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E-procurement Adoption Barriers encountered by Small and Medium-sized Enterprises (SMEs) in the Republic of South Sudan

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Abstract

E-procurement adoption is not without its challenges despite facilitating the purchasing process. Hence, this quantitative cross-sectional survey study aimed to examine the e-procurement adoption barriers encountered by small and medium-sized enterprises (SMEs) in the Republic of South Sudan. The 300 SMEs selected out of 1215 SMEs through systematic sampling methods resulted in 213 valid responses with a 71% response rate. Empirical data were derived from the survey questionnaires distributed through Google Forms and Portable Document Format (PDF) via email and evaluated with descriptive and principal component analysis (PCA), relative importance index (RII), and analytical hierarchy process (AHP). Resultantly, multiple national e-procurement implementation methods and incorrect reassembly of data transmitted were ranked the highest barrier among the technological factors, followed by delays in the transmission of data and information, and the technology immaturity due to political and legal factors, lack of widely acceptable e-procurement software solutions and flexibility for management factors, company culture and cost of IT investment for organizational factors. Future works could compare the e-procurement adoption barriers perceived by SMEs in emerging and developed nations and ascertain their e-procurement acceptance. Meanwhile, stakeholders could attract more IT firms in the current market through adequate training, a unified platform, holistic e-procurement adoption techniques, high public awareness, employment of IT experts, forums to exchange ideas on e-procurement, and utilization of passwords, information encryptions, or data. This study proposed employing mixed-method techniques to examine and alleviate SMEs' e-procurement adoption barriers.

Keywords: Barriers, SMEs, E-procurement, Adoption, South Sudan

1. Introduction

The dynamic landscape of modern business has been fundamentally altered by rapid technological advances, leading to transformative changes in various sectors, including procurement practices. Addo (2019) specifically highlights the accelerated integration of electronic commerce/procurement (e-commerce/e-procurement) into business-to-business markets since the 1990s, which has driven the adoption of innovative supply chain technologies and their widespread implementation. Amidst this paradigm shift, e-procurement, an aspect of e-commerce also referred to as e-business or online shopping, has attracted significant attention from scholars and practitioners alike.

E-procurement involves the use of integrated information technology to streamline various procurement functions such as searching, sourcing, negotiation, ordering, receipts, and post-sale verification (Bhaukarally & Ramesh 2017). Further findings by Afolabi et al. (2019) illustrate the relevance of e-procurement in the construction sector, encompassing activities ranging from bid issuance and submission to material sourcing and communication between stakeholders facilitated by online transactions. The Chartered Institute of Procurement and Supply (CIPS 2022) underlines the efficiency-enhancing potential of e-procurement and defines it as the use of technology to automate procurement processes and thus go beyond manual methods. In this context, the current study summarizes the concept of e-procurement as the electronic means of determining, advertising, tendering, evaluating, purchasing, and receiving goods, works, and services and (ii) making online payments.

The public and private sectors are recognizing the advantages of e-procurement and are increasingly digitizing procurement processes (Organization for Economic Corporation and Development-OECD 2017). The leading pioneering companies such as Pizza Hut, eBay, Amazon, Rakuten-Japan, Alibaba-China and Asos-UK (E-Commerce Nations 2016) shows that the digitalization of procurement processes has gained a foothold worldwide. Notably, the adoption of e-procurement is on the rise in African countries, with Rwanda and Zambia among the early adopters (World Bank 2018), although the Asian Development Bank (ADB 2013) reports the opposite and suggests South Africa as a pioneer. An e-commerce hub was established in South Sudan in 2020 (UNDP 2022).

This digital revolution extends to micro, small, medium-sized enterprises (MSMEs) that have used platforms such as Facebook, Twitter(X), Instagram, Snapchat, TikTok, Threads, and other commercial websites for marketing, selling, and purchasing goods, works and services (Dwivedi et al, 2021). According to the OECD (2017), SMEs are a key driver in the global economy, accounting for about 99% of companies and playing a crucial role in job creation, innovation, and economic growth.

The global retail e-commerce revenue, which reached United States Dollars (USD) 4.28 trillion in 2020 with a projected rise to USD 5.4 trillion by the end of 2022 (Chevalier 2021), affirms that e-procurement generates large-scale revenues. China led the global e-commerce sales in 2021 with over 50% of the online retail sales worldwide, followed by the US (19%), and UK (4.8%) (Coppola 2021).

Online shopping in Africa generated revenue worth USD 27.97 billion in 2020, which depicts a rise of over USD 6 billion since 2019 (Statista 2021). African e-commerce revenues will continue increasing between 2021 and 2025 following the estimates provided by Statista with Nigerian, South African, and Kenyan consumers accounting for 30% of online shopping during the COVID-19 lockdown period (Nielsen 2020). Notably, the entire African e-commerce industry could be worth over USD 46.1 billion in 2025 (Statista 2021).

