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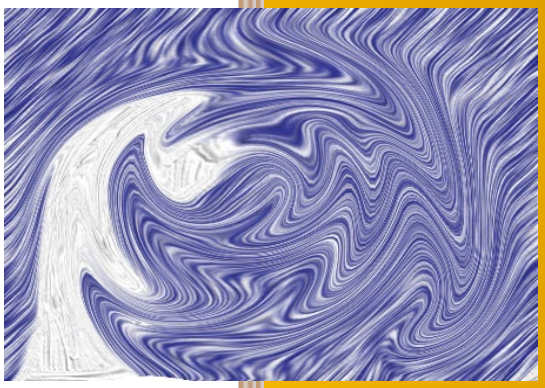

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Contents

Design Science Research: A Practical Methodology for Enhancing Qualitative Liquidity Risk Management

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Abstract: In the banking sector, managing liquidity risk is paramount to ensure financial stability and resilience. This study is motivated by a quest to determine the appropriate research methodology that satisfies both theoretical and practical aspects of designing and developing a system that integrates qualitative factors, specifically news sentiment, into liquidity risk forecasting for risk managers to rely on and use the predicted results. Previous works reveal a significant theoretical gap in liquidity risk prediction, highlighting the necessity for a methodology that bridges theoretical advancements and practical applications. The primary questions focus on evaluating how well Design Science Research (DSR) handles short-term liquidity risk prediction and the influence of qualitative factors on these predictions. The DSR approach in this study involved iterative phases of problem identification, artifact creation, and rigorous evaluation. A predictive model was developed, intertwining news sentiment analysis with quantitative liquidity ratios derived from Basel III principles. The results demonstrate that the model achieves an 86% accuracy rate in theoretical evaluations and an impressive 95.5% in real-world scenarios, outperforming traditional methods. This integration of qualitative factors into the predictive model enhances accuracy, providing a more comprehensive understanding of liquidity risk dynamics. By meeting its objectives, this study answers the posed questions that DSR can be used as a research methodology that validates not only the theoretical aspect of the problem but also the practical application of the framework. The study contributes to advancing risk management practices and suggests future work directions, reinforcing the importance of DSR methodology and similar methods considering qualitative dimensions in banking liquidity risk assessment. This advancement paves the way for more proactive and informed decision-making processes in banking institutions.

Keywords: Design science research (DSR), Proactive liquidity risk management, Liquidity risk scenarios, News sentiment, Predictive model

1. Introduction

Design Science Research (DSR) is a methodological approach that focuses on identifying problems and creating innovative artifacts to enhance technological and scientific knowledge. This study employs DSR to address the complexities associated with measuring liquidity risk in banking systems. Traditional methods of liquidity risk measurement are fraught with challenges, including complexity, time consumption, high costs, and susceptibility to errors. To overcome these issues, this research leverages DSR methodologies to develop practical solutions and innovative artifacts for liquidity risk assessment.

DSR is a top-down strategy that emphasizes problem identification and artifact creation. It aims to generate new knowledge through the development of innovative solutions that not only solve specific problems but also enhance their respective fields of application. In this study, DSR methodologies are used to create a framework for predicting liquidity risk positions in the upcoming months and scenarios. The framework draws from the Basel III model's principles of liquidity risk management, with a particular focus on short-term liquidity resilience in acute stress scenarios. The primary objective is to evaluate the real-world impact of this predictive model on liquidity risk assessment across diverse scenarios.

This research aims to identify a suitable methodology for risk prediction that incorporates qualitative factors. The objective is to develop an effective methods for assessing liquidity risk, which will assist managers in forecasting potential scenarios and taking appropriate actions. The research questions are designed to evaluate

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how well the selected methodology handle the prediction of short-term liquidity risk levels and the influence of qualitative factors, such as news sentiment, on these predictions. The ultimate goal is to bridge the gap between theoretical approaches and practical application, ensuring that the chosen methodology provides a robust and scientifically validated solution for real-world scenarios.

The DSR methodology encompasses distinct phases—Problem Identification, Design, Instantiation, and Use—each incorporating an evaluation step. This iterative process progresses from problem identification through solution provision, aiming to develop artifacts that enrich knowledge and ascertain their real-world applicability through continual interaction.

In the subsequent sections, the paper delves into a literature review (Section 2) and an in-depth discussion of the DSR methodology (Section 3), including its phases and their execution within this study. The evaluation of each DSR phase (Section 4) in this context is also elucidated. The objective and research questions in this study serve to justify the suitability of DSR as the best methodology to solve the problem of liquidity risk assessment in banking systems.

2. Literature Review

Design Science Research (DSR) constitutes a pragmatic paradigm aiming to address real-world challenges by crafting innovative solutions. Simon (1996) underscores DSR's focus on the IT artifact's applicability within specific domains. However, comprehensive investigations into the practical viability and effectiveness of these methods often remain limited to small-scale demonstrations, contributing to a gap in understanding method development and application in real-world settings (Hassel, 2012; Eden & Ackermann, 2018).

Within domains like risk science, publications providing insights into practical method development and application are notably scarce (Cedergren, 2019; Rae et al., 2020). Few studies have employed DSR in risk management, as shown in Table 1. Effiong et al. (2020) explored liquidity risk management's impact on consumer goods companies' financial performance through regression analysis. Arias (2015) proposed a software architectural design for liquidity risk management, utilizing the DSR approach in solution design and implementation.

In digital forensics, the DSR paradigm guided the development of an integrated digital forensic framework (Zhang, 2021). Similarly, Montenegro (2016) employed DSR to assess and reduce information security risks in telecommunication operators. Tavana (2018) introduced a new model employing Artificial Neural Network and Bayesian Networks to assess liquidity risk measurement through a real-world case study. Guerra (2022) utilized machine learning techniques for liquidity risk modeling in the Supervisory Review and Evaluation Process (SREP), providing stress-testing scenarios.

An (2017) proposed a model predicting financial liquidity risk using various models and statistical tests to discern variables affecting firms' liquidity statuses. Cedergren (2022) employed Action Design Research (ADR) to merge Risk Management and Business Continuity Management, focusing on theoretical advancement and practical solutions within a public sector organization.

Despite real-life constraints, ongoing research aiming to bridge the gap between method development and practical implementation remains limited. Swankie (2019) highlighted the gap in using AI to predict liquidity risk, emphasizing AI's potential to streamline risk calculation and factor identification. Nobili et al. (2021) developed an early warning system using predictive algorithms, outperforming traditional procedures. Guerra et al. (2022) investigated AI techniques in liquidity risk modeling, showcasing superior results with the XGBOOST algorithm.

Table 1: Indication of area and problem domains of recent researches –with DSR or Liquidity RM approach

RESEARCH AREA	Problem	Uses DSR	Considers Liquidity Risk Management
SUPPLY CHAIN MANAGEMENT	Lack of specification can affect coordination (Vosooghidizaji, 2020)	✓	
	Consideration of supply chain data analytic approaches (Kakhki, 2019)	✓	

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RESEARCH AREA	Problem	Uses DSR	Considers Liquidity Risk Management
RESEARCH AREA	Problem	Uses DSR	Considers Liquidity Risk Management
INDUSTRY 4.0	Lack of a digital strategy (Cavata, 2020)	✓	
	Integration and digitalization of the quality management system (Kakhki, 2019)	✓	
	Supporting the production strategy using data processing aspects (Campos, 2020)	✓	
	Optimizing resources and reducing hospital stay in intelligent hospitals (Flórez, 2020)	✓	
	Decentralization of productive system control using autonomous devices (Guirro, 2020)	✓	
	Lack of internal firm capabilities for implementing Industry 4.0 (Raj, 2020)	✓	
LIQUIDITY RISK & MANAGEMENT	Information System Architecture for Liquidity Risk (Arias, 2015)		✓
	Investigating how top managers stimulate debates without generating conflict (Pereira, 2019)		✓
	Using AI techniques for liquidity risk measurement (Tavana, 2018)		✓
	Investigating whether AI techniques can model liquidity risk (Guerra, 2022)		✓
	Early warning system for liquidity risk identification (Nobili, 2021)		✓
	Prediction of firm health in liquidity (An, 2017)		✓
	Understanding the effects of liquidity risk management on financial performance (Effiong, 2020)		✓
	Predicting liquidity risk using machine learning techniques (Swankie, 2019)		✓
CONSUMERS INTENTIONS	Factors influencing behavior & measuring actual usage (Wu, 2023)	✓	

Table 1 encapsulates diverse research domains, outlining prevalent problems within each sector and the incorporation of Design Science Research (DSR) alongside the consideration of liquidity risk management. In the realm of supply chain management, challenges encompass issues like specification deficiency affecting coordination and the integration of data analytics for improved processes. Industry 4.0 confronts barriers such as the absence of digital strategies and the need for enhanced integration in quality management systems. Liquidity risk and management explore the utilization of AI techniques for risk measurement and early warning systems. Additionally, it delves into predicting firm health regarding liquidity and studying the impact of risk management on various sectors. Consumer intentions studies the influence of factors on behavior and the implications of liquidity risk management on consumer goods companies. Lastly, within business model innovation, research examines the necessity for profound customer understanding and the role of DSR in developing innovative models, specifically focusing on liquidity risk within these models.

In reviewing Table 1, it's evident that some research within the domain of liquidity risk and management does not actively incorporate Design Science Research (DSR) methodologies. Specifically, several studies within this field focus primarily on exploring liquidity risk, its measurement, and management strategies without explicitly employing the DSR framework. This absence of DSR integration signifies a gap where traditional research methods might prevail over the systematic and iterative approach offered by DSR in addressing liquidity risk within these studies.

The Design Science Research (DSR) paradigm emerges as a promising avenue to address liquidity risk challenges. However, despite its potential, the literature reveals a substantial gap in understanding the practical viability

and effectiveness of such methods, often limited to small-scale demonstrations. Publications addressing the development and application of methods, particularly in risk science domains, remain scarce.

However, the literature review exposes a critical gap: the simultaneous exploration of liquidity risk prediction and DSR methodology. This gap forms the cornerstone of this study's novelty, aiming to integrate quantitative approaches, news sentiment analysis, and the application of liquidity risk positions as artifacts derived from established procedures like BASEL liquidity standards. Such an approach not only enhances predictive accuracy but also empowers risk managers to make informed decisions based on anticipated scenarios, ensuring preparedness through tailored plans for various contingencies.

In conclusion, while DSR holds promise in addressing liquidity risk challenges, there's an urgent need for comprehensive studies bridging the gap between theoretical advancements and practical implementations. This study seeks to fill this void by integrating DSR methodology with liquidity risk prediction, aiming to offer a holistic and practical solution in the banking sector's risk management landscape.

2.1 Liquidity Coverage Ratio (LCR)

The Liquidity Coverage Ratio (LCR) stands as one of the two conventional methods outlined by the Basel Supervisory Committee to assess a bank's capability to cover its net cash flow in the upcoming 30 days through its high-quality asset reserves. This ratio is formulated as LCR equals the quotient of quality cash assets over net outflows in the subsequent 30 days, expressed as a percentage, and it should not fall below 100%. Eq.1 delineates this criterion (BCBS, 2008). The net outflows over this period signify the discrepancy between inflows and outflows within the same duration.

(Eq. 1) $$LCR = \frac{\text{Quality cash assests}}{Net\ outflows\ over\ the\ next\ 30\ days} \geq 100\%$$

Net outflows over the next 30 days=Inflows over the next 30 days – Outflows over the next 30 days

The computation of the Liquidity Coverage Ratio involves three critical factors: firstly, the valuation of cash assets, constituting the numerator, emphasizing assets with high liquidity. Secondly, the recognition of the surplus rate between the liabilities and assets categories. Thirdly, the segmentation of requested deposits into short-term and long-term, with the application of specific coefficients for each deposit category (Tavana, 2018). However, the intricate nature of these calculations and parameter estimations makes the utilization of this ratio challenging and cumbersome in practice.

2.2 Assessment of Liquidity Risk Using Sentiment Analysis

Calculating liquidity risk based on different scenarios is a relatively complex and time-consuming task. Therefore, using traditional methods is inefficient and tedious. In these situations, machine learning and artificial intelligence methods can greatly control computational complexity. Machine learning systems have the capability to adapt to environmental changes, eliminating the need to design and write code for a variety of situations. Instead, the system can intelligently learn behaviors and events in similar situations, delivering the same behavior or an appropriate response.

With the development of artificial intelligence, Natural Language Processing (NLP) has strongly supported machine translation, spam detection, information extraction, summarization, Q&A tasks, and sentiment analysis (Jiang, 2020; Khurana, 2022). Overall, it is expected that liquidity risk can be predicted using sentiment analysis methods to estimate or predict its affecting factors.

3. Research Methodology

The research adopted the Design Science Research (DSR) methodology, a problem-solving approach aimed at advancing human knowledge through the creation of inventive artifacts. These artifacts serve to augment the technological and scientific knowledge domains by addressing problems and refining the settings in which they operate. DSR's outcomes encompass newly devised artifacts and design knowledge (DK) that undergo continuous refinement through design theories, thereby enhancing the relevance of these artifacts in various application contexts (vom Brocke et al., 2020). DSR's primary objective lies in broadening the horizons of human and organizational capabilities through the development of innovative artifacts, evident in constructs, models, methods, and instances. The knowledge pertaining to crafting such artifacts within DSR is termed Design Knowledge (DK) (Gregor et al., 2013).

This section outlines the research steps according to the DSR methodology. Various stages of DSR encompass every aspect, ranging from the problem domain linked to liquidity risk prediction to the solution domain

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connected with real liquidity scenarios. Therefore, DSR validates that the generated artifact is not only novel but also pragmatically applicable. It iterates between the realms of scientific exploration and real-world applicability to refine the artifact and ensure that the results are useful and interact effectively within the environment. In fact, in each of the six phases of Design Science Research (DSR), we develop an artifact relevant to that specific phase.

In this study, during the problem identification phase, we developed an artifact that describes the problem domain by looking forward to liquidity risk and aiming to reduce the complexity of its calculation. Subsequently, we proceeded to the second phase, defining the objectives and boundaries of the solution domain based on theories, models, and algorithms demonstrated in the literature. This involved the consideration of qualitative parameters and related data analysis techniques to simplify the calculation of liquidity risk, aligning with the artifact's relevance. Moving on to the design phase, a solution was devised utilizing a news sentiment approach to extract qualitative and environmental parameters influencing liquidity positions. This phase involved developing a theoretical solution with rigor, incorporating news data and selecting various AI algorithms to assess the impact of these parameters on liquidity risk within a nonlinear space for predictive purposes.

The theoretical solution was then practically demonstrated, taking the theory into real circumstances. The prediction artifact was utilized in actual liquidity scenarios to outline appropriate contingencies and plans. Subsequently, in the evaluation phase, the effectiveness and efficiency of the practical solution were assessed. If successful, the design science and real artifacts were communicated and published. Therefore, all artifacts generated in each phase underwent evaluation to ensure they met environmental requirements and achieved satisfactory results.

3.1 DSR Methodology

Figure 1 illustrates a conceptual framework for comprehending, executing, and appraising the design science research methodology. The environment delineates the problem space housing the focal phenomena, encompassing people, organizations, and existing or planned technologies. Within this space lie challenges and opportunities that articulate the stakeholders' organizational needs, collectively forming the 'research problem.' Aligning research pursuits with these stakeholders' needs ensures innovative research solutions. The knowledge base serves as the primary resource for driving DSR, comprising foundational theories and methodologies. Previous research outcomes and established reference procedures offer theories, frameworks, tools, models, and examples that guide the research's design phase. In the evaluation stage, methodologies dictate the processes to be employed. The research's rigor is established by drawing upon existing foundations and methodologies (Hevner et al., 2004; vom Brocke et al., 2020).

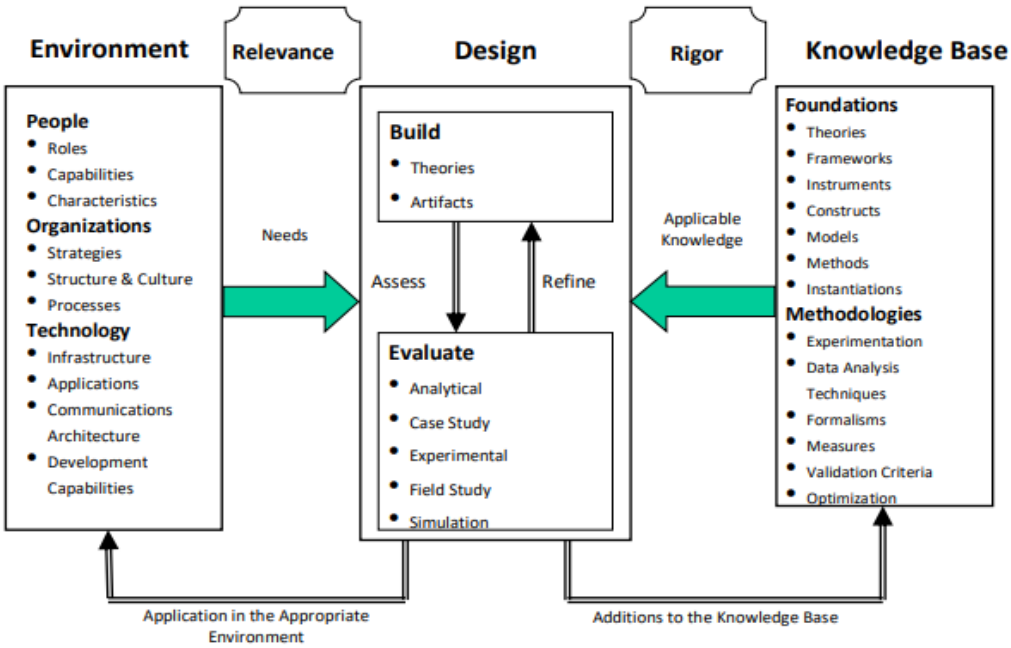

Figure 1: DSR Framework (Jan vom Brocke, 2020)

Being aware of the possibility of stress scenarios or crises, banks can be prepared and make appropriate plans to manage them. Therefore, each scenario is subjected to a certain action plan. According to the European Banking Authority (EBA), there are different plans for each risk level. A business continuity plan is appropriate when no significant risk has been identified. A business contingency plan is needed when the risk level enters the prudential range. Finally, the recovery plan is used in stress scenarios (EBA, 2021; Financial Stability Board, 2022).

The design science research method consists of six steps. Each step has its own characteristics, which are explained for this study:

1. State Problem: Identifying the problem and motivating
2. Define Objectives: Defining objectives of a solution
3. Design and Development: Designing and developing an artifact
4. Demonstration: Finding a suitable context and using the artifact to solve the problem
5. Evaluation: Observing the effectiveness and efficiency of the solution
6. Communication: Scholarly publications and professional publications

Based on the above procedure, the following sections discuss the research method.

3.2 Problem Evaluation

The identified issue has been a focal point in numerous studies. In 2018, Tavana et al. underscored that computing LCR and similar liquidity risk measures is time-consuming, challenging, and sometimes infeasible due to limited information access (Tavana et al., 2018). Additionally, Swankie et al., in a review article, pinpointed a research gap in predicting liquidity risk using artificial intelligence methods (Swankie et al., 2019).

3.3 Design and Instantiation of a Solution

This phase involved the design and instantiation of an artifact. In the context of DSR, an artifact embodies a research innovation, encompassing the definition of desired functionalities, architectural framework, and the actual creation of the artifact. In this study, the targeted artifact was a model predicting the bank liquidity risk for upcoming months. Given the problem's non-deterministic nature and the influential impact of environmental factors like news on liquidity risk, artificial intelligence methods such as text mining and sentiment analysis were applied. These methods aimed to approximate liquidity risk levels, facilitating the anticipation of potential scenarios. The researchers demonstrated a proposed model capable of approximating liquidity levels for the upcoming month.

3.3.1 Proposed model (figure 2 overview)

The proposed model encompasses several phases outlined in Figure 2, addressing various tasks delineated in the preceding section's research questions. Specifically, deep learning and machine learning techniques were utilized to estimate liquidity risk levels and identify the most influential factors derived from feature extraction. Textual news data underwent sentiment analysis to extract key qualitative features crucial for predicting LCR levels.

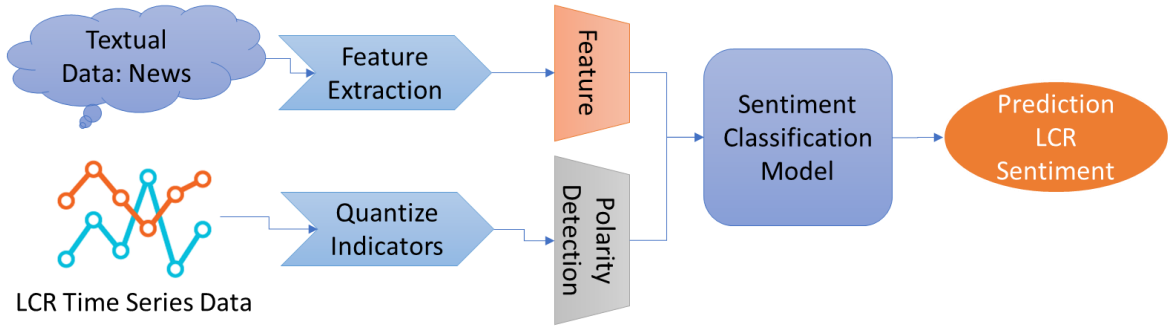

Figure 2: Overview of the research

Input sources encompass news data and computed bank LCR values. Features were extracted from textual data, focusing on feature extraction methods within text mining to identify key qualitative aspects for subsequent use. The subsequent section involved preprocessing and data preparation for subsequent steps. Additionally, the quantitative LCR data obtained from a sample bank over time required classification for use in the sentiment

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predictive model. The time series' quantitative data (LCR) was used to identify the polarity or sentiment of the news—acting as a monthly news indicator—in the area of interest, i.e., the liquidity risk level.

As depicted in Figure 2, machine learning algorithms utilized the selected features to predict the expected output or LCR level. In the case of artificial neural networks, well-predicting features are selected (activating neurons), while those exerting no influence or a counteractive effect have minimal or no impact on the network structure. Despite being a black-box method, the artificial neural network's effectiveness in nonlinear prediction and classification has been established. The evolution of natural language processing methods has transitioned from statistical and linear methods to machine learning, culminating in deep learning techniques and generative AI, notably large language models. Thus, the black-box nature of these methods doesn't imply unpredictability; scientific evaluation criteria, along with data division into evaluation, test, and training sets, ensure result accuracy and generalizability, as employed in this research. Subsequently, the model trained with validation data exhibiting acceptable accuracy underwent testing using previously unseen test data, enabling prediction comparisons with actual values. Moreover, these predictions for the current month could integrate into the liquidity risk time series data, informing future predictions.

The procedural steps are as follows:

- Collect quantitative and qualitative data from pertinent sources (banks and news agencies).
- Preprocess and normalize textual data, along with preparing (labeling) quantitative liquidity risk data.
- Identify and extract qualitative features from news utilizing text representation techniques.
- Develop a sentiment analysis model using machine learning, conventional neural networks, and deep learning methods, constituting the core focus of this project. Various algorithms were employed, parameters fine-tuned for each, and the most optimal one selected based on their comparative outcomes.
- Predict liquidity risk and evaluate the chosen model. Evaluation criteria for classification problems include accuracy, F1-score, recall, specificity, and AUC.

3.3.2 Research variables

This study involved two types of data: dependent and independent variables. The dependent variable comprised features extracted from news, while the independent variable was the liquidity risk ratio used as a predictive variable. Both qualitative and quantitative variables are detailed in Table 2.

Table 2: Research Data Sources

Variable name	Variable type	Type of data	Data time	Source of data
Liquidity Coverage Ratio	Quantitative variable	Bank liquidity risk data	April 2004 – November 2020	**A semi-private sector bank in Iran**
News quality index	Qualitative variable	News	April 2004- November 2020	**Fars News agencies**

3.3.3 Quantitative data

The bank's risk index, indicative of historical and backward-facing trends within the bank's status, was sourced from a semi-private bank as previously referenced (Nopp, 2015). Figure 3 illustrates the liquidity risk index trends of this bank from 2004 to 2020, displaying noticeable shifts in the bank's liquidity risk.

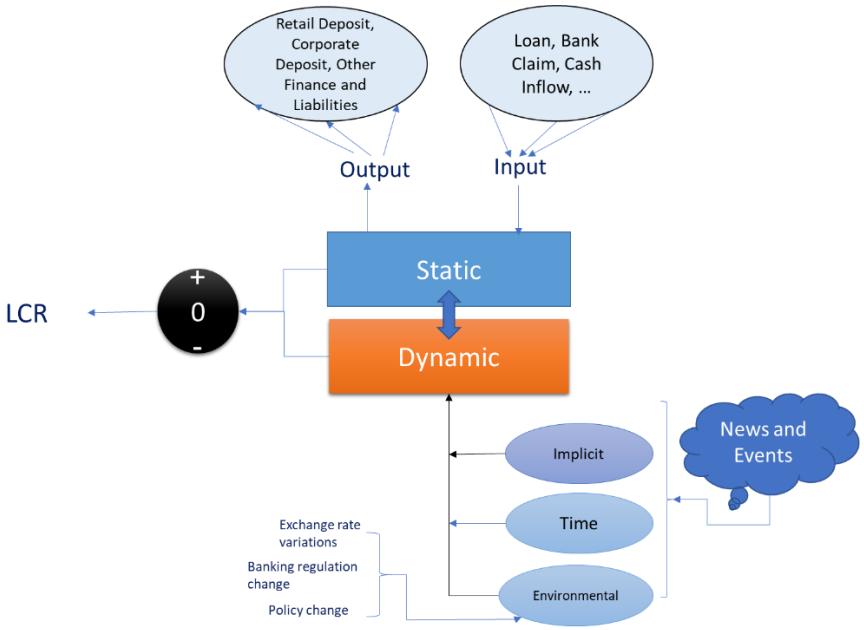

Figure 3: Trend chart depicting the liquidity risk index of the bank under validation throughout the study duration

3.3.4 Collection and preprocessing of qualitative data

In this study, news data were gathered and scraped from the reputable website of Fars News Agency. Extracted from https://www.farsnews.ir/archive between April 2004 and November 2020, these details were consolidated into a table that included news summaries, types, bodies, titles, and dates. For keyword extraction, the summary, title, and body of each news item were combined into a full-text input for subsequent feature extraction. As asserted by Töws (2018), news, being forward-looking, impact the future; hence, the data collection period should match that of liquidity risk data.

3.3.5 Design and instantiation of the solution

In this section, we evaluated the outcomes of the design and instantiation model applied to the bank's liquidity risk data and the gathered news. As previously outlined, the news data were consolidated into sets of 300 and 500 items, and the model was trained utilizing the features matrix, with labels denoting the bank's liquidity risk level. These labels were constructed in both triple-class and quintuple-class formats. Consequently, the input data (refer to Table 3) comprised four cases that were fed into two classifiers: the Feedforward Neural Network and the Convolutional Neural Network. Varied hyperparameters were established for each algorithm. The dense units were indicative of the number of neurons in dense layers. Specific details including activation functions, optimizer methods, input quantities as batch sizes, and the number of training epochs were specified for each evaluation case.

