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Strategic Leadership and Organizational Agility of Micro Start-Up Enterprises in Region XII Towards Industry 4.0 Readiness

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ABSTRACT: This study assessed the Industry 4.0 preparedness of micro start-up enterprises in Region XII (SOCCSKSARGEN) with a focus on strategic leadership and organizational agility. Based on Strategic Leadership Theory, Dynamic Capabilities Theory and the Industry 4.0 Readiness Model, the study investigated organizational capabilities that enable firms to respond to technological and market changes. The study employed a quantitative descriptive-correlational research design involving micro start-up enterprises in the region. The respondents were owners, co-founders or managers and data was collected through structured questionnaires. The levels of strategic leadership, organizational agility and Industry 4.0 readiness were determined through descriptive statistics, tests of significant differences and multiple regression analysis to examine the predictive contribution of the organizational variables. The results showed that strategic leadership and organizational agility were Highly Practiced, and Industry 4.0 readiness was Moderately Ready. Environmental Scanning was relatively a lower dimension of strategic leadership while flexibility and operational speed was relatively a lower dimension of organizational agility. Least mature dimension of Industry 4.0 readiness was Data-Driven Decision Making. Regression analysis showed that organizational agility significantly predicted Industry 4.0 readiness, but strategic leadership did not make a significant unique contribution when both variables were considered simultaneously. Based on these findings, the Strategic Agility and Industry 4.0 Readiness Enhancement (SAIRE) Framework was proposed to strengthen environmental scanning, leadership capability, organizational flexibility, operational speed, digital transformation and data-driven decision making, thus improving competitiveness, innovation, resilience and sustainable development.

KEYWORDS: Industry 4.0 readiness, strategic leadership, organizational agility, micro start-up enterprises, SAIRE Framework

I. INTRODUCTION

Digital technologies have developed rapidly and have brought about major changes in how organizations operate, compete and expand in today's market. The researcher, an academic and program head working directly with would-be entrepreneurs, saw that micro start-ups, small early-stage enterprises that had little funding and people, no longer competed primarily on new products or services. But their existence and expansion were increasingly dependent on the extent of their adaptation to rapid technological innovations. Many smaller start-ups have knowledge about digitalization, but there was a clear gap between knowledge and real implementation of sophisticated technologies. This gap indicated the need to explore the readiness of micro start-ups to address the expectations of Industry 4.0 in terms of their digital infrastructure readiness, technological competence, digital culture, data-driven decision-making capabilities and market-ready competence.

Within the framework of Industry 4.0, technologies like artificial intelligence (AI), big data analysis, cloud computing, and Internet of Things (IoT) have continued to revolutionize corporate operations. Recent research (2023-2025) showed these technologies improved operational efficiency, facilitated data-driven decision-making, increased market responsiveness, and boosted organizational competitiveness. Micro start-ups nonetheless often faced constraints in adoption due to low financial resources, lack of technical competence and limited access to digital infrastructure. Therefore, the larger companies profited from full-scale digital transformation, while the micro start-ups only used basic digital resources, which limited their competitiveness and scalability.

To further boost start-up development and digital transformation, the Philippine government initiated various policies and programs. Innovation was encouraged and incentives were offered for emerging companies including tiny start-ups under Republic Act No. 11337 or the Philippine Innovative Startup Act. Likewise, the Republic Act No. 8792 (E-Commerce Act) and

Republic Act No. 11032 (Ease of Doing Corporate Act) sought to streamline corporate procedures and promote digital transactions. Other agencies such as the Department of Trade and Industry (DTI) and the Department of Information and Communications Technology (DICT) also launched initiatives that focused on digitalization, innovation hubs and capacity-building for MSMEs. However, recent research (2023–2024) revealed that many micro and small firms remained in the early phases of digital adoption, particularly in terms of incorporating advanced Industry 4.0 technology into their operations.

The study aims to add to the digital transformation literature of micro companies by offering empirical insights within a regional context. The results were also expected to assist policymakers, educators and business executives in devising specific strategies to improve the resilience, competitiveness and sustainability of micro start-ups in the growing environment of Industry 4.0.

Research Question

This study sought to determine the Industry 4.0 readiness of micro start-up enterprises in Region XII, with emphasis on the role of strategic leadership and organizational agility. Specifically, it sought to answer the following research questions:

1. What was the demographic profile of micro start-up enterprise owners in Region XII in terms of:
   - 1.1 Age
   - 1.2 Sex
   - 1.3 Educational Background
2. To what extent was strategic leadership practiced among micro start-up enterprises in Region XII (SOCCSKSARGEN) in terms of:
   - 2.1 Visionary Leadership;
   - 2.2 Strategic Decision-Making;
   - 2.3 Innovation Leadership;
   - 2.4 People and Resource Management; and
   - 2.5 Environmental Scanning?
3. To what extent was organizational agility demonstrated by micro start-up enterprises in Region XII (SOCCSKSARGEN) in terms of:
   - 3.1 Responsiveness;
   - 3.2 Flexibility;
   - 3.3 Innovation Capability;
   - 3.4 Customer Adaptability; and
   - 3.5 Operational Speed?
4. To what extent were micro start-up enterprises in Region XII (SOCCSKSARGEN) ready for Industry 4.0 in terms of:
   - 4.1 Digital Infrastructure Readiness;
   - 4.2 Technological Competence;
   - 4.3 Market-Ready Competence;
   - 4.4 Digital Culture; and
   - 4.5 Data-Driven Decision Making?
5. Was there a significant difference in the readiness level of start-up enterprises for Industry 4.0 when grouped according to the demographic profile of start-up enterprise owners?
6. Do strategic leadership and organizational agility significantly predict the Industry 4.0 readiness of micro start-up enterprises in Region XII (SOCCSKSARGEN)?
7. Based on the findings of the study, what Strategic Agility and Industry 4.0 Readiness Enhancement Framework is proposed for Start-Up Enterprises?

II. SCOPE AND LIMITATION OF THE STUDY

The study aimed to determine the Industry 4.0 preparedness of micro start-up firms in Region XII (SOCCSKSARGEN) focusing on strategic leadership and organizational agility. The research studied three primary variables: strategic leadership, organizational agility and Industry 4.0 preparedness. The demographic characteristics of firm owners in relation to age, sex and educational background were also considered. Strategic leadership was measured on visionary leadership, strategic decision-making, innovative leadership, people and resource management, and environmental scanning. Organizational agility was assessed by responsiveness, flexibility, innovation capabilities, customer adaptation and operational speed. The preparation for Industry 4.0

was evaluated considering digital infrastructure readiness, technological competence, market-ready competence, digital culture and data-driven decision-making. The study adopted a quantitative descriptive-correlational design to determine group differences and predictive contributions of strategic leadership and organizational agility to Industry 4.0 preparedness.

The study covered 300 micro start-up firms in Region XII (SOCCSKSARGEN). The firms qualified for inclusion if they had been in operation for five (5) years or less which represented the early-stage phase of enterprise development. The interviews were conducted with one eligible respondent (owner, co-founder, or manager directly involved in the strategic decisions and management of the organization) from each enterprise. Employees and other stakeholders were not included as respondents. The study focused on specific sectors as highlighted in the research, such as food innovation, digital services, logistics and creative industries. The primary study instrument was a structured survey questionnaire and data were collected throughout 2025-2026 academic years.

Geographically, the study was confined only to Region XII (SOCCSKSARGEN) and did not include micro start-up firms from other regions in the Philippines. The geographical delimitation aimed to offer evidence of the Industry 4.0 preparedness in the designated geographic setting that is relevant to the situation. Thus, the study did not control for the variances in economic conditions, digital infrastructure, technical access, and entrepreneurial climate in other parts of the Philippines. Thus, the findings should be seen largely in the light of micro start-up firms in Region XII and should not be automatically extrapolated to other regions or business settings.

Also, the study was limited to strategic leadership, organizational agility, and readiness for Industry 4.0. Other factors that could affect digital transformation such as financial performance, market competition, government funding, customer satisfaction or other organizational and environmental variables were not examined. The chosen sectors were also deliberately limited to food innovation, digital services, logistics and creative industries. This delimitation was developed to ensure a focus analysis of the selected micro start-up sectors important to the study.

Some limitations should also be acknowledged. First, the study employed self-reported answers from owners, co-founders or managers, which implies that the results mirror the perceptions and appraisals of their companies by the respondents and may not completely capture the organizational practices as seen objectively. Second, the cross-sectional approach recorded the variables at a single point in time thus changes in strategic leadership, organizational agility, and Industry 4.0 preparedness over time were not addressed. Third, although the sample was comprised of 300 certified micro start-up firms, the results are still limited by the inclusion criteria, the selected industries and the geographic scope of Region XII. These constraints were considered in the interpretation of the data and the suggested Strategic Agility and Industry 4.0 Readiness Enhancement (SAIRE) Framework.

FRAMEWORK

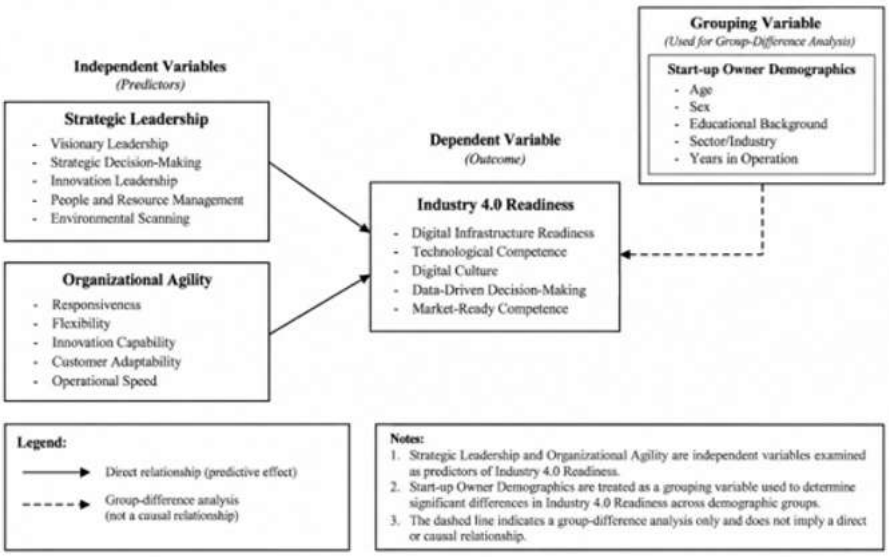


Figure 1. Conceptual Framework

The independent factors of the conceptual framework are Strategic Leadership and Organizational Agility, and the dependent variable is Industry 4.0 Readiness. Solid arrows indicate the predicted correlations analyzed by multiple regression analysis. Start-up Owner Demographics are used as grouping variables to determine whether substantial differences exist in Industry 4.0 Readiness across demographic groups. Therefore, the dashed line is representative of group-difference analysis only and does not

suggest a causative or predictive relationship. The study does not suggest or test any mediating or moderating variable. Therefore, the methodology distinguishes between the predictive analysis of Strategic Leadership and Organizational Agility and the comparative analysis of Industry 4.0 Readiness across demographic groups.

The framework is organized by the variables evaluated in the study and the statistical approaches employed to examine their correlations. Grouping variables included start-up owner demographics to test for substantial variations in Industry 4.0 preparedness. Strategic leadership and organizational agility were considered as organizational determinants of Industry 4.0 preparedness. Thus, the framework did not take into account a mediating or indirect effect of demographics. Instead, demographic parameters were tested for group differences and strategic leadership and organizational agility were tested for their predictive contribution to Industry 4.0 preparedness.

Organizational agility and strategic leadership are examined as organizational preconditions for Industry 4.0 preparedness. Visionary leadership, strategic decision-making, innovative leadership, people and resource management, and environmental scanning are the criteria used to evaluate strategic leadership. Micro start-up owners use these qualities of leadership to determine direction, make strategic decisions, encourage innovation, manage organizational resources, and keep an eye on changes in the business environment.

We measure organizational agility by responsiveness, flexibility, innovative capability, customer adaptation, and operational speed. These characteristics are the enterprise's ability to respond to change, to modify internal processes, to generate creative solutions, to adapt to client needs and to execute organizational operations efficiently. Organizational agility is considered an organizational capability that allows organizations to adjust to changing technical and market situations, in line with Dynamic Capabilities Theory.

Industry 4.0 readiness, which is measured in terms of digital infrastructure readiness, technological competence, market-ready competence, digital culture, and data-driven decision-making, is the study's outcome variable. These elements show how well tiny start-up businesses are able to integrate and utilize digital technology in terms of organizational, technological, and decision-making capabilities.

The framework thus provides two analytical linkages. Demographic variables are analyzed first to identify whether there are substantial disparities in Industry 4.0 readiness between groups of firm owners. Second, multiple regression analysis is used to explore strategic leadership and organizational agility as determinants of Industry 4.0 preparedness. The approach does not assume or test for a mediating link between the variables. Rather, it provides a framework for the analysis of variations between demographic groups and the predictive power of strategic leadership and organizational agility for Industry 4.0 readiness.

Overall, by offering a multifaceted explanation of technology adoption and organizational preparation, the combination of the TRI, TAM, and DOI Theory offers a thorough theoretical foundation for this investigation. The Technology Readiness Index (TRI), Technology Acceptance Model (TAM), and Diffusion of Innovation (DOI) Theory served as the supporting technology-adoption frameworks, while Strategic Leadership Theory, Dynamic Capabilities Theory, and the Industry 4.0 Readiness Model served as the study's primary theoretical and conceptual foundations. The choice and operationalization of study variables were influenced by these methods. As a result, the framework offered a comprehensive foundation for researching demographic differences in Industry 4.0 preparation and figuring out how organizational agility and strategic leadership predict Industry 4.0 readiness among micro start-up companies in Region XII.

Research Design

This study used a quantitative-descriptive correlational research approach to identify the links of strategic leadership, organizational agility, and industry 4.0 readiness of micro start-up firms in Region XII (SOCCSKSARGEN). The descriptive part was used to describe the demographic profile of the micro start-up firm owners in terms of age, sex and educational background. It was also used to determine the levels of strategic leadership, organizational agility and Industry 4.0 preparedness. Meanwhile, the correlational part established the degree and direction of correlations of the major factors, especially the influence of strategic leadership and organizational agility on Industry 4.0 preparedness.

This research approach was suitable as it enabled the collection of quantitative data that were statistically examined to detect trends, connections and significant predictive effects among the study variables. Furthermore, it enabled the analysis of the variances in Industry 4.0 preparedness of respondents when grouped according to their demographic profile and also the assessment of firms involved in culinary innovation, digital services, logistics, and creative industries in Region XII. To ensure objectivity, comparability and empirical validity, the study adopted this approach to determine how demographic variables, strategic leadership and organizational agility collectively predict the Industry 4.0 readiness of micro start-up firms in the regional environment.