1.1. Problem Statement

Despite this fact, e-procurement removes spatial and distance constraints, generates revenues, speeds up procedures, and significantly reduces administrative costs (Bowersox et al. 2020). The SMEs in South Sudan, a country established after 20 years of devastating war and over 2 million deaths, perceived e-procurement implementation as an ambiguity given the lack of comprehension of e-procurement adoption barriers. The Asian Banker (2020) noted that although the e-commerce industry is growing in Africa, online retail is still in its infancy as it accounts for only a small percentage of the continent's total retail sales. Similarly, despite the organizational adoption of e-procurement systems worldwide, Brandon-Jones and Kauppi (2018) have highlighted a persistent underperformance of their implementation. Recognizing the integral role of SMEs in the South Sudanese economy (International Trade Centre-ITC 2022), this study aims to shed light on the complexity of the barriers to e-procurement adoption faced by these companies.

1.2. Research objective

Therefore, the purpose of this study is to examine e-procurement implementation barriers, facilitate SMEs in the Republic of South Sudan, and effectively internalize e-procurement adoption and barriers.

1.3. Research question

The study was guided by the following research question:

RQ. What are the barriers to e-procurement adoption by SMEs in the Republic of South Sudan?

E-procurement adoption includes drivers, benefits, critical success factors, strategies, barriers, and approaches to mitigating barriers. In this study, however, only the barriers were considered.

2. Literature review

2.1. Overview of e-procurement

The introduction of e-procurement brings significant advances in cost efficiency and time management through the automation and standardization of procurement processes. It also increases the level of transparency and accountability in government procurement systems (OECD 2017). While the concept of e-procurement, which often makes use of electronic data interchange (EDI), dates back to the 1960s, its effective use emerged with Sir Tim Berners-Lee's redesign of the World Wide Web in the 1990s (CERN 2019). Notably, the emerging phases of e-procurement gained momentum around 1999, coinciding with the active involvement of pioneer companies like Pizza Hut, eBay, Amazon, and Rakuten in this transformative landscape.

2.2. Conceptual Framework

Numerous scholars have used different frameworks to study e-procurement adoption, incorporating technological, organizational, and environmental (TOE) perspectives (Teo, Lin & Lai 2009; Ibem et al. 2016). Some have compared these with established models such as the Technology Acceptance Model (TAM) (Mohd Daud et al. 2013; Ramkumar et al. 2019), the Theory of Diffusion of Innovation (DOI) (Li et al. 2015; Aduwo et al. 2017), Resource Based View (RBV) (Daoud & Ibrahim 2017) and Unified Theory of Acceptance and Use of Technology (UTAUT) (Ikumoro & Jawad 2019) to comprehensively examine the adoption phenomenon.

In line with this scholarly approach, the present study extends the technology, organizational, and environmental (TOE) framework developed by Tornatzky and Fleischer (1990). The expanded framework includes the following dimensions: i) technological factors, ii) political and legal factors, iii) management factors, and iv) organizational factors (TPMO). Building on this foundation, the extended TPMO framework, shown in the figure 1 below, serves as an extended lens to examine the complex interplay of factors affecting the adoption of e-procurement.

2.3. Barriers to E-procurement Adoption

As inhibiting factors that deter stakeholders from adopting e-procurement or technologies (Govender & Pretorius 2015), barriers are defined by Aduwo et al (2016) as the key determinants hampering the seamless organizational implementation of e-procurement technologies, instruments, and processes. Scholarly reviews on e-procurement adoption barriers have been performed in different domains and nations. The factors contributing to barriers to e-procurement adoption depend on many factors including external factors such as technology, infrastructure and legislation, and environment; and internal factors such as resource constraints and organizational and managerial characteristics (Eei, Husain, & Mustafa 2012). And these have been categorized as Technological Factors, Political and Legal Factors, Management Factors and Organizational Factors (TPMO).

2.3.1 Technological factors

Technological factors are the consequences of ongoing technological advances and set off a chain reaction that produces various other dimensions. Taken together, these dimensions play together and trigger the need for a comprehensive transformation that encompasses existing management systems, technologies, methods and tools (Mullakhmetov 2018). A vivid example is the mishandling or partial display of data transmitted in packets, a concern that resonates with SMEs and discourages the adoption of e-procurement (Eadie, Perera, & Heaney 2010). In addition, concerns about the disclosure of product and supplier data or the possible misuse of procurement information represent a barrier for SMEs to use e-procurement (Au, Ho, and Law 2014).

Security and privacy concerns underscore the justification as additional reasons for SMEs' reluctance to adopt e-procurement, as they want to protect their information and system networks from potential hacker attacks (Ibem & Laryea 2015; Cardoso & Biazzin 2020). Similarly, resistance to e-procurement stems from the need to prevent document tampering, as highlighted by certain companies in the landscape (Bello & Iyagba 2013).

