
	T11	0,0638889
	T12	0,0569444
Human Resources	HR2	0,0638889
(KMO = 0.85)	HR3	0,0534722
	HR4	0,0541667
	HR5	0,0638889
	HR6	0,0645833
	HR7	0,0645833
Organizational	O1	0,0541667
(KMO = 0.80)	O2	0,0506944
	O3	0,0583333
	O4	0,0541667
	O5	0,0555556
	O6	0,0604167
	O7	0,0576389
External Environment	EE3	0,0444444
(KMO = 0.64)	EE4	0,0486111
	EE5	00.59
	EE6	0,0444444
	EE7	0,0430556

Source: (Research Results, 2024)

Interestingly, the indicators originally grouped under the External Environment dimension were split into two separate factors during the EFA process, suggesting distinct subthemes within the construct. The External Environment dimension produced two factors (eigenvalues = 1.87 and 1.15) accounting for a total of 34% of the variance. However, for the purpose of index construction, the External Environment dimension was retained as a single composite factor. This decision was based on the consideration that splitting the dimension into two would result in subdimensions with too few indicators, making them statistically imbalanced and conceptually less comparable to the other dimensions in the model. This aligns with the original framework of Mutula-Brakel, who suggested that environmental enablers for ICT use often overlap and are context-dependent.

During the factor analysis process, communalities were examined to assess how well each indicator was explained by the extracted factors. Communality values represent the proportion of variance in each item that is accounted for by the factors. Indicators with low communalities (below 0.20) were considered for elimination, as they contribute little to the overall factor structure. As a result, several indicators from the proposed research model were removed due to their insufficient communalities, including (T1) Internet access speed, (T2) Number of digital devices owned, (EE1) Affordability of the cost to implement ICT, (EE2) Financial aid from the government and banks, and (HR1) Proportion of ICT workforce. Their exclusion does not necessarily invalidate their importance; rather, as discussed by [13], contextual variability and uneven development of digital infrastructure in developing countries can reduce the statistical strength of otherwise relevant variables. The retained indicators were then used to calculate the E-Readiness Index using a weighted aggregation method, followed by normalization through the min-max approach.

B. E-Readiness of Micro F&B Enterprises in Batu City

With the factor structure confirmed and the final set of indicators established, the study proceeded to calculate the E-Readiness Index for each enterprise of micro F&B in Batu City. Before presenting the results of the e-readiness assessment, it is essential to first describe the demographic characteristics of the respondents. A total of 641 micro (F&B) enterprises in Batu City participated in the survey. Most of the enterprises were located in Batu District (67.6%), followed by Junrejo (20.1%) and Bumiaji (12.3%). Most enterprises operated within residential buildings, which suggests the home-based nature of many micro businesses in this sector. Each enterprise was represented by either the business owner or the manager as the respondent. As summarized in Table

5, the respondents exhibit a diverse demographic profile.

Table 5 Demographic Profile of Respondents

Characteristics	%
Gender	
Male	37.44
Female	62.56
Age	
Youth (15-24 tahun)	3.90
Early Working Age (25-34 tahun)	17.78
Mid Working Age (35-44 tahun)	26.05
Pre-Retirement Age (45-54 tahun)	28.08
Retirement Age (55-64 tahun)	18.10
Older Adults (> 64 tahun)	6.08
Education	
Less than Primary Education	4.21
Primary Education	23.87
Secondary Education	62.09
Tertiary Education	9.83

Source: (Research Results, 2024)

The gender distribution shows a predominance of female respondents (62.56%) compared to male respondents (37.44%), highlighting the significant role of women in the micro-enterprise F&B sector in the region. In terms of age, the majority of respondents were in the pre-retirement age group (45–54 years), accounting for 28.08%, followed by those aged 35–44 (26.05%) and 25–34 (17.78%). Only 3.90% of the respondents were from the youngest age group (15–24 years), indicating that most micro-enterprise actors are older and possibly more experienced, though potentially less digitally native. Regarding educational attainment, most respondents had completed secondary education (62.09%), while 23.87% had only completed primary school. A smaller proportion held tertiary qualifications (9.83%), and 4.20% had not completed primary education. This distribution reflects a relatively moderate educational profile among micro-enterprise operators, which may have implications for their e-readiness and training needs. Understanding the demographic profile of the respondents provides valuable context for interpreting their readiness levels.

Following this, a statistical validation was conducted to ensure that the proposed model appropriately reflects the structure of the underlying constructs. Table 6 presents the E-Readiness Index scores across the four dimensions for each of the three districts in Batu City, as well as the overall city average. The overall average for Batu City was 46.47, which indicates that the average E-Readiness Index across all micro F&B enterprises in Batu City places within the "Not Ready" category. A more detailed examination of the individual enterprise scores shows that 57.10% of enterprises were categorized as "Not Ready", 38.85% as "Moderately Ready", and only 4.05% as "Ready". Among the districts, Batu District shows the highest readiness level with the E-Readiness Index score of 47.18, followed by Junrejo (45.19) and Bumiaji (45.02), which may be attributed to geographical disparities across districts.