Research Instrument

The primary data-gathering instrument of the study was a structured survey questionnaire to measure the variables of the study: demographic characteristics, strategic leadership, organizational agility, and Industry 4.0 readiness of micro start-up enterprises in Region XII (SOCCSKSARGEN). The questionnaire was developed from already validated and established instruments utilized in earlier studies. The items evaluating strategic leadership were taken from Boal and Hooijberg (2001) and Ireland and Hitt (2005) who studied leadership characteristics in dynamic situations. The concept of organizational agility was founded on the frameworks of Doz and Kosonen (2010) and Teece (2007) focusing on responsiveness, flexibility, and strategy renewal. The Industry 4.0 readiness component was adopted from the study by Schumacher, Erol, and Sihn (2016) that measured the digital transformation and technology readiness of the enterprises.

The research instruments were altered and updated to the setting of micro start-up firms while keeping the conceptual and structural integrity of the original instruments. The content validity and credibility of the modified questionnaire was established through expert judgment by three validators who are experts in their professional and academic field, namely the Dean of the Business College of New Brighton School of the Philippines, the Vise President for Finance of KCC Malls, and a Graduate School Professor under the Doctor of Business Administration (DBA) Program of Notre Dame of Dadiangas University. The validators assessed the questionnaire using the General Criteria for the Evaluation of the Questionnaire, paying special attention to the organization, clarity, relevance, appropriateness, adequacy, grammatical correctness and absence of prejudice. The overall mean rating of the questionnaire is 4.58 (Very Satisfactory) which implies that the instrument is adequate and suited for the intended respondents and research aims.

The questionnaire was validated by experts and a pilot test was undertaken to assess its reliability before the real administration of the questionnaire. The findings of the Cronbach's alpha test indicated high internal consistency for the three main constructs, namely Strategic Leadership ($\alpha = 0.957$), Organizational Agility ($\alpha = 0.939$) and Industry 4.0 Readiness ($\alpha = 0.969$). All the coefficients were over the 0.90 threshold which revealed the good internal consistency between the items under each construct. Therefore, the combination of expert validation, 4.58 overall evaluation, and excellent Cronbach's alpha values confirm the validity, reliability, and suitability of the modified instrument for the present investigation.

Data Gathering Procedure

The process of data collection in this study was done systematically and systematically to achieve the correctness, reliability and integrity of the data obtained. The researcher first received consent from competent academic authorities and permission to carry out the investigation. Also coordinated with key agencies including Department of Trade and Industry (DTI) Region XII and local business associations to promote access to micro start-up firms in the research locality.

After permission, the researcher screened and chose qualifying respondents according to the inclusion criteria. A list of possible participants was developed from public business registers, local directories and referrals within Region XII. Respondents were owners, co-founders or managers of tiny start-up firms, actively involved in making strategic choices and daily operations of the business.

Before the actual data collection, the study instrument was pilot tested on a small number of respondents with characteristics similar to the target demographic but not included in the final sample. The findings of the pilot test were utilized to modify the questionnaire and to confirm the clarity, relevance, validity and reliability of the items.

After the instrument was finalized, the survey questionnaires were administered by the researcher face-to-face. The researcher went to the designated micro start-up firms in chosen areas in Region XII and delivered printed copies of the questionnaire to the respondents. During the administration, the researcher gave the clear instruction and explanation regarding the goal of the study and the right way of filling the questionnaire. The researcher was able to use this method to resolve any problems or questions of the respondents, therefore boosting the accuracy and completeness of the responses.

Before the survey questionnaire was distributed an informed consent form was distributed to ensure that the participation was voluntary and that the respondents were fully aware of the goal of the study. The respondents were given sufficient time to fill the questionnaire and in some cases the researcher waited on site to collect the filled forms thus assisting to assure a greater response rate.

Data gathering procedure the completed questionnaires were collected after the data collection process, verified and filtered for completeness and consistency. Incomplete or incorrect replies were eliminated from analysis. The verified data was encoded, arranged and stored securely for further statistical analysis.

The researcher followed the ethical norms throughout the whole process, assuring confidentiality, anonymity and proper treatment of the data acquired. This face-to-face data collection strategy improved the quality of responses, increased participation rates and improved the dependability of data collected for the study.

To further ensure data quality, the researcher maintained uniform processes across all participating firms, and monitored the distribution and retrieval of questionnaires during the data collection period. Each completed questionnaire was reviewed against the set requirements before being allowed for encoding. The answers were sufficiently complete and adequate for further statistical analysis.

Statistical Treatment of Data

The data collected from this study were treated with appropriate descriptive and inferential statistical tools in an effort to meet the research objectives and to determine the relationships between the demographic characteristics, strategic leadership, organizational agility and Industry 4.0 readiness of the micro start-up enterprises in Region XII (SOCCSKSARGEN). The Statistical Package for the Social Sciences (SPSS) or a similar statistical software package was used to conduct the statistical analyzes to assure the correctness and reliability of the results.

The demographic profile of the respondents in terms of age, sex and educational background were summarized and described using descriptive statistics, frequency counts and percentages. These measurements indicated an overview of the distribution of the respondents across these categories.

Furthermore, the weighted mean and standard deviation were calculated to assess the extent of strategic leadership, organizational agility, and Industry 4.0 preparedness. The weighted mean was used to determine the average level of perception of the respondents while the standard deviation was used to determine the variability or the dispersion of their responses. The mean scores obtained were interpreted as per the Likert scale ranges established to categorize the levels as Not Practiced, Slightly Practiced, Moderately Practiced or Highly Practiced for strategic leadership and organizational agility and Not Ready, Slightly Ready, Moderately Ready or Highly Ready for Industry 4.0 readiness.

Inferential statistics: Appropriate statistical techniques were applied to analyze differences, to discover relationships and to test the hypotheses of the study. Analysis of Variance (ANOVA) was used to assess if there was a significant difference in the Industry 4.0 readiness of micro start-up firms based on the demographic profile of the respondents.

Regression analysis was performed to identify the significant association between strategic leadership, organizational agility and Industry 4.0 readiness and to determine the strength and the direction of the relationships among the study variables.

The extent to which strategic leadership and organizational agility predicted Industry 4.0 preparedness was determined using Multiple Linear Regression Analysis. The statistical technique was used to determine the contributions (combined and individual) of the independent variables to the dependent variable and identify which predictor variables strongly predicted the Industry 4.0 readiness of micro start-up firms.

All statistical tests were performed at the 0.05 level of significance at which level null hypotheses were accepted or rejected. The statistical techniques used in the study provided a full analysis of the data which helped in the interpretation of the findings in a legitimate, reliable and meaningful manner with regards to the aims of the research.

III. RESULTS

This chapter presents the study's findings on the strategic leadership and organizational agility of micro-start-up firms in Region XII as they approach Industry 4.0 readiness.

The findings are organized according to the specific problems of the study under the following major headings: the demographic profile of the respondents, including age, sex, and educational background; the level of strategic leadership practiced among micro start-up enterprises in terms of visionary leadership, strategic decision-making, innovation leadership, people and resource management, and environmental scanning; the level of organizational agility in terms of responsiveness, flexibility, innovation capability, customer adaptability, and operational speed; the level of Industry 4.0 readiness in terms of digital infrastructure readiness, technological competence, market-ready competence, digital culture, and data-driven decision-making; the significant differences in the level of Industry 4.0 readiness when respondents are grouped according to their demographic profile; the significant relationship among strategic leadership, organizational agility, and Industry 4.0 readiness; and the proposed Strategic Agility and Industry 4.0 Readiness Enhancement Framework for Micro Start-Up Enterprises, which is designed to strengthen leadership capabilities, enhance organizational agility, and improve digital transformation readiness among micro start-up enterprises in Region XII.

Demographic Profile of Micro Start-Up Enterprise Owners

Table 6
Age of Respondents

AGE	FREQUENCY	PERCENTAGE
20-29	128	42.7
30-39	97	32.3
40-49	57	19.0
50 and above	18	6.0
TOTAL	**300**	**100.0**

Table 6 shows the age distribution of the 300-micro start-up firm owners. The bulk of respondents were aged 20–29 years old with 128 respondents (42.7%) being in this category, followed by 30–39 years old with 97 respondents (32.3%). 57 (19.0%) respondents were in the age group of 40-49 years, while just 18 respondents (6.0%) were 50 years old and above. In general, 75.0% of the respondents were in the age group 20 to 39 years, showing that the micro start-up firms studied were mostly run by young entrepreneurs.

The large representation of respondents aged 20–29 may be related to the early-stage nature of the firms covered by the survey, which were functioning for five years or less. Younger entrepreneurs might also be more willing to participate in start-up activities due to their exposure to digital technologies, online platforms, and new business opportunities. In contrast, the comparatively low representation of respondents aged 50 and above can be attributed to the focus of the survey on newly created firms rather than reduced entrepreneurial activity among older people.

This result corroborates the literature analysis presented in Chapter 2, which shows that younger entrepreneurs tend to have more digital proficiency and a larger propensity for the adoption of emerging technologies such as e-commerce platforms, AI-enabled tools, and data-driven systems. Furthermore, the research highlights that younger micro-enterprise owners often adopt digital solutions that are cost-efficient, such mobile applications, online marketplaces, and social media analytics, to address resource restrictions and grow their market reach. DTI (2024) further highlighted that in the Philippine context, many micro start-up owners, particularly in Region XII, belong to younger age groups and are increasingly active in digital commerce and online entrepreneurship.

Overall, the age profile implies that micro start-up entrepreneurship in the study area is predominantly represented by younger business owners, whose higher exposure to digital technologies may be relevant to the study's focus on organizational agility and Industry 4.0 readiness.

Table 7
Sex of Respondents

SEX	FREQUENCY	PERCENTAGE
Male	111	37.0
Female	188	62.7
Prefer not to say	1	0.3
TOTAL	**300**	**100.0**

Table 7 presents the distribution of the 300 respondents according to sex. The results indicate that the bulk of the sample were females with 188 responses (62.7%) and males comprised 111 respondents (37.0%). Only 1 responder (0.3%) decided not to share their sex. The response pool was thus largely female, with women accounting for roughly two-thirds of the participants.

The larger presence of female responders may indicate the increasing participation of women in micro and small-scale entrepreneurship, especially in enterprises that use digital platforms and technology-enabled operations. The comparatively smaller proportion of male respondents does not necessarily suggest decreased participation in entrepreneurship, but rather the composition of the tiny start-up firms that matched the study's inclusion criteria and participated in the survey. Including a "prefer not to say" option also shows respect for the privacy and liberty of respondents in sharing demographic information.

The literature examined in Chapter 2 supports the findings, indicating that sex-diverse leadership can enhance collaboration and flexibility, both of which are crucial to strategic leadership and organizational agility. Collaboration and flexible leadership are also associated with female entrepreneurship (WEF, 2023; WIPO, 2024) and DTI (2024) notes the increasing role of women in technologically enabled micro and small firms.

In general, a higher number of female responses indicates the strong involvement of women in the micro start-up firm in Region XII. This demographic attribute is pertinent to the study as leadership behaviors, organizational adaptability, as well as technology adoption are critical elements in the understanding of Industry 4.0 preparedness.

Table 8
Educational Attainment of Respondents

EDUCATIONAL ATTAINMENT	FREQUENCY	PERCENTAGE
High School	96	32.0
Vocational	32	10.7
College	169	56.3
Master's	3	1.0
TOTAL	**300**	**100.0**

300 respondents educational attainment Table 8 The plurality, 169 respondents (56.3%), had completed college education, followed by 96 (32.0%) who had completed high school, 32 (10.7%) with vocational education, and only 3 (1.0%) with a master's degree. Thus, the responders with college education were mostly represented in the tiny start-up firms. This may mean that formal education delivers information and skills related to strategic planning, problem-solving, innovation, and the use of digital technologies.

The prevalence of college-educated respondents might also be linked to their exposure to business principles and technical innovations. This finding corresponds to the research in Chapter 2 that emphasizes the importance of educational attainment for technology adoption and digital transformation. OECD (2023) and UNCTAD (2024) stressed the importance of knowledge and skills in adopting technologies like artificial intelligence, cloud computing, and automation, while DICT (2023) and DTI (2024) emphasized the need for digital upskilling and technology-driven business development among Philippine enterprises.

The results, however, show that formal education per se is not a predictor of Industry 4.0 preparedness. Educational attainment demonstrated significant variations only in Technological Competence and Digital Culture, without significant disparities between educational levels for other preparedness aspects. Industry 4.0 preparedness, similar to TAM, Diffusion of Innovation Theory, Strategic Leadership Theory, and Dynamic skills Theory, also rely on continuous learning, experiential learning, organizational skills, and digital resource procurement.

Level of Strategic Leadership Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN)

Table 9
Level of Strategic Leadership Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN) in terms of Visionary Leadership

INDICATORS	WM	SD	INTERPRETATION
1. I communicate a clear vision for the future of the enterprise	3.47	0.62	Highly practiced
2. I set long-term goals aligned with business growth	3.41	0.69	Highly practiced
3. I ensure that the vision of the enterprise is clearly understood by employees	3.47	0.63	Highly practiced
4. I inspire employees to achieve future objectives	3.44	0.68	Highly practiced
5. I align business strategies with future opportunities	3.50	0.64	Highly practiced
Grand Mean	**3.46**	**0.65**	**Highly practiced**

Legend: 1.00-1.75 Not practiced; 1.76-2.50 Slightly practiced; 2.51-3.25 Moderately practiced; 3.26-4.00 Highly practiced

Table 9 shows the level of Strategic Leadership in terms of Visionary Leadership of micro start-up firms in Region XII. The results reveal a grand mean of 3.46 (SD = 0.65) which is regarded as Highly Practiced, indicating that respondents generally have a strong forward-looking attitude in leading their organizations toward growth and future prospects. The highest rated indication was "I align business strategies with future opportunities" (WM = 3.50). The lowest rated indicator was "I set long-term goals aligned with business growth" (WM = 3.41). However, all indicators were Highly Practiced. The small range of weighted averages (3.41-3.50) indicated consistent visionary leadership practices.

The highest ranking indicates that micro start-up owners and managers attach great importance to the alignment of current strategy with new prospects which is vital in dynamic and resource restricted business environments. In contrast, the comparatively low score for long-term goal setting may suggest that uncertainty exists for early-stage firms due to changing markets, limited resources, and shifting corporate priorities. The findings are consistent with Huang et al. (2022) who emphasized the need for innovative thinking and strategic foresight to foster organizational flexibility and digital transformation and Chen et al. (2021) who emphasized the importance of communicating the organizational vision to support digital transformation. Similarly, Boal and Hooijberg (2001) pointed out the importance that strategic leaders should possess clear vision, long-term perspective and ability to see future prospects.