2.3.2 Political and Legal Factors

Political factors arise from government actions and policies, while legal factors stem from changes within the regulatory landscape affecting the economy at large, specific industries, or even individual companies within specific sectors (Peterdy 2022). The integration of e-procurement in SMEs encounters a number of political and legal obstacles. This includes the lack of comprehensive national IT guidelines, which limits the seamless introduction of e-procurement (Bello & Iyagba 2013). Furthermore, an inadequate legal framework undermines the facilitation of the use of e-procurement (Azanlerigu & Akay 2015), accompanied by a lack of legal and political support to establish the necessary standards and practices (Cardoso &

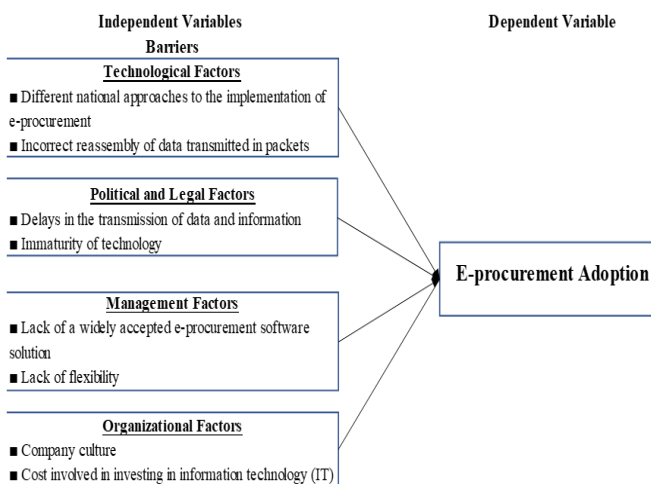


Figure 1. Conceptual Framework

Biazzin 2020).

Further complexities arise from the lack of relevant case law, the limitations of government policies and registries governing the use of e-procurement (Nawi et al. 2016), and inadequate staff training to address these challenges (Costa, Arantes & Tavares 2013). The evolving technology landscape is characterized by immaturity, which increases barriers for SMEs (Altayyar & Beaumont-Kerridge 2016). Furthermore, the lack of a platform for sharing ideas and information hampers the effective use of e-procurement (Ibem, Aduwo & Ayo-Vaughan 2017). Taken together, these political and legal barriers pose significant obstacles for SMEs wishing to adopt e-procurement practices.

2.3.3 Management factors

Management factors result from the decisions and strategies formulated by the company's management. Of paramount importance among these factors is the indispensable role of top management support in guiding the adoption and use of e-procurement technology (Yevu & Yu 2019). However, the landscape is complex and marked by concern and resistance to change, which has proven to be a formidable deterrent to e-procurement implementation (Afolabi et al. 2020; Adebayo & Evans 2015; Zunk et al. 2014).

A study by Au et al. (2014), which studies the Hong Kong hotel industry, unveils a similar narrative, revealing that inconsistencies within management and reluctance on the part of business owners to embrace change are hampering the acceptance of digital procurement. The lack of strong support from top management and system developers has proven to be a significant obstacle for many companies wishing to implement e-procurement effectively (Nazima & Vani 2017). Adebayo and Evans (2015) complement this finding by emphasizing that insufficient financial support from financial institutions casts a shadow over SMEs' propensity for e-procurement. Parallel results from Ateto, Ondieki, and Okibo (2013) illustrate the biggest hurdle of insufficient financing in the area of e-marketplace providers.

In addition, a major obstacle is the lack of widely accepted e-procurement software solutions, further hampering demand from SMEs' enthusiasm for adoption (Eadie et al. 2010). Conversely, Ibem and Laryea (2015) and Amalia (2017) emphasize unequal and unreliable access to essential IT infrastructure as a barrier hampering the achievement of e-procurement goals. The lack of technical expertise and required skills to establish e-procurement technologies and processes poses additional challenges and leaves a negative impression on the path of e-procurement adoption (Aduwo et al. 2016; Edwin & Peter 2014). These management factors interact closely and shape the e-procurement landscape for SMEs.

2.3.4 Organizational factors

Organizational factors include the skills and methods used in orchestrating and organizing work, activities, and

events (Reverso Dictionary 2022). Consequently, organizational barriers describe characteristics within an organization that impede the integration of e-procurement (Yevu, Yu & Darko 2021). Similarly, Altuwajiri and Khorsheed (2012) categorize organizational barriers as obstacles that arise from complicated organizational structures and processes and pose challenges in the seamless adoption of e-procurement technologies.

Numerous comprehensive studies and reviews have delved into the intricacies of organizational barriers that impact e-procurement implementation. In particular, cultural factors such as the lack of a clearly defined company policy, the lack of a generally accepted solution, lack of leadership, inflexible central control, and compromised information quality are identified as catalysts for slowed adoption of e-procurement (Tokta-Palut et al. 2014). Bienhaus and Haddud (2017) agree and attribute the influence of organizational structure and culture to the digital transformation of procurement.