Table 3: Input data modes presents the input data options to the learning model

N	Number of samples	No of Train Samples	No of Test Samples	No of Validation	Type of combination	Number of classes
1	14169	9918	2125	2126	300	3
2	14169	9918	2125	2126	300	5
3	1000	5978	1281	1281	500	3
4	1000	5978	1281	1281	500	5

Feedforward Neural Networks:

In feedforward neural networks, a sequential model composed of standard Dense layers is employed. In these layers, all nodes in one layer are connected to all nodes in the next layer. Before utilizing Dense layers, the number of neurons in each layer must be specified, known as a hyperparameter or Unit, and its suitable value is obtained through experience. Another important point is that before passing outputs from one layer to

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another, they must pass through a non-linear activation function, such as RELU, which is commonly used. This activation function is determined by the activation hyperparameter and maps weighted inputs to neuron outputs. Lastly, for classification problems, the Softmax activation function is typically used in the final layer. The Loss hyperparameter in neural networks represents the loss function, measuring the distance between predicted outputs by the network and the desired outputs. The Optimizer hyperparameter indicates the optimization algorithm that adjusts the weights to minimize error. This algorithm is executed iteratively until an optimal solution is reached.

Convolutional Neural Networks:

In convolutional neural networks (CNNs), one-dimensional convolutional layers, one-dimensional Max Pooling layers, and dense layers are utilized. This research employs a multi-layer CNN for predicting bank liquidity risk. The primary core of the CNN is the convolutional layer, responsible for the majority of computations within the network. Each convolutional layer in a CNN comprises a set of filters, constructing the output by convolving these filters with the input layer. Hyperparameters like Filters in the Conv1D layer represent the number of detected features (output space dimensions), while Kernel_size defines the length of the convolution window in the Conv1D layer.

The objective of the Max Pooling layer is to reduce the spatial size of the feature matrix obtained from the convolutional layer. Unlike the convolutional layer, the Max Pooling layer doesn't possess trainable parameters; it conducts simple yet effective subsampling. The Pool_size hyperparameter in the MaxPooling1D layer determines the size of the Max Pooling window. Typically, the final layers of a CNN serve as dense layers for classification purposes, transforming the extracted feature set into a vector and passing it through a dense classification layer to identify the corresponding class.

3.3.6 Evaluation of the Design and Instantiation Phase

Next, the results pertaining to validation accuracy, test accuracy, precision, recall, and F1-Score for both algorithms are presented in Tables 4 and 5. Additionally, other metrics such as imbalanced accuracy, Cohen's kappa, and ROC AUC are utilized. Several studies have attempted to address the challenge of learning multiclass scoring functions using AUC metrics (Gimeno, 2021).

Table 4: Results of evaluation criteria obtained from the Deep Learning Network

Feedforward Neural Network													
Triple													
Bin size	**Dens e units**	**Activation**	**Optimizer**	**Batch size**	**Epochs**	**val_acc**	**test_acc**	**Precis ion**	**Recall**	**F1 score**	**Balance Accuracy**	**Cohens kappa**	**ROC AUC**
300	512-256-128-64	relu	adam	8	29	83.11	84.1	83.56	84.07	84.1	84.07	75.88	95.44
500	512-256256	relu	rms	64	43	88.91	88.6	88.5	88.63	88.6	88.56	82.75	97.56
Quintuple													
300	1024-512-256128	relu	rms	64	19	84.85	88.29	88.23	88.5	88.29	88.31	85.31	98.53
500	512-256128	relu	rms	64	42	87.35	82.51	82.19	83.42	82.51	82.3	78.04	97.22

In terms of test accuracy, one of the key evaluation criteria for the models, the highest results were observed in the feedforward neural network, achieving approximately 88.6% accuracy with a combination of 500 and triple-class, slightly decreasing to 88.29% with the quintuple-class and a combination of 300. Moreover, the feedforward neural network algorithm exhibited the highest precision, recall, and F1-Score of 88.5%, 88.63%, and 88.6%, respectively, for the combination mode of 300 in the 5-class setup. Another critical metric, ROC-AUC, also favored the feedforward neural network algorithm, reaching approximately 98.53% with the combination model of 300 in the quintuple-class configuration, closely followed by the feedforward neural network with the combination model of 500 in the triple-class configuration.

Table 5: Results of validation criteria obtained from the Convolutional Neural Network

Convolutional Neural Network															
Triple															
Bin size	Filter s	Kern el size	Pool size	Dens e units	Activation	Optimize r	Batch size	Epochs	Balance Accuracy	test_acc	Precision	Recall	F1 score	Cohens kappa	ROC AUC
300	64128256	3	2	256	relu	adam	8	25	82.07	81.7	81.73	82.02	81.7	81.78	72.38
500	64-128	3	2	128	relu	adam	32	21	84.07	**83.29**	82.74	83.32	83.29	83.26	74.63
Quintuple															
300	128-256512	3	2	512	relu	rms	16	16	80.24	81.19	80.9	81.41	81.19	81.22	76.39
500	64128256	3	2	256	relu	adam	64	30	80.95	82.28	82.15	82.33	82.28	82.28	77.78

Considering the outcomes across all criteria, the deep neural network algorithm emerges as a promising model for predicting bank liquidity risks based on qualitative news data.

3.4 Demonstration and Evaluation of the Solution in Practice

Following the Design Science Research (DSR) approach, this section examines the practical application of the proposed model. Initially, the results from the prior step were readied for use. Subsequently, potential scenarios were delineated based on specified ranges derived from the liquidity risk levels of banks. These scenarios were compared with predicted scenarios generated from the instantiation phase to ascertain prediction accuracy. As presented in Table 6, the test data from earlier steps were classified into monthly news. Employing the combination mode (explained in the instantiation phase), each month's news was segmented into several samples (each containing 'm' news pieces). Each sample was fed into the model to predict the subsequent month's liquidity level. As shown in Figure 4, to standardize the labels for each month derived from the risk level of each sample, a voting method was adopted. For instance, if the first month had 20 samples and the labels were predicted 10, 7, and 3 times respectively, the most frequently predicted label was considered the selected label for that month.

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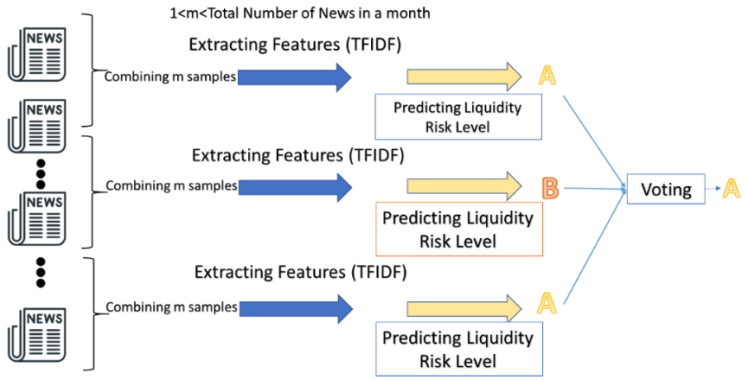

Figure 4: Predicting monthly liquidity level using voting method

The possible liquidity risk scenarios were derived from the risk range defined in Basel. Particularly, the Liquidity Coverage Ratio (LCR), introduced as a liquidity risk measurement index on January 1, 2015, was initially set at a minimum requirement of 60%, gradually increasing by 10% annually to reach 100% by January 1, 2019. This incremental approach aimed to ensure LCR adoption without significantly disrupting banking systems or ongoing economic financing (Basel III: The Liquidity Coverage Ratio and Liquidity Risk Monitoring Tools, 2013). This Basel approach defined two ranges:

- A safe range: above the permissible LCR limit.
- An unsafe range: below the permissible LCR limit.

The European Central Banking Supervision defined four different LCR ranges, establishing three primary thresholds: a recovery indicator, a warning indicator, and a critical indicator. Hence, four main ranges were identified using three thresholds set by the European Banking Authority (EBA). Each range had distinct action plans: a recovery plan for the critical range, a contingency plan for the warning range, and a business continuity plan for the safe range. These ranges were vital in characterizing the investigated scenarios. The following table (Table 6) illustrates the diverse LCR ranges based on the Basel Committee guidelines and EBA Risk Assessment procedures. Furthermore, these ranges were cross-validated with the risk departments of the assessed banks to verify their efficiency and effectiveness (RISK ASSESSMENT OF THE EUROPEAN BANKING SYSTEM, 2021).

Table 6: LCR ranges extracted from BASEL and EBA

YEAR / LCR Risk Range	Before 2016	2016-2017	2017-2018	2018-2019	After 2019
Completely Safe Range	>65	>75	>85	>95	>105
Safe Range	60-65	70-75	80-85	90-95	100-105
Warning Range	20-60	30-70	40-80	50-90	60-100
Critical Range	<20	<30	<40	<50	<60

In this context, the Liquidity Coverage Ratio's (LCR) potential scenarios in banks were categorized into twelve distinct scenarios, each outlined in the EBA report, with specific importance for the bank, necessitating appropriate action plans. Therefore, the identification and anticipation of potential scenarios based on the bank's current situation for the upcoming month were crucial, allowing the bank to proactively mitigate or hedge risks before they materialize (RISK ASSESSMENT OF THE EUROPEAN BANKING SYSTEM, 2021).

Table 7: Scenarios extracted from 4 ranges of LCR

Scenario No	Source range	Destination range	Risk Type	Action from perspective of regulatory	Action from perspective of shareholder
1	Safe Range	Completely Safe Range	Decrease Risk	No action needed	Invest in cases with less liquidity and more profit
2	Completely Safe Range	Safe Range	Increase Risk	No action needed	No action needed

Scenario No	Source range	Destination range	Risk Type	Action from perspective of regulatory	Action from perspective of shareholder
3	Safe Range	Safe Range	Constant Risk	No action needed	No action needed
4	Safe Range	Warning Range	Increase Risk	Invest in cases with more liquidity	Invest in cases with more liquidity
5	Warning Range	Safe Range	Decrease Risk	No action needed	No action needed
6	Warning Range	Warning Range	Constant Risk	Invest in cases with more liquidity	Invest in cases with more liquidity
7	Warning Range	Critical Range	Increase Risk	Low liquidity assets should be sold	Low liquidity assets should be sold
8	Critical Range	Warning Range	Decrease Risk	Invest in cases with more liquidity	Invest in cases with more liquidity
9	Critical Range	Critical Range	Constant Risk	Low liquidity assets should be sold	Low liquidity assets should be sold
10	Critical Range	Safe or Completely Safe Range	Decrease Risk	No action needed	Invest in cases with less liquidity and more profit
11	Safe or Completely Safe Range	Critical Range	Increase Risk	Low liquidity assets should be sold	Low liquidity assets should be sold
12	Completely Safe Range	Completely Safe Range	Constant Risk	No action needed	Invest in cases with less liquidity and more profit

The table above (Table 7) delineates potential scenarios derived from the LCR ranges, approved by the bank's liquidity risk management experts. Moreover, corresponding actions for each scenario should refer to the financial report of the EBA, outlining actions or improvement programs (Supervision, 2018). Subsequently, discussions revolve around scenarios observed within the bank's actual data, utilizing liquidity risk predictions derived from the preceding phase, converted into monthly predictions using the voting method in the prior segment.

Identifying the scenarios in the target bank based on possible scenarios and matching these with the monthly predictions. To evaluate the occurred scenarios and compare them with the monthly predictions from the previous step, these scenarios were identified using available LCR data. They were then compared with the predictions made, assessing the association between the predicted risk levels of the triple and quintuple classes calculated monthly. Figure 5 depicts the scenarios observed in 2019 and 2020, showcasing liquidity risk across the completely safe, warning, and critical ranges, totaling scenarios 6, 7, 8, 9, 11, and 12.

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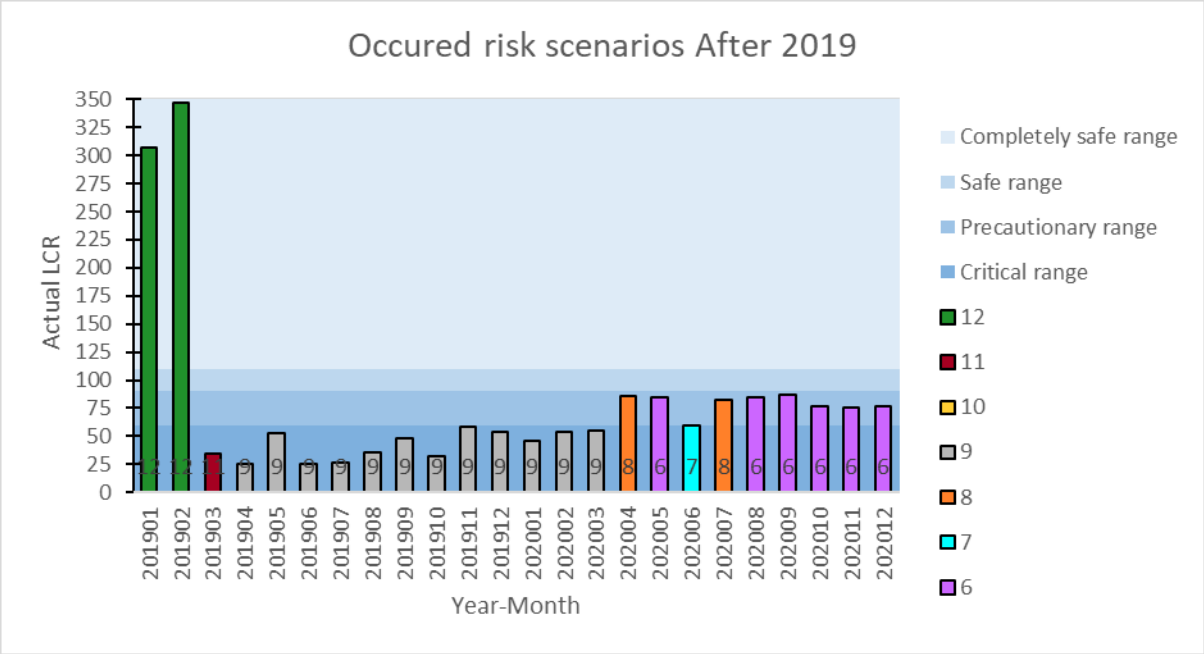

Figure 5: Scenarios that occurred after in the different ranges of liquidity risk

Figure 6 illustrates liquidity risk and its predicted levels, showcasing changes in green (increase), red (decrease), and gray (constant) colors for the combination of 300 and Quintuple class using the deep learning method. The consistency between predicted liquidity levels and LCR value changes across different months is evident. It also displays the labeling of five classes using the deep learning method, depicting trends of increase and decrease, well-aligned with LCR changes. Other prediction modes based on the deep learning algorithm corroborated these findings. These diagrams effectively cover the transitions between safe and unsafe ranges as per the wing committee's instructions in various cases.

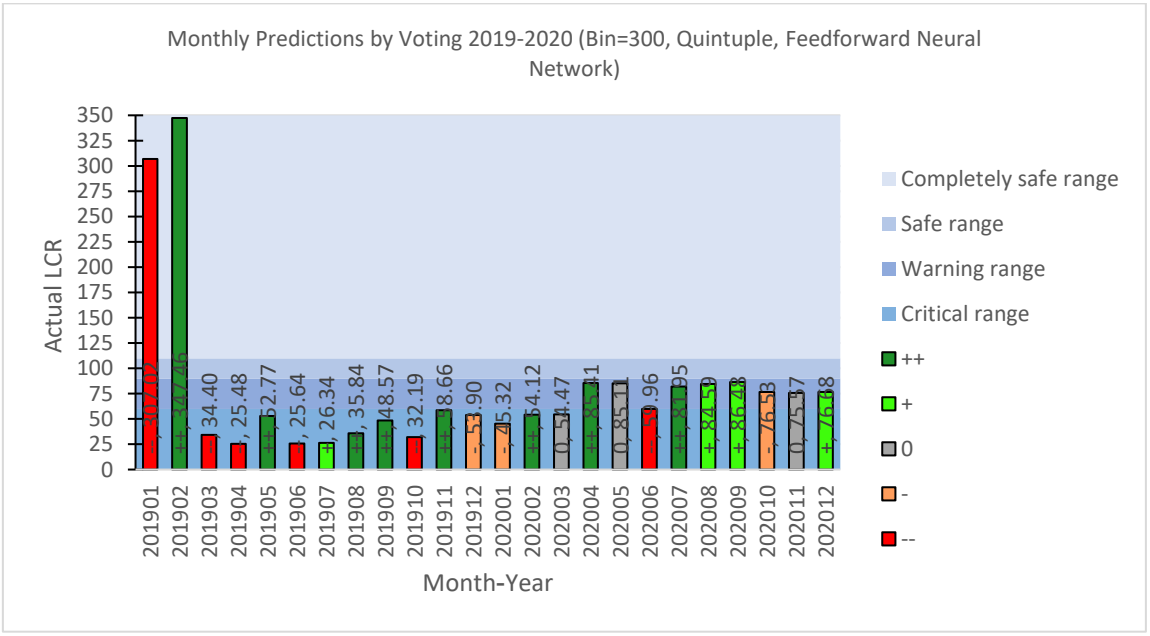

Figure 6: Sentiment prediction with deep learning method, combining 300 and Quintuple tags in months post-2019, depicting actual liquidity changes (++ high increase, + increase, 0 no change, and – low or high decrease compared to the previous month)

Tables 8, 9 compares the liquidity risk level results from occurred scenarios and predicted scenarios via triple-class and quintuple-class methods. In 2019, approximately 64% of the scenarios were accurately predicted.

Similarly, in 2020, around 83% of the triple-class mode and approximately 92% of the quintuple-class mode were correctly recognized.

Table 8: Comparison between risk levels in occurred scenarios and the prediction of risk sentiment each month in the year 2019

Predicted sentiment of monthly risk - Quintuple Mode	Predicted sentiment of monthly risk – Triple Mode	Risk level based on occurred scenarios	Type of occurred scenarios	Date
No change	No change	No change	Scenario 12	02-2019
Significant Increase Risk	Increase Risk	Significant Increase Risk	Scenario 11	03-2019
No change	No change	No change	Scenario 9	04-2019
Significant Decrease Risk	Decrease Risk	No change	Scenario 9	05-2019
No change	No change	No change	Scenario 9	06-2019
No change	No change	No change	Scenario 9	07-2019
Significant Decrease Risk	Decrease Risk	No change	Scenario 9	08-2019
Significant Decrease Risk	Decrease Risk	No change	Scenario 9	09-2019
No change	No change	No change	Scenario 9	10-2019
Significant Decrease Risk	Decrease Risk	No change	Scenario 9	11-2019
No change	No change	No change	Scenario 9	12-2019

Table 9: Comparison between risk levels in occurred scenarios and the prediction of risk sentiment each month in the year 2020

Predicted sentiment of monthly risk - Quintuple Mode	Predicted sentiment of monthly risk – Triple Mode	Risk level based on occurred scenarios	Type of occurred scenarios	Date
No change	No change	No change	Scenario 12	01-2020
Significant Decrease Risk	Decrease Risk	No change	Scenario 12	02-2020
No change	No change	No change	Scenario 11	03-2020
Significant Decrease Risk	Decrease Risk	Decrease Risk	Scenario 9	04-2020
No change	No change	No change	Scenario 9	05-2020
Significant Increase Risk	Increase Risk	Increase Risk	Scenario 9	06-2020

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Predicted sentiment of monthly risk - Quintuple Mode	Predicted sentiment of monthly risk – Triple Mode	Risk level based on occurred scenarios	Type of occurred scenarios	Date
Significant Decrease Risk	Decrease Risk	Decrease Risk	Scenario 9	07-2020
No change	No change	No change	Scenario 9	08-2020
No change	No change	No change	Scenario 9	09-2020
No change	Increase Risk	No change	Scenario 9	10-2020
No change	No change	No change	Scenario 9	11-2020
No change	No change	No change	Scenario 9	12-2020

4. Evaluation and Finalization of the DSR Cycle

This assessment analyzed various scenarios occurring between 2019 and 2020, comparing the outcomes (scenarios) with the predictions from the instantiation phase. Ultimately, it assessed the practical solution's accuracy. The Table 10 illustrates the practical model's accuracy, considering scenarios across different years, reflecting BASEL's perspectives on safe and unsafe ranges, and referencing EBA's four mentioned ranges (completely safe, safe, precautionary, critical). Subsequently, it evaluated whether the DSR cycle was concluded based on the obtained results.

Table 10: Evaluation of Prediction accuracy of risk level in occurred scenarios

Year under assessment		Accuracy of Predicted Scenarios		
		2019	2020	Average
Accuracy of Prediction In Basel Range	*Triple Class*	91%	100%	95.5%
	Quintuple Class	91%	83%	87%
Accuracy of Prediction in EBA	*Triple Class*	83%	64%	73%
	Quintuple Class	92%	64%	75%

Using the DSR approach enables the enhancement of liquidity risk prediction in the bank by considering qualitative factors. As depicted in Table 9, integrating qualitative factors into the prediction model through sentiment analysis techniques achieves a high accuracy rate, approximately 95.5% with the best-selected parameters. This outcome underscores the strong performance of the proposed model. Hence, the DSR cycle is concluded and does not require further continuation.

4.1 Ex Ante and Ex Post Evaluation Results

This section assesses the outcomes derived from the practical solution of the research, adhering to the DSR evaluation framework introduced by Pries-Heje et al. (Pries-Heje, 2008). The framework encompasses four aspects of DSR evaluation, mapping criteria to Ex Ante vs Ex Post and artificial vs naturalistic evaluations, as illustrated in the table below.

Table 11: DSR Evaluation Strategy Selection Framework for this study

DSR Evaluation Strategy Selection Framework		Ex Ante	Ex Post
		Formative Lower Build Cost Evaluate Design Artifacts Less Risk To participants	Summative Slower Evaluate Instantiation Higher Risk To Participants
Naturalistic	Socio-technical Artifacts Higher Cost Organizational Access needed Artifact Effectiveness Evaluation Higher Risk Participants		Real User/Real System and Real Problem Highest Risk to Participants Best Evaluation of Effectiveness Identification of side effects
Artificial	Purely Technical Artifacts Desired Rigor: Control of variable Artifact Efficacy Evaluation Less Risk During Evaluation	Unreal User/ Unreal System Lowest Cost Fastest Lowest Risk To participants	

Table 11 indicates that in Ex Ante evaluation, DSR Research was mapped to artificial evaluation methods (designing purely technical artifacts), while for Ex Post evaluation, it was mapped to naturalistic evaluation methods (real technical artifacts or case studies). Artificial evaluations involve activities like experimentation and observation. The dominance of the scientific/rational paradigm in artificial DSR evaluation provides benefits like stronger scientific reliability, better repeatability, and falsifiability. This study utilized criteria-based analysis (data analysis) to validate the Ex Ante phase.

Conversely, naturalistic evaluation involves assessments in real environments (involving real people, real systems, and real settings), which are empirical and may be interpretive, positive, or critical. This study applied empirical evaluation in the Ex Post phase of DSR, employing scenario analysis within a case study to identify and evaluate the application of solutions in a real situation. Table 12 presents the evaluation method and corresponding results for Ex Ante and Ex Post phases, along with the outcome of each phase.

Table 12: DSR Evaluation Method Selection Framework for this study

DSR Evaluation Method Selection Framework	Ex Ante	Ex Post
Naturalistic		Scenario Analysis Case Study Accuracy = 95.5%
Artificial	Data Analysis Criteria Based evaluation Accuracy=88.6%	

5. Conclusion

This study set out to identify a suitable methodology for risk prediction in the principles of the Basel III model, with a focus on short-term liquidity resilience in acute stress scenarios. Through iterative phases (DSR) of problem identification, design, instantiation, and use, we sought to bridge the gap between theoretical evaluations and practical implementation, providing a scientifically validated solution applicable in real-world scenarios. The DSR method evaluated the real-world instantiation to assess its applicability and validity. Initially, the results underwent assessment within an instance, followed by testing the instantiation stage outcomes in real-case scenarios.

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The practical findings shows the method's accuracy in predicting occurrence scenarios, approximately 75% within four EBA ranges and 95.5% across two Basel ranges in the ex post naturalistic evaluation phase. Considering the accuracy in predicting scenarios and aligning with the evaluation criteria within the DSR methodology across four steps—identification, design, instantiation, and use—the study indicated the methodology in similar design instances (Ex Ante Artificial Evaluation) and its practical application in real scenarios (Ex Post Naturalistic Evaluation).

The research questions guiding this study were designed to assess the efficiency and efficacy of our methodology. The results demonstrated that DSR is a highly effective methodology for addressing complex and time-consuming calculations in financial and risk management problems. While this research focused on the initial iteration due to satisfactory results, future research could incorporate action research to further enhance artifact development and address issues simultaneously.

In conclusion, this study highlights the importance of using a structured research methodology like DSR to develop effective solutions for complex financial problems. The framework and insights generated contribute significantly to liquidity risk management, providing practical tools and knowledge to help banks navigate financial challenges. The proposed DSR approach has shown high accuracy and generalizability in predicting liquidity risk, validating its applicability and establishing a strong foundation for future research and improvements.

Ethical statements: This article does not contain any studies with human participants performed by any of the authors.

Competing interests: Hamed Mirashk as first author and other authors declare no competing interests.

Availability of data/materials: The data that support the findings of this study are available from here and news from here but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Central Bank of Iran.

Source code as supplementary material is also provided here. The source code contains all the custom computer code used to generate results that are reported in this paper and central to its main claims.

Informed consent: This article does not contain any studies with human participants performed by any of the authors.

Author Declaration on AI Tools and Services: The authors affirm that no artificial intelligence (AI) tools or services were used in the creation, analysis, writing, or editing of this manuscript. All content, including text, analysis, and figures, is the result of the authors' independent efforts and original work.

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The Impact of Business Intelligence on Strategic Ambidexterity: The Mediating Role of Knowledge Sharing

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Abstract: This study investigates the mediating role of knowledge sharing in the relationship between business intelligence and strategic ambidexterity within Jordanian telecommunication companies. Utilizing a descriptive analytical approach, data were collected through an electronic questionnaire distributed to 350 managers, yielding 269 valid responses analysed via Structural Equation Modelling (SEM) with Smart PLS 4.1. The methodological rigor of employing SEM allows for a nuanced examination of the complex interplay among latent variables, which include business intelligence (with constructs such as Data Mining, Data Warehousing, OLAP, and Reporting) and strategic ambidexterity (focusing on Exploration and Exploitation).Findings reveal that all latent variables exhibit significant importance, with business intelligence positively impacting strategic ambidexterity, mediated by knowledge sharing. These results advocate enhanced knowledge sharing practices within organizations, enabling internal experts to leverage insights into external opportunities through well-structured business intelligence reports. Overall, this research contributes to the advancement of methodology in business and management by establishing a robust framework for analysing the mediating effects of knowledge sharing, while providing actionable insights for enhancing strategic decision-making in the telecommunications sector. Future studies may further explore the dynamics of these relationships across different industries, thereby enriching the field of business management research.