Visionary Leadership was Highly Practiced among tiny start-up firms in Region XII. This showed a great capability in setting direction and aligning business strategies with future opportunities. These behaviors are aligned with Strategic Leadership Theory,

which emphasizes foresight, vision, innovation and anticipation of change, and are a key basis for organizational agility and digital transformation. Further improving long-term goal setting may also help firms to translate their forward-looking perspective into sustainable growth and better Industry 4.0 preparedness.

Table 10
Level of Strategic Leadership Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN) in terms of Strategic Decision-Making

INDICATORS	WM	SD	INTERPRETATION
1. I make decisions based on data and market analysis.	3.43	0.67	Highly practiced
2. I make timely and effective business decisions.	3.29	0.70	Highly practiced
3. I carefully evaluate risks before making decisions.	3.40	0.67	Highly practiced
4. I consider alternative solutions before taking action.	3.40	0.67	Highly practiced
5. My decisions support long-term business sustainability.	3.44	0.61	Highly practiced
Grand Mean	**3.39**	**0.66**	**Highly practiced**

Legend: 1.00-1.75 Not practiced; 1.76-2.50 Slightly practiced; 2.51-3.25 Moderately practiced; 3.26-4.00 Highly practiced

Table 10 shows the level of Strategic Leadership in terms of Strategic Decision-Making for micro start-up firms in Region XII. The findings suggest a grand mean of 3.39 (SD = 0.66) which may be regarded as Highly Practiced. This means that on average, the respondents are generally using robust procedures in making educated and sustainability-oriented business decisions. The top-rated indicator was “I make decisions based on data and market analysis” (WM = 3.44) and “My decisions support long-term business sustainability” (WM = 3.43). Meanwhile, “I make timely and effective business decisions” scored the lowest grade (WM = 3.29) despite being Highly Practiced.

The top ranking indicates entrepreneurs are concerned about the long-term sustainability and competitiveness of their firms and appreciate the relevance of data and market knowledge in making business decisions. The considerably lower ranking for timely and effective judgments may imply, by comparison, difficulties in responding quickly to business issues given limited resources, information, experience, or uncertainty. The findings are supported by Boal and Hooijberg (2001) who emphasized the value of strategic leadership for informed decision-making and navigating uncertainty. Huang et al. (2022) and Kraus et al. (2023) support the importance of strategic thinking, adaptability, information and organizational capabilities in dynamic business environments.

Micro start-up firms in Region XII practiced Strategic Decision-Making quite high. In line with the Strategic Leadership Theory, the high emphasis on sustainability, data and market analysis, risk assessment and alternative solutions denotes the entrepreneurs’ strategic orientation in managing uncertainty and seeking long-term competitiveness. However, additional improvements in the timeliness and effectiveness of implementation of decisions may improve the agility of the organization and the possibility of adaptation of firms to changing commercial and technical conditions.

Table 11
Level of Strategic Leadership Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN) in terms of Innovation Leadership

INDICATORS	WM	SD	INTERPRETATION
1. I encourage creativity and innovation within the enterprise.	3.41	0.66	Highly practiced
2. I support employees in developing new ideas.	3.27	0.77	Highly practiced
3. I promote innovation even with limited resources.	3.32	0.67	Highly practiced
4. I support experimentation and learning from failures.	3.34	0.69	Highly practiced
5. I encourage continuous improvement in operations.	3.49	0.56	Highly practiced
Grand Mean	**3.37**	**0.67**	**Highly practiced**

Legend: 1.00-1.75 Not practiced; 1.76-2.50 Slightly practiced; 2.51-3.25 Moderately practiced; 3.26-4.00 Highly practiced

Table 11 shows the Level of Strategic Leadership relative to Innovation Leadership of micro start-up firms in Region XII. The results reveal a grand mean of 3.37 (SD = 0.67) interpreted as Highly Practiced, which means that respondents generally exhibit strong innovation-oriented leadership behaviors. The indication scored highest was “I encourage continuous improvement in operations” (WM=3.49). The lowest-ranked indicator was “I support employees to develop new ideas” (WM=3.27). Despite the disparity, all metrics were Highly Practiced, which indicates that the firms continuously exhibit innovative leadership.

The highest ranking indicates that entrepreneurs value continuous improvement as a method to refine operations and remain competitive, even with limited resources and evolving business conditions. The lower score for enabling employees to generate

new ideas may suggest that there is scope to improve employee involvement in innovation. This may be particularly so for smaller start-ups where limited staff and resources may limit prospects for formal employee-driven innovation. Teece (2018) and Teece and Leih (2022) validated this finding and stressed that firms may cope with changing market and technical conditions by constantly improving and reconfiguring their organizational resources and capacities. The research also points to the relevance of teamwork, information sharing and continual learning in enhancing innovation and organizational adaptation.

Generally, Innovation Leadership was Highly Practiced in tiny start-up firms in Region XII, with continual improvement in operations being the strongest practice. The results support the Dynamic Capabilities Theory. Entrepreneurs have a strong foundation for innovation and capability development. However, increasing employee participation in the generation and development of new ideas may further improve innovation capability, organizational agility and Industry 4.0 readiness.

Table 12
Level of Strategic Leadership Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN) in terms of People and Resource Management

INDICATORS	WM	SD	INTERPRETATION
1. I allocate resources effectively to support business priorities.	3.44	0.63	Highly practiced
2. I empower employees to contribute ideas and solutions.	3.27	0.70	Highly practiced
3. I promote teamwork and collaboration.	3.39	0.69	Highly practiced
4. I support employee development and learning.	3.33	0.70	Highly practiced
5. I ensure efficient use of available resources.	3.31	0.67	Highly practiced
Grand Mean	**3.35**	**0.68**	**Highly practiced**

Legend: 1.00-1.75 Not practiced; 1.76-2.50 Slightly practiced; 2.51-3.25 Moderately practiced; 3.26-4.00 Highly practiced

Table 12 shows the level of strategic leadership implemented among micro start-up firms in Region XII (SOCCSKSARGEN) in terms of People and Resource Management. The findings reveal a grand mean of 3.35 (SD = 0.68) which is regarded as Highly Practiced. Thus, respondents are generally effective in their practices in managing personnel and maximizing the existing resources of the firm. The indication that is next in rank is the indicator of distributing resources efficiently to meet corporate priorities while boosting cooperation and collaboration (WM = 3.39, SD = 0.69) with a weighted mean of (WM = 3.44, SD = 0.63). The lowest ranked criteria were empowering employees to contribute ideas and solutions (WM = 3.27, SD = 0.70) but still Highly Practiced.

The high score on resource allocation indicates that tiny start-up owners and managers value the efficient use of scarce financial, human and material resources in pursuit of business goals. This is especially true for startups that function with limited resources, where prioritization and effective use can directly contribute to organizational effectiveness. The lower ranking for employee empowerment indicates that while employee participation is encouraged, the opportunity for employees to share their ideas and solutions may not always be available. This may be an indication of the owner-centered decision-making structure generally associated with micro firms. Huang et al. (2022) and Nguyen et al. (2023) pointed out that employee empowerment, collaboration, and ongoing learning are vital to develop organizational capability and innovation, while Teece (2018) and Teece and Leih (2022) emphasized the significance of mobilizing and reconfiguring resources effectively in responding to a changing environment.

Generally, People and Resource Management was Highly Practiced which means that micro start-up firms tend to manage their people and resources efficiently and match it with company priorities. The results support Strategic Leadership Theory which identifies effective management of people and resources as a fundamental leadership competence, and Dynamic Capabilities Theory which stresses the mobilization and reconfiguration of resources in response to environmental changes. However, enhancing employee empowerment could further improve collaborative decision making, innovation and organizational agility of micro start-up firms.

Table 13
Level of Strategic Leadership Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN) in terms of Environmental Scanning

INDICATORS	WM	SD	INTERPRETATION
1. I regularly monitor market trends and changes.	3.31	0.69	Highly practiced
2. I adapt business strategies based on environmental changes.	3.23	0.71	Moderately practiced
3. I analyze competitor activities to improve strategies.	3.29	0.71	Highly practiced
4. I anticipate technological developments in the industry.	3.24	0.69	Moderately practiced
5. I consider external opportunities and threats in planning.	3.36	0.65	Highly practiced
Grand Mean	**3.29**	**0.69**	**Highly practiced**

Legend: 1.00-1.75 Not practiced; 1.76-2.50 Slightly practiced; 2.51-3.25 Moderately practiced; 3.26-4.00 Highly practiced

Table 13 presents the level of strategic leadership practiced among micro start-up enterprises in Region XII (SOCCSKSARGEN) in terms of Environmental Scanning. The findings show a grand mean of 3.29 (SD = 0.69), interpreted as Highly Practiced, indicating that respondents generally monitor and assess changes in their external business environment. The highest-rated indicator was considering external opportunities and threats in planning (WM = 3.36, SD = 0.65), followed by monitoring market trends (WM = 3.31, SD = 0.69) and analyzing competitor activities (WM = 3.29, SD = 0.71). In contrast, adapting business strategies based on environmental changes received the lowest rating (WM = 3.23, SD = 0.71), while anticipating technological developments obtained WM = 3.24; both were interpreted as Moderately Practiced.

The high rating for considering external opportunities and threats suggests that entrepreneurs are generally attentive to market conditions, competitive pressures, and other external factors when planning and making strategic decisions. However, the lower ratings for anticipating technological developments and adapting strategies indicate a gap between environmental awareness and proactive strategic response. This may be particularly relevant to micro start-ups, where limited resources and expertise can make it more difficult to continuously anticipate technological changes and translate environmental information into timely strategic adjustments.

The findings are supported by Huang et al. (2022) and Kraus et al. (2023), who emphasized the importance of anticipating environmental changes, recognizing emerging opportunities, and mobilizing resources for innovation and competitiveness. Similarly, Teece (2018) and Teece and Leih (2022), through Dynamic Capabilities Theory, emphasized the organizational ability to sense opportunities and threats, seize opportunities, and reconfigure resources in response to environmental changes. Overall, Environmental Scanning was Highly Practiced, but strengthening technology forecasting, environmental analysis, and strategy adjustment could help micro start-up enterprises move from simply recognizing environmental changes toward proactive adaptation, thereby improving organizational agility and Industry 4.0 readiness.

Table 14
Summary of the Level of Strategic Leadership Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN)

INDICATORS	WM	SD	INTERPRETATION	RANK
1. Visionary Leadership	3.46	0.55	Highly Practiced	1
2. Strategic Decision-Making	3.39	0.53	Highly Practiced	2
3. Innovation Leadership	3.37	0.54	Highly Practiced	3
4. People and Resource Management	3.35	0.54	Highly Practiced	4
5. Environmental Scanning	3.29	0.56	Highly Practiced	5
Overall Mean	**3.37**	**0.54**	Highly Practiced	

Table 14 shows the overview of the level of strategic leadership practiced by micro start-up firms in Region XII (SOCCSKSARGEN). The results indicate an overall mean of 3.37 (SD = 0.54), which is regarded as Highly Practiced, suggesting that respondents generally exhibit good practices of strategic leadership. The greatest weighted mean was achieved in the aspect of Visionary Leadership (WM = 3.46, SD = 0.55) followed by Strategic Decision-Making (WM = 3.39), Innovation Leadership (WM = 3.37), and People and Resource Management (WM = 3.35). Environmental Scanning was ranked lowest (WM = 3.29, SD = 0.56) but still was Highly Practiced.

A high score for Visionary Leadership means that the firms are strongest in leadership techniques related to setting direction, articulating goals, and maintaining a clear future outlook. This is especially true in the case of micro start-ups, where the owner/manager is usually both a strategic and operational player. Strategic Decision-Making also scored high which means that entrepreneurs do focus a lot on decisions that promote business sustainability. Conversely, the lower rating for Environmental Scanning implies that entrepreneurs are keeping track of their external environment, but they may be facing more difficulties in

forecasting technological developments and in timely strategic adjustments to environmental changes, consistent with the results shown in Table 12.

The findings are consistent with the Strategic Leadership Theory which highlights vision, strategic decision-making, innovation, management of people and resources, and environmental awareness as fundamental components of strategic leadership (Boal & Hooijberg, 2001; Barbu et al., 2021). They are also reinforced by Huang et al. (2022) and WEF (2023), who highlighted the value of innovation, flexibility, digital foresight and organizational learning in dynamic business contexts. Dynamic Capabilities Theory highlights the need for the ability to recognize opportunities and dangers, seize emerging possibilities and rearrange resources to response to technological and market developments (Teece, 2018; Teece & Leih, 2022). The result showed that strategic leadership was Highly Practiced and Visionary Leadership was the strongest dimension, while Environmental Scanning was the weakest. Therefore, enhancing proactive environmental monitoring, particularly through anticipating technology and adapting strategy, can further enhance organizational agility and Industry 4.0 preparedness of organizations.

Level of Organizational Agility Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN)

Table 15
Level of Organizational Agility Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN) in terms of Responsiveness

INDICATORS	WM	SD	INTERPRETATION
1. Our enterprise responds quickly to customer needs.	3.40	0.62	Highly practiced
2. We react promptly to changes in the market.	3.19	0.76	Moderately practiced
3. We address operational issues immediately.	3.26	0.66	Highly practiced
4. We act quickly on customer feedback.	3.31	0.64	Highly practiced
5. We adjust rapidly to unexpected situations.	3.34	0.70	Highly practiced
Grand Mean	**3.30**	**0.68**	**Highly practiced**

Legend: 1.00-1.75 Not practiced; 1.76-2.50 Slightly practiced; 2.51-3.25 Moderately practiced; 3.26-4.00 Highly practiced

Table 15 presents the level of organizational agility practiced among micro start-up enterprises in Region XII (SOCCSKSARGEN) in terms of Responsiveness. The results show a grand mean of 3.30 (SD = 0.68) which is defined as Highly Practiced. This means that the firms show a significant capacity to respond to consumer requests, operational problems, feedback and unforeseen situations. The highest weighted mean was on responding swiftly to customer demands, (WM = 3.40, SD = 0.62), followed by reacting rapidly to unexpected situations (WM = 3.34, SD = 0.70) and acting quickly on input from customers (WM = 3.31, SD = 0.64). Conversely, responding quickly to changes in the market was rated the lowest (WM = 3.19, SD = 0.76) and was evaluated as Moderately Practiced.

The high score for quick response to client requests shows that customer responsiveness is a major strength of organizational agility among the firms. Maybe it is important to keep close customer contacts and adapt quickly to shifting client demands. The high score for dealing with unforeseen scenarios also means that the firms are generally capable of solving the immediate operational problems. But the lower score for responding to changes in the market shows the firms are more reactive to immediate consumer and operational issues than to wider external market trends. The higher standard deviation of 0.76 also suggests greater variance across the firms in their capacity to respond to market fluctuations.