The cost of investing in information technology represents another obstacle on the path to e-procurement implementation, where the costs often outweigh the perceived benefits of moving to e-procurement (Tokta-Palut et al. 2014; Aduwo et al. 2016). Similarly, Afolabi et al. (2020) that the limited adoption of e-procurement tools and technologies is mainly due to the exorbitant costs associated with these innovations and their add-on components. The previous research by Nazima and Vani (2017) on the challenges and potential benefits of adopting e-procurement for economic growth in Mauritius highlights how high system maintenance costs and system downtime act as a disincentive and deter companies from adopting e-procurement platforms to use.

3. Research Methodology

3.1. Study Design

This quantitative cross-sectional research examined the SME's e-procurement adoption barriers in the Republic of South Sudan. Following Creswell and Creswell (2018), quantitative studies concerned assumptions on deductive theory-testing, establishing protection against bias, controlling alternative or counterfactual justifications, and outcome generalization and replication.

3.2. Study Population and Sampling Strategy

A sample size of 300 out of 1215 SMEs was methodologically selected using Yamane's (1967) formula $[(5/100) \cdot n = N / (1 + N(e)^2)]$ with an assumed 95% confidence level and $P = .05$. Notably, 'n' denotes sample size, 'N' implies population size, and 'e' represents a precision level.

3.3. Data Collection Procedures

The study was approved by the University of Zambia Humanity and Social Sciences Research Ethics Committee and consent was obtained from participants prior to data collection. The confidentiality of their information was strictly maintained throughout the study.

The survey questionnaire consisted of Section A-Personal Data and Section B-Barriers to E-procurement Adoption, which was developed with a Cronbach's alpha value of 0.933 following past literature, was emailed as a hyperlink, and attachment through Google Form and PDF, respectively, for primary data collection. Stockemer (2019) highlighted the prominence of digital surveys in empirical works over the past two decades following their affordability. Meanwhile, secondary data were gathered by reviewing journal articles, books, blogs, and online data from research organizations. The survey respondents encompassed non-management, first-level supervisors, middle managers, and top managers of SMEs in the Republic of South Sudan. Out of the 300 distributed questionnaires in the form of a 5-point Likert scale with 1=strongly disagree, 2=disagree, 3=neither agree nor disagree (NAD), 4=agree and 5=strongly agree, 213 responses were valid while one (0.47%) was either erroneous or incomplete, thus resulting in a 71% response rate. This outcome corresponded to Neuman's (2014) recommendation of response rates between 10 and 50 for questionnaire surveys. The remaining 86 (28.66%) questionnaires were not addressed or received.

3.4. Data Analysis

The study data were extracted with International Business Machines Corporation (IBM) Statistical Package for Social Sciences (SPSS) version 25 and excel. Descriptive statistics was first employed to analyse and tabulate respondents' demographic attributes through frequency and percentage (Table 1). The frequency and percentage distribution of 30 factors deterring SMEs e-procurement adoption in the Republic of South Sudan were subsequently computed. Second, exploratory factor analysis was performed using principal component analysis (PCA) and varimax rotation methods. Third, the Relative Important Index (RII) was analysed to initiate the Analytic Hierarchy Process (AHP), and fourth, AHP was applied to support multi-level decisions and assess key barriers to e-procurement adoption. The PCA, RII, and AHP methods are explained in the following sections.

3.4.1 Principal Component Analysis

Invented by Karl Pearson in 1901, PCA is a mathematical method that uses a limited set of factors to describe the variance in a data set (Palit, Bari & Karmaker 2022). PCA aimed to extract the information from the datasets and then express it as a set of new orthogonal variables named principal components (Rajput & Singh 2018). Palit et al. (2022) add that PCA helps to select the most important data from the data table, reduce the size of the dataset by keeping only the key information, simplify the description of the dataset, and examine the structure of the observations and variables. In this study, the PCA contributed to the identification and categorization of criteria and sub-criteria and the dimension reduction of independent variables that help in generating the

hierarchical AHP structure. The phases of PC analysis include:

i) Data normalization: After processing the data, the variables were normalized using min-max techniques to rescale all variables to values between 0-1 scale (Abdrabo et al. 2023). Normalizing individual variables offers a linear transformation that maintains the ranking and correlation structure of the original data and allows for variables with different scales to be tallied (Tran, O'Neill, & Smith 2010). The equation for the min-max technique is shown below as Eq-1.

$$\text{Min} - \text{Max}(C_x) = \frac{C_x - C_{\text{Min}}}{C_{\text{Max}} - C_{\text{Min}}} \quad (\text{Eq.1})$$

Where:

C_x = is the original value of barriers to e-procurement adoption

C_{Min} = is the minimum value of barriers to e-procurement adoption

C_{Max} = is the maximum value of barriers to e-procurement adoption

ii) Screen Plot: A screen plot was carried out to determine the number of components to be retained for the principal component analysis (Fig 2). According to Brown (2009), the screen plot is a graph of the relationship between the relative magnitude of the eigenvalues and the number of components. To achieve the screen plot, eigenvalues were plotted against the number of factors in their order of extraction, and the shape of the resulting curve is used to evaluate the cut-off point (Hair et al. 2019). Consequently, four-factor components were extracted namely i) technological factors, political and legal factors, management factors, and organizational factors.