Keywords: Business intelligence, Strategic ambidexterity, Knowledge sharing, Telecom, Jordan

1. Introduction

In today's rapidly evolving business landscape, organizations are constantly challenged by ongoing technological advancements, shifting consumer demands, and the unescapable impact of globalization (Hijazin, Tamayo-Torres & Nusairat, 2023). For sustainable growth, this has led to the requirement for digital synergies—the balancing of strategy, innovation, and technology (Alshdaifat et al., 2024). Businesses must balance the two imperatives of efficiency and long-term adaptation through innovation in order to achieve these synergies. The key to this is strategic ambidexterity, which is the capacity to take advantage of what you already have while looking for fresh growth prospects (O'Reilly & Tushman, 2013). Strategic ambidexterity is an essential organizational skill, particularly in industries with high levels of technology disruption and market instability, such as telecommunications (Masa'deh et al., 2024). It means managing the balance between exploitation optimizing current operations for efficiency – and exploration – fuelling innovation and positioning the organization for future success (Li et al., 2022). Achieving this balance is essential to developing digital synergies that will enable organizations to adapt and prosper in a rapidly evolving business environment.

Business intelligence (BI), a collection of methodologies and technologies that transform data into insights, is one of the main drivers of these synergies. Decision-making, operational excellence, and innovation are enhanced by BI technologies such as data mining, data warehousing, online analytical processing (OLAP), and advanced reporting (Cardoso et al., 2023; Rialti et al., 2023).

But for BI to really deliver on strategic ambidexterity it needs to be accompanied by knowledge sharing. Knowledge sharing ensures that insights generated by BI systems are shared across organizational units, bridging

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the gap between data driven strategies and execution. This practice improves both exploratory and exploitative activities and organizational agility and innovation (Zamiri & Esmaeili, 2024). Digital platforms can promote collaboration and learning, as evidenced by research by Khanchel (2023) that identifies a number of factors impacting Tunisian students' use of social networks for knowledge sharing.

Khanchel (2023) highlighted a number of important elements that influence social network involvement, including perceived utility of online networks, trust in digital platforms, and ease of access. These findings highlight how digital environments support seamless knowledge sharing, which is essential for encouraging innovation and strategic decision-making within businesses. This aligns with the growing role of digital tools in corporate knowledge management. Even though it is crucial, little is known about how information sharing functions as a bridge between BI and strategic ambidexterity, particularly in sectors like telecoms where quick changes in technology necessitate integrated and flexible approaches (Popovič et al., 2012; Eidizadeh, Salehzadeh, & Chitsaz Esfahani, 2016).

Although the importance of business information and knowledge sharing in promoting ambidexterity is becoming more widely recognized, an adequate understanding of the mechanisms underlying these connections is still lacking. While some studies indicate that business intelligence can enhance both exploration and exploitation, others highlight the difficulties that come with complicated decision-making in dynamic settings, which might minimize the usefulness of business intelligence (Ayadi et al., 2024).

Despite its significance, little is known about the function that information sharing plays as a mediator in this situation, which highlights a crucial subject for further research (Zhang, Wang, & Chun 2022). In order to establish long-lasting digital synergies in Jordanian telecom companies, the current study intends to investigate how information sharing mediates the relationship between business intelligence and strategic ambidexterity. The goal of this investigation is to provide insight into how organizations might improve their strategic flexibility by leveraging knowledge exchange and business information. (Alghadi et al, 2024).

The study's findings will offer practical advice to organizations looking to foster a culture of information exchange while effectively utilizing business intelligence to strike a balance between operational optimization and creativity. Organizations seeking to promote a culture of knowledge sharing while efficiently employing business intelligence to facilitate both exploration and exploitation will find useful advice in the study's conclusions.

Jordanian communication companies are facing increasing difficulties in a dynamic and rapidly changing commercial environment. These businesses must improve their capacity to investigate new opportunities, seize them for business continuity, and successfully use business intelligence if they hope to endure and compete (Rialti et al., 2023). However, little is known about how business intelligence affects strategic ambidexterity and how information sharing may operate as a mediator in this relationship (Popovič et al., 2012). The findings of this study may provide valuable information for businesses seeking to strengthen their information systems and ambidexterity in order to attain better and more sustainable performance, guaranteeing long-term competitiveness and flexibility (Badwan, 2024; Alhasnawi et al., 2024).

This study makes significant contributions to achieving sustainable digital synergies in dynamic business environments. First, it addresses a gap in the literature by examining the relationship between business intelligence and strategic ambidexterity, specifically analyzing how components of business intelligence such as data mining, data warehousing, OLAP, and reporting affect the two key dimensions of strategic ambidexterity: exploration and exploitation. Second, the research explores whether knowledge sharing serves as a mediating factor in this relationship, potentially strengthening the link between business intelligence and strategic ambidexterity. Third, it offers a new perspective on how knowledge sharing enhances the connection between business intelligence and strategic ambidexterity, emphasizing its role in amplifying the positive effects of business intelligence on an organization's ability to balance ambidextrous capabilities. Theoretically, the study provides a deeper understanding of how business intelligence, knowledge sharing, and strategic ambidexterity interact. It highlights the critical role of knowledge exchange in balancing exploratory and exploitative activities, contributing to the ongoing discussion on strategic ambidexterity. Additionally, by investigating business intelligence's strategic role beyond its operational functions, this research broadens the scope of the literature on organizational flexibility and strategy. The findings provide valuable insights into the relationship between business intelligence, knowledge sharing, and strategic ambidexterity within the context of ambidextrous strategy development.

2. Research Gap

There is still a great deal to learn about how knowledge sharing mediates the relationship between business intelligence (BI) and strategic ambidexterity, particularly in rapidly changing industries like telecommunications, despite the growing body of research on BI and its role in improving organizational performance. Prior studies, such as Rialti et al. (2020), has looked at how knowledge management can help achieve strategic flexibility in the big data era. However, neither the telecom industry, where maintaining competitive advantage requires striking a balance between exploration and exploitation, nor knowledge sharing as a mediating factor were specifically examined. Furthermore, Popovič et al. (2012) highlighted the impact of organizational culture and BI system maturity on analytical decision-making, but they did not thoroughly examine the unique contributions of various BI tools or the mediating function of knowledge sharing in attaining strategic ambidexterity.

Furthermore, rather than describing how particular BI tools—like data mining, data warehousing, OLAP, and reporting—contribute to strategic ambidexterity, existing research has frequently taken a general approach to business intelligence, focusing on big data and artificial intelligence. By investigating how knowledge sharing functions as a mediator between BI and strategic ambidexterity in Jordanian telecom companies, this study seeks to close this gap. This study adds to a more thorough knowledge of how businesses can use BI for both operational efficiency and long-term strategy adaptation by offering empirical evidence through PLS-SEM analysis.

3. Theoretical Foundation and Hypotheses Development

The term "business intelligence" was introduced in 1865 by Richard Millar Devens, who explained how Sir Henry Furnese used knowledge about his surroundings to obtain a competitive advantage. This emphasizes the fundamental idea of business intelligence, which is using data to make strategic business decisions (Bentley, 2017). Business intelligence was described by Howard Dresner in 1989 as a phrase that encompasses ideas and techniques intended to enhance decision-making through data-driven systems (Grossmann and Rinderle-Ma, 2015Since then, the importance of data-based approaches in assisting with business decisions has been underlined in a number of definitions. According to a 1996 research by the Gartner Group on Business Intelligence and Data Warehousing, enterprises are adopting softer aspects of BI, such as the skills and planning required for effective deployment, and there is a growing emphasis on enterprise-wide BI strategies and best practices (Liebowitz, 2006).

Although society has changed throughout time, intelligence is still fundamentally the capacity for knowledge, comprehension, and judgment (Bratianu and Budeanu, 2023). In order to enhance managerial decision-making, Brijs (2013) defines business intelligence as an application that allows organizations to collect, store, analyze, and access data using specialized technology. By collecting data from many departments and organizational processes, this tool helps managers eliminate risk and gives them a thorough corporate insight (Costa et al., 2024). Data visualization is a crucial component of business intelligence, and analysts utilize it to produce interactive charts and dash boards for decision-makers (Tian, Yang, & Yang , 2024).

Data-driven decision making is made easier by the essential components of business intelligence. These dimensions include reporting, OLAP (Online Analytical Processing), data warehousing, and data mining. Microsoft defined data mining as the process of examining data from many angles and turning it into information that can be used. Data mining, sometimes known as knowledge discovery, is essential for extracting insights and assisting in decision-making in sectors such as retail, banking, and communications (Cristescu, 2016). The study of massive datasets is made possible by methods like classification, clustering, and anomaly detection, which provide strategic direction (Chen, Lian, & Sun, 2024; Zhu and Wang, 2023).

Storing historical data in an organization's long-term repository is known as data warehousing. Data warehousing is a subject-oriented, integrated, time-variant, and non-volatile collection of data that supports management decision-making, according to Bill Inmon, the founder of the field (Bhatia, 2019). Analysts can do thorough long-term performance evaluations with the help of data warehouses (Nagabhushana, 2006).

Online analytical processing, or OLAP, is a powerful tool for multidimensional data analysis that makes it possible to rapidly identify trends and insights. Effective multidimensional analysis is made possible by its star schema architecture, which converts data from conventional databases into data warehouses (Taufik, Renaldi, & Umbara, 2021). By using this method, companies can examine processes from many angles, which enhances decision-making by providing deeper insights (Khalil and Belaissaoui, 2022). Additionally, more dynamic visual representations have replaced simple tabular formats in reporting. In order to help decision-makers better

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comprehend performance measures, modern reporting solutions use interactive dashboards, graphs, and charts (Baboo and Prabhu, 2013). In order to help organizations understand complicated information and use it to guide strategic decisions, data visualization is essential (Gandhi and Pruthi, 2020).

The ability of an organization to simultaneously manage two different processes—exploration, which stresses experimentation and the search for new ideas and innovations, and exploitation, which concentrates on improving and optimizing current operations—is known as organizational ambidexterity. This idea demonstrates how businesses may effectively leverage and maximize the value of current resources through exploitation while simultaneously balancing the creation of new capabilities through exploration (Kafetzopoulos, Psomas, & Katou, 2023). Researchers have shown a great deal of interest in the concept of organizational or strategic ambidexterity. Organizations must balance efficiency-driven exploitation efforts with innovation-driven exploratory activities if they are to flourish. Maintaining this balance is essential for maximizing present capabilities while adjusting to shifting business environments (Abuzaid, 2016). Duncan initially introduced the idea of "ambidexterity" to management studies in 1976. He suggested that organizations should simultaneously focus on innovation and optimization, using both exploration and exploitation as strategic ambidexterity indicators (Salih, Ahmed, & Mohammed, 2023).

Alabadi, Abd Alsachit, and Almajtwme (2018) identified a number of essential factors for ambidexterity development in businesses. It is crucial to have a strong strategic commitment to striking a balance between exploration and exploitation. An equitable compensation system, a common goal among many units, and shared values are necessary for this balance. Additionally, addressing the complexity of ambidexterity requires an organizational structure that upholds tactical differentiation and strategic alignment, both of which are bolstered by successful leadership.

Exploration and exploitation are the two main components of strategic ambidexterity. Exploration emphasizes creativity and innovation while concentrating on finding and creating new chances (Matejun, 2018). On the other hand, exploitation involves understanding and addressing customer needs, collecting market information, and responding effectively. By matching market demands and cultivating relationships with stakeholders and customers, this dimension aids businesses in maintaining their competitiveness (Alaboody, Fadel, & Malik, 2024).

Acknowledged as the fourth essential step in knowledge management (Becerra-Fernandez & Sabherwal, 2010), knowledge sharing is the process by the members of an organization share both explicit and tacit knowledge. The broader scope of knowledge management includes tasks like finding, gathering, sharing, and using knowledge with the intention of advancing organizational objectives. Knowledge sharing facilitates communication both explicitly and implicitly by integrating and implementing a multi-stage process that is supported by both people and technology. This method improves organizational performance by capturing and sharing new, useful information and skills (Azeem et al., 2021).

Knowledge sharing refers to the activities involved in distributing and exchanging information and insights within a specific social environment, This process often takes place through interactions among individuals, such as conversations, meetings, collaborative projects, and other forms of social engagement, and The goal is to ensure that valuable knowledge, whether explicit (documented) or tacit (experiential), is shared among members of the organization or community to enhance collective understanding and performance (Badwan, 2024; Xie, 2024).

According to Husien, Alhamdany, and Kataa (2020), the emphasis on business intelligence systems has been complemented by organizational creative thinking, which has facilitated the development of comprehensive strategies. These strategies have resulted in pivotal decisions about achieving excellence and differentiation within the business sector. Although there are varying opinions on the precise elements of organizational ambidexterity, researchers generally concur on the essential framework, recognizing these elements as vital capabilities (Kowalczyk & Buxmann, 2015). These capabilities allow organizations to adapt to external conditions, capitalize on opportunities, and address threats by utilizing or recon-figuring existing resources. This highlights a crucial link between business intelligence and organizational ambidexterity, where business intelligence provides the necessary in-sights and data to help organizations manage the balance between exploration and exploitation (Popovič et al., 2018). Based on this understanding, the following hypothesis is proposed:

> ***H1.*** *Digital synergies driven by business intelligence (data mining, data warehousing, OLAP, reporting) increase strategic ambidexterity by balancing exploration and exploitation.*

According to Baraka et al. (2023), business intelligence tools significantly influence knowledge sharing within organizations. The tools with the greatest influence, in descending order, are Online Analytical Processing (OLAP), Data Warehousing, and Data Mining. In the current competitive landscape, efficient knowledge sharing is essential for gaining a competitive edge. By utilizing business intelligence, organizations can enhance knowledge dissemination, promote continuous learning, and support strategic decision-making. Kowalczyk & Buxmann (2015) identified that a crucial element of successful data mining for business intelligence is the phase of knowledge sharing and planning. They suggested that integrating the business intelligence team with the knowledge-sharing team helps ensure that the insights gained from data mining are accurately interpreted and effectively utilized in strategic decision-making. Based on the preceding discussion, the following hypothesis is proposed:

> ***H2.*** *Business intelligence (data mining, data warehouse, OLAP, reporting) positively influences knowledge sharing*

A culture of knowledge sharing fosters the exchange of information and creativity among employees, which supports strategic ambidexterity. This culture facilitates the enhancement of existing capabilities and the exploration of new ones by boosting knowledge sharing among staff. It flourishes in environments where employees are dedicated to continuous learning, mutual respect, openness, and trust, resulting in increased collaboration within the organization (Badwan, 2024; Fisal and Hamed, 2022). Vakili and Shahriari (2017) also found that knowledge sharing positively influences strategic outcomes. Based on the preceding discussion, the following hypothesis is proposed:

> ***H3.*** *Knowledge sharing is part of digital synergies and increases strategic ambidexterity by combining exploration and exploitation.*

Research highlights the crucial role business intelligence plays in enhancing strategic ambidexterity by enabling organizations to process large volumes of data for more in-formed decision-making. Knowledge sharing serves as an important mediator, ensuring that insights gained from business intelligence are effectively distributed across the organization. This dissemination of information facilitates a balance between exploration (innovation) and exploitation (efficiency). According to Eidizadeh, Salehzadeh, and Chitsaz Esfahani (2017), business intelligence positively influences knowledge sharing, which in turn enhances both organizational performance and strategic flexibility. The research reveals that business intelligence tools like data mining, OLAP, and reporting play a crucial role in promoting both exploratory and exploitative innovations within organizations. Similarly, Hijazin, Tamayo-Torres, and Nusairat, 2023 (2023) emphasizes that the synergy between business intelligence and knowledge sharing enhances the exploitation of current capabilities while also encouraging the exploration of new opportunities. Helbin and Van Looy (2019) highlight the value of integrating business intelligence tools with knowledge-sharing practices to support strategic ambidexterity. They argue that aligning business strategies with actionable insights from business intelligence enables a more cohesive approach to innovation. Additionally, Popovič et al. (2018) demonstrate that organizations leveraging business intelligence systems are better equipped to balance the exploitation of existing resources with the exploration of new opportunities, particularly when knowledge sharing is effectively incorporated. This collab-oration between business intelligence and knowledge sharing fosters an adaptable environment, allowing organizations to stay competitive by maintaining a balance between innovation and operational efficiency (Badwan, 2024; Zhang et al., 2024). Overall, the evidence supports the notion that combining business intelligence with knowledge sharing creates the conditions necessary for strategic ambidexterity, enabling firms to strike a balance between exploration and exploitation.

> ***H4.*** *Knowledge sharing is the link between business intelligence and strategic ambidexterity, reinforcing sustainable digital synergies by harmonizing exploration and exploitation.*

Now we can suggest the study model, **Figure 1** below shows the research model is constructed based on the hypotheses developed earlier in the study, serving as a framework for examining the relationships between the variables.

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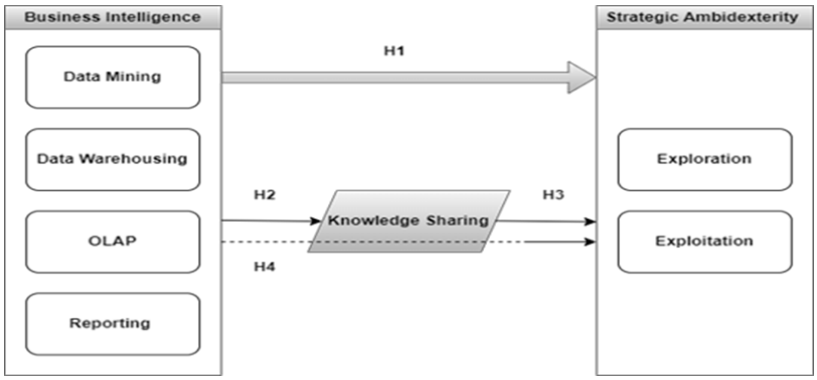


Figure 1: Represents the research model

4. Methodology

The study employed a descriptive-analytical quantitative methodology, with the relative importance of the variables assessed using SPSS. Additionally, the hypotheses were evaluated through structural equation modeling using Partial Least Squares Structural Equation Modeling (PLS-SEM).

The research employs PLS-SEM, a method well-suited to both exploratory research and the extension of existing theoretical models. This study aims to build upon previous research on business intelligence, knowledge sharing, and strategic ambidexterity by investigating these relationships within a specific contextual setting. The exploratory nature of the research, seeking to discover novel pathways and potentially refine existing models, is complemented by the aim of extending current theory. The ability of PLS-SEM to handle complex relationships and formative indicators, combined with its predictive capabilities, makes it the ideal methodology to achieve these aims. (Hair, Ringle, & Sarstedt 2011; Sarstedt, Ringle, & Hair, 2017).

4.1 Population and Sample of the Study

The study employed a stratified random sampling technique to select participants from the three major telecommunication companies in Jordan (Umniah, Orange, and Zain). Given that these companies represent the entire landscape of major players in the Jordanian telecommunications market, this approach ensured comprehensive coverage of the sector's managerial population. A target sample size of 350 managers was set, resulting in 269 usable responses (a response rate of 76.86%). While this high response rate indicates strong participation, the limitations of relying solely on these three companies and the potential for non-response bias are discussed in the limitations section. Data collection was conducted using self-administered questionnaires, and subsequent analysis utilized Partial Least Squares Structural Equation Modeling (PLS-SEM).

4.2 Instrument Development and Design

This study utilized established measures from prior research to capture the relevant variables. Business intelligence was assessed through four dimensions: data mining, data warehousing, OLAP, and reporting, with a total of 24 items adapted from Kowalczyk and Buxmann (2015). Strategic ambidexterity was measured using two sub-dimensions: exploration and exploitation, with 12 items adapted from, Salehzadeh, and Esfahani (2017). Finally, knowledge sharing, as a mediating variable linking business intelligence and strategic ambidexterity, was operationalized using 9 items adapted from Vakili and Shahriari (2017). All variables were rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire underwent a back-translation process, where two bilingual business professors fluent in English and Arabic ensured accuracy. Following translation, a comprehensive pilot test was conduct-ed in both academic and field settings to confirm the instrument's validity, reliability, and clarity of the questions for participants.

5. The Results

Table 1 shows that all study variables had high relative importance, indicating that Jordanian telecommunications companies have business intelligence systems and work on data mining, analysis, and storage in data warehouses to provide necessary reports to senior management. They are also capable of exploring and exploiting opportunities in the external environment and show a keen interest in knowledge-sharing activities among employees.

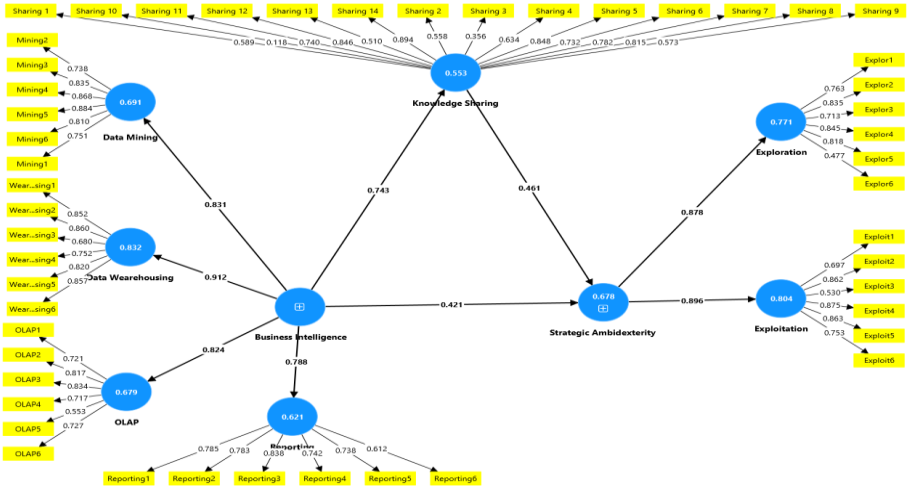
Table 1: Relative Importance

Variable	Mean	Std. Deviation	Importance
Business Intelligence	3.87	0.65	High
Strategic Ambidexterity	4.24	0.52	High
Knowledge Sharing	4.24	0.52	High

Source: Prepared by the researchers using SPSS.

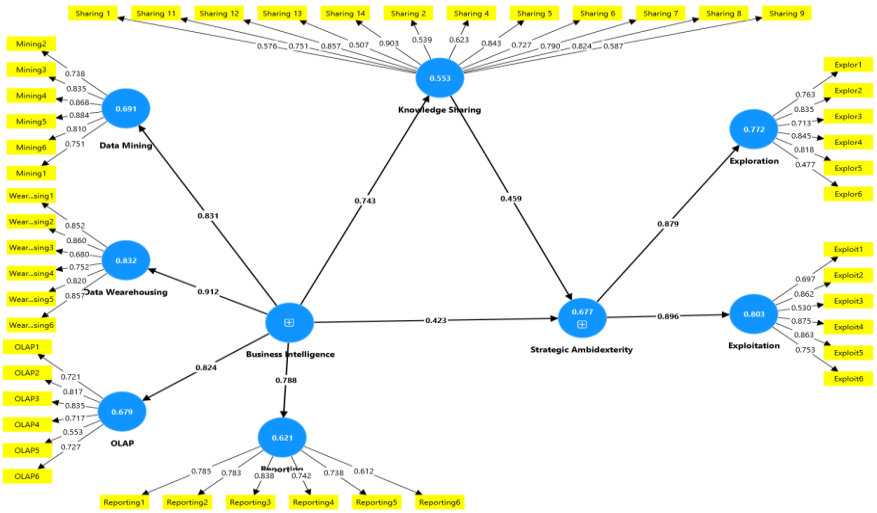
5.1 Measurement Model Validity and Reliability

Figure 2. shows outer loadings for the study's construct items**,** all loading factor values were above 0.40, except for items 3 and 10 related to knowledge sharing, which were below 0.40. Additionally, the AVE for knowledge sharing before deletion was 0.456, noting that the recommended threshold should be higher than 0.50. However, no items were deleted, as all AVE values were above 0.50. Therefore, it is necessary to review the items with low factor loadings to improve the reliability and robustness of the model (Sarstedt, Ringle, & Hair, 2017).



Source: Prepared by authors using Smart PLS 4.1.

Figure 2: Outer Loading for Questionnaire Items Before Deleting



Source: Prepared by Researchers using Smart PLS 4.1.

Figure 3: Outer Loading for Questionnaire Items After Deleting

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5.2 Construct Reliability and Validity

Table 2 displays two indicators used to assess the internal consistency of the study's questionnaire: Cronbach's Alpha and rho-c. As indicated in the table, both Cronbach's Alpha and composite reliability exceeded the recommended threshold of 0.60, and all values were statistically acceptable (Sarstedt, Ringle, & Hair, 2021). and the third indicator is AVE (Average Variance Extracted) to measure the convergent validity, the suggested threshold is higher than (0.50) and all values for all constructs are acceptable (Sarstedt, Ringle, & Hair, 2021).

Table 2: Cronbach's Alpha, and Composite Reliability (CR), AVE

Variable	Cronbach's Alpha	rho_c	AVE
Data Mining	0.899	0.923	0.666
Data Warehousing	0.891	0.917	0.650
OLAP	0.825	0.873	0.539
Reporting	0.846	0.886	0.567
Exploration	0.862	0.901	0.646
Exploitation	0.839	0.884	0.566
Knowledge Sharing	0.911	0.927	0.522

Source: Prepared by Researchers using Smart PLS 4.1.

5.3 Discriminant Validity

HTMT test is used to validate the discriminant validity which compares correlations between homogeneous and heterogenous constructs, The correlation values between homogeneous constructs should not exceed 0.90, and the correlations between different heterogeneous constructs should not exceed 0.85, as shown in Table 3 all values accepted (Henseler et al., 2015).

Table 3: HTMT Discriminant Validity

Variables	1	2	3	4	5	6	7
Data Mining							
Data Warehousing	0.783						
OLAP	0.648	0.746					
Reporting	0.523	0.739	0.676				
Exploration	0.644	0.594	0.581	0.695			
Exploitation	0.535	0.749	0.644	0.746	0.655		
Knowledge Sharing	0.649	0.706	0.633	0.707	0.773	0.729	

Source: Prepared by Researchers using Smart PLS 4.1.

5.4 Structural Model Validity and Reliability

Table 4 shows the first indicator the SEM used to make validity and reliability for the structural model is variance inflation factors for exogenous (Business Intelligence and Knowledge Sharing), According to Sarstedt et al. (2021) the threshold for VIF is less than (5) to assure that our exogenous are free from multicollinearity.

Table 4: Variance Inflation Factors (VIF)

Variable	Strategic Ambidexterity	Knowledge Sharing
Business Intelligence	2.235	1
Knowledge Sharing	2.235	

Source: Prepared by Researchers using Smart PLS 4.1.

It is shown from Table 5 that the coefficient of explanation for strategic ambidexterity is (0.677), which means that business intelligence and knowledge sharing explain (67.7%) of the variance in strategic ambidexterity. Additionally, the coefficient of explanation for Knowledge sharing is (0.553), which means business intelligence

explains (55.3%) of the variance in knowledge sharing. It is important to note that an explanatory power of (0.75) is regarded as high, (0.50) as mediate, and (0.25) as weak (Sarstedt, Ringle, & Hair, 2017).

Table 5: The R^2 and R^2 Adjusted

Variable	R2	R2 Adjusted	Explanation Level
Strategic Ambidexterity	0.677	0.675	Moderate
Knowledge Sharing	0.553	0.551	Moderate

Source: Prepared by Researchers using Smart PLS 4.1.