These results are in line with Shams et al. (2021) and Al-Moaid et al. (2024) who underlined that start-ups working in dynamic contexts benefit from learning-oriented techniques, fast experimentation, adaptable strategies, and technology advancements. These results also support the Dynamic Capabilities Theory, which defines organizational agility as the capacity to sense changes, seize opportunities and reconfigure resources in response to changing situations. Overall, Responsiveness was Highly Practiced, with Responding Fast to Customer Needs being the strongest practice. However, enhancing enterprises' capacity to monitor, anticipate and respond to wider market trends could further boost organizational agility, resilience and Industry 4.0 readiness.

Table 16
Level of Organizational Agility Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN) in terms of Flexibility

INDICATORS	WM	SD	INTERPRETATION
1. Our enterprise can easily modify processes when needed.	3.25	0.67	Moderately practiced
2. Employees can perform multiple roles when required.	3.24	0.71	Moderately practiced
3. We adjust strategies based on changing conditions.	3.26	0.71	Highly practiced
4. Operations can be restructured when necessary.	3.24	0.70	Moderately practiced
5. We adapt easily to new technologies.	3.26	0.70	Highly practiced
Grand Mean	**3.25**	**0.70**	**Moderately practiced**

Legend: 1.00-1.75 Not practiced; 1.76-2.50 Slightly practiced; 2.51-3.25 Moderately practiced; 3.26-4.00 Highly practiced

Table 16 shows the amount of organizational agility applied among micro start-up firms in Region XII (SOCCSKSARGEN) in terms of Flexibility. The results show a grand mean of 3.25 (SD = 0.70) which is interpreted as Moderately Practiced, meaning that the firms have some ability to modify their strategies, processes, operations, staff roles, and technologies to the changing situations. The top ranked indications were altering tactics depending on changing conditions and adapting easily to new technologies with a weighted mean of 3.26. In contrast, the lowest weighted means of 3.24 were reached by employees performing numerous jobs when required and operations being reformed, when necessary, regarded as Moderately Practiced.

The substantially higher scores for strategy adjustment and new technology adaptation indicate entrepreneurs' overall willingness to respond to external changes and their awareness of the significance of technological adaptation for preserving competitiveness. Nevertheless, the marginal divergence of these indicators from the general mean suggests that such flexibility exists but is not yet firmly entrenched. Lower grades on employee job flexibility and operational restructuring indicate that translating strategic adaptability into internal organizational changes may be more difficult. This may be due to the limited manpower and resources of micro start-ups which may limit their capacity to disperse duties or restructure operations without disturbing ongoing activities.

The findings are consistent with Dynamic Capabilities Theory, which focuses on the ongoing renewal, adaptation, and reconfiguration of organizational resources and capabilities in response to changing market and technology conditions (Teece, 2018; Teece & Leih, 2022). Similarly, Shams et al. (2021) and Al-Moaid et al. (2024) have highlighted the need for adaptable tactics, quick experimentation, and technological integration for start-ups functioning in unpredictable contexts. In general, Flexibility was Practiced at a Moderate level, which is an area that requires more strengthening. Improving process change, personnel flexibility, and operational restructuring can assist micro start-up companies in converting their strategic and technology flexibility into better organizational agility and enhanced Industry 4.0 preparedness.

Table 17
Level of Organizational Agility Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN) in terms of Innovation Capability

INDICATORS	WM	SD	INTERPRETATION
1. Our enterprise develops new products or services regularly.	3.23	0.66	Moderately practiced
2. Employees are encouraged to suggest innovative ideas.	3.16	0.71	Moderately practiced
3. We support creativity and experimentation.	3.24	0.68	Moderately practiced
4. We apply lessons from past experiences to improve operations.	3.40	0.64	Highly practiced
5. Innovation is integrated into our daily business activities.	3.33	0.64	Highly practiced
Grand Mean	**3.27**	**0.67**	**Highly practiced**

Legend: 1.00-1.75 Not practiced; 1.76-2.50 Slightly practiced; 2.51-3.25 Moderately practiced; 3.26-4.00 Highly practiced

Table 17 shows the amount of organizational agility practiced among micro start-up firms in Region XII (SOCCSKSARGEN) in terms of Innovation Capability. The results indicated a grand mean of 3.27 (SD = 0.67) which is regarded as Highly Practiced implying that the firms generally incorporate innovation into their operations and use previous experiences to improve business processes. The top-rated indicator was the application of lessons learned from previous experiences to improve operations (WM = 3.40, SD = 0.64), followed by the integration of innovation into daily company activities (WM = 3.33, SD = 0.64). Conversely, the lowest ranking (WM=3.16, SD=0.71) was given to encouraging employees to offer innovative ideas, while generating new products or services regularly (WM=3.23) and supporting creativity and experimentation (WM=3.24) were also Moderately Practiced.

The high score for learning from prior experience implies that companies highly regard organizational learning as a practical way to improve operations, which can be particularly essential for tiny start-ups that operate with few resources. The relatively high ranking for the integration of innovation into everyday activities also suggests that innovation is integrated into everyday company practices and not just confined to new product development. However, the lower grade for supporting employee-generated ideas may signal that innovation will remain mostly owner- or manager-driven, with few structured chances for employees to participate in innovation. Constraints on resources, market uncertainty and operational needs may also drive moderate ratings for product or service development and experimentation.

The findings are in line with Shams et al. (2021) and Al-Moaid et al. (2024) who underlined the need for continuous innovation, organizational learning, fast experimentation, adaptable methods, and technology integration for start-ups in volatile contexts. These findings are also consistent with the Dynamic Capabilities Theory which stresses the constant building, renewing and reconfiguring of organizational capabilities in response to changing market and technology conditions. Overall findings showed that Innovation Capability was Highly Practiced, particularly through learning from previous experiences and embedding innovation in daily operations. However, increasing the employee participation, innovation, experimentation and continuous development of new products or services could improve the organizational agility and help the Industry 4.0 preparedness.

Table 18
Level of Organizational Agility Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN) in terms of Customer Adaptability

INDICATORS	WM	SD	INTERPRETATION
1. We modify products/services based on customer needs	3.39	0.63	Highly practiced
2. We use customer feedback to improve our offerings	3.28	0.74	Highly practiced
3. We personalize services to meet customer expectations	3.28	0.69	Highly practiced
4. We regularly assess customer preferences	3.27	0.67	Highly practiced
5. We adapt quickly to changing customer demands	3.27	0.63	Highly practiced
Grand Mean	**3.30**	**0.67**	**Highly practiced**

Legend: 1.00-1.75 Not practiced; 1.76-2.50 Slightly practiced; 2.51-3.25 Moderately practiced; 3.26-4.00 Highly practiced

Table 18 Level of Organizational Agility Practiced among the Micro Start-up Enterprises in Region XII (SOCCSKSARGEN) in terms of Customer Adaptability The results show a grand mean of 3.30 (SD = 0.67) interpreted as Highly Practiced. This means that the firms generally have strong ability to comprehend and respond to changing client wants and preferences. The highest ranked signal was the modification of products or services based on client demands (WM = 3.39, SD = 0.63), followed by the application of client input to enhance offerings and the personalization of services to satisfy client expectations, both with WM = 3.28. The lowest-rated measures were the regular assessment of consumer preferences and the swift adaptation to changing client demands with WM = 3.27. However, all indicators were scored as Highly Practiced indicating consistently good customer focused adaptability.

The high rating on changing products and services according to client needs shows that micro start-ups are proactive in changing their offers to remain relevant to the customers. This finding is consistent with the research in Chapter 2 which indicates customer adaptability is an integral part of organizational agility, since agile organizations constantly adjust to changes in consumer tastes, market conditions, and emerging possibilities. According to Shams et al. (2021), learning-oriented and adaptive practices are crucial for start-ups to respond effectively to dynamic market demands, and Al-Moaid et al. (2024) underlined the importance of adaptive strategies and technological capabilities for enterprises to respond quickly to changing business conditions. The relatively lower ratings for regularly assessing consumer preferences and quickly adapting to changing demands suggest that while enterprises respond well to identified customer needs, more systematic and proactive monitoring of changing customer expectations could still be strengthened.

The most practiced dimension in the overall was Customer Adaptability. The most practiced item was adapting products and services to customer needs. The findings also corroborate the Dynamic Capabilities Theory, which posits that organizations maintain competitiveness by perceiving changes and opportunities, seizing them, and reconfiguring organizational capabilities accordingly (Teece, 2018; Teece & Leih, 2022). An important adaptive skill is the ability of organizations to collect feedback from customers, tailor services and adjust their products. Systematic customer assessment and anticipation of evolving consumer requests would improve organizational agility and increase Industry 4.0 readiness of micro start-up firms in Region XII.

Table 19
Level of Organizational Agility Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN) in terms of Operational Speed

INDICATORS	WM	SD	INTERPRETATION
1. We deliver products/services efficiently.	3.32	0.62	Highly practiced
2. Our processes are streamlined for faster operations.	3.15	0.72	Moderately practiced
3. We respond quickly to operational disruptions.	3.23	0.64	Moderately practiced
4. Tasks are completed within expected timeframes.	3.25	0.66	Moderately practiced
5. We maintain fast and efficient service delivery.	3.28	0.64	Highly practiced
Grand Mean	**3.25**	**0.66**	**Moderately practiced**

Legend: 1.00-1.75 Not practiced; 1.76-2.50 Slightly practiced; 2.51-3.25 Moderately practiced; 3.26-4.00 Highly practiced

Table 19 reveals the amount of organizational agility implemented among micro start-up firms in Region XII (SOCCSKSARGEN) in the aspect of Operational Speed. The findings show a grand mean of 3.25 (SD = 0.66), interpreted as Moderately Practiced. This implies that the firms have some capability to execute activities and produce products or services efficiently, but the pace of operations is not yet consistently robust across all domains. The greatest weighted mean (WM = 3.32, SD = 0.62) was delivering products and services efficiently. Next was sustaining fast and efficient service delivery (WM = 3.28, SD = 0.64). These two were regarded as Highly Practiced. Conversely, the least practiced dimension was the simplification of procedures to achieve speedier operations (WM = 3.15, SD = 0.72). The completion of activities within projected timeframes (WM = 3.25) and responding swiftly to operational interruptions (WM = 3.23) were moderately practiced.

Higher scores for the effective delivery of products and services indicate that the firms are reasonably competent to sustain timely customer-facing operations despite resource restrictions. This may be due to the pressure on smaller start-ups to be efficient and keep customers happy in very competitive marketplaces. However, with a lower rating for simplifying internal operations, this may signal that internal operational efficiency may be more difficult than customer-facing delivery. This result is consistent with the literature in Chapter 2, which defines operational speed as a significant component of organizational agility that promotes rapid execution, reduced time-to-market and increased organizational efficiency. Shams et al. (2021) and Al-Moaid et al. (2024) also highlighted that start-ups operating in volatile environments benefit from learning-oriented practices, rapid experimentation, adaptive strategies, and technological innovations such as automation, digital platforms, and data-driven decision-making tools.

Overall, Operational Speed was Moderately Practiced, showing firms can supply products and services efficiently, but they should enhance internal process streamlining and swift reactions to operational disturbances. The results are consistent with the Dynamic Capabilities Theory, which describes organizational agility as the ability to continuously adapt and reconfigure resources and processes in response to changing circumstances (Teece, 2018; Teece & Leih, 2022). As noted in Chapter 2, operational speed, coupled with responsiveness, flexibility, innovation capability and customer adaptability, is an essential expression of dynamic capabilities and contributes to Industry 4.0 preparedness. So, enhancing process efficiency, task completion and disruption reaction may improve organizational agility and better prepare micro start-ups for digital transformation.

Table 20
Summary of the Level of Organizational Agility Practiced Among Micro Start-Up Enterprises in Region XII (SOCCSKSARGEN)

INDICATORS	WM	SD	INTERPRETATION	RANK
1. Responsiveness	3.30	0.56	Highly Practiced	1
2. Flexibility	3.25	0.57	Moderately Practiced	4
3. Innovation Capability	3.27	0.55	Highly Practiced	3
4. Customer Adaptability	3.30	0.55	Highly Practiced	1
5. Operational Speed	3.25	0.56	Moderately Practiced	4
Overall Mean	**3.27**	**0.56**	**Highly Practiced**	

Table 20 shows the overview of the level of organizational agility practiced among micro start-up firms in Region XII (SOCCSKSARGEN). The findings indicate a mean of 3.27 (SD = 0.56). This is regarded as Highly Practiced, indicating that the firms have a high ability to respond to changes, adapt to consumer needs, explore innovations, and manage operations. Responsiveness and Customer Adaptability scored the highest weighted mean (WM = 3.30), both ranked first and considered as Highly Practiced, followed by Innovation Capability (WM = 3.27, SD = 0.55). In contrast, Flexibility and Operational Speed both received the lowest weighted mean of 3.25 and were evaluated as Moderately Practiced.

The high scores for Responsiveness and Customer Adaptability suggest that the enterprises' key characteristics of agility are the ability to respond to urgent business and customer needs and to adapt their offers to customer expectations. This is in line with the research in Chapter 2, which identifies organizational agility as being particularly crucial for resource-constrained start-

ups because it allows them to quickly adjust to change, continuously innovate, and stay relevant in the market, despite having limited infrastructure or funds. Start-ups in volatile environments succeed through learning-oriented practices, fast experimentation, adaptive strategies, and technological innovations (Shams et al., 2021; Al-Moaid et al., 2024), including automation, digital platforms, and data-driven decision-making tools. Conversely, the low scores for Flexibility and Operational Speed show that the firms would be more adept at adaptability in customer-facing than in restructuring internal processes, reallocating roles, simplifying operations, and responding promptly to operational disturbances.

Overall, Organizational Agility was Highly Practiced with Responsiveness and Customer Adaptability being the strongest qualities. The findings are consistent with the Dynamic Capabilities Theory, which defines agility as the capability to perceive and seize changes and opportunities and to rearrange organizational resources and capabilities in response to changing situations (Teece, 2018; Teece & Leih, 2022). Chapter 2 also introduces responsiveness, flexibility, innovation capability, customer adaptability, and operational speed as expressions of dynamic capabilities that enable continual innovation, technology adoption, and market responsiveness. The study discovered that organizational agility was a significant predictor of Industry 4.0 readiness, suggesting that strengthening the relatively weaker areas of Flexibility and Operational Speed could further enhance enterprises' capacity to adjust internal processes, react to disruptions, and move toward greater Industry 4.0 readiness.