iii) Varimax rotation: After determining the number of components, the retained components were rotated to facilitate interpretation (Abdi & Williams 2010). Highly correlated indicators were grouped based on the correlation matrix resulting from using the Varimax rotation tool (Abdrabo et al. 2023). To eliminate data redundancy, strongly correlated variables were reviewed (Field 2018; Torok 2018). In this study, the number of significant dimensions were chosen by keeping the components with eigenvalues > 1 (de Sherbinin & Bardy 2015; Torok 2018).

iv) The Kaiser-Meyer-Olkin (KMO) test and Bartlett's test: To assess the robustness of the model, the KMO test and Bartlett's test of sphericity for sampling adequacy were applied. The KMO values vary between 0 and 1 (Field 2018; Abdrabo et al 2023). A value of 0 indicates that the sum of partial correlations is large relative to the sum of correlations, indicating spread in the correlation pattern (hence factor analysis is likely to be inappropriate), and a value close to 1 indicates that the correlation patterns are large relatively compact and therefore the factor analysis should provide clear and reliable factors (Field 2018). The

threshold values for component analysis according to Kaiser and Rice (1974) are 0.90 (marvellous), 0.80 (meritorious), 0.70 (middling), 0.60 (mediocre), 0.50 (miserable), and below 0.50 (unacceptable). Field (2018), to follow the letter M, changed the words "Unacceptable" to "Merde". A statistically significant Bartlett test for sphericity ($p < 0.001$) indicates that there are sufficient correlations between variables to proceed (Hair et al. 2019). In this study, the KMO used to measure overall sample adequacy gave a score of 0.946, which Kaisers and Rice (1974) say is marvelous, while the individual KMO scores for the questions were also greater than 0.7, which according to Kaisers and Rice indicates middling to marvelous. The result of Bartlett's test of sphericity was statistically significant, $\chi^2 (435) = 4661.376, p < 0.001$.

3.4.2 Relative Importance Index (RII)

RII is an equal contribution that a variable makes to the predictor variables themselves and or in combination with other predictor variables in the regression equation (Johnson & LeBreton 2004). In a definition by Dixit et al. (2019), RII denotes the sum of all responses divided by the number of responses and the maximum number of the Likert scale. For this study, the RII technique was used to rank the criteria in accordance with their relative importance (Akadiri, Olomolaiye & Chinyio 2013). The RII is a dependable technique for rating variables using a structured survey (Dixit et al. 2019). Aduwo et al. (2020), Priyatna and Sunandar (2021), and Nitharsan and Francis (2022) have utilised RII approaches in examining the anti-corruption capabilities, key success factors, and adaptability of blockchain-based in e-procurement determinant, respectively. According to the definition of Dixit et al., the RII is calculated using the following formula (Eq.2):

$$RII = \frac{\sum w}{A \times N} \tag{eq.2}$$

w is the weight respondents give each factor on a scale of 1(least) to 5 (highest). A is the highest (5) weight and N is the total number of respondents, which is 213 for this study. According to Akadiri (2011), the RII values were divided into five levels, and they include High (H) ($0.8 \leq RII \leq 1$), High-Medium (H-M) ($0.6 \leq RII \leq 0.8$), Medium (M) ($0.4 \leq RII \leq 0.6$), Medium-Low (M-L) ($0.2 \leq RII \leq 0.4$) and Low (L) ($0 \leq RII \leq 0.2$). All the survey questions, which were rated with H-M relative importance levels, characterized the significance of each question as an SME e-procurement adoption barrier in the Republic of South Sudan.

3.4.3 Analytical Hierarchy Process (AHP)

Invented by Prof. Saaty in the 1970s (1971-1975), AHP is a measurement theory in which pairwise comparisons rely on the judgments of experts to derive scales of priority (Saaty 2008). AHP is an efficient and useful decision-making approach for solving problems where the decision criterion can be structured hierarchically into sub-criteria (Agrawal, Seth & Dixit 2020). AHP has been used in supplier selection in e-procurement (Benyoucef & Canbolat 2007;

Deepika 2023), to determine success factors of mass rapid transit (MRT) parts in e-procurement (Hartanto, Ginting & Sunardi 2019), and to examine the performance impact of e-procurement adoption (Masudin et al. 2021). For AHP analysis, the ranking values obtained from RII were used (Gunduz & Almuajebh 2020). The steps involved in AHP analysis include:

Step 1. Definition of problems and research objectives/goals to determine knowledge needed in identifying barriers to e-procurement acceptance.

Step 2. Identification of criteria and sub-criteria by PCA for barriers to e-procurement adoption by SMEs. The decisions were hierarchically structured into level 1 focus/objective/goal, level 2 criteria, and level 3 sub-criteria. The hierarchical structure is shown in Figure 3 below.