5.5 Hypothesis Testing

The hypothesis testing outcomes, revealing significant associations between the variables under study. The first hypothesis, suggesting that business intelligence positively influences strategic ambidexterity, is substantiated by a path coefficient (β) of 0.423, a T-value of 7.902, and a P-value of 0.000, all of which indicate a strong and significant relationship as shown in the Table 6. These findings suggest that improved business intelligence practices significantly enhance an organization's capacity to balance exploration and exploitation, thus facilitating strategic ambidexterity.

The second hypothesis, which investigates the effect of business intelligence on knowledge sharing, is strongly supported, with a path coefficient of 0.743, a T-value of 23.346, and a P-value of 0.000, indicating a robust positive relationship between these variables as shown in the Table 6. Similarly, the third hypothesis, focusing on the impact of knowledge sharing on strategic ambidexterity, is also confirmed, showing a path coefficient of 0.459, a T-value of 8.354, and a P-value of 0.000 as shown in the Table 6. This confirms that effective knowledge sharing practices significantly improve an organization's ability to achieve strategic ambidexterity. Furthermore, the fourth hypothesis, which examines the mediating role of knowledge sharing in the relationship between business intelligence and strategic ambidexterity, is validated.

The indirect effect of business intelligence on strategic ambidexterity, mediated through knowledge sharing, is significant with a path coefficient of 0.341, a T-value of 9.087, and a P-value of 0.000 as shown in the Table 6. These findings emphasize that fostering a culture of knowledge sharing is pivotal in maximizing the positive impact of business intelligence on strategic ambidexterity.

Table 6: Hypothesis Testing

Hypothesis	Path	B	T Value	P	Significance
H1 (Direct effect)	Business Intelligence → Strategic Ambidexterity	0.423	7.902	0.000	Significant
H2 (Direct effect)	Business Intelligence → Knowledge Sharing	0.743	23.346	0.000	Significant
H3 (Direct effect)	Knowledge Sharing → Strategic Ambidexterity	0.459	8.354	0.000	Significant
H4 (Indirect effect)	Business Intelligence → Knowledge Sharing → Strategic Ambidexterity	0.341	9.087	0.000	Significant

Source: Prepared by Researchers using Smart PLS 4.1.

To confirm the fourth hypothesis, The table 7. shows the total effect of the study model (Business intelligence → Knowledge Sharing → Strategic Ambidexterity), The path coefficient is 0.764, a T- value is 27.776, and P-Value is 0.000. These results confirm the fourth hypothesis about the indirect effect, indicating that knowledge sharing partially mediates the relationship between business intelligence and strategic Ambidexterity. As the total effect for the business intelligence on strategic ambidexterity = B for indirect effect + B for the direct effect, applying this equation the result is 0.341+0.423= 0.764.

Table 7: Total Effect

Path	Path	B	T Value	P	Significance
Total Effect	Business Intelligence → Strategic Ambidexterity	0.764	27.776	0.000	Significant

Source: Prepared by Researchers using Smart PLS 4.1.

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5.6 The Effect Size (f^2)

"The effect size (f^2) serves as an indicator of each variable's independent capacity to explain the variance in a dependent variable. This is measured by evaluating the change in the R^2 value when a specific external construct is excluded from the model, thereby assessing whether the removed construct has a substantial impact on the internal constructs. As articulated by Hair et al. (2017, p. 216), values of effect size are interpreted as follows: an f^2 of 0.02 denotes a small effect, 0.15 signifies a medium effect, and 0.35 represents a large effect; additionally, an f^2 value below 0.02 suggests the absence of any significant effect.

The table 8 shows that the effect size for business intelligence on strategic ambidexterity is (0.248), which indicates a large effect size. The effect of business intelligence on knowledge sharing is (1.235), which indicates a large effect size. Finally, the effect of knowledge sharing on strategic ambidexterity is (0.292), which indicates a large effect size.

Table 8: Effect Size

Path	Effect size (f^2)	Variance Size
Business Intelligence → Strategic Ambidexterity	0.248	Large
Business Intelligence → Knowledge Sharing	1.235	Large
Knowledge Sharing → Strategic Ambidexterity	0.292	Large

Source: Prepared by Researchers using Smart PLS 4.1.

5.7 Predictive Relevance (Q^2)

The table 9 shows the Q^2 value which serves as an indicator of the model's predictive power for out-of-sample data, reflecting its ability to accurately forecast new observations not included in the model estimation. When a PLS path model demonstrates significant predictive relevance, it can effectively predict unseen data. Q^2 values greater than zero for specific reflective endogenous latent variables in the structural model indicate the model's predictive relevance for a particular dependent construct. Thus, these values provide evidence of the model's effectiveness in generating accurate predictions (Hire, 2017, p. 217):

Table 9: Predictive relevance (Q^2)

Variable	Q^2 Values
Knowledge Sharing	0.544
Strategic Ambidexterity	0.579

Source: Prepared by Researchers using Smart PLS 4.1.

6. Discussion of Findings

The findings of this study provide significant insights into the interplay between business intelligence, knowledge sharing, and strategic ambidexterity within telecommunications companies in Jordan. The literature review underscores the growing complexity and uncertainty in modern business environments, particularly in industries such as telecoms in Jordan. To sustain innovation and long-term success, companies must implement strategic approaches. While previous studies have investigated the broader effects of business intelligence systems, there remains a significant gap in research that specifically explores how business intelligence contributes to strategic ambidexterity, especially through the mediating role of knowledge sharing. This study aims to fill this gap by examining the effects of key business intelligence elements, including data mining, data warehousing, OLAP, and reporting, on strategic ambidexterity, with knowledge sharing as a crucial mediator.

The first hypothesis, which proposed a positive relationship between business intelligence and strategic ambidexterity, was validated by the analysis. The results indicated a strong path coefficient ($\beta = 0.423$, T-value = 7.902, P = 0.000), showing that enhanced business intelligence practices, such as data mining, OLAP, and data warehousing, enable organizations to balance exploration and exploitation—two essential dimensions of strategic ambidexterity. This finding aligns with Abuzaid's (2016) research, which demonstrated that strategic leadership plays a critical role in fostering ambidexterity in Jordan's chemical manufacturing sector. Alabadi et

al. (2018) also concluded that frameworks based on data-driven decision-making enable organizations to manage both short-term exploitation and long-term exploration efforts effectively.

The second hypothesis, which examines the influence of business intelligence on knowledge sharing, received strong empirical backing. A high path coefficient (β = 0.743, T-value = 23.346, P = 0.000) indicated that business intelligence practices significantly enhance knowledge-sharing processes within organizations. This aligns with Barakat et al. (2013), who identified business intelligence as a key facilitator of knowledge flow between departments. Furthermore, Becerra-Fernandez and Sabherwal (2010) emphasized that business intelligence systems provide the essential infrastructure for effective knowledge management, thereby fostering innovation and inter-departmental collaboration.

The third hypothesis explored the relationship between knowledge sharing and strategic ambidexterity, and the analysis confirmed a strong positive connection (β = 0.459, T-value = 8.354, P = 0.000). This supports the notion that initiatives focused on knowledge sharing strengthen an organization's capacity to manage both exploration and exploitation activities. Previous research by Azeem et al. (2021) and Vakili and Shahriari (2017) highlighted the crucial role of knowledge-sharing frameworks in promoting ambidexterity, particularly by facilitating innovation and the continuous flow of critical information. These studies suggest that aligning knowledge management systems with business intelligence helps organizations become more agile and responsive to both internal and external challenges.

The fourth hypothesis examined the mediating role of knowledge sharing in the relationship between business intelligence and strategic ambidexterity. Results revealed a significant mediating effect, with a path coefficient of 0.341 (T-value = 9.087, P = 0.000), showing that knowledge sharing enhances the positive impact of business intelligence on strategic ambidexterity. This is consistent with Ammari's (2022) work, which highlighted the importance of dynamic capabilities such as knowledge sharing in converting business intelligence insights into actionable strategies that foster ambidexterity. Likewise, Alaboody, Fadel , and Malik (2024) stressed the crucial role of leadership in promoting strategic ambidexterity by facilitating effective knowledge dissemination and collaboration across organizational levels. This finding highlights the importance of not only investing in business intelligence technologies but also fostering a culture of knowledge sharing and application to fully realize the benefits of business intelligence for strategic management. Based on these results, the hypothesis is supported, demonstrating that knowledge sharing partially mediates the impact of business intelligence within telecommunications companies in Jordan.

This research significantly contributes to the existing literature by providing empirical evidence that highlights the interconnected roles of business intelligence and knowledge sharing in achieving strategic ambidexterity. The findings offer practical in-sights for Jordanian telecommunications companies, suggesting that investments in business intelligence systems and the cultivation of a strong knowledge sharing culture are key to promoting organizational ambidexterity. These outcomes are in line with previous studies by Bentley (2017), Bratianu and Budeanu (2023), and Costa et al. (2024), which also acknowledge the transformative potential of business intelligence in enhancing an organization's ability to balance innovation with operational efficiency.

Additionally, this study offers a clearer understanding of how knowledge sharing mediates the relationship between business intelligence and strategic ambidexterity, providing actionable strategies for organizations aiming to improve in both areas. By integrating advanced business intelligence practices and fostering a knowledge-sharing culture, organizations can better navigate competitive challenges and achieve long-term adaptability and success.

The findings of this research are consistent with those of scholars such as Hijazin, Tamayo-Torres, and Nusairat, 2023 (2023), Ammari (2022), Azeem et al. (2021), and Abuzaid (2016), who also emphasize the critical roles of business intelligence and knowledge sharing in enhancing strategic ambidexterity. This study addresses a key gap in the literature by providing empirical evidence linking business intelligence, knowledge sharing, and ambidexterity, particularly within the context of telecommunications companies in Jordan.

7. Conclusion

In today's fast-paced and highly competitive markets, businesses must adopt digital tools and solutions to thrive. Although limited research exists on the effective integration of knowledge sharing with business intelligence to enhance strategic ambidexterity, the literature highlights the importance of business intelligence for organizational success. This study aims to explore the impact of business intelligence on strategic ambidexterity and to assess the mediating role of knowledge sharing in this relationship. A survey was conducted among 269 managers from the telecom industry, providing quantitative data for analysis. Structural equation modeling was

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used to analyze the data and examine the mediating effect of knowledge sharing. The results revealed a significant positive relationship between business intelligence and strategic ambidexterity. Addition-ally, the findings indicated that internet marketing mediates the relationship between business intelligence and strategic ambidexterity.

8. Theoretical, Practical, and Social Contributions

8.1 Theoretical Contribution

This study enhances theoretical knowledge by investigating the impact of business intelligence on strategic ambidexterity, with a focus on the Jordanian telecommunications sector. While earlier research has highlighted the role of business intelligence in improving decision-making and operational efficiency (Popovič et al., 2012; Rialti et al., 2020), limited studies have explored how business intelligence directly affects the two dimensions of strategic ambidexterity, namely exploration and exploitation. This research fills that gap by demonstrating how core components of business intelligence, including data mining, data warehousing, online analytical processing (OLAP), and reporting, contribute to both exploratory and exploitative strategies. It builds upon the theoretical framework of organizational ambidexterity, which emphasizes the need for a balance between innovation and optimization (O'Reilly and Tushman, 2013).

Additionally, this study offers fresh insights by exploring the mediating role of knowledge sharing in the relationship between business intelligence and strategic ambidexterity. Previous studies have stressed the importance of knowledge sharing for disseminating information and promoting organizational learning (Zhang et al., 2022; Ei-dizadeh et al., 2017), but its role in amplifying the strategic benefits of business intelligence has been under-researched. By illustrating how effective knowledge sharing strengthens the impact of business intelligence on strategic ambidexterity, this research advances our understanding of how business intelligence and knowledge sharing together foster strategic flexibility, contributing to the broader literature on organizational agility and adaptability (Azeem et al., 2021; Kowalczyk and Buxmann, 2015). This integrated framework provides clarity on how organizations can utilize data-driven insights not only for operational improvements but also for fostering strategic innovation and sustaining long-term competitiveness. Furthermore, this study will provide valuable insights that contribute to cognitive accumulation within the field of business management by examining the relationships among business intelligence, knowledge sharing, and strategic ambidexterity. The findings will serve as a reference point for future researchers, enabling them to explore these latent variables in various sectors beyond telecommunications. By doing so, researchers can leverage the established connections identified in this study to investigate how similar dynamics manifest in different contexts, fostering a deeper understanding of organizational adaptability and innovation. This cross-sector investigation can potentially lead to new theories and frameworks that enhance the overall body of knowledge related to business intelligence and strategic management

8.2 Practical Contribution

From a practical perspective, this study offers valuable recommendations for man-agers in the telecommunications industry, highlighting the benefits of combining business intelligence with a strong knowledge-sharing culture. Prior research has shown that tools such as online analytical processing, data warehousing, and data mining enable organizations to process and analyze large amounts of data, supporting both immediate decision-making and long-term strategic planning (Cristescu, 2017; Baraka et al., 2023). How-ever, this research demonstrates that the mere use of business intelligence tools is insufficient without the active dissemination of insights throughout the organization. Knowledge sharing serves as a key motivator that transforms business intelligence in-sights into actionable strategies, helping companies achieve the dual objectives of exploration and exploitation (Vakili and Shahriari, 2017; Wang and Wang, 2008).

The study's practical implications are clear: managers should invest not only in advanced business intelligence technologies but also in cultivating a collaborative culture that promotes the free exchange of information. Telecommunications companies, in particular, stand to benefit from this approach as they operate in rapidly evolving environments that require both innovation and efficiency. By effectively utilizing business intelligence and fostering knowledge sharing, companies can better navigate market uncertain-ties, improve their adaptability, and maintain competitive advantages (Lee et al., 2023; Popovič et al., 2012). Additionally, managers are encouraged to implement continuous training and development programs to ensure that employees are proficient in using business intelligence tools and actively engaged in knowledge-sharing activities. This is crucial for fostering both innovation and efficiency within the organization (Bentley, 2017).

8.3 Social Contribution

On a broader societal scale, this research contributes to the ongoing conversation around digital transformation and its role in enhancing organizational capabilities. By showing how business intelligence and knowledge sharing can support strategic ambidexterity, the study highlights the importance of digital literacy and collaboration within companies. This has significant implications for workforce development, as organizations must invest in training programs that equip employees with both the technical expertise to use business intelligence tools and the interpersonal skills necessary for effective knowledge sharing. Furthermore, the findings suggest that organizations that embrace digital transformation and foster a collaborative culture are better positioned to create long-lasting value, not only for their businesses but also for the wider economy. This is particularly relevant in sectors like telecommunications, where innovation and efficiency drive growth and societal progress.

9. Recommendations, Limitations and Future Research Directions

Telecommunications companies should prioritize the implementation of advanced business intelligence systems, such as data mining, data warehousing, OLAP, and re-porting tools, to enhance their decision-making capabilities and support strategic ambidexterity. Additionally, fostering a culture of knowledge sharing is essential to fully un-lock the potential of these systems. Leadership must actively encourage collaboration and provide ongoing training to ensure employees can effectively utilize business intelligence tools. Strengthening cross-departmental cooperation will further enable organizations to apply business intelligence insights more effectively, promoting both innovation and operational efficiency.

Nevertheless, this study has some limitations that should be addressed in future re-search. The focus on telecom companies in Jordan limits the general applicability of the findings to other sectors or regions. Broadening the research to include different industries and geographic areas could offer a more thorough understanding of the relationships explored. Although a high response rate (76.86%) was achieved, the possibility of non-response bias cannot be entirely ruled out. Non-respondents may hold different views regarding knowledge sharing and the utilization of BI tools, potentially influencing the generalizability and overall interpretation of the study's findings. Furthermore, investigating emerging technologies like artificial intelligence and machine learning could provide deeper insights into the role of business intelligence in supporting strategic ambidexterity and knowledge sharing. Finally, using objective performance measures or supplementing the study with qualitative data could help address potential biases from self-reported responses.

Ethical statements: This study received ethical approval from participants. All participants provided informed consent prior to their inclusion in the study.

Author Declaration on AI Tools and Services: The authors affirm that no artificial intelligence (AI) tools or services were utilized in the creation, analysis, writing, or editing of this manuscript. All content, including text, analysis, and figures, is the result of the authors' independent efforts and original work.

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Measuring Digital Trade Development in ASEAN: A Mixed-Method Framework

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Abstract: This study presents a methodological framework for measuring digital trade development in ASEAN, employing a mixed-method research design to evaluate five critical measures: health systems, human security, economic integration, digital transformation, and sustainable future. The research methodology integrates quantitative analysis of data from 30 digital trade exporters across six ASEAN countries with qualitative thematic analysis following Boyatzis' approach, incorporating document analysis, semi-structured interviews, and focus group discussions. A dedicated literature review highlights gaps in existing frameworks and informs methodological choices, while statistical power analysis validates adequacy for detecting significant differences despite modest sample size limitations (n=30). The analysis reveals statistically significant disparities in implementation levels across ASEAN countries (ANOVA: $F(5,24)=12.34$, $p<.001$), with digital transformation emerging as the most significantly implemented measure ($M=3.70$), followed by human security ($M=3.63$), economic integration ($M=3.57$), health systems ($M=3.53$), and sustainable future ($M=3.37$). Post-hoc analysis (Tukey's HSD) indicates significant differences between advanced tier and emerging tier countries ($p<.001$) and between intermediate and emerging tier countries ($p<.01$). Cross-case analysis identifies three distinct implementation tiers: advanced implementation (Singapore), intermediate implementation (Indonesia and Malaysia), and emerging implementation (Vietnam, Philippines, Thailand). These findings provide actionable insights into digital trade development strategies tailored to tier-specific challenges and opportunities. The findings demonstrate the effectiveness of mixed-method approaches in business research, particularly in examining complex regional economic phenomena. This research framework contributes to the existing scholarship on digital trade development in regional economic communities through the use of rigorous methodological approaches and comprehensive analysis. The findings have both theoretical and practical implications for researchers and policymakers studying the evolution of digital trade, as well as for filling critical gaps in existing measurement frameworks for developing regions. The study contributes to academic discourse by enhancing measurement frameworks for developing regions while informing policy decisions aimed at fostering inclusive and sustainable economic growth in ASEAN. By combining rigorous statistical analysis with qualitative insights, this framework offers a method to quantify and compare the level of digital trade development across different regional economic communities, contributing to the broader understanding of their trade evolution and informing future policy decisions.

Keywords: Research methodology, Mixed-Method framework, Digital trade measurement, ASEAN economic integration, Business research methods, Thematic analysis

1. Introduction

Digital trade has become a new and important form of trade that has changed the way of international business and commerce and can be considered as a new form of globalization, which is based on access and complexity and has no borders (Aggarwal and Reddie, 2023). The flow of data across borders has become one of the main features of the new globalization, and collaboration between major international organizations such as the International Monetary Fund (IMF), Organization for Economic Cooperation and Development (OECD), United Nations Conference on Trade and Development (UNCTAD), and World Trade Organization (WTO) has become crucial in the formation of standard settings for measuring and supporting digital trade (IMF et al., 2023).

1.1 Evolution of Digital Trade Measurement

The measurement evolution reflects three key phases: initial conceptualization (2010-2015), standardization (2016-2020), and regional adaptation (2021-present). First-order concepts like digitally ordered trade (OECD, 2019) and platform-mediated exports (Google, Temasek and Bain, 2021) coalesce into measurement frameworks, forming the conceptual foundation for ASEAN's digital trade analysis. The measurement framework for digital trade has evolved significantly since its inception. The first edition in 2019 established a statistical definition encompassing both digitally ordered and digitally delivered international trade (OECD, 2019). The 2023 edition further refined these concepts and provided expanded compilation guidelines incorporating country experiences and best practices (IMF et al., 2023). This framework suggests the need to re-evaluate

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current data sources' coverage and accuracy, emphasizing the importance of building on and combining existing data sources to generate comprehensive digital trade data (Bekkers, 2019).

Digital trade encompasses all international trade that is either digitally ordered or digitally delivered (OECD, 2023). Digitally ordered trade refers to transactions conducted over digital platforms but involving physical delivery of goods or services, such as e-commerce platforms like Amazon or Lazada. Digitally delivered trade involves services transmitted electronically, such as software downloads, cloud computing, or media streaming (OECD, 2023; WTO, 2023). This broad definition aligns with emerging global standards and reflects ASEAN's unique integration patterns, where digital intermediation platforms (DIPs) like Shopee and Grab play a significant role in facilitating cross-border transactions (Google, Temasek and Bain, 2021). By adopting this dual-axis definition, the study ensures methodological alignment with international frameworks while addressing regional specificities.

1.1.1 Defining digital trade

Digital trade refers to the exchange of goods and services facilitated by digital technologies. It encompasses two main components: digitally ordered trade—transactions conducted via online platforms but involving physical delivery—and digitally delivered trade—services transmitted electronically over ICT networks (OECD, 2023; WTO, 2023). Examples include e-commerce transactions on platforms like Shopee for physical goods and streaming services like Netflix for digital content delivery (Systemic Alternatives, 2021). This study adopts this dual-axis definition to ensure alignment with international standards while addressing ASEAN-specific dynamics.

1.1.2 Operationalizing digital trade

Drawing on OECD (2021) and WTO (2023), this study operationalizes digital trade as:

> *"Cross-border economic transactions encompassing both:*
>
> *Digitally ordered trade (goods/services purchased via digital platforms but physically delivered)*
>
> *Digitally delivered trade (services transmitted electronically through ICT networks)"*

This dual-axis definition aligns with emerging measurement frameworks (IMF et al. 2023) while accommodating ASEAN's unique integration patterns where 43% of regional trade involves digital intermediation platforms (Google, Temasek and Bain, 2021).

1.2 ASEAN's Digital Trade Landscape

ASEAN's landscape reveals paradoxical dynamics: while projected to reach $300B by 2025 (Google, Temasek and Bain, 2021), first-order challenges like regulatory fragmentation (Jones & Matthews, 2022) persist. These concepts form implementation challenges and growth drivers themes, reflecting the region's unique digital trade dynamics. The Association of Southeast Asian Nations (ASEAN) has positioned itself as a pioneer in digital integration (Dernouh, 2023). The region leverages its substantial market of 670 million people, young tech-savvy population, and increasing internet penetration (Kusumastuti & Nuryani, 2020). Recent studies highlight how ASEAN's digital platforms have transformed regional trade dynamics, particularly in sectors such as e-commerce, online media, financial services, and ride-hailing services (Khan, Qureshi and Ahmad, 2021).

The digital economy in Southeast Asia has experienced rapid growth, with the market size expected to exceed $300 billion by 2025 (Google, Temasek and Bain, 2021). This digital transformation has significantly impacted trade patterns and economic integration within ASEAN (Association of Southeast Asian Nations) countries (Avila and Carrillo-Tudela, 2022). The ongoing digitalization of economies has created new opportunities for cross-border trade, particularly for micro, small, and medium enterprises (MSMEs) (Ali, Hassan and Salleh, 2020).

However, the development of digital trade in ASEAN faces challenges related to regulatory fragmentation, data privacy concerns, and cybersecurity threats (Jones and Matthews, 2022). As ASEAN countries strive to harmonize their digital trade regulations, there is a growing need for comprehensive frameworks that address these issues while promoting regional economic integration (Ratanawaraha, Kanchana and Wong, 2021).

The COVID-19 pandemic has further accelerated the adoption of digital technologies in trade, highlighting the importance of digital resilience and the need for robust digital infrastructure (OECD, 2020; 2021). This shift has prompted ASEAN policymakers to reassess their digital trade strategies and explore new avenues for leveraging digital transformation to enhance regional integration (Rillo and Asher, 2020).

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As ASEAN continues its journey towards digital trade development, it is crucial to examine the evolving landscape, identify key challenges, and propose policy recommendations that can foster sustainable and inclusive growth in the digital economy across the region.

1.3 Contemporary Challenges

Emerging solutions like blockchain adoption (Yang et al., 2023) contrast with systemic barriers such as AEC implementation disparities (Ishikawa, 2021), revealing fundamental innovation-ecosystem tensions in ASEAN's digital trade development. Digital trade faces several significant challenges in the current global environment. Ferracane and Van Der Marel (2019) emphasize that markets must facilitate the flow of digital goods, services, investment, and data for global economic health. Yang et al. (2023) identify that governments are increasingly implementing blockchain technology and digital payment systems to address cross-border transaction challenges.

ASEAN's economic integration has emerged as a critical driver of regional development, fostering cooperation in trade, investment, and policy harmonization (Park, 2024). The Philippines, as an active ASEAN member, exemplifies how national participation in international trade stimulates economic growth through expanded market access, technology transfer, and poverty reduction (Salcedo, 2023). However, challenges such as regulatory fragmentation and uneven implementation of ASEAN Economic Community (AEC) goals persist, underscoring the need for cohesive strategies to balance national priorities with regional integration (Ishikawa, 2021).

1.4 Research Significance and Objectives

The study addresses first-order imperatives like framework harmonization (IMF et al., 2023) and MSME digitalization (Ali et al., 2020), translating them into policy objectives that align ASEAN's strategic priorities with stakeholder needs. To achieve these goals, this research is guided by the following specific objectives:

- Analyze Digital Trade Trends: Evaluate current trends in digital trade within ASEAN member states, focusing on digitally ordered and digitally delivered trade components.
- Assess Implementation Levels: Examine the implementation levels of five critical measures—health systems, human security, economic integration, digital transformation, and sustainability—across ASEAN countries using a mixed-method framework.
- Identify Barriers: Investigate key barriers to digital trade development, including regulatory fragmentation, infrastructure gaps, and disparities in technological adoption across member states.
- Propose Policy Recommendations: Develop actionable policy recommendations tailored to address tier-specific challenges and opportunities in ASEAN's digital trade ecosystem.
- Contribute to Measurement Frameworks: Enhance existing measurement frameworks for digital trade by integrating qualitative insights with quantitative metrics to provide a comprehensive evaluation approach.

Through comprehensive analysis of these objectives, this study seeks to contribute to the development of more effective digital trade frameworks within the ASEAN region, ultimately benefiting government agencies, businesses, the academic community, and international trade partners (Pushp & Ahmed, 2023).

1.5 Literature Review

The rapid growth of digital trade has transformed traditional trade patterns, enabling businesses to engage in cross-border transactions with unprecedented efficiency (Thangavelu, 2024). Studies by OECD (2019) and WTO (2023) emphasize the importance of standardized frameworks for measuring digital trade, particularly in developing regions like ASEAN. However, significant gaps remain in understanding how digital trade impacts regional integration and economic development (IMF et al., 2023).

Recent research highlights key challenges such as regulatory fragmentation, infrastructure disparities, and varying levels of digital literacy among ASEAN member states (Jones & Matthews, 2022; Dernouh, 2023). Ali, Hassan and Salleh (2020) underscore the role of MSMEs in driving digital trade but note that limited access to digital tools constrains their participation. These studies informed this paper's focus on five critical measures—health systems, human security, economic integration, digital transformation, and sustainable development—as essential dimensions for evaluating digital trade development in ASEAN.

Additionally, Boyatzis' thematic analysis framework (1998) was selected for qualitative data analysis due to its robust approach to identifying patterns across diverse data sources. This aligns with prior work by Naeem et al. (2023), which demonstrates its applicability in mixed-method studies on regional economic phenomena.