Table 6. E-Readiness Index Scores based on Dimensions and Districts.

	Technology	Organizational	External Environment	Human Resources	E-Readiness
Batu District	25.33	58.52	47.53	57.34	**47.18**
Bumiaji District	21.94	56.01	42.09	60.05	**45.02**
Junrejo District	22.67	57.05	44.75	56.29	**45.19**
Batu City	**24.32**	**57.88**	**46.23**	**57.47**	**46.47**

Source: (Research Results, 2024)

Looking at each dimension, the Organizational and Human Resources dimensions showed higher levels of readiness compared to the others, with average scores of 57.88 and 57.47 respectively. In contrast, the Technology dimension consistently had the lowest scores in all districts, with an average of only 24.32**,** suggesting that access to or use of technology remains a key limitation among micro enterprises. This result indicates that most micro F&B enterprises had good internal motivation and basic skills to use technology but struggle to face ongoing challenges related to digital infrastructure and technology use. This echoes insights from [12] that organizational readiness often precedes technological capability in small firm. These issues are commonly encountered among micro and small enterprises in developing regions, consistent with findings by [5] and [9] who noted that ICT adoption in SMEs is often constrained by limited financial resources, low digital awareness, and resistance to technological change.

The consistently low performance of the Technology dimension, which scored the lowest among all dimensions, is supported by the respondents' mean scores. Most indicators in this dimension received average ratings between 1.1 and 1.7 on a 1–4 scale, particularly those related to

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technology use in daily operations, such as business/financial transactions (T5), bills and inovices (T7), human resource management (T11), and budget planning (T12). These results indicate that many micro-enterprises have not yet adopted basic digital practices. The low average scores align with the demographic profile of respondents. More than 60% of respondents completed only secondary education and fewer than 10% held tertiary qualifications, implying digital literacy barriers that hinder effective technology use as technology-related dimensions that require a minimum level of digital literacy. Limited formal education can hinder the ability to understand and utilize digital tools effectively, particularly in areas such as digital transactions, data security, and online marketing. In addition, the majority of business owners or managers were female (62.56%) and over 70% were aged 35 and above. This demographic context may also influence how digital tools are accessed and adopted and influence the e-readiness outcomes. Digital adoption efforts may face generational barriers as older entrepreneurs may be less familiar or comfortable with adopting new technologies. This argument is supported by [5], who found that ICT adoption patterns among SMEs vary significantly based on age, education, and prior digital exposure.

C. Practical Implications for Batu City

From a policy perspective, the proposed e-readiness assessment model can help governments or policymakers identify which dimensions of digital readiness require the most urgent attention. In the case of Batu City, the Organizational and Human Resources dimensions showed relatively high scores compared to other dimensions, suggesting the existence of basic managerial willingness and internal awareness to adopt digital solutions. However, the Technology dimension consistently showed the lowest levels of readiness. The combination of infrastructure limitations, cost barriers, and skill gaps explains the overall low Technology readiness score.

Given the demographic and readiness profile of micro F&B enterprises in Batu City, policy responses should prioritize efforts on inclusive, localized, and capacity-oriented interventions. With over 62% of the entrepreneurs being women and the majority aged 35 and above, digital literacy initiatives should be tailored to these demographic groups. Government agencies such as the Department of Communication and Informatics (Diskominfo) and the Cooperative and SME Office can collaborate with community institutions like Family Welfare and Empowerment (PKK) and women's business associations to organize hands-on workshops delivered in community centers. These trainings should focus on practical, application-based topics, such as digital payments, inventory management, and online marketing, using mobile devices.

Given that many businesses are home-based, universities (e.g., Politeknik Statistika STIS or local campuses in Malang) can mobilize student volunteers to provide in-home technical mentoring, helping business owners adopt digital tools suited to their daily operations. Since most respondents completed only secondary education and have limited digital exposure, peer-to-peer learning models may be more effective than formal training. Establishing local "Digital Champions" (successful entrepreneurs who already use ICT tools) could foster peer mentoring within business clusters. Phased improvement approach aligns with the recommendation by [9] and [12], who emphasized that levels of digital readiness and maturity lie on a continuum and require tiered interventions.

In parallel, infrastructure improvement remains essential, particularly in districts like Bumiaji and Junrejo where e-readiness scores were lower. Partnerships between local government and telecom providers could expand affordable internet access through public Wi-Fi points or subsidized packages. Finally, because Batu District showed higher readiness compared to the other two districts, policies should be geographically differentiated: Batu can pilot advanced interventions, while Junrejo and Bumiaji may benefit more from foundational support in infrastructure and literacy. These area-specific strategies allow local authorities to more effectively allocate resources and ensure inclusive digital progress across the region.