Step 3. Pairwise comparison using RII is a method to assign numerical values to the relationships between different elements or criteria based on the actual measurement and their relative importance. According to Gunduz and Almuajebh (2020), the new approach to analyse AHP is to transfer values from RII. In this study Saaty's 1-9 point scale of 1=equally important, 3=moderately important, 5=strong important, 7= very strong important, 9= extreme strong, and 2,4,6, 8=intermediate values between adjacent scale were assigned values that correlate to RII ranges as follows: High Importance ($0.8 \leq RII \leq 1$): Assigned values of 7, 8, or 9. High-Medium Importance ($0.6 \leq RII \leq 0.8$): Assigned values of 5, 6, or 7. Medium Importance ($0.4 \leq RII \leq 0.6$): Assigned values of 3 or 4. Low Importance ($0 \leq RII \leq 0.2$): Assigned value of 1. The defined scale was used to assign pairwise comparison values to the element that correspond to RII values as shown in Table 6. A pairwise comparison matrix (A) is defined by the following equation (Eq.3).

$$A = a_{ij} = \begin{matrix} A_1 & A_2 & \dots & A_n \\ A_1 & 1 & a_{12} & \dots & a_{1n} \\ A_2 & 1/a_{12} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ A_n & 1/a_{1n} & 1/a_{2n} & \dots & 1 \end{matrix} \tag{eq.3}$$

Where $0 \leq a_{ij} \leq 1, a_{ij} + a_{ji} = 1$. The element a_{ij} ($i, j = 1, 2, \dots, n$) represents that a membership degree at which alternative A_i is more important than A_j . The larger a_{ij} ($i, j = 1, 2, \dots, n$) is, the more important alternative A_i is than A_j . Alternative A_i is as important as A_j . when a_{ij} is equal to 1. The result of pairwise comparison is shown in Table 7a, 7b, 7c and 7c

Step 4. The decision matrix A was normalized to obtain priority vectors by computing the eigenvalues and eigenvectors of Matrix A (Table 5). The eigenvector denoted by X_{ij} corresponding to the largest eigenvalue λ_{max} was selected. The eigenvector X_{ij} was normalized by dividing each element by the sum of all elements, ensuring that the vector values sum up to 1 (equation (eq.4). The normalized eigenvector X_{ij} represents the ranking of priorities for the sub-criteria (X1, X2, X3...Xn.). The priority vector X_i was calculated by averaging each row of normalized matrix X_{ij} (eq.5).

$$X_{ij} = \frac{a_{ij}}{\sum_{i=1}^n a_{ij}} \tag{eq.4}$$

$$X_i = \frac{\sum_{i=1}^n a_{ij}}{n} \tag{eq.5}$$

Step 5. The Consistency Ratio (CR) was calculated using consistency index (CI) to check the validity of the results (Table 6). The CI is defined as by (eq.6)

$$C.I = \frac{\lambda_{max} - n}{n - 1} \tag{eq.6}$$

Where λ_{max} is the largest eigenvalue of the comparison matrix, n is the number of criteria or alternatives being compared. The CI formula subtracts the number of criteria from the largest eigenvalue and then divides the result by the difference between the number of criteria and the 1.

The CR is calculated by dividing the CI by the Random Index (RI). The RI provides a reference value based on the number of criteria being compared and is used to determine an acceptable level of consistency. The formula for CR is given by (eq.7).

$$CR = \frac{CI}{RI} \tag{eq.7}$$

Step 6. Ranking of the factor based on optimal weight calculation.

4. Results and Discussions

4.1. Table 1 presents the study respondents’ demographic information for a sound understanding of their background.

Table 1: Demographic Variables

		Frequency	Percentage (%)
Your Gender	Female	30	14.1
	Male	183	85.9
Age group (years)	20-25	1	.5
	26-35	80	37.6
	36-50	117	54.9
	51-65	15	7.0
Highest completed education level	Bachelor’s Degree	128	60.1
	Certificate	10	4.7
	Diploma	43	20.2
	Doctoral Degree	2	.9
	Master's Degree	30	14.1
Job status	First-level supervisor	9	4.2
	Middle Management	50	23.5
	Non-management	5	2.3
	Top management	149	70.0
Number of years employed in the company	Under 1	2	.9
	1-2	14	6.6
	3-5	65	30.5
	6-10	74	34.7
	Over 10	58	27.2

Based on Table 1, the large proportion of male respondents (85.9%) compared to their female counterparts (14.1%) indicated the male dominance in SMEs within the Republic of South Sudan. Age-wise, most respondents

(54.9%) were from 36 to 50 years old, 37.6% were from 26 to 35 years old, 7% were from 51 to 65 years old, and 0.5% were from 20 to 25 years old. In this vein, most SMEs are run by young individuals. With regards to education level, most of the individuals (60.1%) graduated with a Bachelor’s degree, 20.2% graduated with a Diploma, 14.1% graduated with a Master’s degree, 4.7% graduated with a certificate, and 0.9% graduated with a Doctoral degree. Concerning job status, most respondents (70%) worked as top managers, 23.5% were middle managers, 4.2% were first-level supervisors, and 2.3% were non-managers. Most of the individuals (34.7%) had between 6 to 10 years of working experience, 30.5% had between 3 to 5 years, 27.2% had over 10 years, 6.6% had 1 to 2 years, and only 0.9 had under 1 year.