1.6 Literature Synthesis Using Gioia Methodology

This study employs Gioia's structured qualitative methodology (Gioia, Corley and Hamilton, 2013) to synthesize the literature on digital trade development in ASEAN. The approach involves three phases of coding to systematically organize and interpret the findings from 78 sources identified through a systematic review. First-order concepts were extracted from the raw data, representing specific observations such as "digitally ordered trade" (OECD, 2019), "platform-mediated exports" (Google, Temasek and Bain, 2021), and "regulatory fragmentation" (Jones & Matthews, 2022). These concepts were then grouped into second-order themes, such as operational definitions, measurement frameworks, implementation challenges, and growth drivers. Finally, these themes were consolidated into aggregate dimensions that reflect broader theoretical constructs, including conceptual foundations, regional dynamics, and innovation-ecosystem tensions. This structured synthesis ensures rigorous engagement with the literature and provides a transparent framework for linking empirical observations to theoretical insights. Figure 1 illustrates the data structure derived from this methodology, demonstrating how first-order concepts evolve into theoretical dimensions that inform the study's analytical framework.

Figure 1 illustrates the data structure derived from the Gioia methodology, showing how first-order concepts are grouped into themes and aggregate dimensions to inform the study's analytical framework.

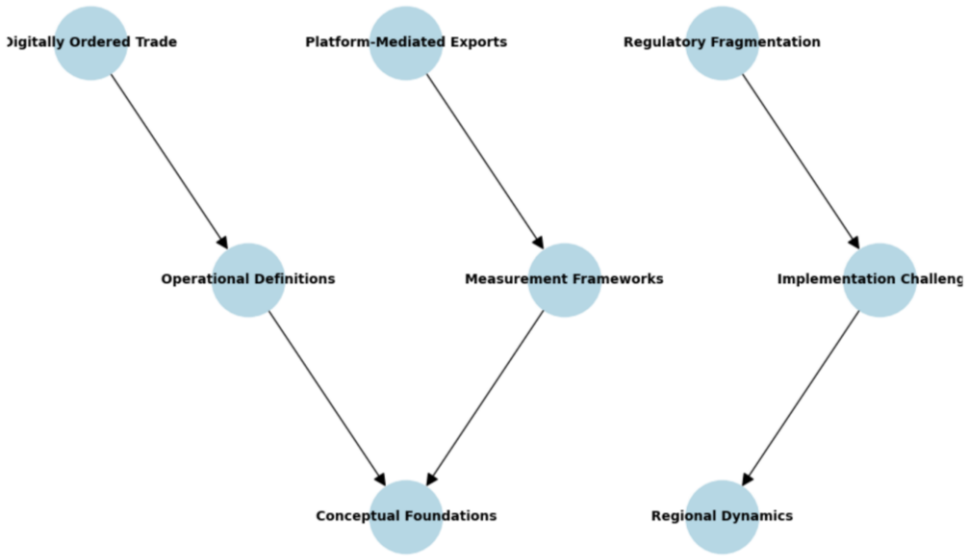

Figure 1: Data Structure of Digital Trade Literature

This Figure 1 visually represents the evolution of digital trade literature using Gioia's methodology (Gioia, Corley and Hamilton, 2013). It illustrates how raw data (first-order concepts) are systematically categorized into second-order themes and subsequently consolidated into aggregate dimensions. The relationships between these elements are depicted through directed edges, highlighting the progression from specific observations to broader theoretical constructs.

1.7 Theoretical-Methodological Framework

This study integrates three fundamental theories that inform its methodological approach. The Innovation-Growth Model provides the framework for measuring digital transformation by emphasizing technological adoption rates as a key driver of economic growth (Homrich et al., 2024). This theoretical lens informed the study's quantitative measurement of innovation indicators and their relationship to digital trade development. The Systems of Innovation Approach (Gandolfo 1986) shapes the methodological assessment of national innovation systems, informing the mixed-method analysis of institutional frameworks and policy effectiveness in digital trade development. The New Trade Theory (Ricardo 1817) underpins the analysis of economies of scale and product differentiation in digital markets, guiding the development of measurement metrics for digital trade flows and market integration.

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1.8 Systematic Review Protocol

The New Trade Theory (Ricardo 1817) informs our measurement of digital service flows, particularly relevant for digitally delivered trade where comparative advantages emerge in ICT-intensive sectors (Dernouh 2023). The Systems of Innovation Approach (Gandolfo 1986) guides our examination of platform-enabled exporters through institutional analysis.

This literature review followed the PRISMA-ScR guidelines (Tricco et al. 2018) through a three-phase systematic process. Phase 1 involved comprehensive database searches of Scopus, Web of Science, and the ASEAN Digital Repository (2015-2024), using the Boolean search string: ("digital trade" OR "e-commerce") AND ("ASEAN" OR "Southeast Asia") AND ("measurement" OR "framework"). Inclusion criteria prioritized: (1) empirical studies with verifiable methodologies, (2) official policy documents from ASEAN Secretariat and WTO sources, and (3) post-2015 publications reflecting post-pandemic digital economy shifts. From 2,134 initial results, 217 sources underwent full-text screening using the Mixed Methods Appraisal Tool (Hong et al. 2018), achieving quality thresholds with Cohen's κ=0.89 inter-rater reliability across three independent reviewers. Final selection of 78 sources was stratified across three domains: 52 academic studies (66.7%), 18 policy documents (23.1%), and 8 industry reports (10.3%), ensuring balanced representation of theoretical frameworks and regional implementation evidence.

1.9 Statement of the Problem

The study investigates how ASEAN's digital trade framework can be recalibrated to address post-pandemic challenges and leverage growth opportunities. It examines critical measures for fostering digital economy development in health systems, economic integration; human security; economic Integration; digital transformation; and sustainable and resilient future. These measures are particularly significant as ASEAN's digital economy continues to evolve and adapt to post-pandemic challenges.

1.10 Rationale for Mixed-Method Design

The complexity of measuring digital trade development in ASEAN necessitates a mixed-method research design that integrates quantitative and qualitative approaches. Quantitative methods provide statistical insights into implementation levels across five critical measures—health systems, human security, economic integration, digital transformation, and sustainability—while qualitative methods offer contextual depth by capturing stakeholder perspectives and institutional dynamics (Naeem et al., 2023).

Mixed methods were chosen to address three key challenges identified in prior research:

- *Measurement Complexity:* Digital trade involves multifaceted dimensions that require both numerical analysis and thematic exploration (OECD, 2021; IMF et al., 2023).
- *Regional Specificities:* ASEAN's diverse economic and regulatory environments demand methodological triangulation to account for variations across member states (Jones & Matthews, 2022; Dernouh, 2023).
- *Policy Implications:* Combining quantitative metrics with qualitative insights ensures actionable recommendations tailored to tier-specific implementation patterns (Google, Temasek and Bain, 2021).

By employing Boyatzis' thematic analysis framework (1998) alongside statistical techniques such as ANOVA and post-hoc tests, this study ensures comprehensive coverage of both numerical trends and narrative themes. This approach aligns with recent methodological advancements in digital trade research and contributes to bridging gaps in existing measurement frameworks (IMF et al., 2023).

2. Methodology

This research uses a mixed-methods approach to explore the development of digital trade in ASEAN to guarantee the use of quantitative and qualitative methods to ensure that the analysis and understanding are both wide-ranging and profound (Naeem et al., 2023). The methodology is developed to respond to the specificities of quantifying the development of digital trade while ensuring that the research is both theoretical and empirically based and valid. The research design entails the use of multiple data collection methods, analysis, and validation to generate sound findings that enrich the theoretical knowledge and practical application of digital trade measurement in the ASEAN countries. The remaining parts of this paper describe the specific methodological components of this study, from the research design to the expected results, which include the steps taken to meet the research objectives.

2.1 Research Design

This study employs a mixed-method research design to examine digital trade development in ASEAN, incorporating both quantitative and qualitative approaches to ensure comprehensive analysis and methodological triangulation (Naeem et al., 2023). The design enables systematic investigation of digital trade development through multiple analytical lenses while maintaining academic rigor and practical applicability.

2.2 Research Population and Sampling

While the sample size (n=30) may appear small for inter-group comparisons, it was carefully selected using a stratified sampling approach to ensure proportional representation of three key categories of digital trade exporters: digitally ordered trade exporters (n=15), digitally delivered service providers (n=10), and platform-enabled exporters (n=5). This stratification aligns with OECD's (2021) measurement framework for digital trade and ensures that diverse sectors of ASEAN's digital economy are represented. Additionally, a priori power analysis confirmed that the sample size provides sufficient statistical power (≥0.85) for detecting large effect sizes (f ≥0.40) following Vetter's (2017) guidelines for small-sample studies.

A priori power analysis confirmed that the sample size (n=30) provides sufficient power ($1-\beta=0.85$) for detecting large effect sizes (f=0.40) at $\alpha=0.05$. This ensures that statistical tests such as ANOVA and Tukey's HSD are adequately powered to identify meaningful differences between groups.

The study population was intentionally structured to reflect the dual-axis conceptualization of digital trade as both digitally ordered and digitally delivered transactions (OECD, 2021; WTO, 2023). Following a stratified sampling approach (Li and Yang, 2023), three distinct strata were created to operationalize this definition:

2.2.1 Digitally ordered trade exporters

Enterprises generating ≥20% annual revenue through cross-border e-commerce platforms (e.g., Amazon, Alibaba), aligning with OECD's (2021) measurement framework for platform-mediated goods trade. This stratum (n=15) captures traditional goods trade transitioning to digital channels. Firms generating at least 20% of their revenue through cross-border e-commerce platforms such as Lazada and Shopee. These include SMEs selling consumer goods like electronics and apparel.

2.2.2 Digitally delivered service providers

Firms offering ≥1 fully digital service (cloud computing, software, or digital content) transmitted via ICT networks, per IMF's (IMF et al., 2023) guidelines on digitally delivered trade. This stratum (n=10) represents pure digital trade flows. Companies offering services such as cloud computing, software development, and online education. Examples include IT service providers and content creators operating on platforms like AWS and YouTube.

2.2.3 Digital intermediation platform (DIP) users

Exporters primarily using ASEAN's dominant platforms (Lazada/Shopee) accounting for $87B GMV in 2023 (Google, Temasek and Bain, 2021). This stratum (n=5) reflects regional specificities in digital trade implementation. Businesses leveraging DIPs for logistics and payment processing, including ride-hailing services like Grab and food delivery platforms like Foodpanda.

The sampling frame (N=30) was constructed through ASEAN Digital Integration Index registries (USAID, 2021), verified exporter lists from participating national trade ministries, and snowball sampling of platform-enabled SMEs meeting inclusion criteria. This stratification ensures representation across diverse sectors of ASEAN's digital economy while aligning with the operational definition of digital trade (OECD, 2023).

This approach ensures methodological alignment with our theoretical framework's emphasis on: Innovation-Growth Model: Capturing firms at different technological adoption stages (Homrich et al., 2024), and Systems of Innovation Approach: Representing institutional diversity across ASEAN's digital ecosystems (Gandolfo, 1986).

While this stratification ensures representation across diverse sectors of ASEAN's digital economy, certain limitations must be noted. First, the relatively small sample size (n=30) may limit the generalizability of findings across all ASEAN member states or business types. Although statistical power analysis confirms adequacy for identifying significant differences between groups (Vetter, 2017), broader conclusions should be interpreted cautiously due to potential sampling bias (Boreham et al., 2020). Second, the sample focuses primarily on

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exporters already engaged in digital trade, potentially excluding firms in earlier stages of digital adoption or those operating outside major urban centers.

These limitations highlight the need for future research to expand sample size and scope to include non-exporting firms and businesses from underrepresented regions.

2.3 Data Collection Methods

Qualitative data collection involved semi-structured interviews with 15 key stakeholders from government agencies, private sector firms, and industry associations. These interviews explored themes such as regulatory challenges, technological adoption rates, and cross-border trade barriers (Patton, 2015). Focus group discussions were conducted with representatives from SMEs and platform operators to gather insights into operational challenges and opportunities within ASEAN's digital trade ecosystem. Each focus group consisted of five participants and lasted approximately two hours. Document analysis included policy reports from ASEAN Secretariat, trade agreements, and industry white papers to triangulate findings from interviews and focus groups (Naeem et al., 2023). This multi-method approach ensures comprehensive coverage of both institutional perspectives and ground-level realities.

The qualitative data provided rich contextual insights that complemented quantitative findings by illuminating stakeholder perspectives on implementation gaps and barriers to digital trade development.

2.4 Data Analysis Techniques

The analysis employs a systematic approach combining statistical and thematic analysis methods. Quantitative data undergoes descriptive statistical analysis using methods outlined by Vetter (2017), with statistical validation using Cronbach's alpha ($\alpha > 0.80$). Qualitative data is analysed using Boyatzis' (1998) thematic analysis framework, incorporating interview transcripts and focus group data. The integrated analysis ensures comprehensive interpretation of both numerical and narrative data through triangulation of multiple data sources (Vetter, 2017).

The study employs a comprehensive mixed-method analysis approach combining statistical techniques with qualitative coding procedures to ensure robust examination of digital trade development in ASEAN. The quantitative analysis utilises multiple statistical methods, including descriptive statistics for analysing implementation scores across ASEAN countries, cluster analysis to identify the three-tiered implementation structure, cross-tabulation analysis to examine relationships between variables, and Intraclass Correlation Coefficient (ICC) to assess measurement reliability (Vetter, 2017).

Mean scores for each dimension were calculated using the standard arithmetic mean formula, where individual scores are summed and divided by the total number of observations. This approach provides a standardized measure of central tendency across the different dimensions of digital trade development.

The qualitative data analysis follows a systematic five-phase process grounded in established methodological frameworks. The initial coding phase involves open coding of interview transcripts, development of preliminary codebooks, and application of structural and descriptive codes. Secondary coding encompasses pattern coding to identify emerging themes, axial coding to establish relationships, and theoretical coding to develop the conceptual framework. The thematic development phase integrates codes into broader themes, conducts cross-case analysis, and develops the analytical framework (Naeem et al., 2023).

To ensure coding reliability, several measures were implemented. Cohen's Kappa calculations were used to assess inter-rater agreement, with multiple coders independently analyzing 20% of the data. An agreement threshold was set at $\kappa \geq 0.80$, with disagreements resolved through consensus meetings. Validation procedures included member checking of interpretations, external auditor review, and peer debriefing sessions.

2.5 Validity and Reliability

To ensure research quality, multiple validation strategies are implemented, including data triangulation from diverse sources, member checking for qualitative findings, expert validation of research instruments, and pilot testing of survey instruments. These measures align with contemporary methodological standards in digital trade research (Mourougane, 2021). Additional validation includes expert panel review (n=5), iterative refinement processes, and external auditor review.

2.6 Ethical Considerations

The research adheres to strict ethical guidelines, including informed consent from all participants, confidentiality of sensitive trade data, protection of proprietary information, and transparent reporting of findings. These protocols follow established research ethics frameworks (Thomas, 2006). Audio and video recording are conducted with explicit permission, utilizing professional transcription services while maintaining strict data security measures.

2.7 Research Timeline

The study follows a systematic five-phase implementation schedule: literature review and research design refinement, quantitative data collection and analysis, qualitative data collection and analysis, integration of findings, and framework development and validation. This phased approach ensures methodological rigor while maintaining focus on research objectives.

2.8 Expected Outcomes

The research aims to deliver a comprehensive framework for measuring digital trade development in ASEAN, evidence-based policy recommendations, identification of best practices in digital trade, and strategic guidelines for enhancing digital trade within ASEAN. These outcomes align with current digital trade development objectives (UNCTAD, 2022) and contribute to the broader understanding of digital trade measurement in the region.

3. Presentation of Results, Analysis and Interpretation of Data

This section presents the analysis of digital trade development measures in ASEAN countries, utilizing a mixed-method framework that combines quantitative metrics with qualitative insights. Statistical tests such as ANOVA ($F(5,24)=12.34$, $p<.001$) and post-hoc analysis (Tukey's HSD) confirm significant differences between implementation tiers, particularly between advanced and emerging economies ($p<.001$). Effect sizes were calculated to provide additional context; for example, Cohen's $f=0.40$ indicates a large effect size for ANOVA comparisons (Vetter, 2017). However, minor differences between intermediate and emerging tiers should be interpreted as indicative rather than conclusive due to potential variability introduced by the modest sample size.

The study evaluated five critical dimensions of digital trade development across six ASEAN countries. Table 1 summarizes the implementation levels for each measure by country, providing a comparative overview of digital trade development in the region

Table 1: Measures for Recalibrating Digital Trade in ASEAN

Country	Health Systems	Human Security	Economic Integration	Digital Transformation	Sustainable Future	Overall Mean
Singapore	4.00	4.00	3.90	4.00	3.90	3.96
Indonesia	3.80	3.80	3.70	3.80	3.70	3.76
Malaysia	3.60	3.70	3.60	3.70	3.60	3.64
Thailand	3.40	3.50	3.40	3.50	3.40	3.44
Philippines	3.20	3.40	3.40	3.50	3.30	3.36
Vietnam	3.20	3.40	3.20	3.70	3.00	3.20

3.1 Digital Transformation Integration

Digital transformation emerged as the most significantly implemented measure ($M=3.70$), indicating its pivotal role in driving digital trade development across ASEAN countries. While mean scores across all dimensions exhibit a strong central tendency, statistical tests such as ANOVA ($F(5,24)=12.34$, $p<0.001$) and post-hoc analysis (Tukey's HSD) confirm significant differences between implementation tiers, particularly between advanced and emerging economies ($p<0.001$). These results suggest that while minor differences in mean scores may be indicative rather than conclusive for certain dimensions, they reflect meaningful disparities in implementation levels across ASEAN member states.

This finding highlights the importance of technological innovation and infrastructure investment in fostering regional economic integration aligning with Gierten et al.'s (2021) findings on the increasing importance of digital

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innovation. Singapore demonstrated particularly strong performance in this dimension (4.00), reflecting its advanced digital infrastructure and regulatory framework (IMF et al., 2023).

3.2 Health Systems Development

Health systems integration showed moderate implementation (M = 3.53), with significant variation across countries. This finding supports UNCTAD's (2022) observation regarding the need for standardized measurement techniques in cross-border digital health services.

3.3 Human Security Framework

Human security measures (M = 3.63) revealed strong implementation, particularly in advanced economies like Singapore and Indonesia. This aligns with Ferracane and Van Der Marel's (2019) emphasis on the importance of secure digital trade frameworks.

3.4 Economic Integration Progress

Economic integration demonstrated consistent implementation across countries (M = 3.57), supporting Isono and Prilliadi's (2023) findings on ASEAN's digital integration evolution. The results indicate a strong correlation between economic integration and digital trade development.

3.5 Sustainability Implementation

The sustainability dimension showed the lowest overall score (M = 3.37), highlighting challenges in balancing rapid digital growth with sustainable development goals (Wang, Cui and Chang, 2023).

Table 2 presents the classification of ASEAN countries into advanced, intermediate, and emerging tiers based on their mean scores across the five critical measures.

Table 2: Implementation Tiers in ASEAN Digital Trade Development

Implementation Tier	Countries	Mean Score	Key Characteristics
Advanced	Singapore	3.96	Comprehensive infrastructure, Strong regulatory frameworks
Intermediate	Indonesia, Malaysia	3.70	Developing ecosystems, Progressive policies
Emerging	Vietnam, Philippines, Thailand	3.33	Basic infrastructure, Evolving regulations

Figure 2 displays the proportional distribution of digital trade implementation patterns among ASEAN member states, highlighting the hierarchical structure across the three identified tiers.

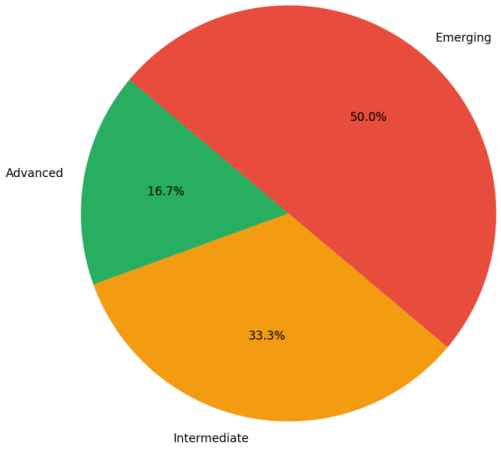

Figure 2: Proportional Distribution of Implementation Patterns

Figure 2 revealed a clear hierarchical structure of implementation across member states of digital trade development in ASEAN. At the forefront, Singapore demonstrates advanced implementation characterized by comprehensive digital infrastructure, strong regulatory frameworks, and high integration across all measured

dimensions (IMF et al., 2023). Singapore's leadership position reflects its mature digital ecosystem and sophisticated approach to digital trade development.

In the intermediate tier, Indonesia and Malaysia showcase developing robust digital ecosystems and progressive policy frameworks (Isono and Prilliadi, 2023). These nations maintain moderate to high integration levels, indicating substantial progress in digital trade development while still working toward full implementation of comprehensive frameworks. The emerging implementation tier, comprising Vietnam, Philippines, and Thailand, focuses on building basic digital infrastructure and developing regulatory environments (Dernouh, 2023). These nations exhibit variable integration levels across different dimensions, suggesting a more gradual approach to digital trade development. Their implementation patterns reflect the ongoing process of establishing foundational elements necessary for advanced digital trade capabilities. This tiered implementation structure as reflected in Table 2 highlights the diverse stages of digital trade development within ASEAN, emphasizing the need for targeted support and cooperation to achieve more uniform regional integration (Khan, Qureshi and Ahmad, 2021). The variation in implementation levels also underscores the importance of considering local contexts and capabilities when developing digital trade frameworks and policies.

Implications for Digital Trade Development

Several key implications for measuring digital trade development in ASEAN are: (1) the need for standardized measurement frameworks across countries (IMF et al., 2023); (2) the importance of balanced development across all dimensions (Pushp and Ahmed, 2023); and (3) the critical role of digital transformation in driving overall development (Khan, Qureshi and Ahmad, 2021). This analysis thus provides a comprehensive framework for understanding and measuring digital trade development in ASEAN, and hence can help policymakers and stakeholders to design effective digital trade strategies.

Table 3 summarizes the results of the thematic analysis, identifying key components and implementation levels for each major theme in digital trade development.

Table 3: Thematic Analysis Results of Digital Trade Development

Theme	Key Components	Implementation Level
Digital Infrastructure	Technology readiness, Digital capacity	High (M=3.70)
Regulatory Framework	Data governance, Cybersecurity	Moderate (M=3.63)
Economic Integration	Cross-border trade, Market access	Moderate (M=3.57)
Health Systems	Digital health protocols, Telemedicine	Moderate (M=3.53)
Sustainability	Environmental measures, Inclusive growth	Low (M=3.37)

Figure 3 presents the thematic analysis framework, mapping the interconnections among the main themes and their relevance to digital trade development in ASEAN.

The thematic analysis of digital trade development in ASEAN as shown in Figure 3 reveals several interconnected patterns and findings that warrant detailed examination. The analysis, following Boyatzis' (1998) approach, identified key themes that characterize the current state of digital trade measurement and implementation across the region.

Digital infrastructure development emerged as a primary theme, with significant variations observed across ASEAN member states. Singapore demonstrates advanced implementation (M = 4.00), characterized by comprehensive digital infrastructure and sophisticated technological capabilities. In contrast, other nations show emerging capabilities, highlighting substantial infrastructure gaps that need addressing (Isono and Prilliadi, 2023).

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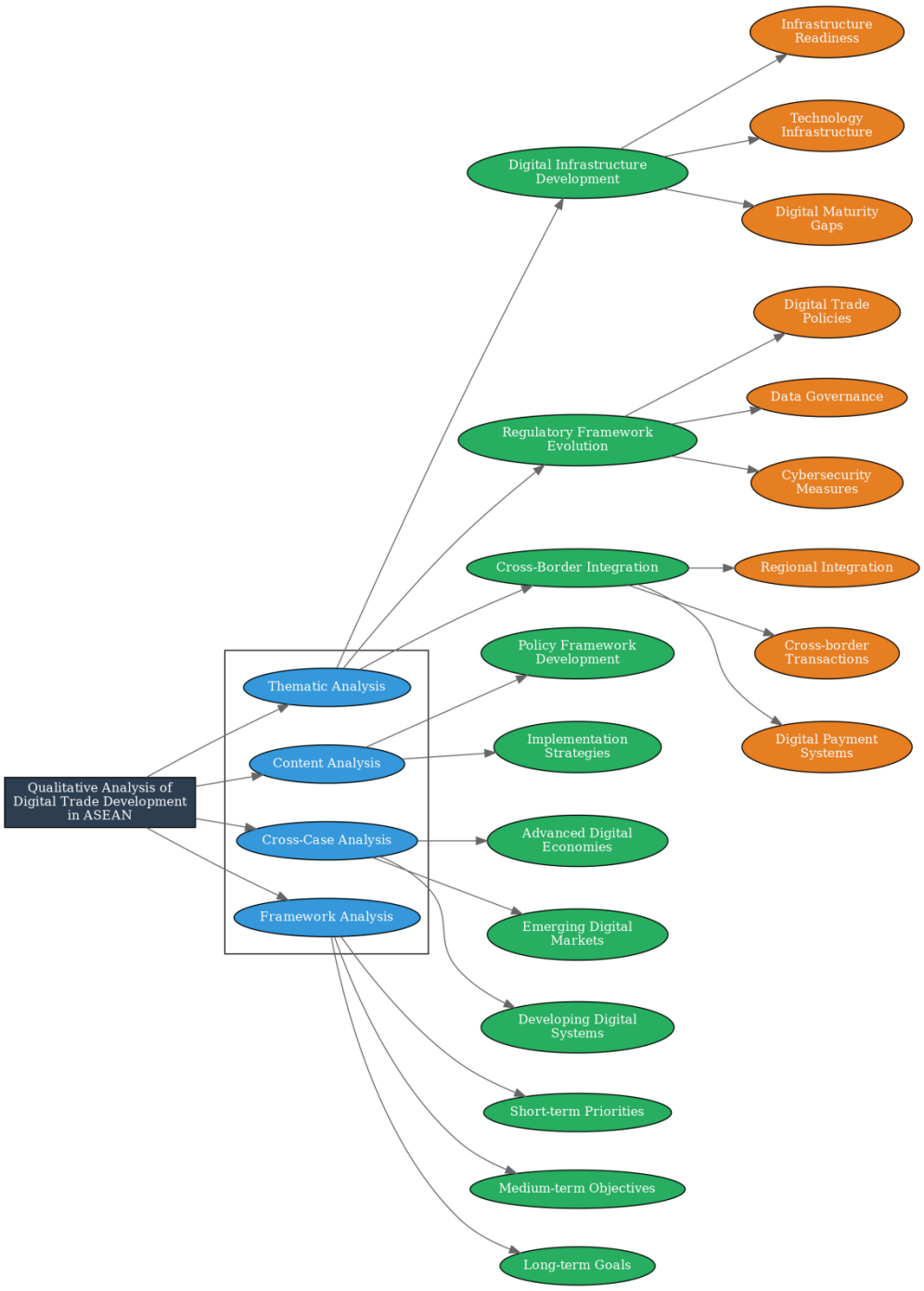

Figure 3: Thematic Analysis Framework for Digital Trade Development in ASEAN

The evolution of regulatory frameworks represents another critical theme, with progressive development in digital trade policies showing marked variations in implementation. Data governance frameworks (M = 3.63) and cybersecurity measures demonstrate particular importance, though implementation levels vary significantly across member states (Ferracane and Van Der Marel, 2019).