Readiness Level of Micro Start-Up Enterprises for Industry 4.0

Table 21
Readiness Level of Micro Start-Up Enterprises for Industry 4.0 in terms of Digital Infrastructure

INDICATORS	WM	SD	INTERPRETATION
1. The use of digital tools for the enterprise' daily operations	3.22	0.68	Moderately Ready
2. Reliable internet and digital systems	3.08	0.80	Moderately Ready
3. Digital platforms integrated into operations	3.13	0.74	Moderately Ready
4. Software for business processes and records	3.17	0.79	Moderately Ready
5. Digital tools for communication and coordination	3.24	0.76	Moderately Ready
Grand Mean	**3.17**	**0.76**	**Moderately Ready**

Legend: 1.00-1.75 Not ready; 1.76-2.50 Slightly ready; 2.51-3.25 Moderately ready; 3.26-4.00 Highly ready

Table 21 presents the readiness level of micro start-up enterprises in Region XII (SOCCSKSARGEN) for Industry 4.0 in terms of Digital Infrastructure. The results show a grand mean of 3.17 (SD = 0.76) interpreted as Moderately Ready, which means that the firms have developed basic digital infrastructure, but have not yet achieved a level that supports fully integrated and advanced digital transformation. Digital instruments for communication and coordination had the highest weighted mean (WM = 3.24, SD = 0.76), followed by the use of digital devices for daily operations (WM = 3.22, SD = 0.68). Meanwhile, the lowest rating (WM = 3.08, SD = 0.80) was given to reliable internet and digital systems. All five indicators were scored as Moderately Ready.

The relatively high score for digital instruments used for communication and coordination implies that fundamental digital technologies are currently available and embedded in normal business processes. The lower score for reliable internet and digital systems, however, suggests that connection and systems reliability continue to be significant infrastructural gaps. The biggest standard deviation of 0.80 also indicates heterogeneity among firms in their perception of the reliability of infrastructure. Similarly, the moderate grades for integrating digital platforms (WM = 3.13) and business-process software (WM = 3.17) further indicate that digital technologies can still be used in a relatively fragmented manner rather than being fully incorporated into business processes. This is congruent with what Kraus et al. (2023) stated in Chapter 2 regarding the fragmented application of digital technology in corporate operations.

The results are reinforced by the research in Chapter 2 which defines reliable connectivity, digital platforms and technology resources as the basic foundations for Industry 4.0 readiness, particularly for firms in developing regions (ADB, 2023; Xu et al., 2021). Also, the results are compatible with the Industry 4.0 Readiness Model which emphasizes the need for strong technological foundations for advanced technology adoption and the Technology Acceptance Model (TAM) which underlines perceived usefulness and ease of use in technology adoption. Overall, Digital Infrastructure was Moderately Ready, with communication and collaboration tools being the strongest sector. Improving internet stability, digital systems, platform integration, and business-process software may assist tiny start-up firms to evolve from basic digital adoption toward more comprehensive Industry 4.0 preparedness.

Table 22
Readiness Level of Micro Start-Up Enterprises for Industry 4.0 in terms of Technological Competence

INDICATORS	WM	SD	INTERPRETATION
1. Digital skills of employees	3.23	0.69	Moderately Ready
2. Provision of training on new technologies	3.13	0.79	Moderately Ready
3. Effective use of digital tools by the staff	3.14	0.80	Moderately Ready
4. Adaptation with new technological systems	3.17	0.75	Moderately Ready
5. Employees' confidence in using digital platforms	3.15	0.74	Moderately Ready
Grand Mean	**3.16**	**0.76**	**Moderately Ready**

Legend: 1.00-1.75 Not ready; 1.76-2.50 Slightly ready; 2.51-3.25 Moderately ready; 3.26-4.00 Highly ready

Table 22 shows the readiness level of micro start-up firms in Region XII in terms of Technological Competence. The firms had a grand mean of 3.16 (SD = 0.76), which was assessed as Moderately Ready. This meant they have fundamental technical capabilities but still require more improvement in digital skills, training, technology utilization, system adaption, and employee confidence. The highest rating was on the digital abilities of employees (WM = 3.23) and the lowest was on the provision of training on new technologies (WM = 3.13).

The highest ranking of the digital abilities of employees indicates that the firms have created a basic degree of technology capability needed for everyday business activities. The lower ranking for training on new technologies, however, suggests that continual digital upskilling may still be limited. The results align with Chapter 2 literature highlighting the significance of digital skills, workforce capability, and ongoing training for Industry 4.0 preparation, especially for tiny companies with technology and resource limitations (DICT, 2023; DTI, 2024).

Overall, Technological Competence was Moderately Ready, meaning that the firms have a basis for digital technology adoption but need more capabilities development. The ability to embrace and sustain more advanced Industry 4.0 technologies may be enhanced by strengthening continuous training, the effective use of digital resources by employees, adaption to new technical systems and confidence in digital platforms. This corresponds to the Technology Acceptance Model and Diffusion of Innovation Theory, which highlight the significance of perceived utility, ease of use, awareness, and gradual adoption of technology.

Table 23
Readiness Level of Micro Start-Up Enterprises for Industry 4.0 in terms of Market-Ready Competence

INDICATORS	WM	SD	INTERPRETATION
1. Regular adaptation of new technologies	3.14	0.73	Moderately Ready
2. Innovation as part of the business strategy	3.10	0.77	Moderately Ready
3. Investment in technological improvements	3.06	0.82	Moderately Ready
4. Implementation of new ideas to improve operations	3.16	0.78	Moderately Ready
5. Support for digital innovation initiatives	3.15	0.74	Moderately Ready
Grand Mean	**3.12**	**0.77**	**Moderately Ready**

Legend: 1.00-1.75 Not ready; 1.76-2.50 Slightly ready; 2.51-3.25 Moderately ready; 3.26-4.00 Highly ready

Table 23 shows the level of preparation of micro start-up firms of Region XII (SOCCSKSARGEN) toward Industry 4.0 in terms of Market-Ready Competence. The results show a grand mean of 3.12 (SD = 0.77) interpreted as Moderately Ready. The firms have developed a basic capacity to respond to market demands through technological adaptation, innovation and operational improvements, but these capabilities have not reached a highly ready level yet. The highest weighted mean (WM = 3.16, SD = 0.78) was obtained in implementation of new ideas to improve operations, followed by the support for digital innovation initiatives (WM = 3.15, SD = 0.74) and frequent adaptation of new technologies (WM = 3.14, SD = 0.73). Conversely, spending on technological advancements had the lowest grade (WM = 3.06, SD = 0.82) followed by innovation as an element of corporate strategy (WM = 3.10, SD = 0.77). All indications were read as Moderately Ready.

The better ranking for implementing new ideas to improve operations shows that the firms are generally competent of turning innovation into tangible operational gains. It implies an increasing ability to adjust to changing business and technology environments. The results align with the literature in Chapter 2, which highlights that organizational agility enables organizations to continuously adapt resources and capabilities, engage in innovation, and address changing market possibilities. Shams et al. (2021) and Al-Moaid et al. (2024) emphasized the value of learning-oriented techniques, fast experimentation, adaptive strategies, and technical innovation for start-ups functioning in risky contexts. However, the lowest rating for investment in technical advances indicates that financial and resource restrictions may serve as an obstacle to the enterprises' capacity to transform their commitment to innovate into continuous technological investment. The very high SD of 0.82 also shows heterogeneity across firms in their ability to invest in technology developments.

Overall Market-Ready Competence was Moderately Ready, with the strongest practice being implementing new ideas to improve operations and the worst being technology investment. The results are consistent with Dynamic Capabilities Theory, particularly the requirement to identify opportunities, grab them through innovation and technology adoption, and rearrange resources to remain competitive (Teece, 2018; Teece & Leih, 2022). They are also linked to the Technology Acceptance Model (TAM) and Diffusion of Innovation Theory that stress the importance of organizational support, perceived value, resources and conditions that aid in technology adoption. Thus, greater investment in technological improvements, more systematic integration of innovation into business strategies, and continued support for digital innovation can allow micro start-up firms to transform their current adaptive capabilities into stronger market-oriented capabilities and greater Industry 4.0 readiness.

Table 24
Readiness Level of Micro Start-Up Enterprises for Industry 4.0 in terms of Digital Culture

INDICATORS	WM	SD	INTERPRETATION
1. Promotion of digital transformation	3.07	0.73	Moderately Ready
2. Openness to adopting new technologies	3.04	0.79	Moderately Ready
3. Supporting digital initiatives for leadership	3.08	0.71	Moderately Ready
4. Encouragement of continuous learning in the organization	3.09	0.75	Moderately Ready
5. Digital practices as embedded in daily operations	3.11	0.70	Moderately Ready
Grand Mean	**3.08**	**0.74**	**Moderately Ready**

Legend: 1.00-1.75 Not ready; 1.76-2.50 Slightly ready; 2.51-3.25 Moderately ready; 3.26-4.00 Highly ready

Table 24. Level of readiness of micro start-up firms in Region XII (SOCCSKSARGEN) to Industry 4.0 in terms of Digital Culture The results indicate a grand mean of 3.08 (SD = 0.74) which is interpreted as Moderately Ready, i.e., the enterprises have started to develop a culture to be digital-oriented but the practices of technology adoption, continuous learning, leadership support and digital transformation are not yet consistently established at a high ready level. The digital practices embedded in daily practices had the greatest weighted mean (WM = 3.11, SD = 0.70) followed by encouragement of continuous learning (WM = 3.09, SD = 0.75) and leadership support to digital initiatives (WM = 3.08, SD = 0.71). Conversely, openness to adopt new technologies was the least rated (WM = 3.04, SD = 0.79). All indications were assessed as Moderately Ready.

The higher score for incorporating digital practices into daily operations indicates that digital technologies are already becoming part of routine corporate activity. This implies a growing digital culture, where technology is not only used in discrete applications, but is rapidly being embedded in business operations. However, the lower ranking on receptivity to new technologies indicates that resource restrictions, capability gaps, or ambiguity about the value and application of new technologies may still limit the desire to adopt new technologies. The findings agree with the research in Chapter 2 that firms must integrate technology into business processes and establish capacities for continuous learning, innovation, and adaptation to achieve digital transformation. The research also shows that strategic leadership can lead to digital transformation through innovation, employee empowerment and continual improvement. Likewise, Shams et al. (2021) and Al-Moaid et al. (2024) highlighted the significance of learning-oriented practices, experimentation, adaptive tactics and technology integration as crucial competencies of start-ups in dynamic contexts.

Overall, Digital Culture was Moderately Ready. The strongest area was embedding digital practices into daily operations while the weakest area was openness to adopting new technology. The results align with the Technology Acceptance Model (TAM) and Diffusion of Innovation Theory, emphasizing the significance of perceived usefulness, simplicity of use, organizational support, awareness, and conditions conducive to technology adoption. They are also congruent with the Dynamic skills Theory where businesses need to continuously build and reconfigure skills to cope with technological and environmental changes (Teece, 2018; Teece & Leih, 2022). Therefore, enhancing openness to new technologies, leadership support, continuous learning and translating organizational agility into a stronger digital culture may systematically improve the promotion of digital transformation in micro start-up enterprises.

Table 25
Readiness Level of Micro Start-Up Enterprises for Industry 4.0 in terms of Data-Driven Decision Making

INDICATORS	WM	SD	INTERPRETATION
1. Use of data and analytics in decision-making	3.02	0.77	Moderately Ready
2. Use of customer data to improve services	2.93	0.82	Moderately Ready
3. Monitoring performance using digital tools	3.01	0.78	Moderately Ready
4. Use of reports and analytics as guide in business strategies	3.06	0.74	Moderately Ready
5. Regular use of data in planning and decision-making	3.07	0.75	Moderately Ready
Grand Mean	**3.02**	**0.77**	**Moderately Ready**

Legend: 1.00-1.75 Not ready; 1.76-2.50 Slightly ready; 2.51-3.25 Moderately ready; 3.26-4.00 Highly ready

Table 25 illustrates the readiness level of micro start-up firms in Region XII (SOCCSKSARGEN) for Industry 4.0 in the aspect of Data-Driven Decision Making. The results show a grand mean of 3.02 (SD = 0.77), interpreted as Moderately Ready, suggesting that the firms have started to use data, analytics, performance information, and digital resources to support business choices, but these practices have not yet reached a highly ready level. Regular use of data in planning and decision-making had the highest weighted mean (WM = 3.07, SD = 0.75), followed by the use of reports and analytical tools to influence corporate plans (WM = 3.06, SD = 0.74). Conversely, the use of customer data for improving services received the lowest grade (WM = 2.93, SD = 0.82) while monitoring performance utilizing digital technologies received WM = 3.01 (SD = 0.78). All indications had a rating of Moderately Ready.

The high grade for the regular use of data in planning and decision-making indicates that companies are beginning to see the importance of the information they have in guiding company activities. The application of reporting and analytical tools to inform plans also points to an expanding capacity to embed data into strategic and operational decision-making. But a lower ranking for leveraging customer data to improve services implies that consumer information is still an underutilized source of corporate insight. The comparatively high standard deviation of 0.82 also suggests that there is a higher variety in the utilization of customer data across organizations. This study is pertinent to Chapter 2 literature stressing that agile start-ups benefit from the data-driven decision-making, digital platforms and technology breakthroughs that allow them to adjust to changing market and consumer conditions. These capabilities assist start-ups to operate effectively in volatile contexts, as underlined by Shams et al. (2021) and Al-Moaid et al. (2024).

Overall, Data-Driven Decision Making was Moderately Ready with regular use of data in planning and decision-making being the strongest practice and the use of customer data to improve services being the poorest. The findings are supportive of the Dynamic Capabilities Theory, including sensing opportunities and threats, seizing opportunities, and reconfiguring organizational resources depending on relevant information (Teece, 2018; Teece & Leih, 2022). Data and analytics can help businesses develop these capabilities by supplying them with current information on market conditions, customer needs and operational performance. Thus, improving data collecting, analytics, customer-data use, and digital performance monitoring will allow tiny start-up firms to make better choices and further expand their Industry 4.0 readiness.

Table 26
Summary of the Readiness Level of Micro Start-Up Enterprises for Industry 4.0 in Region XII (SOCCSKSARGEN)

INDICATORS	WM	SD	INTERPRETATION	RANK
1. Digital Infrastructure Readiness	3.17	0.65	Moderately Ready	1
2. Technological Competence	3.16	0.66	Moderately Ready	2
3. Market-Ready Competence	3.12	0.67	Moderately Ready	3
4. Digital Culture	3.08	0.63	Moderately Ready	4
5. Data-Driven Decision Making	3.02	0.68	Moderately Ready	5
Overall Mean	**3.11**	**0.66**	**Moderately Ready**	

Table 26 Summary of Readiness Level of Micro Start-up Enterprises for Industry 4.0 in Region XII (SOCCSKSARGEN) The results show a grand mean of 3.11 (SD = 0.66) which is interpreted as Moderately Ready. This means that the firms have created the basic capabilities for Industry 4.0 adoption but not at the highly ready level. Digital Infrastructure Readiness was the highest scored, with the highest grand mean (WM = 3.17, SD = 0.65), followed by Technological Competence (WM = 3.16, SD = 0.66), Market-Ready Competence (WM = 3.12, SD = 0.67) and Digital Culture (WM = 3.08, SD = 0.63). Data-Driven Decision Making was rated fifth with the lowest grand mean (WM = 3.02, SD = 0.68). The five dimensions were all assessed as Moderately Ready.