4.2. Table 2: Frequency and Percentage Distribution of Barriers to E-procurement Adoption by SMEs in the Republic of South Sudan

Insert Table 2 Here

(Table 2: Adoption by SMEs in the Republic of South Sudan)

The SMEs e-procurement adoption barriers in the Republic of South Sudan were examined in this study. Specifically, the research respondents indicated the degree to which they concurred with specific statements on SMEs e-procurement adoption barriers in the Republic of South Sudan by selecting a suitable number from a Likert scale of 1 to 5: 1 = Strongly Disagree (SD), 2 = Disagree (D), 3 = Neither Agree nor Disagree (NAD), 4 = Agree (A), and 5 = Strongly Agree (SA). Table 2 presents the frequency and percentage distribution for each question on SMEs e-procurement implementation barriers in the Republic of South Sudan.

Most respondents agreed and strongly agreed to the following questionnaire items: lack of support from top management and system developer, resistance to change, lack of technical expertise, lack of resources, such as human and finance, lack of employee training in use of e-procurement, cost involved in investing in IT, lack of flexibility, perception of no business benefit realized, lack of forum to exchange ideas on the use of e-procurement, company culture, high maintenance cost, lack of trust, lack of publicity or awareness of best practice, lack of pertinent case law guiding e-procurement use, different national approaches to e-procurement adoption, inadequacies in government policy and legislation, lack of a widely acceptable e-procurement software solution, prevention of possible tampering with documents, limited access to internet, security in the process: data transmission to wrong person, unauthorized viewing of confidential information, incorrect reassembly of data transmitted in packets, insufficient assessment of systems prior to installation, partial data display and incompatible document provided, internal and external interoperability of e-procurement software, technical challenges associated with transition

from paper-based method to e-procurement use, delays in the transmission of data and information, and immaturity of technology. Contrarily, 40 (18.8%) and 39 (18.3%) respondents disagreed and strongly disagreed, respectively, that low supplier interest hampered SMEs e-procurement adoption in the Republic of South Sudan.

4.3. Principal Component Analysis (PCA) Results for Barriers to E-procurement Adoption by SMEs in the Republic of South Sudan.

The scree plot in Figure 2 aided in identifying the number of components to be retained for PCA. Observably, four components were retained following a directional shift after component four.

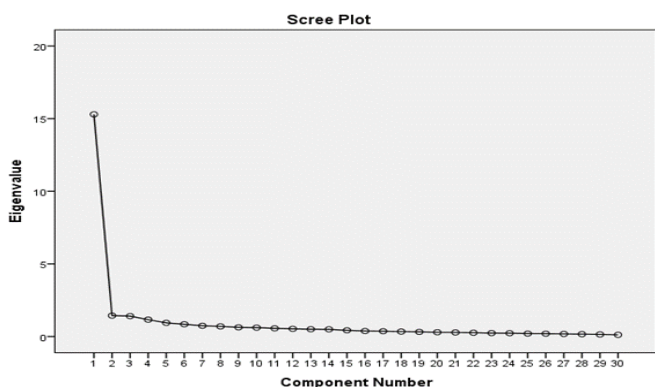


Figure 2: Screen plot for SMEs E-procurement Adoption Barriers in the Republic of South Sudan.

Table 3 depicts the PCA extraction method with a cumulative variance of 64.345% explained. Factors 1, 2, 3, and 4 contributed to 50.989%, 4.800%, 4.683%, and 3.8735% of variance, respectively, post-extraction.

Insert Table 3 Here

(Table 3: Component Transformation Matrix for SMEs E-procurement Adoption Barriers)

Table 4 demonstrates the rotated component matrix of SMEs e-procurement adoption barriers in the Republic of South Sudan. The four-factor components are labelled as technological, political and legal, management, and organizational. As such, the PCA objective was fulfilled by categorizing and mitigating the 30 barriers, which were divided into four components.

Insert Table 4 Here

(Table 4: Rotated Component Matrix for SMEs E-procurement Adoption Barriers)

In line with Table 4, the technological factors (component 1) encompassing 10 variables explained

50.989% of the variance. Political and legal factors (component 2), which entailed 8 variables, explained 4.8% of the variance. Meanwhile, the management factors (component 3) containing 8 variables explained 4.683% of the variance. Lastly, the organizational factors (component 4) constituting 4 variables explained 3.873% of the variance.

4.4. Relative Importance Index (RII) Results for SMEs E-procurement Adoption Barriers in the Republic of South Sudan.

The RII served to rank each survey question based on their relative importance to SMEs e-procurement adoption barriers in the Republic of South Sudan. Table 5 presents the ranking results for each variable with RII analysis.