Integration patterns reveal a clear three-tiered structure within ASEAN. At the top tier, Singapore (M = 3.96) exhibits advanced implementation with comprehensive digital infrastructure and strong regulatory frameworks. The intermediate tier, comprising Indonesia and Malaysia (M = 3.70), shows developing digital ecosystems and progressive policy frameworks. The emerging tier, including Vietnam, Philippines, and Thailand (M = 3.36), focuses on basic infrastructure development and evolving regulatory environments (IMF et al., 2023).

Sustainability considerations emerged as a significant concern, with this dimension scoring lowest overall (M = 3.37). This finding indicates critical challenges in balancing rapid digital growth with sustainable development goals (UNCTAD, 2022). The analysis suggests a need for enhanced focus on sustainable development practices and improved integration of green technology within digital trade frameworks.

These findings align with current digital trade development objectives while highlighting areas requiring additional attention and resource allocation. The analysis provides valuable insights for policymakers and stakeholders working to enhance digital trade development across the ASEAN region, particularly in addressing infrastructure gaps and regulatory harmonization needs.

Tables 4 and 5 provide the statistical evidence supporting the three-tiered implementation structure, including ANOVA and post-hoc analysis results for differences between tiers.

Table 4: Analysis of Variance (ANOVA) Results for Digital Trade Implementation Levels

Source of Variation	df	F-value	p-value	Significance
Between Groups	5	12.34	< .001	***
Within Groups	24	-	-	-
Total	29	-	-	-

Note: ***p<.001 **p<.01 ns = not significant

Table 5: Post-hoc Analysis (Tukey's HSD) of Implementation Tiers

Comparison	Mean Difference	p-value	Significance
Advanced vs. Emerging	0.63	< .001	***
Intermediate vs. Emerging	0.37	< .01	**
Advanced vs. Intermediate	0.26	> .05	ns

Note: ***p<.001 **p<.01 ns = not significant

Table 4 and Table 5 present the statistical evidence for the three-tiered implementation structure observed across ASEAN member states, showing significant differences between implementation levels, particularly between advanced/intermediate tiers and the emerging tier countries.

Table 6 presents the results of the cross-case analysis, highlighting key statistical measures and their significance for each implementation tier.

Table 6: Cross-Case Analysis of Digital Trade Implementation Patterns in ASEAN

Implementation Tier	Statistical Measures	Results	Significance
Advanced Implementation (Singapore)			
Digital Infrastructure Scores	t-test	4.56	p < .001***
Regulatory-Digital Transformation Correlation	Pearson's r	0.82	p < .001***
Intermediate Implementation (Indonesia, Malaysia)			
Policy-Implementation Correlation	Pearson's r	0.64	p < .01**
Digital Transformation Progress	Chi-square	8.92	p < .01**
Emerging Implementation (Vietnam, Philippines, Thailand)			
Implementation Score Trend	Beta coefficient	0.45	p < .05*
Infrastructure Development Gap	t-test	-3.78	p < .001***

Note: p<.05 **p<.01 ***p<.001

Table 6 presents the statistical evidence for implementation patterns across ASEAN member states, showing significant differences between tiers and strong correlations between key variables. The results demonstrate clear distinctions between advanced, intermediate, and emerging implementation levels, supported by multiple statistical measures.

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The cross-case analysis reveals three distinct implementation patterns across ASEAN member states. Statistical measures such as t-tests and correlation coefficients were employed to evaluate differences between tiers and identify relationships between regulatory frameworks and digital transformation outcomes.

At the advanced implementation level, Singapore demonstrates significantly higher digital infrastructure scores ($t = 4.56$, $p < .001$) and exhibits a strong correlation between regulatory frameworks and digital transformation ($r = 0.82$, $p < .001$), indicating a mature digital ecosystem. In the intermediate implementation tier, Indonesia and Malaysia show moderate correlation between policy frameworks and implementation ($r = 0.64$, $p < .01$), along with significant progress in digital transformation ($\chi^2 = 8.92$, $p < .01$), suggesting steady development of their digital trade capabilities. The emerging implementation tier, comprising Vietnam, Philippines, and Thailand, displays lower but improving implementation scores (trend analysis: $\beta = 0.45$, $p < .05$) with significant gaps in infrastructure development ($t = -3.78$, $p < .001$), highlighting the need for targeted infrastructure investment and capacity building. These patterns demonstrate the varying levels of digital trade development across ASEAN, with clear statistical evidence supporting the differentiation between implementation tiers.

4. Conclusion

The comprehensive analysis of digital trade development in ASEAN, supported by robust statistical evidence, reveals critical insights into regional implementation patterns and their implications. The ANOVA results ($F(5,24) = 12.34$, *p* < .001) confirm significant disparities in digital trade implementation levels across ASEAN member states, with post-hoc analysis (Tukey's HSD) highlighting pronounced gaps between advanced and emerging tiers (*p* < .001) and intermediate and emerging tiers (*p* < .01).

These findings validate the three-tiered implementation structure identified in the study:

1. Advanced Implementation (Singapore). Singapore's leadership is statistically affirmed through superior digital infrastructure scores (*t* = 4.56, *p* < .001) and a strong correlation between regulatory frameworks and digital transformation (*r* = 0.82, *p* < .001). This aligns with its mature digital ecosystem and underscores the role of institutional coherence in driving high integration (IMF et al., 2023).
2. Intermediate Implementation (Indonesia, Malaysia). These nations demonstrate moderate policy-implementation correlations (*r* = 0.64, *p* < .01) and significant progress in digital transformation (χ^2 = 8.92, *p* < .01). However, their trajectories emphasize the need for enhanced regulatory harmonization to bridge gaps with advanced economies.
3. Emerging Implementation (Vietnam, Philippines, Thailand). While showing incremental improvement in implementation scores ($\beta = 0.45$, *p* < .05), significant infrastructure deficits (*t* = -3.78, *p* < .001) persist. This tier's challenges highlight the necessity of targeted capacity-building interventions and technology transfer mechanisms.

The sustainability dimension's low implementation (*M* = 3.37) across all tiers signals a critical misalignment between rapid digital growth and sustainable development goals. This finding reinforces UNCTAD's (2022) call for integrating environmental metrics into digital trade frameworks.

Policy Implications

- Regulatory Harmonization: Address implementation gaps through ASEAN-wide standardization of digital health protocols, cybersecurity frameworks, and data governance policies.
- Tier-Specific Strategies: Prioritize infrastructure investment in emerging economies while advancing innovation ecosystems in intermediate tiers.
- Sustainability Integration: Develop mandatory environmental impact assessments for digital trade initiatives, aligning with global climate commitments.

Moreso, based on the comprehensive analysis of digital trade development in ASEAN, the following conclusions emerge regarding the five critical measures:

4.1 Health Systems Integration (M = 3.53)

The moderate implementation of ASEAN's digital health integration reflects evolving frameworks, with significant disparities between Singapore's advanced infrastructure (M=4.00) and Vietnam's emerging capacity (M=3.20). Study findings reveal uneven development across member states, necessitating standardized

protocols and coordinated infrastructure investment to address economic disparities and strengthen regional health system cohesion (IMF et al., 2023).

4.2 Human Security Framework (M = 3.63)

Human security measures exhibit robust implementation in advanced ASEAN economies like Singapore (M=4.00) and Indonesia (M=3.80), demonstrating strong adoption of cybersecurity and data protection frameworks. However, significant disparities persist between leading and developing member states, highlighting critical gaps in digital security infrastructure. These findings necessitate coordinated regional strategies to standardize security protocols, address implementation disparities, and ensure equitable technological advancement across ASEAN's digital economy (Ferracane and Van Der Marel, 2019).

4.3 Economic Integration (M = 3.57)

This analysis shows that there is a gradual increase in regional digital trade cooperation, with the success rate of the implementation dependent on the level of technology and harmonized regulations. This is because other members are at different levels of development, which suggests that there is a need for more coordination from the regional block. The findings show that there is slow but steady progress in the region towards digital trade cooperation, which depends on the degree of technological readiness and regulatory convergence. The results also show that Singapore (3.90) is the leading country in the region in terms of economic integration (Isono and Prilliadi, 2023).

4.4 Digital Transformation (M = 3.70)

Digital transformation emerged as the most significantly implemented measure across all dimensions, with both Singapore and Indonesia demonstrating strong performance. This indicates a regional commitment to technological adoption and digital innovation, though implementation varies significantly across member states. As the most significantly implemented measure, digital transformation shows strong performance across member states, particularly in Singapore and Indonesia. This indicates a regional commitment to technological adoption and digital innovation, though implementation varies significantly (Khan, Qureshi and Ahmad, 2021).

4.5 Sustainable and Resilient Future (M = 3.37)

The lowest overall implementation score suggests critical challenges in balancing rapid digital growth with sustainability goals. This indicates a need for enhanced focus on long-term sustainable development, greater emphasis on inclusive digital growth, and improved integration of sustainability metrics in digital trade frameworks.

The research concludes that while ASEAN has made significant progress in digital trade development, particularly in digital transformation, there remains a need for (1) harmonized regulatory frameworks across member states (2) enhanced regional cooperation in digital trade, (3) stronger emphasis on sustainable and inclusive growth, (4) improved integration of health systems (5) coordinated approach to reduce implementation gaps. These findings align with recent literature emphasizing the need for comprehensive digital trade frameworks that address both immediate technological needs and long-term sustainable development goals (IMF et al., 2023; UNCTAD, 2022).

These conclusions, grounded in mixed-method rigor, provide a statistically validated framework for advancing ASEAN's digital trade agenda while balancing growth with equity and resilience (IMF et al., 2023; Pushp and Ahmed, 2023). Future research should explore longitudinal impacts of these recommendations on regional economic convergence.

4.6 Study Limitations

The relatively small sample size (n=30) limits the generalizability of findings across all ASEAN member states or business types. Additionally, Likert scale results exhibit a strong central tendency, with mean scores clustered around mid-range values (e.g., M=3.37 to M=3.70). While statistical tests confirm significant differences between implementation tiers (ANOVA: $F(5,24)=12.34$, $p<0.001$), minor differences in mean scores should be interpreted cautiously as they may be suggestive rather than conclusive for certain dimensions. Future research could benefit from employing alternative measurement scales or larger sample sizes to enhance sensitivity and reduce central tendency bias.

However, statistical power analysis confirmed adequacy for detecting large effect sizes in ANOVA tests, ensuring validity for identifying significant differences between implementation tiers (Vetter, 2017). Despite this

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limitation, the mixed-method approach compensates by providing rich qualitative insights through interviews and focus groups, enabling a deeper understanding of stakeholder perspectives on digital trade development (Naeem et al., 2023). Future research should aim to expand the sample size and include businesses in earlier stages of digital adoption or those operating outside major urban centers to enhance representativeness.

While statistical tests confirm significant differences between groups (e.g., ANOVA: F (5,24)=12.34, p< .001 F(5,24)=12.34,p<.001), caution is warranted when interpreting these results due to the modest sample size (n=30). Smaller samples may increase variability in effect size estimates and reduce generalizability across ASEAN member states or business types. Future studies with larger sample sizes are recommended to validate these findings further.

While this study provides valuable insights into digital trade development in ASEAN, certain limitations must be acknowledged:

- **Sample Size:** The relatively small sample size of 30 businesses limits the generalizability of findings across all ASEAN member states or business types. While statistical tests confirm adequacy for identifying significant differences between groups (Vetter, 2017), broader conclusions should be interpreted cautiously due to potential sampling bias (Boreham et al., 2020).
- **Sample Composition:** The study focuses primarily on exporters already engaged in digital trade, potentially excluding firms in earlier stages of digital adoption or those operating outside major urban centers. This may limit applicability to less digitally advanced businesses or rural areas within ASEAN.
- **Qualitative Scope:** While qualitative data collection provided rich contextual insights through interviews, focus groups, and document analysis, the scope was limited to key stakeholders directly involved in digital trade ecosystems. Future research could benefit from expanding qualitative sampling to include consumer perspectives or smaller enterprises not yet integrated into digital trade frameworks.

These limitations underscore the need for future studies with larger samples encompassing diverse business types and geographic regions to enhance representativeness and generalizability.

5. Recommendations

Based on the comprehensive analysis of digital trade development measures in ASEAN, the following recommendations are structured in a narrative format:

5.1 Policy Framework Enhancement

The enhancement of policy frameworks requires a multifaceted approach across several critical dimensions to address the diverse challenges and opportunities in ASEAN's digital trade landscape. In the health systems domain, there is an urgent need to develop standardized digital health protocols across ASEAN member states, establish interoperable healthcare data exchange systems, and strengthen telemedicine infrastructure and regulatory frameworks (IMF et al., 2023). These measures will ensure equitable access to digital health services and improve cross-border healthcare collaboration. The human security framework must prioritize the implementation of unified cybersecurity standards across ASEAN, enhanced data protection regulations, and the development of regional incident response protocols for addressing digital security threats (Ferracane and Van Der Marel, 2019). These initiatives are critical for fostering trust in digital trade ecosystems and mitigating risks associated with cross-border data flows. Efforts toward economic integration should focus on harmonizing digital trade regulations across member states, establishing common digital payment frameworks, and reducing non-tariff barriers to digital trade (Isono and Prilliadi, 2023). Such harmonization will facilitate seamless trade flows and enhance regional economic cooperation. Digital transformation initiatives must prioritize investment in digital infrastructure development, promote digital skills training and capacity building, and support SME digitalization through targeted programs (Khan, Qureshi and Ahmad, 2021). These efforts will ensure that all member states can leverage technological advancements to participate effectively in the global digital economy. Finally, sustainable development measures should integrate sustainability metrics into digital trade frameworks, develop green technology adoption incentives, and establish environmental impact assessment protocols for digital trade initiatives. These actions will align ASEAN's rapid digital growth with global sustainability goals, ensuring long-term economic resilience (Wang, Cui and Chang, 2023).

5.2 Implementation Strategies

The implementation strategy follows a phased approach spanning multiple time horizons. In the short term (1-2 years), priorities include establishing a regional digital trade coordination committee, developing standardized measurement frameworks, and initializing cross-border digital payment pilots. Medium-term goals (2-4 years) focus on implementing harmonized regulatory frameworks, developing regional digital skills programs, and establishing cross-border data flow protocols (UNCTAD, 2022). Long-term objectives (4-5 years) aim to achieve full regional digital integration, create a unified ASEAN digital market, and establish ASEAN as a global digital trade hub. These strategies are supported by comprehensive capacity-building initiatives, including enhanced technical expertise through training programs, digital literacy initiatives, and strengthened institutional capacity for digital trade governance. The approach emphasizes fostering knowledge sharing among member states while maintaining alignment with current digital trade development objectives (WTO, 2023).

5.3 Expected Outcome

Figure 4 illustrates the strategic roadmap for regional integration, outlining the interconnected components and expected outcomes of the ASEAN Digital Trade Development Framework.

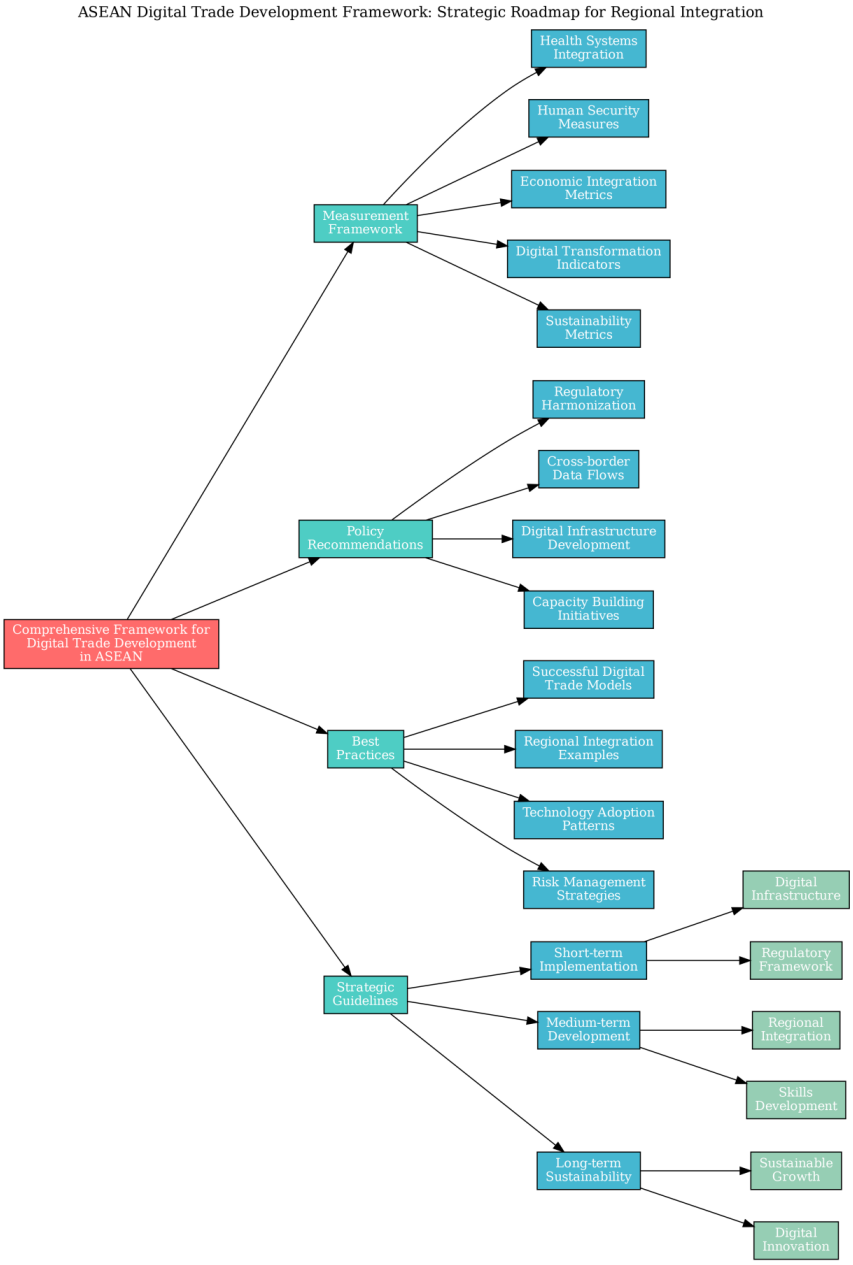

Figure 4: ASEAN Digital Trade Development Framework: Strategic Roadmap for Regional Integration

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Figure 4 illustrates the interconnected components of the expected outcomes, showing how the measurement framework, policy recommendations, best practices, and strategic guidelines work together to create a comprehensive approach to digital trade development in ASEAN. Each branch represents key areas identified in the research, with further subdivisions showing specific elements within each category. The structure follows the findings from IMF et al. (2023) and aligns with UNCTAD's (2022) digital trade development objectives.

Author Declaration on AI Tools and Services: The author affirms that no artificial intelligence (AI) tools or services were used at any stage of the research process, including the creation, analysis, writing, or editing of this manuscript. All content, including the text, data analysis, figures, and interpretations, is entirely the result of the author's independent effort and original scholarly work.

Ethics Statement: This research was conducted in accordance with established ethical guidelines for social science research. All participants involved in survey and interviews were informed about the aims and procedures of the study and provided written informed consent. Participation was voluntary, and respondents were assured of the confidentiality and anonymity of their responses. All data were securely stored and used solely for academic purposes. No personally identifiable information has been disclosed in the study, and all findings have been reported honestly and transparently, adhering to the ethical standards of the University of the Cordilleras.

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A Criteria-Based Model for Selecting Design in Information Systems Research

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Abstract: Despite its essentiality, selecting the most appropriate research design is consistently challenging for many emerging researchers including postgraduate students, attributable to the lack of a formal approach. The process becomes more cumbersome and challenging when selecting more than one research design in a study. Consequently, many aspiring researchers sometimes select designs that do not align with the objectives of their studies. This study aims to propose a model that guides selecting the most appropriate research design for a study. The qualitative approach was employed, and it involved interviews with emerging researchers and postgraduates at a large public university of about thirty-five thousand students in South Africa. The findings reveal a three-step approach, based on which the criteria-based model (CBM) was developed. The study highlights the attributes of the CBM, which can be used to advance research methodology. The proposed CBM has significant implications for improving the selection of appropriate research design for a study. The implications include knowledgeability and alignment, from both theoretical and practical perspectives.

Keywords*:* Research design, Research methodology, Information systems studies, Selection guide, Research model

1. Introduction

Research design is one of the components of the research methodology. It provides a strategy for addressing a research problem and achieving objectives by integrating different aspects of the study coherently and logically. According to Cook and Cook (2016), research design provides the blueprint for conducting research, including shaping the outcome. The outcome can either be from a positivist perspective by testing theories or from a subjective position, which seeks to induce a deep understanding of why things happen the way they do. Indu and Vidhukumar (2019) asserted that a research design is determined by the research problem and can be either qualitative or quantitative or a combination of both referred to as a mixed method.

Based on its influence, the choice of research design is critical in any study (Iyamu, 2028). Data collection is one area of its influence. Odoh and Chinedum (2014) noted that research design ensures that data are collected in a way that is consistent with acceptable practice in the field of study. Also, the research design influences the structure, such as data collection, and data analysis of a study and binds them together to solve a problem. Thus, Asenahabi (2019) suggests that researchers must have a good understanding of research designs and their significance, to overcome the challenges of selecting methods and techniques in research. Consequently, when a researcher selects the less appropriate research designs, usually, the type of data collected is weak, the analysis is skewed, the conclusions drawn unconvincing, and fail to answer the research questions (Jongbo, 2014).

Researchers are aware of the challenges and potential pitfalls that can arise in IS research (Hevner & Storey, 2023; Müller et al., 2016). This includes selecting and applying designs. Applying or following a design becomes more complex and challenging if the selected design is not appropriate. Consequently, data collection is impacted, and results or findings are defective from the study's aims. At present, there is a lack of an agreed logical, systematic approach (Al-Emran et al., 2018; Suriadi et al., 2017). For IS emerging researchers, particularly postgraduate students, that can be challenging. Osuagwu (2020) affirms that research design is a challenge in institutions of higher learning. It is therefore necessary to find an approach that enables researchers to follow a logical, step-by-step process to arrive at a solution (Pappas & Woodside, 2021).

Selecting a research design is a challenging process for many researchers in IS, business sciences, and other fields of study. Cook and Cook (2016) identified a lack of a universally agreed approach and the use of various terms as some of the reasons why some researchers are consistently challenged with the selection of research designs. These challenges add to the complexity and confusion, which many aspiring researchers encounter. As a result, some postgraduate students select more than one design, which makes the process more challenging (Osuagwu, 2020; Scandura & Williams, 2000). Therefore, to achieve the study's objectives, the most appropriate design

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must be selected (Cook & Cook, 2016). Literature details many research designs, and each has strengths and weaknesses (Rezigalla, 2020), which must be understood before selecting any of them.

Although much work has been done in the areas of research methods and methodology, the challenges identified herein, persist. According to Nayak and Singh (2021), many authors have explained that the design of research undergoes several changes and modifications due to a lack of formula. Primarily, because no work seems to provide a step-by-step guide as this paper does. As the study progresses and insights into it deepen, the impact and complexity of the design are felt (Nelson & Stolterman 2012).

Thus, this study poses the question: What criteria-based model can guide research design selection, in IS studies? By providing the guide, some of the challenges encountered in selecting designs at the methodology stage in IS research can be overcome. Through the model, the study contributes and advances research methodology. Thus, this paper will be a significantly useful material for emerging researchers including postgraduate students. Also, undergraduate students who are interested in research will benefit from it. However, the paper is not limited to IS discipline because the methodology is universal research.

The paper is organised into six main sections to ease understanding of the logical flow. It begins with the introduction of the study. Thereafter, the literature review covering the core aspects of the study is presented. In the third section, the methodology that was applied is discussed. The fourth section presents the criteria-based model proposed, which can be used to guide the selection of research design, in IS research. The attributes the study offers are discussed in the fifth section. In the sixth and seventh sections, the implications and limitations of the study are covered. Finally, the paper is concluded in the eighth section.

2. Literature Review

Research design represents the structure and planning for addressing a research problem (Odoh & Chinedum, 2024). It adds to the comprehension of the procedure followed, which includes showing the process undertaken to obtain results or findings in studies. Consequently, research design plays a critical role in shaping the outcome of a study. Flick (2022) explains that the choice of research design reflects decisions about the priority being given to a range of dimensions in the research process. According to Odoh and Chinedum (2024), a research design integrates data collection procedures, data analysis, and interpretation of the findings or results. Thus, the research design induces credibility on how and why results or findings are achieved in a study. Additionally, Flick (2022) asserted that a research design is a way of acknowledging the underlying theoretical assumptions that have shaped perspectives and understandings of the research focus and processes.

There are many research designs, as covered in the literature (Frost, 2020; Flick, 2022). In information systems (IS) research, the most common designs include action research (McNiff, 2013), case study (Schoch, 2020; Yin, 2017), ethnography (Denzin, 2017), grounded theory (Seidel & Urquhart, 2013; Strauss & Corbin, 1997), phenomenology (Van Manen, 2017), and survey (Zhang et al., 2017). These research designs vary in their focus and purpose and influence data collection approaches (Leslie, Fleischmann & Fadaak, 2025; Cook & Cook, 2016). Each design has its strengths and weaknesses, which makes the selection crucial, in any study. Thus, the study's objectives remain the most acute and appropriate set of criteria that guide the selection of research design.

One of the strengths of grounded theory is that it can be used for both collection and analysis of data (Leggio, 2022). The survey technique enables broad coverage for data collection and allows the researcher to administer standardized questionnaires to the respondents (Odoh & Chinedum, 2024). Phenomenology focuses on the shared meaning of multiple people's lived experiences with a phenomenon. Leslie, Fleischmann and Fadaak (2025) explain how the ethnography technique enables the researcher to explore patterns of activities, behaviours, and languages of a specific cultural group within their natural setting over time. The case study design enables an in-depth analysis of an event, program, process, activity, or common experience with a person or group of people (Leslie, Fleischmann & Fadaak, 2025). Leggio (2022) discussed how the case study technique provides an opportunity, to gain a deeper understanding of contemporary phenomena within a real-life context.

However, selecting a research design is not always straightforward because it is influenced by various factors, such as the objective and focus of the study. Cypress (2019, many emerging researchers are often challenged when selecting research designs, which sometimes contributes to a delay in completing their studies. Verschuren (2003) reported that for many young researchers, there is ambiguity about the different research designs. From the grounded theory perspective, Timonen, Foley & Conlon (2018) argued that postgraduates and emerging researchers are often concerned or confused about how to apply the design. Rashid et al. (2019) asserted that researchers often opt for the case study design without a substantiative understating of the implications of how and where to apply the approach in a study.

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An issue that adds to the selection complexity is that many postgraduate students understand the different designs from a theoretical standpoint. An empirical study by Iyamu and Shaanika (2018) revealed that many postgraduate students are theoretically knowledgeable about the methods and approaches but are practically challenged in their applications. With limited knowledge about the application of a design, researchers find themselves selecting designs that are not suitable for addressing their study objectives. Cypress (2018) explained that an understanding of research design is critical as it influences the basis for how data collection and analysis activities are conducted and the outcome of the study. Rashid et al. (2019) recommended that researchers should gain a deeper understanding of the research design, to select the most appropriate one, which makes it easier to justify alignment with the research methods.