The higher ranking for Digital Infrastructure Readiness, relative to other areas, shows that firms have made more progress in accessing and exploiting basic digital resources, systems and technology to support their operations. This corresponds to the

research in Chapter 2 emphasizing digital infrastructure as a critical building block for Industry 4.0 adoption, especially in developing and resource-constrained environments (ADB, 2023; Xu et al., 2021). The second highest ranking for Technological Competence also shows that firms have a base level of digital skills, but may need further upskilling for more sophisticated technology. In particular, the lower ratings for Digital Culture and Data-Driven Decision-Making show that the use of technology has not yet been effectively integrated into organizational procedures and systematic use of information. This is consistent with the discussion in Chapter 2 that start-ups gain from learning-oriented techniques, fast experimentation, adaptable tactics, digital platforms, and data-driven decision-making tools (Shams et al., 2021; Al-Moaid et al., 2024).

Overall, Industry 4.0 readiness was Moderately Ready, with Digital Infrastructure Readiness being the strongest characteristic and Data-Driven Decision-Making being the weakest. The results are in line with the Industry 4.0 preparedness Model, which considers preparedness as a multidimensional construct, based not just on technology foundations but also on organizational skills and digital practices. They also underpin the study's Dynamic Capabilities Theory, which highlights the ability to sense changes, grab opportunities, and rearrange resources and capabilities in response to technology and market conditions (Teece, 2018; Teece & Leih, 2022). Therefore, although the organizations have laid the essential foundation for digital transformation, the enhancement in data analytics and decision-making, digital culture, technological competence and market-oriented digital skills may assist the firms to develop toward a greater level of industry 4.0 readiness.

Table 27
Significant Differences in Industry 4.0 Readiness of Micro Start-Up Enterprises According to the Age of Enterprise Owners

INDICATORS	AGE	N	WM	F	P-VALUE	DECISION H^0	INTERPRETATION
Digital Infrastructure				1.298	0.275	Accept H^0	Not Significant
	20-29	128	3.17				
	30-39	97	3.14				
	40-49	57	3.13				
	50 and above	18	3.46				
	Total	300	3.17				
Technological Competence				2.115	0.098	Accept H^0	Not Significant
	20-29	128	3.12				
	30-39	97	3.12				
	40-49	57	3.25				
	50 and above	18	3.48				
	Total	300	3.16				
Market-ready Competence				2.879	0.036	Reject H^0	Significant
	20-29	128	3.04				
	30-39	97	3.09				
	40-49	57	3.26				
	50 and above	18	3.44				
	Total	300	3.12				
Digital Culture				1.061	0.366	Accept H^0	Not Significant
	20-29	128	3.03				
	30-39	97	3.06				
	40-49	57	3.16				
	50 and above	18	3.24				
	Total	300	3.08				
Data-driven Decision Making				1.658	0.176	Accept H^0	Not Significant
	20-29	128	2.97				
	30-39	97	2.99				
	40-49	57	3.09				
	50 and above	18	3.31				
	Total	300	3.02				
Industry Readiness	20-29	128	3.06	2.125	0.097	Accept H^0	
	30-39	97	3.08				
	40-49	57	3.18				
	50 and above	18	3.39				
	Total	300	3.11				

Significant at $\alpha = 0.05$.

Table 27 summarizes the results of the one-way ANOVA testing if the Industry 4.0 readiness of micro start-up firms is substantially different across the age of enterprise owners. The results indicated that there was no significant difference in total Industry 4.0 preparedness across the age groups ($F = 2.125$, $p = 0.097$). Thus, the null hypothesis was accepted which implies that age does not significantly differentiate the overall Industry 4.0 preparedness of micro start-up firms in Region XII. Respondents aged 50 and above had the greatest overall weighted mean (WM = 3.39), followed by those aged 40–49 (WM = 3.18), 30–39 (WM = 3.08), and 20–29 (WM = 3.06), but the differences were not statistically significant.

Similarly, no significant variations were found across age groups for Digital Infrastructure Readiness, Technological Competence, Digital Culture and Data-Driven Decision Making. The study points to a growing sharing of digital tools and the aptitude to use them across generations. This is consistent with Chapter 2 literature that younger entrepreneurs are more prone to demonstrate greater technological literacy and a higher preference for AI-enabled tools, e-commerce and data-driven systems, and older entrepreneurs bring valuable business experience and stability in decision-making (ADB, 2023; OECD, 2023; UNCTAD, 2024). These findings also imply that age is not sufficient to explain variations in Industry 4.0 preparedness, particularly as digital technologies and possibilities for technology adoption grow more available.

Market-ready Competence changed substantially with age ($F = 2.879$, $p = 0.036$). The highest weighted mean (WM = 3.44) was reached by respondents aged 50 and above, followed by those aged 40–49 (WM = 3.26), 30–39 (WM = 3.09) and 20–29 (WM = 3.04). This demonstrates that older entrepreneurs have better capabilities in product and service commercialization, market opportunity recognition, customer demands anticipation, and competition preparedness. The finding is in line with Huang et al. (2022) who pointed out the role of entrepreneurial maturity and strategic expertise for opportunity detection and alignment with

changing client expectations. Also, DTI (2024) found that experienced entrepreneurs generally possess a greater market orientation, company planning and strategic networking.

Overall, the findings show that age does not considerably differentiate the overall Industry 4.0 preparedness of micro start-up firms, but it significantly differentiates Market-ready Competence. This is consistent with the Technology Acceptance Model and Technology Readiness perspective, as discussed in Chapter 2, which acknowledge that while age may influence some technology-related attitudes and entrepreneurial competencies, increased exposure to digital technologies and opportunities for digital upskilling can reduce generational differences in technology readiness (Davis, 1989; Parasuraman & Colby, 2019). In the view of the Dynamic Capabilities Theory, the preparation for Industry 4.0 is more closely related to the enterprise's capacity to identify opportunities, adopt innovations, and rearrange resources than to demographic features alone (Teece, 2018). Hence, interventions should be less age-based and more geared on improving technological competence, strategic leadership, organizational agility and market-oriented capacities of all ages.

Table 27-A
Significant Difference in Market Ready Competence when grouped according to age

Age Group	N	Mean	F-value	p-value	Decision on H_0	Tukey HSD Post Hoc Result
20–29	128	3.0438	2.879	.036*	Reject H_0	No significant pairwise difference
30–39	97	3.0887	—	—	—	No significant pairwise difference
40–49	57	3.2561	—	—	—	No significant pairwise difference
50 and above	18	3.4444	—	—	—	No significant pairwise difference

Table 27-A presents the test of significant variations in Market-Ready Competence among respondents when grouped according to age. A one-way ANOVA revealed an F-value of 2.879 and a p-value of .036, which was significant at the .05 level. Therefore, the null hypothesis was rejected implying that the Market-Ready Competence was significantly different across the respondent groups based on age.

The respondents aged 50 years and above achieved the highest score (WM = 3.4444) followed by the age group 40–49 years (WM = 3.2561), 30–39 years (WM = 3.0887) and 20–29 years (WM = 3.0438) as shown in the weighted means.

The aggregate ANOVA showed a significant difference but the Tukey HSD test did not reveal a statistically significant difference in any individual pair wise comparison. The closest comparison was between the 20–29 and 50+ groups, with a mean difference of -0.4007 and a post hoc p-value of .079, still over the .05 criteria. All other age group comparisons were not statistically significant. The importance of the ANOVA was that it showed differences between the age groups in general but the post hoc analysis did not find any significant difference between any specific pair of age categories.

Table 27-B
Post Hoc Details

Tukey HSD Comparison	Mean Difference	p-value	Interpretation
20–29 vs. 30–39	−0.0449	0.958	Not significant
20–29 vs. 40–49	−0.2124	0.185	Not significant
20–29 vs. 50 and above	−0.4007	0.079	Not significant
30–39 vs. 40–49	−0.1675	0.43	Not significant
30–39 vs. 50 and above	−0.3558	0.158	Not significant
40–49 vs. 50 and above	−0.1883	0.719	Not significant

Table 27-B showed the Tukey HSD post hoc analysis of Market-Ready Competence based on the grouping of respondents by age. None of the six pairwise comparisons were statistically significant (all p's > .05) as shown in the results. The highest mean difference was between those aged 20–29 and those 50 and beyond (MD = −0.4007, p = .079). However, this change was statistically non-significant. The remaining age groups comparisons also did not show significant differences.

Although the overall ANOVA indicated a statistically significant difference in Market-Ready Competence across age groups, the post hoc analysis did not find any pair of age groups that differed significantly. Following correction for multiple comparisons, no pairwise comparison accounted for the total variation in Market-Ready Competence by age.

Table 28
Significant Differences in Industry 4.0 Readiness of Micro Start-Up Enterprises According to the Sex of Enterprise Owners

INDICATORS	SEX	N	WM	F	P-VALUE	DECISION H^0	INTERPRETATION
Digital Infrastructure				5.854	0.003	Reject H^0	Significant
	Male	111	3.19				
	Female	188	3.17				
	Prefer not to say	1	1.00				
	Total	300	3.17				
Technological Competence				5.626	0.004	Reject H^0	Significant
	Male	111	3.18				
	Female	188	3.16				
	Prefer not to say	1	1.00				
	Total	300	3.16				
Market-ready Competence				5.216	0.006	Reject H^0	Significant
	Male	111	3.12				
	Female	188	3.14				
	Prefer not to say	1	1.00				
	Total	300	3.12				
Digital Culture				6.242	0.002	Reject H^0	Significant
	Male	111	3.03				
	Female	188	3.12				
	Prefer not to say	1	1.00				
	Total	300	3.08				
Data Driven Decision Making				5.126	0.006	Reject H^0	Significant
	Male	111	2.97				
	Female	188	3.06				
	Prefer not to say	1	1.00				
	Total	300	3.02				
Industry Readiness				7.427	0.001	Reject H^0	Significant
	Male	111	3.10				
	Female	188	3.13				
	Prefer not to say	1	1.00				
	Total	300	3.11				

Significant at $\alpha = 0.05$.

Table 28 displays the results of the one-way ANOVA on whether the Industry 4.0 readiness of micro start-up firms substantially changes according to the sex of enterprise owners. The category “prefer not to say” had only one respondent and hence only male and female respondents were considered for inferential analysis. The results indicated there was a significant difference in total Industry 4.0 preparedness ($F = 7.427$, $p = 0.001$). Hence, the null hypothesis was rejected. Female respondents achieved slightly higher overall weighted mean (WM = 3.13) compared to male respondents (WM = 3.10), demonstrating that both groups had similar levels of preparedness, with sex being statistically correlated to variations in Industry 4.0 readiness.

Significant differences were also observed in all five dimensions: Digital Infrastructure Readiness ($F = 5.854$, $p = 0.003$), Technological Competence ($F = 5.626$, $p = 0.004$), Market-ready Competence ($F = 5.216$, $p = 0.006$), Digital Culture ($F = 6.242$, $p = 0.002$), and Data-Driven Decision Making ($F = 5.126$, $p = 0.006$). The male respondents had somewhat higher means for digital infrastructure (WM = 3.19) and technological competence (WM = 3.18) whereas the female respondents had higher means for market-ready competence (WM = 3.14), digital culture (WM = 3.12), and data-driven decision making (WM = 3.06). These results indicate that both male and female entrepreneurs have significant technological talents, and female entrepreneurs have a somewhat higher market orientation, digital culture and use of data in operating their firms.

The findings are consistent with the literature in Chapter 2, which demonstrates that female entrepreneurs tend to display participative, flexible and relationship-oriented leadership styles which foster collaboration, flexibility and innovation (WEF, 2023; WIPO, 2024). Philippine literature also acknowledges the growing participation of women in micro and small enterprises, especially technology-enabled organizations, where client engagement and service innovation add to competitiveness (DTI, 2024; Philippine Commission on Women, 2023). The higher scores of female respondents in digital culture and data-driven decision making also align with Strategic Leadership Theory which highlights vision, innovation orientation and strategic action as significant influencers on organizational outcomes (Boal & Hooijberg, 2001).

The results reveal that sex is a significant differentiator in Industry 4.0 readiness, although the practical differences between male and female responders are rather minimal. The results especially show the more positive evaluations of female entrepreneurs in market preparedness, digital culture and data-based decision making. These findings corroborate Dynamic Capabilities Theory which highlights an organization’s ability to identify opportunities, exploit innovations and reorganize resources in response to changing situations (Teece, 2018). They also reaffirm the Chapter 2 synthesis that demographic variables may influence leadership and organizational agility and that these competencies contribute to Industry 4.0 readiness (WEF, 2023; WIPO, 2024; Teece, 2018).

Table 29
Significant Differences in Industry 4.0 Readiness of Micro Start-Up Enterprises According to the Educational Attainment of Enterprise Owners

INDICATORS	AGE	N	WM	F	P-VALUE	DECISION H^0	INTERPRETATION
Digital Infrastructure				1.986	0.116	Accept H^0	Not Significant
	High School	96	3.06				
	Vocational	32	3.13				
	College	169	3.24				
	Master's	3	2.87				
	Total	300	3.17				
Technological Competence				3.276	0.021	Reject H^0	Significant
	High School	96	3.02				
	Vocational	32	3.39				
	College	169	3.20				
	Master's	3	2.93				
	Total	300	3.16				
Market-ready Competence				2.013	0.112	Accept H^0	Not Significant
	High School	96	3.01				
	Vocational	32	3.32				
	College	169	3.15				
	Master's	3	3.13				
	Total	300	3.12				
Digital Culture				2.740	0.044	Reject H^0	significant
	High School	96	2.93				
	Vocational	32	3.09				
	College	169	3.16				
	Master's	3	3.27				
	Total	300	3.08				
Data Driven Decision Making				1.213	0.305	Accept H^0	Not Significant
	High School	96	2.91				
	Vocational	32	3.09				
	College	169	3.07				
	Master's	3	2.87				
	Total	300	3.02				
Industry Readiness				2.460	0.063	Accept H^0	Not Significant
	High School	96	2.99				
	Vocational	32	3.21				
	College	169	3.17				
	Master's	3	3.01				
	Total	300	3.11				

Significant at $\alpha = 0.05$

Table 29 shows the findings of the one-way ANOVA as to whether the Industry 4.0 readiness of micro start-up firms substantially varies by the educational level of the enterprise owners. The results demonstrated that the overall Industry 4.0 preparedness difference between the educational groups was not statistically significant ($F = 2.460$, $p = 0.063$). Consequently, the null hypothesis was accepted, showing that the overall readiness was same independent of the educational background. Vocational graduates have the greatest overall weighted mean (WM = 3.21) followed by college graduates (WM = 3.17), master's degree holders (WM = 3.01) and high school graduates (WM = 2.99), however, these variations were not significant. This means that the readiness of an enterprise for Industry 4.0 does not depend just on the formal educational level.