D. Strengths and Limitations of the Proposed Model

The results of this study generally support the proposed research model consisting of four dimensions: Technology, Organizational, External Environment, and Human Resources. Overall, the proposed e-readiness assessment model performed well and met the necessary statistical criteria. The factor analysis confirmed the validity of the four-dimensional structure, with most indicators aligning well with their intended dimensions. Most indicators showing strong factor loadings and acceptable communalities. The KMO and Bartlett's tests further confirmed that the data was suitable for factor analysis, strengthening the reliability of the model. Compared to earlier e-readiness frameworks that focused mostly on large firms or national assessments, as discussed in [13], [15], or ended up as a conceptual proposal like in [11], [18],

[30], this model fills an important gap by offering a practical and scalable tool for assessing E-Readiness at the micro-enterprise level. This model also contributes to the literature by emphasizing that digital transformation is not only about infrastructure, but also about capacity, support systems, and skills.

The model also facilitated comparisons across geographic areas. In the case of Batu City, among Batu, Junrejo, and Bumiaji districts, Batu District recorded the highest E-Readiness score, which may be attributed to better infrastructure, higher exposure to digital initiatives, and proximity to urban services. Such comparisons can reveal gaps in ICT infrastructure and help identify geographic areas that need to be prioritized for intervention, such as internet access improvement or infrastructure investment in districts with the lowest technological readiness.

However, some limitations were also observed. The External Environment dimension produced two distinct factors, suggesting that the indicators may reflect different aspects rather than one unified concept. This aligns with the original version of Mutula-Brakel framework, which being noted that "external environment" variables are often multidimensional, encompassing both infrastructural enablers (e.g., internet access, electricity) and market-related readiness (e.g., digital behavior of customers and suppliers). Although this dimension was treated as a single construct in this study, mainly to keep the number of indicators balanced across dimensions, this finding suggests the potential need to reconceptualize the External Environment.

For better clarity, future studies may need to refine or separate this dimension into two separate constructs: Infrastructure Readiness, which includes access to internet providers and electricity, and Market Readiness, which relates to ICT use of customers and suppliers. In addition, five indicators were removed due to low communality values, indicating that some of the original items were not strong enough to represent their intended constructs. Moving forward, future research should consider expanding the range of indicators to enhance the comprehensiveness and applicability of the model.

As the model has a clear structure and has been tested statistically, it can be adapted and applied in other geographic or sectoral contexts. The four dimensions are general enough to apply in many contexts, yet flexible enough to allow indicator adjustment based on local conditions. As this research was conducted only on micro-enterprises in the F&B sector in Batu City, the model may not be generalizable to other sectors or regions with different infrastructure, economic, and policy conditions. Nevertheless, any future application of this model in different regions should be preceded by statistical validation to ensure construct relevance and indicator suitability within the new context. When adapted properly, this model serves as a helpful tool for understanding E-Readiness and for guiding practical efforts to support ICT adoption among micro enterprises more broadly.

CONCLUSION

This study proposed and validated a four-dimensional model to assess the E-Readiness of micro enterprises. This study also proposed tailored measurement indicators to reflect the unique characteristics of micro enterprises. Using data collected from micro food and beverage (F&B) enterprises in Batu City, Indonesia, the model was validated through exploratory factor analysis and used to construct the E-Readiness Index. Using exploratory factor analysis, the model demonstrated good construct validity, with most indicators loading strongly onto their respective dimensions. Although some indicators were excluded due to low communalities and one dimension (External Environment) showed signs of multidimensionality, the overall structure performed well statistically. Beyond confirming the validity of the proposed e-readiness model, this study demonstrates its usefulness in producing detailed and meaningful assessments of E-Readiness among micro enterprises. The proposed research model was successfully applied to evaluate the level of E-Readiness among micro F&B enterprises in Batu City. The resulting E-Readiness Index revealed that most micro enterprises in Batu City are not yet fully prepared to adopt digital technologies. The Technology dimension received the lowest scores, while Organizational and Human Resources dimensions showed relatively higher readiness. This indicates that while internal motivation and basic skills are present, infrastructural and external support limitations remain critical challenges.

By structuring readiness into four dimensions, the model enables a multidimensional analysis that helps policymakers break down the strengths and weaknesses of ICT adoption in a more meaningful way. The model also enables policymakers to assess readiness levels across districts, identify specific gaps, and tailor interventions accordingly, whether through digital infrastructure development,

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training, or financial assistance. Given its structure and flexibility, the model can be adapted for use in other sectors or regions, provided that context-specific validation is conducted. While this study provides a validated framework for assessing e-readiness among micro-enterprises, several opportunities for further research remain. This study was limited to micro F&B enterprises in one city, which may affect the generalizability of the results. Additionally, since this research represents the initial empirical validation of a newly proposed model, further validation using Confirmatory Factor Analysis (CFA) or Structural Equation Modeling (SEM) is recommended to test the model's fit and to strengthen the model's validity and reliability in other contexts. Future studies may also consider expanding the set of indicators to capture emerging aspects of e-readiness. A mixed-methods approach could be adopted to capture contextual factors, such as social norms, cultural attitudes, and local policies, that may influence e-readiness.

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