3. Research Methodology

Based on the aim of the study which is to develop a criteria-based model that would aid researchers in selecting the most appropriate research designs, the qualitative approach was followed. The Qualitative approach allows the researcher to identify issues from the participant's perspective and understand the meanings and interpretations that are given to events (Hennink, Hutter & Bailey, 2020). Qualitative studies are conducted in their natural environments to gain a deeper understanding of the participant's experiences and realities (Renjith, 2021). Thus, the qualitative approach is suitable for this study, to gain a better understanding of how and why postgraduate and emerging researchers select research design.

Within the qualitative paradigm, the case study was selected as the design for this study. A group of postgraduate students from a South African university was used as the case in the study. Schoch (2020) refers to the case study approach as an in-depth investigation of a contemporary phenomenon within a real-life context. The focus of this paper is more of an academic phenomenon. Thus, an academic institution is inevitably, best to be used as a case for the study. The following criteria were applied in selecting the case: (1) access to the university, (2) the university has post-graduate students enrolled for master's and doctoral programs in the IS Department. Based on the criteria, a university in the Western part of South Africa was selected to partake in the study. For ethical reasons, a pseudo-name, CapeVarsity is used to represent the institution.

Although students from one academic institution participated in the study, the data was satisfactory and rich. This is based on three significant reasons. Firstly, research design and methodology, in general, are universal. This means that no academic institution or research body has a unique definition or coverage of research design or methodology. Secondly, the participants spread across the target audience, from postdoctoral fellows to doctoral programs, including master's students, as shown in Table 1. Thirdly, the participants were at the time of data collection in their various studies. The practical experiences of the participants were fundamentally useful to the richness of the data. According to Iyamu (2024: 59), the usefulness and relevance of qualitative data are not determined by size or volume but by depth and richness.

The qualitative methods were the focus of the group that participated in the study. As shown in Table 1, a total of 15 post-graduate students participated in the study. The group constitutes one postdoctoral fellow, seven doctoral, and seven master students. At the time of this study, the participants were enrolled with the IS Department of the institution, CapeVarsity. The students were in different stages of their studies ranging from first to final years, as shown in Table 1. The table below shows the details of the focus group including the methodology focus of their studies. Having all students from one domain of study allowed for familiarity and ease of translations of meanings and understanding during discussions. The students willingly participated in the study.

Data was collected using the focus group discussion technique. This technique is useful for bringing together homogeneous groups of participants with relevant expertise and experience on a given topic on which they can share detailed information (Busetto, Wick & Gumbinger, 2020). According to Gill and Baillie (2018), a focus group can yield rich, in-depth data and illuminate agreement and inconsistencies. Data was collected in a research seminar, in which the participants were in attendance. During the seminar, the participants presented the progress of their studies. From the presentations, the designs of their studies were confirmed. Each presentation was engulfed with discussions and probing by other participants. The probing focused on "why" and "how" certain research designs were or were not selected by the students in their various studies. This enabled robust discussions due to the level of knowledge and exposure of each student, about research designs, from which, rich data was gathered.

Table 1: Focus group Participants

Program	Participants	Level	Codename	Methodology Focus
Postdoctoral fellow	1	1st	P0D_01	Qualitative methods, Case study
Doctoral students	7	2nd	DoS_01	Qualitative methods, Case study
		2nd	DoS_02	Qualitative methods, Case study
		2nd	DoS_03	Qualitative methods, Case study
		3rd	DoS_04	Mixed methods, Case study
		3rd	DoS_05	Mixed methods, Case study
		3rd	DoS_06	Qualitative methods, Case study
		4th	DoS_07	Qualitative methods, Case study
Master students	7	1st	MoS-01	Qualitative methods, Case study
		1st	MoS-02	Mixed methods, Case study
		1st	MoS-03	Qualitative methods, Case study
		2nd	MoS-04	Qualitative methods, Case study
		3rd	MoS-05	Qualitative methods, Case study
		3rd	MoS-06	Qualitative methods, Case study
		4th	MoS-07	Qualitative methods, Case study
Total	15			

One of CapeVarsity's Professors who also played a supervisory role helped facilitate the discussion with the focus group. During the discussion, the supervisor managed the questions and answers section including maintaining focus on the discourse and keeping track of time. Additionally, clarifications were sought, which enriched the data. Unanimously, the group agreed for the conversation to be recorded.

4. A Criteria-Based Model for Selecting Research Design

This study aims to develop a criteria-based model (CBM) for selecting research design in IS studies. The CBM is a three-step approach. The first step cohorts the components that must be aligned, towards selecting the most appropriate design. In the second step, the focuses of the most common research designs are described, for understanding purposes. The third step is the methodological approach towards selection. The three steps are discussed below and should be read in conjunction with one another, for ease of understanding.

Step #1: Components alignment

The core aspects of research are usually the problem, objectives, and questions, as shown in Figure 1. Thus, the focus of the research depends on the alignment of the core components: problem, objectives, and questions being investigated. Bougie and Sekaran (2019) argued that the research problem, objectives, and questions must be strongly aligned, to avoid deviation. It is therefore critical to ensure that there is no disparity between the components. The alignment promotes synergy among the three components, primarily directing the study towards the defined aim. Coe et. al (2021) explained how the alignment of components situates the problem, logically, in conducting the investigation. Bottomline, the components are interdependent and, therefore, should not be developed in isolation from each other.

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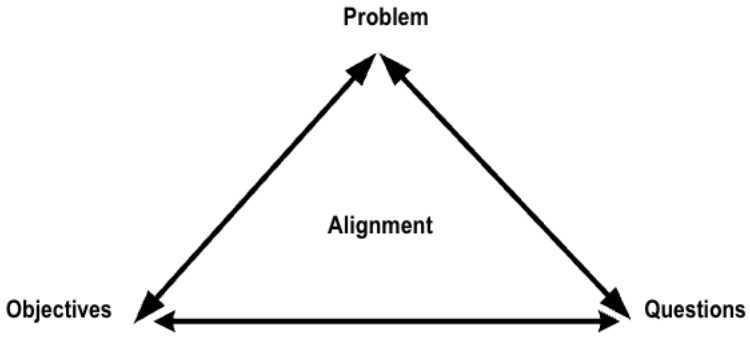

Figure 1: Alignment Components

Despite its criticality, the alignment between the three components can be challenging, especially for emerging researchers. Complementarily with the objective, this paper intends to ease this challenge. For example, once the alignment is achieved, it becomes easier to determine the next step. It thus, influences the methodology applied in the research. The methodology articulates the logic and flow of the systematic processes followed in conducting a research project, to gain knowledge about the phenomenon being studied (Khatri, 2020).

Step #2: Research Design

There are different types of research designs a researcher can choose from. Significantly, some of the designs constitute similar attributes. This makes it difficult for some researchers to select the most appropriate design. When selecting a research design the researcher must have a good understanding of its primary focus. A design focus represents components that uniquely identify and set it apart from other designs. Table 2 describes some of the most common designs in IS research.

Table 2: Design focus

Design	Focus	Descriptions
Action Research	Cyclical, participative and collaborative	Action research follows a systematic and cyclical pattern of reflection, planning, action, observation, and data collection, evaluation that repeats in an iterative and ongoing manner (Johnson, 2020).
Archivary and documentary	Documentary of historical events	Focuses on documentaries that historical actors leave behind. The archives comprise documentation that an organisation has accumulated over time (Tennent & Gillett, 2023).
Case Study	In-depth inquiry into real life-context	In a case study, an object is studied exhaustively from multiple perspectives of complexity and uniqueness in a real context (Bondía & Gracia, 2022).
Ethnography	Historical events, cultural context	Investigate intact cultural or social groups to find and describe beliefs, values, and attitudes that structure the behaviour, language, and interactions of the group (Hancock et al., 2021)
Experiments	Numeric, manipulate variable, test hypothesis	Experiments take the form of altering the environment and observing subsequent reactions (May & Perry, 2022).
Grounded Theory	Theory development data grounded.	Grounded Theory aims to generate theory that is grounded in data according to the views of the participants (Turner & Astin, 2021).
Phenomenology	Phenomenon lived experience	Explore the meaning of several people's lived experiences around a specific issue or phenomenon (Hancock et al., 2021).
Survey	Standardised wider coverage	The survey design allows for questions to be presented in a fixed and standard order to a larger and more diverse population (Braun et al., 2021).

Step #3: Methodological approach development

Step #3 consists of two tables: Tables 3 and 4. The two tables should be applied, linearly. In Table 3, there are three columns and three rows. The first column contains the focus of the objectives. Usually in IS, the focus of an objective is either to conduct an experiment, empirical study or a combination of both. In the second column, the types of methods that can be employed are presented. There are three types of methods: quantitative, qualitative, and mixed methods (Taherdoost, 2022; Flick, 2022). In the third column, the three most common approaches in IS research, which are deductive, inductive, and abductive, are presented. When following a

deductive approach, the researcher begins with a theory and then collects data that either supports or refutes the theory. In contrast, inductive research involves gathering data and building a theory based on the analysis of the data (Jones & McCrickard, 2021). Abduction represents a combination or synthesis of both deduction and induction and can be considered an equally important approach to research (Karlsen, Hillestad & Dysvik, 2021). As shown in Table 3, depending on the type of study, any of the approaches can be selected.

The three components of Table 3, objectives, method, and approach are interdependent, which means that one determines or influences the other, starting from the objective to the approach stages. For example, a research objective which is experimentally driven compels the researcher to collect quantitative data using a deductive approach. Khatri (2020) explains that if the researched phenomenon is about the relationship between different variables and testing of the hypothesis, it leads towards deductive whereas if the phenomena to be researched are about the human experiences and social-cultural processes, the focus is on multiple realities following the inductive approach. Therefore, research objectives, inherently influence the types of data and the approach to be applied in the study.

The rows in Table 3 are assigned codes, BA, BB, and BC. The codes are determinants and enable ease of reference. Code BA indicates studies that have objectives that are required to be solved by following the objectivism process. Code BB signifies that a study requires a subjective technique, which entails empirical evidence. Code BC infers that the research requires both quantitative and qualitative to resolve the problem being studied.

Table 3: Method selection

Code	Objectives/problem	Method	Approach
BA	Experiment	Quantitative	Deductive
BB	Empirical	Qualitative	Inductive
BC	Experiment and empirical	Mixed	Abductive

The latter part of Step #3 is Table 4. The Table consists of a list of the commonly used designs in IS research. The designs are grouped into three categories, Groups A, B, and C. Group A, Group B, and Group C contain qualitative, quantitative, and mixed methods, respectively.

Table 4: Research designs grouping

Group	Design				
Group A	Case study	Ethnography	Grounded theory	Phenomenology	Archivary and documentary
Group B	Action research	Survey	Simulation	Experiments	
Group C	Select at least one from each Group				

To select a research design, the codes presented in Table 3 should be aligned with the groupings in Table 4, thereafter, a conditional statement or approach should be applied as follows:

- If the code is equal to BA, then select a design from Group B.

When the selected code is equal to BA, the study objectives focus is quantitative. In a quantitative study, researchers study phenomena objectively using natural sciences approaches to measure and quantify dependent and independent variables. Kandel (2020) explains that quantitative approaches are for testing theories by examining the relationship among variables. Thus, this code applies to studies that do not require personal attachment that comes with a deep immersion in the social environment but rather objectivity where there is a distance between the researcher and the subjects.

- If the code is equal to BB, then select a design from Group A.

If 'BB' is selected, it means that the study seeks to examine actors' actions and gain a better understanding of their experiences in a natural environment. It therefore relies on qualitative research designs. Research designs with a qualitative focus, allow researchers to study phenomena by observing and asking questions such as "why" and "how" things happen in the way that they do. Qualitative techniques aim to understand, describe, and interpret social phenomena as perceived by individuals and groups (Holloway & Galvin, 2023).

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- If the code is equal to BC, then select at least one design, each from both Group A and B.

Depending on the study's objectives, more than one research design may be required to resolve the defined problem. In such a case, the study employs designs from both qualitative and quantitative resulting in a mixed-method approach. Creswell (2014) suggests that mixed methods research is an approach in which the researcher collects analyses and interprets both quantitative and qualitative data, integrates the two approaches in various ways and frames the study within a specific design.

The CBM provides a predefined control set, which eradicates or reduces the challenges often encountered in selecting research design. Thus, the selection of the research design is neither by an individual's preference nor lack of know-how. Selecting a research design is guided and controlled using the proposed three-step approach.

5. Discussion

This discussion focuses on the attributes of the study. The attributes are fundamental potential aids of the criteria-based model (CBM) presented in this paper, which include clarity, systematic, and precision. The CBM introduces a pattern for selecting designs in IS research. Affirmatively, Nayak and Singh (2021) argued that the essential challenge for researchers is to build better and more comprehensive theories than existing ones. This requires the vehicle's appropriateness, making the selected design a critical part of the research process. Mastering the CBM imbibes simplifications through clarity, systematic approach, and precision in selecting research design.

Clarity - the three-step approach of the CBM clarifies how the decision to select a design was reached in research. The clarity induced by the CBM can lead to a stream of rich data, which is an important aspect of research. Such clarity helps to identify stakeholders, adds to the rigour, and appropriateness of the research. Osuagwu (2020) suggests that these attributes are additions to relevance associated with the research results. The result can lead to a significant lack of clarity (Alter, 2008). *According to one of the participants, it is always tricky to distinguish between the research design, the case study and ethnography are an example* (DoS_02), Additionally, the CBM provides clarity that is clear and explicitly procedural steps in selecting research designs. This is to avoid complexity and guide postgraduates in selecting research design. Collins et al. (2021) emphasise that lack of clarity creates a gap, which must be closed even if it means redefining. Von Nordenflycht (2023) explains how clarity is valuable in research design research towards achieving results.

Systematic approach – the three-step approach makes the CBM systematic. The approach encores a procedural in resolving the challenges of selecting designs in IS research. *Without the supervisors' guidance, we sometimes do guesswork, which works for some of us* (*MoS-02; MoS-03*). *However, with time, some of us got better at gaining a better understanding of the strengths and distinctions between the research designs* (D*oS-05;).* The approach enacts a rules-based in selecting a design in IS research. In its systematic approach, the CBM stimulates a repeatable-based process, for both emerging researchers and postgraduates. Steininger (2019) postulates how the systematic approach allows patterns within disciplines. The pattern forms a knowledge repository facilitating a routinised assurance of a process (Samtani et al., 2023; Suriadi et al., 2017). It enables applying a set of precise rules to select designs, towards gaining a better understanding of complexity and avoiding overly simplification of reality.

Precision – as studies progress, some students including emerging researchers sometimes realise that they have not been acute in selecting design. *One of the challenges is that there is no formula to determine the precise or most appropriate approach selected for our studies until the research supervisors approve (DoS_06; MoS-04)*. The CBM provides a concise and precise way to represent relationships and dependence between variables (methods and designs). The preciseness enables navigating between the methods, to determine the most appropriate designs. It steers towards granularity by grouping the methods. Thus, precision helps to trail between criteria in conformance checking (Leemans & Polyvyanyy, 2023). Fantinato, Peres & Reijers (2023) explained that precision allows using the CBM to assess and ensure that unrelated variables do not mix. Precision holds the characteristics of strengthening a formulaic approach by ensuring the relevance and appropriateness of variables.

6. Implications for Research Design Practice

- Order of Use – A study is not always underpinned by one research design. Depending on the objectives, more than one design can be selected. By employing more than one research design, it brings more complexity to the study, especially in terms of order of use. When more than one design is required, there is a need to determine the designs' order of use, to have coherence towards the

integration of different approaches. What is even more challenging is when the selected designs are of different paradigms (qualitative and quantitative). According to Johnson and Onwuegbuzie (2004), when a researcher employs the mixed method there is a need to determine the dominancy and time of implementation of the methods. Thus, the researcher must be clear about the research output and how each design contributes to such.

- Knowledgeability - There is a need for post-graduate students and other researchers to understand the different designs that exist. Choosing a design without understanding other designs limits the researchers from selecting the most appropriate, for the defined research problem. Şahin and Ozturk (2019), asserted that researchers who do not fully understand the philosophy and purpose of specific research designs end up conducting studies, which are not compatible with the purpose of that design. However, having a good knowledge of the different research designs requires comprehending the strengths and weaknesses including how and when to apply each design. This can be a complex process in practice. Thus, knowledgeability ensures a researcher selects the design based on its potency for addressing the research objectives and not because of it is ease of use, popularity in the literature or familiarity.
- Alignment – Alignment is the other implication in practice. The implication requires researchers to understand how to align the different components (problem, objectives, questions) of the study. *The core aspects of our study, as we know it, include the research problem and the objectives, which must be understood in depth because they determine the direction and outcome* (*MoS-05; DoS-05;* D*oS-07)*. The components are interdependent and should not be developed in isolation. Many researchers are unaware of the research components' alignment. Consequently, misalignment between these components (problem statement, research objectives and questions) is one of the major contributing factors to why theses and proposals get rejected upon submission. The disjoint between these components often complicates the design selection process leading to researchers opting for designs that might not be suitable and cannot justify their applications towards resolving the defined problem.

7. The Limitations of the Study

Despite the comprehensiveness and contribution of the study, it carries typical limitations of an exploratory study. We identify two limitations: narrow focus on the quantitative and empirical evidence expansion. The study focuses only on qualitative research. It excludes those focused on quantitative research who could have participated in the study. Including both qualitative and quantitative (mixed methods) researchers could add more value and contribution, from theoretical and practice perspectives. Significantly, the mixed methods allow a more holistic view of both social and natural, in IS research (Reis, Maier & Weitzel, 2022; Ågerfalk, 2013).

The empirical evidence should be extended beyond IS, to cover other fields of study. This will enrich theoretical and practical knowledge because it represents a real-life experience and know-how. Also, the extension is vital because empirical evidence is consistently viewed as an essential part of research. Another rationale is that it is a central aspect of research, in gaining a more detailed, understandable, and enriched outcome from both the social and scientific world (Collins et al., 2021; Mithas et al., 2012). Despite the limitations, the study is a huge step toward practical, theoretical, and methodological contributions to research methodology. Following the three-step approach, the proposed CBM can be evaluated and validated in future IS research, in the future.

8. Conclusion

Applying the criteria-based model (CBM) proposed in this paper in selecting a research design, enables researchers including postgraduates to increase appropriateness and improve rigour in their studies. This study highlights the critical challenges such as the difficulty in finding studies where and opportunities faced by postgraduates and researchers in the IS field due to the lack of a formal approach or method to selecting research design. We argue that our CBM contributes to the advancement of research methodology, from practical, theoretical, and methodological perspectives on the basis that (i) clarity is an essential step towards selecting a more appropriate design, (ii) the systematic approach provides guidelines for synthesizing the process of selecting designs in IS research, and (iii) the precision enhances the appropriateness of the selected research design in a study.

The formulaic aspect of the CBM makes it practical for researchers including postgraduates. This makes the CBM a powerful way of simplifying complexity and increasing the chances of selecting the most appropriate design in IS research. More importantly, the CBM allows repetition across the various studies of IS. Also, it transparently draws the relationships between the methods and designs and, therefore, makes the trends visible through the

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clarity, systematic and precisive approaches that it provides. The CBM is a systematically structured three-step approach that imbibes methodological clarity towards preciseness in selecting research design in IS research. It is thus rich in contextual information, for both postgraduate students and emerging researchers. Although the study was conducted in the IS environment, it can be applied in other fields of study. Also, the CBM sets the foundation for selecting theories to underpin the study.

Theoretically, the study therefore provides a solution, which is a typical concern of many emerging researchers and postgraduates in research methodology. From a pragmatic viewpoint, we recognise that researchers have different levels of scholarly expertise and implicit or explicit types of knowledge, in selecting research design. How the knowledge is applied varies because there is no formula or guide for selecting research design. This is another powerful aspect of the CBM, it is flexibility, which allows modification or transformation, arbitrarily.

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Evaluating the Impact of Entrepreneurial Success Through Educational, A Family Support: Case Study of Somali Graduates

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Abstract: Purpose: This paper demonstrates the analyses of the role of educational and family support for the development of personal skills and risk willingness, which are important for pursuing entrepreneurial ventures. Entrepreneurship is seen as a critical component of economic development and growth, particularly in developing countries. Design/Methodology: The data was collected from three universities ((SIMAD University, Somali National University and Mogadishu University) in Banadir region purposively selected based on their research publication, formation of entrepreneurial sites, entrepreneurial fields, and entrepreneurial faculties. The study randomly selected 306 students across eight faculties from total population of 350 using Slovin's Formula, the study utilized multiple linear regressions as technique of data analysis. The study used structural models through PLS software. Findings: The results revealed that that educational and family support significantly and positively impacted entrepreneurial intentions. The role of mediating variables (personal skills and risk willingness) also improves entrepreneurial intentions among graduate students. Moreover, the model shows that the changes of independent variables explain 34% of the changes of dependent variable, while the remaining 62% of changes might explained by unidentified factors which are not incorporated in the model. Recommendations: Thus, it is recommended that the private financial institutions and public institutions work together to establish micro finance center for the position of inspiring entrepreneurship joint ventures or ventures in the country.

Keywords: Entrepreneurial, Educational support, Family support, Personal skills, Risk willingness

1. Introduction

Entrepreneurship is seen as a critical component of economic development and growth. Previous studies have looked at its role in the growth of firms and their ability to compete in the entrepreneurship market (Kanama, 2020). For a long time, progressive and changing states have been trying to help start-ups through solid administrative support. It is essential to recognize a critical strategy that will affect the launch of new and relevant businesses that will create, grow, and maintain products and services that meet people's needs and help the economy grow (Ezema et al., 2020). Despite its potential benefits, starting a business can be challenging, particularly for individuals without the necessary support and resources. In the case of Somali graduate students, who face a range of unique challenges, the role of institutional and family support, as well as personal skills and risk willingness, can be particularly important in their pursuit of entrepreneurial ventures. According to a study by Mohamed and Omar (2021), institutional support in the form of entrepreneurship training, mentorship, and access to capital is a critical factor in the success of Somali graduate students in starting and running their own businesses. Additionally, family support, particularly financial assistance, and emotional support, plays a crucial role in enabling these students to pursue their entrepreneurial aspirations.

Moreover, the study highlights the importance of personal skills such as creativity, communication, and problem-solving abilities in entrepreneurial success. Somali graduate students who possess these skills are more likely to identify and pursue business opportunities and navigate the challenges that come with starting a new venture. Finally, willingness to take a risk is identified as a critical trait among successful entrepreneurs, particularly in a context like Somalia, where there is significant uncertainty and risk involved in starting a business(Binti Shamsudin et al., 2017 ;Gieure et al., 2019).

Apart from personal skills and risk willingness, the most driven factor of entrepreneurship is unemployment (Lingappa et al., 2020). One of the biggest social and economic issues that many countries are now dealing with is unemployment. This circumstance calls for the promotion of the idea of entrepreneurship, which places an emphasis on increasing the number of individuals who are self-employed (Shahzad et al., 2021). Recently,

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without a doubt, entrepreneurs have made major societal contributions. One of the main contributions of entrepreneurs has been recognized as the creation of jobs (Koe et al., 2012). Consequently, the government should support people starting their own businesses, but there are some perceived obstacles that can affect someone's decision to do so (Upadhaya & Chadha, 2019). Starting a new business is risky, and despite entrepreneurs' best efforts, many ventures fail. Most new businesses also struggle to survive and succeed in a volatile, complex, dynamic, and global environment, especially if they lack the necessary resources and capabilities (Jeng & Hung, 2019). Moreover, graduates must ultimately change their focus from looking for work to starting their own businesses since governments could not always be able to provide enough jobs for all tertiary-level graduates (Yusoff et al., 2016).

With the breakdown of the Somalia government in 1991, the nation of Somalia has experienced a persistent, serious emergency. Several public jobs were lost, the rate of poverty has grown, and the unemployment rate has increased as a consequence of the civil war that resulted and the many natural disasters that followed (Ali & Abdel Hafiez Ali, 2013). Somalia stands out as a "case study" in comparison to the established ecosystems of Eastern African nations like Kenya or Tanzania because of its precarious political status. Daka and Siad (2022), important institutions from the public and commercial sectors are crucial players in the entrepreneurial ecosystem. Nonetheless, the Somali government's present capability requires immediate attention, particularly given the lack of micro, small, and medium-sized companies (MSMEs). In Somalia, innovation is not always understood well, and a survey found that the lack of regulatory and policy tools made it difficult for 55% of entrepreneurs to operate their businesses (Daka & Siad, 2022). Moreover, Entrepreneurs in low-income nations like Somalia often struggle with a lack of capital, weak infrastructure, difficulties registering and paying taxes on their firms, and safety concerns (Abdullahi, Khelghat-Doost, & Hassan, 2021). however, this was not preventing the creativity of entrepreneurial activities and many young graduates starts and operates in the market by doing their own businesses, this changes of their living of standards and have improved the quality of life for their family, there are also a number of new and ongoing firms (Abdullahi et al., 2021).

Entrepreneurial purpose refers to the ability and desire to take on the design, development, and administration of a productive business with all associated risks while pursuing profit as the reward (Neneh, 2014). Many studies of entrepreneurial motivation tend to emphasize either the function of exogenous elements, such as goals or financial rewards, as motivators of entrepreneurial behavior or the influence of endogenous elements, such as self-regulatory or affective constructs (such as identity coherence and a drive for entrepreneurship) (Murnieks et al., 2020) the family environment affects entrepreneurial interest (Sugianingrat et al., 2020). Family has been considered and evaluated as a setting for people's business goals. According to this viewpoint on family embeddedness, the family is an important institution that individuals depend on when making startup choices (Shen et al., 2017). In order to inspire students to become entrepreneurs, schools have recently begun to link academic degrees with job needs (Yusoff et al., 2016).

One of the most important and person-based aspects of entrepreneurship, risk-taking, is one of the systems that best explains how an individual takes risks. Those who actively engage in risk-taking activity make choices that may not turn out as planned (Bergner et al., 2021). The choice to work for oneself is influenced by a number of factors, including risk tolerance, income level, and demand for independence (Sheriff et al., 2018).This research finds that a high degree of self-confidence is positively connected to a greater desire to become self-employed, suggesting that personal abilities, qualities, and behavior may also affect and decide if one may become a successful entrepreneur (Mustapha & Selvaraju, 2015). As a result, the present study's goal is to find out how personal skills and risk tolerance might help university students have more entrepreneurial intentions by examining the role that family and educational support play in this process.

2. Literature Review

According to the Global Entrepreneurship Monitor (GEM) report, entrepreneurship is considered a key driver of economic growth and job creation (Bosma et al., 2019). However, the level of entrepreneurial activity in Somalia remains low, with only 3% of the adult population involved in starting or running a new business in 2019 (GEM, 2020). One of the ways to promote entrepreneurship in Somalia is to focus on the younger generation. Moreover, academics and politicians have lately paid a great deal of attention to entrepreneurial purpose because of the efficacy that it may provide in commercial operations(Che Nawi et al., 2022). However, not much is known about the factors that influence the entrepreneurial intentions of Somali students.