The individual variables of Digital Infrastructure Readiness ($F = 1.986$, $p = 0.116$), Market-ready Competence ($F = 2.013$, $p = 0.112$), and Data-Driven Decision Making ($F = 1.213$, $p = 0.305$) did not demonstrate significant variations among educational groups. The findings imply that access to digital resources, market-oriented competences and data utilization can be gained via practical experience, training, business exposure and continued professional development, not by formal education alone. This is especially true for modest start-ups, where entrepreneurs may develop digital capabilities through real company operations and accessible digital platforms. Chapter 2 further observes that while education is helpful in the adoption of technologies and digital upskilling, micro start-ups in Region XII are more reliant on technologies that are easily available such as social media, mobile payments, and online selling platforms (DTI, 2024; DICT, 2023).

In contrast, significant differences were detected in Technological Competence ($F = 3.276$, $p = 0.021$) and Digital Culture ($F = 2.740$, $p = 0.044$). Vocational graduates recorded the highest weighted mean for Technological Competence (WM = 3.39) showing that competency-based and practical education may develop abilities that are directly applicable to the use of technology. Master's degree holders in Digital Culture scored the highest weighted mean (WM = 3.27), reflecting stronger attitudes toward organizational learning, innovation, collaboration, and sustained technology use. These results are consistent with Chapter 2 literature suggesting that higher education can provide a boost to knowledge and implementation of digital technologies, and digital upskilling can boost technological capability and confidence (OECD, 2023; DICT, 2023). Also, they support the Technology Acceptance Model and the Diffusion of Innovation Theory which emphasize the value of knowledge, familiarity, learning and openness to innovation for the adoption of technology.

In general, the results reveal that educational attainment does not considerably differentiate overall Industry 4.0 preparedness of micro start-up firms, but significantly differentiate Technological Competence and Digital Culture. This means that formal education is one of the factors that contribute to the technology-related competencies but is not sufficient to evaluate the total readiness. Dynamic Capabilities Theory is where Industry 4.0 readiness is dependent on the enterprise's ability to absorb knowledge, respond to technological change and to reconfigure its resources. Strategic Leadership Theory is concerned with strategic direction, innovation and effective mobilization of organizational resources. Thus, the improvement of Industry 4.0 readiness must not be confined to formal education but rather focus on continual digital upskilling, hands-on technical training, strategic leadership, organizational flexibility, and entrepreneurial experience. This is consistent with the larger synthesis from Chapter 2 that demographic traits drive digital transformation, but that organizational competencies and adaptability are still key to Industry 4.0 readiness.

Table 29-A
Significant Differences in Technological Competence and Digital Culture According to Educational Attainment

Variable	Educational Attainment	N	Mean	F	p-value	Decision on H_0	Significant Tukey HSD Comparison	MD	Post Hoc p
Technological Competence	High School	96	3.0188	3.276	.021	Reject H_0	High School vs. Vocational	−0.375	.026
	Vocational	32	3.3938					0	
	College	169	3.2047						
	Master's	3	2.9333						
Digital Culture	High School	96	2.9313	2.740	.044	Reject H_0	High School vs. College	−0.225	.027
	Vocational	32	3.0938					0	
	College	169	3.1562						
	Master's	3	3.2667						

Note. p < .05. MD = mean difference. Only statistically significant Tukey HSD pairwise comparisons are displayed. Negative mean differences indicate that the first listed group obtained the lower mean.

Table 29-A displays the results of the test of significant differences in Technological Competence and Digital Culture when the respondents were classified according to educational attainment. Results indicated that both measures were significantly different across groups of educational attainment.

The one-way analysis of variance for Technological Competence produced an F-value of 3.276 with a p-value of .021. The p-value found was below than the .05 level of significance so the null hypothesis was rejected. This shows that the Technological Competence of the respondents significantly differs in terms of educational attainment.

The weighted means showed that respondents with vocational education had the highest Technological Competence score (WM = 3.3938) followed by college graduates (WM = 3.2047), high school graduates (WM = 3.0188) and respondents with a master's degree (WM = 2.9333). The Tukey HSD post hoc test showed a statistically significant difference between the high school and vocational groups (MD = −0.3750, p =.026). The negative mean difference revealed that the vocational group had higher Technological Competence than the high school group. All other pairwise comparisons were not statistically significant.

The one-way ANOVA for Digital Culture showed a significant difference between groups on the basis of educational attainment, F (2, 270) = 2.740, p = .044. The null hypothesis was rejected with a p-value less than the.05 significance threshold. This suggested that Digital Culture varied widely by level of educational attainment.

According to the weighted means, the highest Digital Culture score belongs to respondents with a master's degree (WM = 3.2667), followed by college graduates (WM = 3.1562), respondents with vocational education (WM = 3.0938), and high school graduates (WM = 2.9313). The Tukey HSD post hoc test showed that there was a significant difference between the high school and college groups (MD = −0.2250, p = .027). The negative mean difference suggested that the college group had greater Digital Culture score than the high school group. All other pairwise comparisons were not statistically significant.

Overall, the results showed that the level of Technological Competence and Digital Culture were significantly related to educational achievement. However, most of the significant pairwise differences were restricted to specific educational categories. For Technological Competence, the significant difference was between high school and vocational groups and between high school and college groups for Digital Culture. Thus, the observed differences were not uniformly distributed across all educational attainment levels but instead were concentrated in certain comparisons across groups.

Strategic Leadership and Organizational Agility as Predictors of Industry 4.0 Readiness of Micro Start-Up Enterprises

Table 30
Strategic Leadership and Organizational Agility as Predictors of Industry 4.0 Readiness of Micro Start-Up Enterprises

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	.503[a]	0.253	0.248	0.48903	0.253	50.220
Model		**F**	**p-value**	**Decision H_0**	**Significant**	
1	Regression	50.220	.000[b]	reject	Significant	
	Residual					
	Total					
a. Dependent Variable: INDUSTRYREADI						
b. Predictors: (Constant), ORGLAGILITY, STRATLEAD						
Model		**Unstandardized Coefficients**		**t**	**p-value**	**Interpretation**
		B	Beta			
1	(Constant)	1.098		4.957	0.000	
	strategic leadership	0.068	0.055	0.818	0.414	not significant
	organizational agility	0.545	0.464	6.858	0.000	significant
a. Dependent Variable: Industry Readiness						

Table 30 displays the outcome of the multiple linear regression study on whether organizational agility and strategic leadership are important predictors of Industry 4.0 readiness of micro start-up firms in Region XII (SOCCSKSARGEN). The model showed a multiple correlation coefficient of R = 0.503, and an R2 = 0.253, which means that the two predictors account together for 25.3% of the variance in Industry 4.0 readiness. The corrected R2 of 0.248 implies that after controlling for the number of predictors, about 24.8% of the variation is still explained. The other organizational, technological, environmental and managerial elements not included in the model account for the remaining 74.7%.

The total regression model was statistically significant ($F = 50.220$, $p < .001$), rejecting the null hypothesis. Thus, the combination of organizational agility and strategic leadership is a strong predictor of Industry 4.0 preparedness. However, when analyzing the individual variables, organizational agility was the sole significant predictor ($B = 0.545$, $\beta = 0.464$, $t = 6.858$, $p < .001$). The positive sign of its standardized coefficient means that stronger organizational agility is related to higher Industry 4.0 readiness. However, when organizational agility was included in the model, strategic leadership did not substantially predict Industry 4.0 readiness ($B = 0.068$, $\beta = 0.055$, $t = 0.818$, $p = 0.414$). It is crucial to point out that this finding does not suggest that strategic leadership is irrelevant. It was not statistically significantly unique in its contribution to the prediction of readiness in this particular regression model.

The results show that organizational agility was the most important predictor of Industry 4.0 readiness among the variables included in the model. While strategic leadership remains important for direction and innovation, the results show that the ability of micro start-up enterprises to respond quickly, adapt operations, innovate and reconfigure resources is more directly related to their readiness for Industry 4.0. Thus, the development of strategic leadership competencies and the improvement of organizational agility should be the focus of efforts to improve Industry 4.0 readiness. This interpretation is congruent with the theoretical framework of the study, which views organizational capacities and adaptability as critical processes for attaining digital transformation and competitiveness.

Proposed Strategic Agility and Industry 4.0 Readiness Enhancement Framework for Micro Start-Up Enterprises

Framework Title: **Strategic Agility and Industry 4.0 Readiness Enhancement Framework (SAIRE Framework)**

The framework indicates the need for improving the current strategic leadership capabilities of micro start-up enterprises through environmental scanning, which can be further translated into increased organizational flexibility and operational speed, supported by digital transformation initiatives that improve data-driven decision-making, thereby improving the overall Industry 4.0 readiness and eventually leading to competitive, innovative, agile and sustainable micro start-up enterprises.



Figure 2. Strategic Agility and Industry 4.0 Readiness Enhancement framework (SAIRE Framework)

The empirical findings of the study on micro start-up firms in Region XII (SOCCSKSARGEN) were utilized in the development of the Strategic Agility and Industry 4.0 Readiness Enhancement Framework. The framework offers a methodical roadmap to translate the existing strengths of micro start-up firms in strategic leadership and organizational agility into enhanced Industry 4.0 readiness. Instead of considering all dimensions as equally needing intervention, the framework places specific emphasis on the lowest-ranked dimensions within each major variable – Environmental Scanning within Strategic Leadership, Flexibility and Operational Speed within Organizational Agility, and Data-Driven Decision Making within Industry 4.0 Readiness. The framework thus represents a focused improvement strategy that is based directly on the areas identified by the study as requiring substantially more attention.

Environmental Scanning earned the lowest rank among these dimensions. Although remaining in the Highly Practiced interpretation, its significantly lower rank indicates an area where further strengthening might be good. Thus, the framework emphasizes the systematic monitoring and interpretation of the external environment. Micro start-up entrepreneurs must regularly scrutinize nascent technology, consumer tastes, competition strategies, industry advances, market prospects, regulatory changes and possible dangers. Environmental scanning is especially crucial when considering Industry 4.0 because technology and commercial factors might change quickly. An entrepreneur may have a strong vision, but this vision is more effective when regularly informed by correct understanding of changes occurring outside the firm. Thus, the framework aims to reinforce the transition from knowledge of environmental change to strategic foresight and informed strategic action.

A competitive firm is better placed to adapt to market demands and distinguish itself from its competitors. An innovative organization is able to continuously improve its goods, services, processes, and business models. An agile and resilient enterprise is able to respond to disturbances and changing consumer expectations. Finally, a sustainable enterprise can achieve long-term financial viability while responding to technological and environmental developments.

This chapter presents the summary of findings, conclusions, and recommendations of the study based on the results of the statistical analyses conducted on the strategic leadership, organizational agility, and Industry 4.0 readiness of micro start-up enterprises in Region XII (SOCCSKSARGEN).

This study determined the readiness of micro start-up businesses in Region XII (SOCCSKSARGEN) for Industry 4.0 in terms of strategic leadership and organizational agility. Specifically, it described the demographic profile of the respondents; determined the level of strategic leadership and organizational agility practiced by micro start-up enterprises; evaluated their level of Industry 4.0 readiness; identified significant differences in Industry 4.0 readiness according to demographic characteristics; investigated the predictive contribution of strategic leadership and organizational agility to Industry 4.0 readiness; and developed the Strategic Agility and Industry 4.0 Readiness Enhancement (SAIRE) Framework.

Demographic Profile of the Respondents

Most of the respondents were female, belonged to the age bracket of 20–29 years old, and had college-level educational attainment. The sample was composed of 62.7% female respondents, 42.7% respondents aged 20–29, and 56.3% respondents with college-level educational attainment. The results show that the investigated micro start-up firms were run by relatively youthful and college-educated entrepreneurs.

Level of Strategic Leadership

The overall level of strategic leadership of micro start-up firms of Region XII was Highly Practiced with a grand mean of 3.37 (SD = 0.54). Among the five dimensions, the greatest mean is found in Visionary Leadership (3.46) and the lowest mean in Environmental Scanning (3.29). However, both dimensions were read as very well practiced. The results show that tiny start-up firms are strong in strategic leadership especially in setting organizational direction and long-term goals. However, the relatively low score for environmental scanning highlights the possibility to enhance entrepreneurs' capacity to scan technology, market, competitive environment and business opportunities.

Level of Organizational Agility

Organizational Agility among Micro Start-up Enterprises in Region XII was Highly Practiced with a grand mean of 3.27 (SD = 0.56). Responsiveness and Customer Adaptability has the highest mean of 3.30 and the next highest is Innovation Capability with 3.27. Flexibility and Operational Speed received the lowest mean, 3.25, and were evaluated as Moderately Practiced.

The results reveal that smaller start-up companies show high organizational agility in general, especially in terms of change management, adaptation to client needs, and creativity. The relatively low scores for flexibility and operational speed, however, highlight possibilities for growth, especially in terms of changing organizational processes and strategies and executing operations quickly and efficiently. Organizational agility is a present strength but it may be further enhanced by making internal flexibility and speed of execution even better, and this should lead to an increased capability of the organizations to respond to fast changing commercial and technological surroundings.

Level of Industry 4.0 Readiness

The overall Industry 4.0 preparedness of micro start-up firms in the said region was Moderately Ready with a grand mean of 3.11 (SD = .66). The greatest mean among the five characteristics was for Digital Infrastructure Readiness, with 3.17, while the lowest mean was for Data-Driven Decision Making, with 3.02. Both dimensions were assessed as Moderately Ready.

The results reveal that the companies have developed fundamental digital systems and technologies that facilitate their activities. The relatively lower ranking for data-driven decision making, however, indicates that digital information is not yet completely used to support strategic and operational decisions. Therefore, in addition to developing digital infrastructure, data management, analytical aptitude, technological literacy, and evidence-based decision-making methods should be improved.

Significant Differences in Industry 4.0 Readiness According to Demographic Profile

The results indicated that the influence of demographic features on Industry 4.0 preparedness was not consistent across all ages, genders and educational backgrounds. Only Market-Ready Competence was strongly predicted by age, while the other characteristics and total Industry 4.0 preparedness did not show significant variations. Educational background substantially predicted Technological Competence and Digital Culture but not general Industry 4.0 readiness. However, sex demonstrated substantial variations in all measures of Industry 4.0 preparation and overall level of preparedness.