An individual's aim to develop innovation in a commercial endeavor is expressed in (Hong et al., 2020), followed by (Ohanu & Ogbuanya, 2018). According to (Li et al., 2020), encouraging entrepreneurial activity is now crucial

in emerging nations because of their rising contribution to the creation of job possibilities and the acceleration of economic development. Economic considerations, the hunt for possibilities in a cutthroat market, a lack of or unhappiness with career options, and even the urge for self-actualization have all been linked to the motives for establishing a company (Ferreira et al., 2017). described entrepreneurship as an activity of identifying opportunities, creating resources, creating innovations, and meeting the needs of those opportunities. In vice-verse argues that entrepreneurship encourages income inequality in developing (Azamat & Nilufar, 2023).

The most reliable, durable, and commonly used predictor of entrepreneurial activity and firm success, according to recent research, is entrepreneurial intention (EI) (Yu et al., 2021). in opposition. EI is the simplest and best predictor of business activity since it is the initial action in a prospective chain of entrepreneurial actions (Liu & Zhao, 2021).the motivations behind people's aspirations to launch their own businesses are the focus of an increasing amount of entrepreneurship study. For example, (Marques et al., 2019), Entrepreneurs may be driven inside to succeed and achieve a goal while being driven outwardly to amass riches and prestige. Although the majority of study on entrepreneurship makes the assumption that an entrepreneur is driven by benefits from outside sources, such as money, power, or prestige (Carsrud & Brännback, 2011).

Within the field of entrepreneurship research, the examination of entrepreneurial intentions has grown significantly. As intentions have been demonstrated to predict later entrepreneurial action, it aims to understand the motivations behind individuals starting their own firms. (Baluku et al., 2020). Hence, these intentions play a crucial role in determining entrepreneurial activity and operate as a moderator of the effects of demographic, personal, psychological, social, cultural, and environmental factors on entrepreneurial behavior and action (Fragoso et al., 2020).

Incubators for startups, STEM (science, technology, engineering, and mathematics) labs, and innovation centers are all brand-new in Somalia. The Somali STEM Society, a coordinating organization for STEM initiatives throughout all of Somalia, was founded in 2017. It brings together academics, businesspeople, entrepreneurs, and other professionals with an interest in STEM education. This group of businesses promotes the sharing and learning of expertise in the STEM fields. Yet, operating such centers is severely hampered by the absence of an innovation strategy (Daka & Siad, 2022).

> *Hypothesis one(H1): there is a positive and significant effect of educational and family support on entrepreneurial intentions*

In reality, family finances are said to be "the greatest single source of start-up financing in the world" and are often regarded as being patient and rapidly mobilized. (Sieger & Minola, 2017). Family support, according to (Xu et al., 2020), is another important element that enhances one's desire to pursue entrepreneurship. Family support is a constant source of inspiration for new ventures and strength for business goals. Graduate students often live with their parents, making them a member of their family. Young entrepreneurs who lack both social and financial capital must turn to their families for practical and emotional assistance in order to launch a new firm.

As compared to sources from other financial institutions or investors, family members' supporting resources provide more flexible financing options for business owners who need to foster and maintain new companies. (Xu et al., 2020), Also, greater family support enables business owners to modify their daily objectives considering monetary concerns. For instance, family members may help gather resources via their extensive networks of prospective customers, suppliers, or other stakeholders in addition to offering financial assistance, since entrepreneurs require financial resources to create new goods or services (Arregle et al., 2015). Money is a more crucial component of running any company, particularly when starting a new one. In fact, (Edelman et al., 2016), found that Chinese entrepreneurs sought initial funding from their family rather than from outside sources only if they anticipated lower transaction costs and low levels of family inference in the business. The study covered 202 new ventures launched by young entrepreneurs in Hong Kong and 130 Chinese entrepreneurs. (Arregle et al., 2015), contend that increased family financial assistance for starting a new business result in both stronger financial and non-financial commitments. Potential founders are aware of these commitments and prepare for poor performance. The research, which examined a sample of 23,304 respondents from 19 nations, validated this and discovered that the negative association was reliant on both familial cohesiveness and personal entrepreneurial self-efficacy.

Denanyoh et al. (2015), obtaining a good education may encourage a person's desire to pursue entrepreneurship universities may be considered potential breeding grounds for future businesses. Most institutions(SIMAD University, Somali National University and Mogadishu University) in today have made significant financial

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investments to develop a successful entrepreneurship program for their students (Mustapha & Selvaraju, 2015). Entrepreneurship programs typically offer opportunities for students to learn from real-world practical experiences and inspire the students to change their mindsets. They also raise awareness by giving students general information about entrepreneurship that encourages them to consider it as a career.

Moreover, in addition to providing educational assistance, institutions may help university students who are interested in starting their own businesses by promoting the development of resources that are useful for entrepreneurship programs. By extracurricular activities including conscientious participation in seminars, workshops, skills-based training sessions, and interactive meetings with successful businesses, it should foster an entrepreneurial culture (Shahzad et al., 2021). Likewise, concur that there is a beneficial relationship between company setup and education. Students that get entrepreneurial education gain the information, skills, and extra abilities needed to apply to the context of starting a new firm or enterprise (Koe et al., 2012).

In several European nations, including Romania, encouraging entrepreneurship via higher education and training has lately been added to the national strategic agenda. Several studies highlight the beneficial effects of entrepreneurship education on students' short- and long-term entrepreneurial intentions (Vodă & Florea, 2019). Using the convenience sampling method, (Hassan et al., 2021), examined the direct and indirect roles of individual entrepreneurial orientation and entrepreneurship education in determining students' entrepreneurial intention. The results show that entrepreneurship education facilitates both individual entrepreneurial orientation and entrepreneurial motivations and has a positive association with entrepreneurial intention.

It is the obligation of the institutions to educate students on how to build new businesses. Enhancing entrepreneurial intent is crucial in connection to public opinion and attitudes toward new businesses. (Fayolle & Linan, 2013), In the entrepreneurship literature, structured institutional advantages such as cash awards, subsidies, one-on-one counseling, and technical and legal support are often cited as the primary drivers of women's entrepreneurial endeavors from an institutional viewpoint (Kazumi & Kawai, 2017). Low levels of student entrepreneurial intention are caused by a lack of entrepreneurial education (Mengesha, 2020). Training and development programs for entrepreneurs may help people get the knowledge and confidence they need to explore ideas for profitable businesses and market potential for their goods and services (Adekiya & Ibrahim, 2016).

Additionally, research (Adeel et al., 2023), came to the conclusion that entrepreneurship education affects the development of certain personal attributes. It was shown that students who took entrepreneurship classes were better able to identify possibilities based on their prior expertise and to connect their incentives with launching a new firm. These findings show how important entrepreneurship education is for encouraging youthful entrepreneurship, which is essential to support social and economic growth in the modern world. (Sriyakul & Jermsittiparsert, 2019), The need to establish graduate entrepreneurship education is even greater for many developing nations since it serves as a foundation for both national competitiveness and economic growth in addition to serving as a way of promoting venture formation and entrepreneurial development. The role of Campus student entrepreneurs in Student entrepreneurial engagement is that they act as industry mentor and supervise students, where they give business training and mentoring the students group under their business (Mohamed, 2023).

Universities in several nations get additional public and foreign funds to start programs. As a result, their presence indicates a public interest in entrepreneurship, as opposed to entrepreneurship education, which was previously addressed, which indicates an interest in entrepreneurship on the part of universities. Programs could persuade some students to become entrepreneurs or at the very least make them aware of self-employment as a possible career path (Walter et al., 2013) In the instance of Somalia, Simad University, one of the top institutions for entrepreneurship, was founded three years ago. Simad Innovation Lab (I Lab) provided support and training for several entrepreneurial and digital courses for students both locally and worldwide. Most students who benefited from the educational and financial support of the (I Lab) became entrepreneurs, really generated more income, and were completely independent thanks to these new amenities, which have helped to create an overall innovation environment that is unmatched in the country and has been embraced by our community.

Hypothesis two (H2): Personal skills and risk willingness mediate the relationship between educational and family support on entrepreneurial intentions.

Entrepreneurship is correlated with risk-taking behavior. For instance, (Mawardi & Sujarwoto, 2021), discovered that those who wish to pursue an entrepreneurial career are more risk-averse than those who seek to get a safe

job with an established business. Income loss, financial difficulty, and bankruptcy are all examples of financial risk. Risk that involves someone who has a chance of failing in life is known as non-financial risk (Hoogendoorn et al., 2019). A study by (Ozaralli & Rivenburgh, 2016), showed a significant relationship between taking risks and being entrepreneurial. (Khedhaouria et al., 2015), discovered that risk-taking propensity had a significant impact on entrepreneurial attitude, revealing a significant relationship between attitudes and launching a new business. Finally, (Binti Shamsudin et al., 2017), claimed that taking calculated risks is a crucial component of entrepreneurship. This is due to the uncertainty around whether desired items can be created, customer demands can be satisfied, or profits can be made prior to the introduction of a new good or service. Excellent theorizations for risk-taking propensity include an individual inclination toward taking advantage in each circumstance requiring decision-making.

On the other hand, there is no question that business owners that are driven to carry out expert work, prepared to take a risk, and employ cutting-edge methods may better compete in the market (Shahzad et al., 2021). In addition to these benefits, entrepreneurial talents effectively contribute to the growth of huge social networks and intense market competitiveness. Observed particular social abilities, such as the capacity to judge others, adjust to shifting or varied social settings, initially and persistently produce positive impressions on others, and effectively convince others, are according to (Gieure et al., 2019). The fact that this type of education and training helps students develop an entrepreneurial spirit as well as many other entrepreneurial skills, including creativity, risk-taking propensity, problem-solving, and business networking, is why many universities around the world have included it in their curricula. Giving pupils entrepreneurship training should thus broaden their knowledge and abilities (Gieure et al., 2019).

3. Methodology

The research data was collected from top ranking universities ((SIMAD University, Somali National University and Mogadishu University) in Banadir region in terms of research publication, formation of entrepreneurial sites, entrepreneurial fields, and entrepreneurial faculties. The study used quantitative through survey questionnaire. The survey was designed to gather data from graduate students from the different faculties and departments in selected private universities. A purposive sampling method was used to collect data from eight faculties: Management Science, Accounting and Finance, Information Technology, Social Science, Economics, Engineering and Telecommunication, Medicine and health Science. The rational of this selection was to capture graduate students in the field entrepreneurial activities at universities. The study was selected randomly 306 students across eight faculties from total population of 350 using Slovin's Formula, the study utilized multiple linear regressions as technique of data analysis to determine incorporated model fitness of the variables.

3.1 Data Measures

The process of a person intentionally choosing to undertake and launch a new venture or initiative as a profession is known as entrepreneurial intentions. Five (5) items were taken from (Hue, D. T., Thao, T. P., Toan, P. C., Luong, H. D., Hao, P. T., Huyen, D. T., & Hoa, N. T. (2022) to measure the construct. The term "educational support" refers to the lessons and instruction provided by educational institutions to students who are starting new businesses and who need moral and technical assistance. It was designed by six items taken from (Hue, et al., 2022).

Family support is a concept in society that denotes how the family's financial and moral assistance might assist a new venture (Xu, Kellermanns, Jin, & Xi, 2020). It was calculated by four items taken from (Hue, et al., 2022). While starting a firm, having the necessary personal abilities is essential for organizing, constructing, and carrying out projects (Mustapha & Selvaraju, 2015). These were measured six items adopted from (Hue, et al., 2022). Graduates' entrepreneurs must be risk-tolerant or ready to accept chances in order to realize their full prospective. ((Hue, et al., 2022). It was measured six items adopted ((Jegede & Nieuwenhuizen, 2020)

3.2 Results

The study focused on two independent and two mediating variables such as educational support, family support, personal skills and risk willingness, the latter two were used as mediating variables. The questionnaire was distributed to the participants via online channels. The data was collected from graduate students from the different faculties and departments selected private universities in Banadir region. 306 questionnaires were distributed to the respondents. Two hundred and twenty-nine (229) were completed and returned and used for the data analysis, while the remaining of 77 was consisted of incomplete and unusable for data analysis. Respondents were given the assurance that their private details will be kept as privacy and solely utilized for the

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purpose of the research during the data-gathering gathering process. Table 1 illustrates profile of the respondents.

Table 1 shows the demographics analysis of the respondents in the study. Male respondents accounted for 76 percent of the total, while female respondents accounted for 24 percent. Respondents are 20-30 25 years about 71.6 percent and 24.5 percent were 30-40 years; the age group above 40years is represented by 4 percent. On the other hand, 61.1 percent of respondents have a bachelor's degree, while 27.9 percent have a master's degree and 7 percent were diploma. Furthermore, 4% of the respondents had PHD. According to working experience, 62.4 percent of respondents were between 1-5 years' experience, 24.9 percent have 5- 10 years' experience, and 12.7 have more than 10 years' experience.

Table 1: Respondent Profile

Questions	Frequency	present	cumulative (%)
Gender			
Male	174	76	76
Female	55	24	100
Age			
20-30	164	71.6	71.6
30-40	56	24.5	96.1
Above 40	9	4	100
Qualification			
Diploma	16	7	7
Bachelor	140	61.1	68.1
Master	64	27.9	96
PDH	9	4	100
Working experience			
1-5 years	143	62.4	62.4
5 - 10 years	57	24.9	87.3
Over 10 years	29	12.7	100

Source: Author 2023

3.3 Reliability Analysis

Table 2 presented the results of the factor loadings (27 items) as ranged from 0.829 to 0. 0.595. The result of internal consistency reliability Alpha Cronbach values was ranged from 0.804 to 0.716. The composite reliability (CR) was also computed to test the reliability of the study constructs and ranged from 0.805 to 0.724. Moreover, average variance extracted (AVE) was also computed to ratify the validity and reliability of the research constructs, the cutoff of value of AVE must be over 0.50. Hence, all variables provided combinations of information are reliable and consistent, as shown in Table 2.

Table 2: Model Measurement (Factor Loadings, Cronbach's alpha, Composite Reliability and AVE)

Constructs	**Factor Loadings**	**Cronbach's alpha**	**Composite Reliability**	**AVE**
Entrepreneurial Intentions		0.748	0.758	0.501
ENI1	0.751			
ENI2	0.682			
ENI3	0.743			
ENI4	0.754			
ENI5	0.595			

Constructs	Factor Loadings	Cronbach's alpha	Composite Reliability	AVE
Educational Support		0.801	0.805	0.501
ES1	0.744			
ES2	0.682			
ES3	0.700			
ES4	0.757			
ES5	0.667			
ES6	0.801			
Family Support		0.716	0.724	0.638
FS1	0.829			
FS2	0.685			
FS3	0.732			
FS4	0.732			
Personal Support		0.804	0.801	0.505
PS1	0.644			
PS2	0.698			
PS3	0.643			
PS4	0.815			
PS5	0.682			
PS6	0.774			
Risk Willingness		0.763	0.785	0.514
RW1	0.751			
RW2	0.682			
RW3	0.743			
RW4	0.754			
RW5	0.595			
RW6	0.694			

3.4 Validity Analysis

The study utilized Heterotrait-monotrait ratio (HTMT) and Fornell-Larcker criterion. The results of both methods were confirmed the rule thumb, the values of Fornell-Larcker criterion follows; the value of entrepreneurial intention (0.708), (0.857), educational support (0.708), family support (0.798), personal support (0.711) and risk willingness (0.717) as presented table 3.

Table 3: Discriminant validity (Fornell-Larcker criterion)

Constructs	1	1	3	4	4
Entrepreneurial Intentions	0.708				
Educational Support	0.328	0.708			
Family Support	0.519	0.327	0.798		
Personal Support	0.495	0.316	0.382	0.711	
Risk Willingness	0.519	0.267	0.419	0.535	0.717

Sources: Computed by Authors (2025)

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For (HTMT), (Henseler, Hubona, & Ray, 2015) to achieve discriminant validity of all constructs, all values should occur between the values of −1 and 1. Table 4 showed the results of (HTMT) for all study constructs and obtained values lies between the range of -1 and 1.

Table 4: Heterotrait-monotrait ratio (HTMT)

Constructs	Heterotrait-monotrait ratio (HTMT)
Educational Support <->Entrepreneurial	0.42
Family Support <-> Entrepreneurial	0.708
Family Support <-> Entrepreneurial	0.432
Personal Support <-> Entrepreneurial	0.628
Personal Support <-> Educational Support	0.391
Personal Support <-> Family Support	0.493
Risk Willingness <-> Entrepreneurial	0.676
Risk Willingness <-> Educational Support	0.337
Risk Willingness <-> Family Support	0.54
Risk Willingness <-> Personal Support	0.677

Sources: Computed by Authors (2025)

4. Structural Model (Model Estimation)

The model estimation of R-Square result values explains how the change of independent variable explains the changes of dependent variable. Figure 1 showed (R-Squared) value of 0.338% approximately 34% which shows that the changes of independent variables explain 34% of the changes of dependent variable. The remaining 62% of changes might be explained by unidentified factors which are not incorporated in the model. Structural Model of model Estimation is used to determine the correlations between observable and latent variables. The study tested the quality of model measurement by calculating reliability and validity and reliability, then the study conducted structural model test and result was demonstrated in figure.

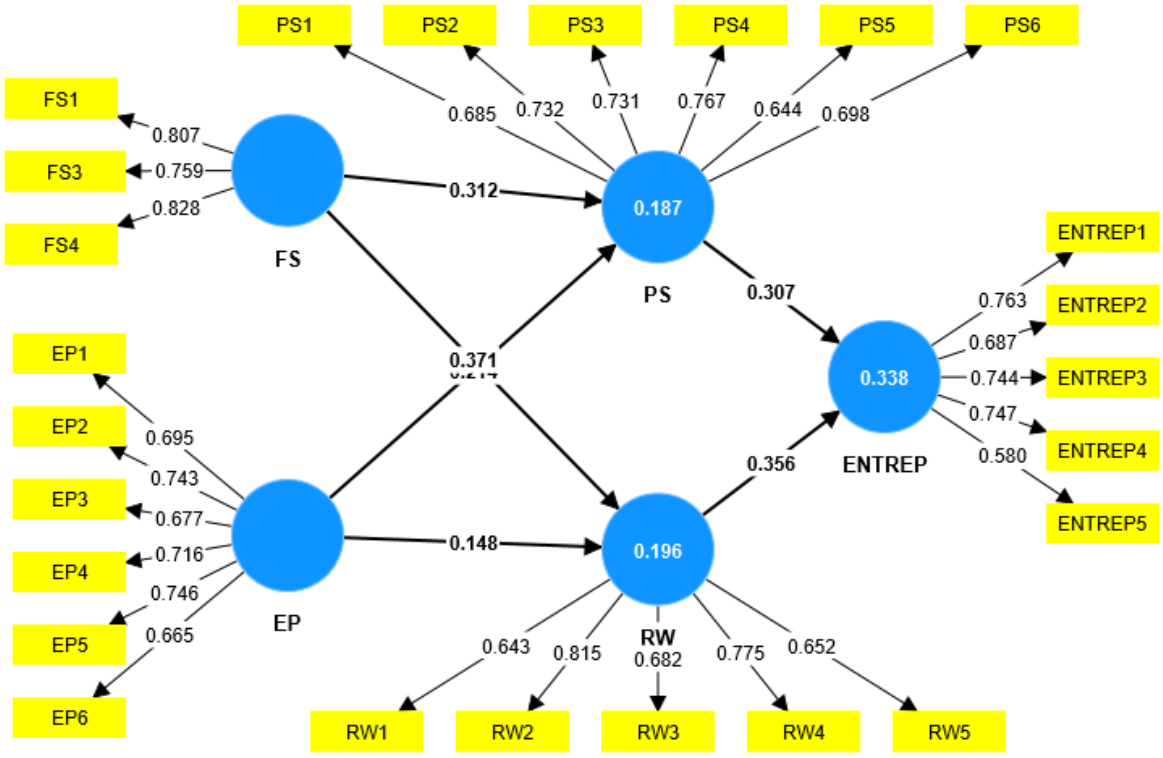

Figure 1: Valid model estimation

5. Analysis of the Structural Model

Hypothesis one(H1):

The proposed study hypothesis one that family support and educational support affect entrepreneurial intentions. To assess the relevance of the hypotheses, the path model's PLS bootstrap methods were applied. Table 5 illustrates the values of (β-Values), (T statistics) and (P values) obtained from the path of direct effect. According to table 5, it was discovered that support from family and education had a positive influence on risk-taking propensity and personal skills as shown by β-Values = (0.313, 0. 0.372), T. values = (4.150, 5.452), P. Value= (0.000, 0.000) respectively. Educational support also had a positive impact on personal skills and risk willingness as evidenced by β-Values = (0.213, 0. 0.145), T. values = (3.012, 2.066), P. Value= (0.003, 0.039) respectively. Personal skills had a positive impact on entrepreneurial intentions as presented by (0.214), T. value = (2.42), P. Value= (0.015). Risk willingness had a positive effect on entrepreneurship intentions as showed through (0.254), T. value = (3.52), P. Value= (0.000).

Table 5: Direct Effect

Hypothesize Paths	β-Values	T. values	P. Value	Decision
Educational Support -> Personal Skills	0.213	3.012	0.003	Supported
Educational Support -> Risk Willingness	0.145	2.066	0.039	Supported
Family Support -> Personal Skills	0.313	4.15	0.000	Supported
Family Support -> Risk Willingness	0.372	5.452	0.000	Supported
Personal Skills -> Entrepreneurial Intentions	0.214	2.42	0.015	Supported
Risk Willingness -> Entrepreneurial Intentions	0.254	3.52	0.000	Supported

Sources: Computed by Authors (2025)

Table 6: Indirect Effect

Hypothesize Paths	β-Values	T statistics	P values	Decision
Family Support -> Risk Willingness -> Entrepreneurial	0.094	2.869	0.004	Supported
Educational Support -> Personal Skills -> Entrepreneurial	0.046	1.693	0.090	Supported
Educational Support -> Risk Willingness -> Entrepreneurial	0.037	1.588	0.112	Rejected
Family Support -> Personal Skills -> Entrepreneurial	0.067	2.127	0.033	Supported

Sources: Computed by Authors (2025)

6. Mediation Evaluation (Indirect Effect)

Hypothesis two(H2):

The second research hypothesis, the study proposed was an indirect association between family supports and educational support and entrepreneurial intentions as mediated by personal skills and risk willingness. PLS bootstrapping methods were used to confirm the indirect effect. Table 6 demonstrated that risk willingness mediated by correlation among family and educational support and entrepreneurial intentions with observed the results being (β-Values = 0.094, 0.037), (T. values = 2.869, 1.588), (P. Value= 0.004, 0.112) respectively. Personal skills also mediated the relationship between family and educational support and entrepreneurial intentions with obtained values (β-Values =0.046, 0.067), (T. values = 1.693, 2.127), (P. Value= 0.090, 0.033) respectively. Regarding to these findings, all variables entirely mediated and positively and significantly and impacted the correlations except one variable (Educational Support -> Risk Willingness -> Entrepreneurial) which generated insignificant value as its P values= 0.112. All other hypotheses were confirmed and accepted.

7. Findings

The study focused on two independent and mediating variables. The findings were argued in two main parts; first, the results indicated that family and educational support had significant impact on entrepreneurship intentions though personal skills and risk willingness. Such variables have a significant influence on prospective entrepreneurs' decision to launch a new company endeavor, previous research also supports (Marques et al., 2019; Carsrud & Brännback, 2011; and Sheriff et al., 2018). However, the most prior studies focused the

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importance of entrepreneurship and the affect nation's economic growth and development ((Kim, Petalcorin, Park, Jinjarak, Quising & Tian, 2022) while others studies (Hassan, Anwar, Saleem, Islam & Hussain ,2021, Hong, Sha'ari, Zulkiffli, Aziz, & Ismail, (2020), looked the entrepreneurial challenging factors as holistically the current study attempts to draw deeply entrepreneurial success factors.

Second, the results also indicated that all mediating factors (personal skills and risk willingness) mediate the correlation among family and educational support and entrepreneurial intentions. Prior research stated that personal skills are a key indicator of success and viability of entrepreneurial activities (Bergner et al., 2021). Moreover, (Sheriff et al., 2018), argued that risk willingness of individuals and greater level of self-assurance are highly associated with a help enhance of individuals' decision-making process, it strengthens the individuals' desire and knowledge to pursue entrepreneurship, which improves overall innovative abilities and enables individuals to take risks and make risky choices.

In this study, risk willingness is a mediator factor and significantly impacts the relationship between educational skills, family support and entrepreneurial intentions. Furthermore, prior study (Xu, Kellermanns and Jin (2020) have demonstrated that family involvement influences the entrepreneurship ambition positively and minimizes the likelihood of business startup failures. In this study, the result indicated that family support has positive influence on entrepreneurship intentions. Personal skills are mediated the relationship between family and educational support and entrepreneurship intentions, also risk willingness is mediated relationship between family and educational support and entrepreneurship intentions.

For current study, educational support has positive significant effect on entrepreneurship intentions as educational support has governed graduates' connections with entrepreneurial business startups which is already included in college and university curriculums in order to benefit the concepts into the entrepreneurial techniques. Moreover, educational support includes spreading networks and consciousness, which boosts entrepreneurship intentions (Galvão, Marques and Ferreira,2020).

8. Conclusion

The paper examines the relationship between variables on the success of entrepreneurial intentions. It gives aspiring entrepreneurs an objective and boosts Somalis' entrepreneurial field by launching fresh initiatives in business, which in turn helps the country's economy thrive. It has two significant results: First, the results indicated that family and educational support had positivity and significantly influence on entrepreneurship intentions though personal skills and risk willingness. Second, the results also indicated that all mediating factors (personal skills and risk willingness) mediate the relationship between family and educational support and entrepreneurial intentions. The study illustrates the importance of using the suggested model to comprehend Somali graduates' intentions to startup new businesses. It gives young graduates directions and boosts Somali's entrepreneurial industry by launching new enterprises that eventually help the country's economy flourish.

9. Policy Implications

This study provides the guidance of Somali young entrepreneurs who thinking and practicing their entrepreneurship joint ventures, the study may help them to develop their entrepreneurial roles in business sector. First, the study inspires graduate students to start businesses by giving entrepreneurial awareness. It demonstrates the significance of conceptual frameworks of entrepreneurial intentions those under current study (educational support, family support, personal skills, risk willingness) that positively affect the graduate entrepreneurs to establish their own business. Second, the study, provides platforms and insights to the colleges and universities to add their faculties and courses entrepreneurial departments and inspiring courses and to encourage their students to start their own business instead of searching for jobs from employers, also it will increase the country's economy.

Third, it will reduce the unemployment rate and young graduate immigration which assist the country's political stability as well as security. Fourth, during college and university study, the study highlights the importance of students' knowledge and skills to learn how to overcome entrepreneurial obstacles. Finally, the current study advised to the private financial institutions and public work together institutions to establish micro finance center for the position of inspiring entrepreneurship joint ventures or ventures in the country. Micro-finance institutions, other financial institutions should develop an entrepreneurship framework program that motivates the graduates to incentive staring new business. Also, the government should provide entrepreneurial platforms that encourage new business startups.

Ethical statement: The research was executed in compliance with pertinent institutional and international ethical norms, and no ethical issues were detected during the investigation.

Artificial Intelligence Declaration: All content was exclusively created by the authors without any AI aid, guaranteeing the authenticity and uniqueness of the work.

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