The results of this study reveal that demographic variables have different and dimension specific effects on the Industry 4.0 preparedness. Age and education were associated with differences in selected readiness aspects, although sex was more broadly connected with the ready measures. Thus, the results should not be taken to imply that demographic factors always have low predictive power. Instead, the influence of demographic characteristics differs across the precise facet of Industry 4.0 preparedness investigated, with sex being the demographic feature most consistently connected in the study. Therefore, efforts to improve Industry 4.0 preparedness should consider distinctions between entrepreneur groups and embrace a wider approach to organizational competencies and digital transformation.

Significant Relationship Between Strategic Leadership, Organizational Agility, and Industry 4.0 Readiness

The multiple regression analysis revealed that the total regression model was statistically significant ($F = 50.220$, $p < .001$), with $R = 0.503$ and $R^2 = 0.253$, which means that strategic leadership and organizational agility together explained 25.3% of the variance in Industry 4.0 readiness. However, examination of the individual regression coefficients revealed that only organizational agility made a statistically significant unique contribution to predicting Industry 4.0 readiness ($\beta = 0.464$, $p < .001$), while strategic leadership was not a significant predictor when organizational agility was included in the model ($\beta = 0.055$, $p = .414$).

Multiple regression analysis indicated that the total regression model was statistically significant ($F = 50.220$, $p < .001$), with $R = 0.503$ and $R^2 = 0.253$, showing that strategic leadership and organizational agility jointly explained 25.3% of the variance in Industry 4.0 readiness. Conversely, scrutiny of the individual regression coefficients indicated that organizational agility was the more robust predictor of Industry 4.0 readiness ($\beta = 0.464$, $p < .001$), while strategic leadership did not contribute statistically significantly to the prediction of Industry 4.0 readiness when both predictors were included in the model ($\beta = 0.055$, $p = .414$).

The results thus offer empirical validation for framing organizational agility as a core mechanism in the proposed SAIRE Framework, while without implying that strategic leadership is irrelevant to Industry 4.0 readiness. Instead, strategic leadership may supply the strategic direction, while organizational agility reflects the organizational capacity to translate that direction into adaptive and actionable responses to digital transformation.

Proposed Strategic Agility and Industry 4.0 Readiness Enhancement Framework

The researcher suggested the framework of Strategic Agility and Industry 4.0 Readiness Enhancement based on the outcomes of the study. Strategic leadership acts as the basis for establishing leadership competencies that enhance organizational agility, which was identified as the highest predictor of Industry 4.0 preparedness in the framework. Organizational agility helps the implementation of digital transformation efforts that improve the preparedness of digital infrastructure, technological competence, market-ready competence, digital culture and data-driven decision making. Ultimately the framework aims at developing competitive, innovative, resilient and sustainable micro start-up firms that can thrive in the Industry 4.0 environment.

Considering the foregoing findings, the following conclusions were drawn:

1. The micro start-up businesses in Region XII (SOCCSKSARGEN) were largely owned by women who were comparatively young and college-educated. The profile of the respondents reflects the features of the enterprises involved in the study and confirms the involvement of emerging and educated entrepreneurs in the regional micro start-up sector.
2. Micro start-up firms in Region XII showed well practiced strategic leadership. Visionary Leadership was a crucial strength, whereas Environmental Scanning was comparatively less developed. It implies that although organizations have

established leadership processes, they need to pay more attention to the systematic monitoring of technical developments, competitive situations, market trends, and other external changes to support proactive strategic decision-making.

3. Micro start-up firms in Region XII shown highly practiced organizational agility. Strengths were identified as Responsive Customer Adaptability and Innovation Capability, although Flexibility and Operational Speed require additional strengthening. This implies that organizations are generally able to adapt to evolving consumer and market needs but need to increase the internal flexibility and speed of execution of operational choices and modifications.
4. The micro start-up firms in Region XII showed a moderate readiness for Industry 4.0. Enterprises have prepared the groundwork for digital transformation, especially for their digital infrastructure, but they need to continue improve it to be more ready. In particular, there is a need for improved data-driven decision making and digital organizational processes to better realize the translation of available technology and information into strategic and operational gains.
5. We found that demographic variables affected Industry 4.0 readiness differently across demographic groupings and readiness dimensions. Age was significantly different for Market-Ready Competence only. Educational attainment was significantly different for Technological Competence and Digital Culture but not for the overall Industry 4.0 preparedness. Sex made a substantial difference on all Industry 4.0 readiness variables and overall preparedness. These data demonstrate that demographic parameters do not have an equal effect on the readiness of Industry 4.0, but the effect depends on the dimension of readiness.
6. Organizational agility was found to be a stronger individual predictor of industry 4.0 readiness of micro start-up firms in Region XII. When strategic leadership and organizational agility were entered concurrently into the regression model, organizational agility was a strong predictor of Industry 4.0 readiness but strategic leadership did not give a statistically significant distinctive contribution. This shows that the capacity of tiny start-up businesses to respond, adapt, innovate and alter their operations is vital in boosting their preparation for Industry 4.0.
7. The Strategic Agility and Industry 4.0 preparedness Enhancement (SAIRE) Framework provides an evidence-based pathway for enhancing the Industry 4.0 preparedness of micro start-up firms. The framework places strategic leadership as a fundamental aspect and highlights leadership capability development, organizational agility, digital transformation initiatives, and Industry 4.0 preparation. It provides a systematic approach for tiny start-up firms to increase their adaptive capacity, develop their digital competences, and move to more competitive, inventive, agile, resilient, and sustainable micro start-up enterprises.

Based on the findings and conclusions of the study, the following recommendations are presented:

1. Government agencies, LGUs, HEIs, and business support groups should develop and implement accessible and inclusive digital entrepreneurship programs within the next 12 months to ensure that training opportunities are available to micro start-up owners of all ages, genders, and educational backgrounds. The programs should include practical and easily understandable approaches such brief workshops, mentoring sessions, demonstrations and hands-on activities related to technology, company management and innovation.
2. Recommendation 5 Micro start-up founders should create a simple monthly environmental-scanning practice in the next six months. This could include looking at what competitors are doing, what customers are saying, new technology, market trends and any government programs that might be relevant. Owners can also keep a basic digital or notebook based "business watchlist" that they assess during monthly planning to identify at least one opportunity, threat or company improvement action that needs attention.
3. Micro start-up businesses should assess their typical business operations over the following 12 months and identify activities that generate unnecessary delays. Owners need to simplify their process, clearly allocate tasks, make decisions faster, and leverage cheap digital resources, such as online forms, shared documents, chat apps, digital payment systems, or inventory apps, whenever they can. Review progress quarterly to check if procedures are faster and easier to manage.
4. Industry 4.0 readiness was graded as Moderately Ready, with . Within the next six months micro start-up firms should begin to keep systematic digital records of key company information such as sales, expenses, inventories, customers and product or service performance. Owners should pick a few simple business indicators that are relevant to their operations and evaluate those records monthly to help them make decisions around pricing, inventory, marketing, customer service and resource allocation. This will enable smaller start-ups to move beyond just preserving digital records to using information to make real business decisions.
5. Demographic characteristics varied across the several dimensions of Industry 4.0 readiness, but did not provide consistent explanations for overall readiness, so support programs should be based on actual business needs and skill

gaps, rather than demographic features alone. DTI, DICT, LGUs, HEIs and other support organizations should conduct need-based trainings and mentoring on digital skills, organizational agility, innovation and technology adoption in the next 12 months. Micro start-ups should be encouraged to select interventions based on their current competencies, available resources, and the specific operational issues they face.

6. As organizational agility was the biggest indicator of Industry 4.0 preparedness, tiny start-up firms should focus on making adaptation a constant management priority over the next 12 months. Owners should encourage staff to respond quickly to consumer requests, test practical changes, adapt processes when situations change and offer new methods of doing things. A quarterly agility assessment can be done to identify operational bottlenecks, customer problems, developing opportunities and enhancements that can be executed promptly. Strategic leadership is to continue to support these efforts by offering clear direction, fostering innovation and creating an environment where staff can adapt to change.
7. Rather than expensive or complex digital transformation, a useful roadmap is suggested in the Strategic Agility and Industry 4.0 Readiness Enhancement (SAIRE) Framework. Micro start-ups may use the framework in phases focusing first on improving leadership practices, building staff capacities, enhancing organizational agility, acquiring suitable and affordable digital resources, and incrementally boosting Industry 4.0 preparedness. Over the following 12 months, organizations can utilize the methodology to identify critical skill gaps, select appropriate actions, make practical improvements and assess their progress each quarter. The framework can be used by DTI, DICT, LGUs, HEIs, and business-support organizations as a reference for mentoring, training, company incubation, digital transformation help, and enterprise development initiatives.

REFERENCES

1) **Al-Emran, M. (2023)**. Beyond technology acceptance: Development and evaluation of technology-environmental, economic, and social sustainability theory. Technology in Society, 75, 102383. https://doi.org/10.1016/j.techsoc.2023.102383
2) **Al-Mamary, Y. H., & Alshallaqi, M. (2022).** The impact of digital leadership on digital transformation: The mediating role of digital organizational culture. Journal of Innovation and Entrepreneurship, 11, Article 23. https://doi.org/10.1186/s13731-022-00218-3
3) **Al-Moaid, N. A. A., & Almarhdi, S. G. (2024).** Developing dynamic capabilities for successful digital transformation projects: The mediating role of change management. Journal of Innovation and Entrepreneurship, 13, Article 85. https://doi.org/10.1186/s13731-024-00446-9
4) **Aldaba, R. M. (2023).** Digital transformation of MSMEs in the Philippines. Philippine Institute for Development Studies.
5) **Almeida, F., Santos, J. D., & Monteiro, J. A. (2020).** The challenges and opportunities in the digitalization of companies in a post COVID-19 world. IEEE Engineering Management Review. https://doi.org/10.1109/EMR.2020.3013206
6) **Asian Development Bank. (2023).** Digital transformation and MSME development in Asia. Asian Development Bank.
7) **Baran, B. E., & Woznyj, H. M. (2021).** Managing VUCA: The human dynamics of agility. Organizational Dynamics, 50(2), 100787. https://doi.org/10.1016/j.orgdyn.2020.100787
8) **Barbu, A., Cretu, A. E., & others. (2021).** Leadership and digital transformation. Sustainability, 13(12).
9) **Boal, K. B., & Hooijberg, R. (2000).** Strategic leadership research: Moving on. The Leadership Quarterly, 11(4), 515–549. https://doi.org/10.1016/S1048-9843(00)00057-6
10) **Chen, Y., et al. (2021).** Digital leadership and innovation performance. Journal of Business Research, 124.
11) **Creswell, J. W., & Creswell, J. D. (2018).** Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). SAGE Publications.
12) **De Castro, J. (2023).** Transformational leadership and digital adoption among MSMEs in the Philippines. Philippine Management Review, 30(1), 45–60.
13) **Department of Information and Communications Technology. (2023).** Philippine digital transformation report. Department of Information and Communications Technology.
14) **Department of Science and Technology. (2023).** Innovation and technology report. Department of Science and Technology.
15) **Department of Science and Technology–Metals Industry Research and Development Center. (2022).** Industry 4.0 readiness of MSMEs. Metals Industry Research and Development Center.
16) **Department of Trade and Industry. (2023).** MSME development report. Department of Trade and Industry.

17) **Department of Trade and Industry. (2024).** Region XII MSME profile report. Department of Trade and Industry.
18) **European Commission. (2022).** Digitalisation of businesses: A guide to EU funding opportunities. European Commission.
19) **Farida, N. (2022).** Leadership and digital competitiveness in SMEs. Journal of Small Business Management, 60(4), 789–805.
20) **Gloria, J. V. (2025).** Enhancing the impact of transformational leadership on sustainability through agility and resilience with application of Lewin's change model in sustainable manufacturing. Discover Sustainability, 6, Article 770. https://doi.org/10.1007/s43621-025-01736-2
21) **Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2022).** Multivariate data analysis (8th ed.). Cengage.
22) **Huang, S., et al. (2022).** Digital leadership and transformation success. Technological Forecasting and Social Change, 175, 121–135.
23) **Kraus, S., et al. (2023).** Digital transformation in SMEs. Journal of Business Research, 150.
24) **Ng, W., & Lam, A. (2022).** Digital creativity and innovation. Creative Industries Journal, 15(3), 200–215.
25) **Nguyen, T. T., & Luu, T. T. (2020).** Leadership and innovation. Journal of Business Research, 112, 123–134.
26) **Nguyen, H., et al. (2023).** Organizational agility and firm performance. Management Decision, 61(2), 456–472.
27) **Organisation for Economic Co-operation and Development. (2023).** OECD SME and entrepreneurship outlook 2023. OECD Publishing.
28) **Shams, S. R., et al. (2021).** Organizational agility and firm performance. Journal of Business Research, 134, 1–10.
29) **Shiferaw, K., & Kero, C. (2024).** Leadership and digital transformation. Information Systems Frontiers, 26, 345–360.
30) **Su, X., et al. (2022).** Digital services and innovation. Technological Forecasting and Social Change, 173, 121–135.
31) **Teece, D. J. (2022).** Dynamic capabilities and strategic management. Strategic Management Journal, 43(1), 1–20.
32) **Teece, D. J., & Leih, S. (2022).** Dynamic capabilities and entrepreneurship. California Management Review, 64(3), 5–27.
33) **Tsolakis, N., et al. (2023)**. Food supply chain digitalization. Sustainability, 15(2), 1–18.
34) **Tsourela, M., & Nerantzaki, D.-M. (2020).** An internet of things (IoT) acceptance model assessing consumer's behavior toward IoT products and applications. Future Internet, 12(11), 191. https://doi.org/10.3390/fi12110191
35) **United Nations Conference on Trade and Development. (2024).** Digital economy report 2024. United Nations.
36) **United Nations Industrial Development Organization. (2023).** Digital transformation and SMEs. United Nations Industrial Development Organization.
37) **UNESCO. (2023).** Creative economy outlook 2023. United Nations Educational, Scientific and Cultural Organization.
38) **World Bank. (2023).** Digital economy for development report. World Bank.
39) **World Economic Forum. (2023).** The future of jobs report 2023. World Economic Forum.
40) **World Intellectual Property Organization. (2024).** Global innovation index 2024: Unlocking the promise of social entrepreneurship. WIPO. https://doi.org/10.34667/tind.50062
41) **Xu, X., et al. (2021).** Industry 4.0 readiness assessment. International Journal of Production Research, 59(10), 1–15.

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