Insert Table 5 Here

(Table 5: The RII for SMEs E-procurement Adoption Barriers in the Republic of South Sudan)

In parallel with Table 5, the costs associated with investments in IT represented the highest implied barrier (0.7735), followed by company culture (0.7455), technical challenges associated with transition from paper-based method to e-procurement use (0.7349), different national approaches to e-procurement adoption (0.7321), lack of forum to exchange ideas on the use of e-procurement (0.7264), prevention of possible tampering with documents (0.7245), and lack of publicity or awareness of best practice (0.7236). The three lowest-ranking questions (28th, 29th, and 30th) are presented as follows: partial data display and incompatible document provided (0.6474), lack of resources, such as human and finance (0.6434), and lack of interest of suppliers (0.6132).

4.5. Analytical Hierarchy Process (AHP) Results for SMEs E-procurement Adoption Barriers in the Republic of South Sudan.

4.5.1 Hierarchical structure for Barriers to E-procurement adoption.

Figure 3 shows hierarchical structures based on PCA results and divided into three levels. Level 1 is the objective, goal or focus presented here as barriers to e-procurement adoption. Level 2 is criteria consists of four decision criteria, namely technological factors, political and legal factors, organizational factors and management factors. Level 3 consisted of 30 sub-criteria.

Insert Figure 3 Here

(Figure 3: Hierarchical Structure for SMEs E-procurement Adoption Barriers)

4.5.2 Pairwise comparison for Criteria (Technological, Political and Legal, Management and Organizational factors)

Table 6 shows the defined scale used to assign pairwise comparison values to the element that correspond to RII values.

Table 6: Assign Pairwise Comparison Values to RII Values.

Scale	Range	Assigned Value
High Importance	0.8-1.0	7,8,9
High Medium	0.6-0.8	5,6,7
Medium	0.4-0.6	3,4
Medium Low	0.2-0.4	2
Low	0.0-0.2	1

Table 7a, 7b, 7c, and 7d shows pairwise comparison matrix of the Criteria (Technological factors, Political and Legal factors, Management factors and Organizational factors).

[Insert Table 7\(a, b, c, d\) Here](#)

(Table 7a: Pairwise Comparison of Technological factors)

(Table 7b: Pairwise Comparison of Political and Legal factors)

(Table 7c: Pairwise Comparison of Management factors)

(Table 7D: Pairwise Comparison of Organizational factors)

Tables 7a, 7b, 7c and 7d specify matrices to capture the pairwise comparisons between each element and criterion. The diagonal element of the matrix is 1, indicating that an element is equally important as itself. The upper triangular elements contain the assigned values based on the RII, representing the preference or importance of one element over another. The lower triangular elements are the reciprocals of the corresponding upper triangular elements.

4.5.3 Normalization of Decision Matrix

The decision matrix was normalized to obtain priority vectors by computing the eigenvalues and eigenvectors of the matrix as shown in Table 8a, 8b, 8c and 8d.

[Insert Table 8\(a, b, c, d\) Here](#)

(Table 8a: Normalized Matrix of Technological Factors)

(Table 8b: Normalised Matrix of Political and Legal Factors)

(Table 8c: Normalized Matrix of Management Factors)

(Table 8D: Normalised Matrix of Organisation Factors)

Tables 8a, 8b, 8c, and 8d indicate the eigenvector corresponding to the largest eigenvalue, denoted as λ_{max} . The eigenvector was normalized by dividing each element by the sum of all elements, ensuring that the vector values sum up to 1. The normalized eigenvector represents the ranking of priorities for the sub-criteria.

4.5.4 Consistence Ratio

In the AHP, the Consistency Index (CI) is a crucial metric for assessing the consistency of pairwise comparisons made by decision makers. It quantifies the degree of inconsistency of judgments made during the settlement process. To further evaluate the level of consistency, the consistency ratio (CR) is calculated by dividing the consistency index (CI) by the randomness index (RI) and the results are shown in the Table 9 below.

[Insert Table 9 Here](#)

(Table 9: Consistence Ratio for Barriers to e-procurement adoption)

Table 9 shows that the consistency ratio of each sub-criteria is almost zero. Therefore, the normalised Eigenvector is perfectly calculated and utilised for decision-making.

4.5.5 Ranking of the factor based on optimal weight calculation

Table 10 show ranking of the factor based on the optimal weight calculation on each sub-criterion.

[Insert Table 10 Here](#)

(Table 10: AHP Weightages and Ranking of Barriers to E-Procurement Adoption)

The results from Table 10 show that the main barriers to the adoption of e-procurement within the management factors are the lack of a widely accepted e-procurement software solution and lack of flexibility. These findings are consistent with the discovery of Eadie et al. (2010) agree that the lack of a widely accepted e-procurement software solution prevents many SMEs from adopting e-procurement. Furthermore, Eei et al. (2012), Tokta-Palut et al. (2014) and Laryea and Ibem (2014) emphasize that a lack of flexibility prevents several SMEs from effectively using the e-procurement platform.

In the category of organizational factors, company culture is the main obstacle, followed by the costs associated with information technology (IT) investments. This is consistent with Bienhaus and Haddud's (2017) observation that organizational structure and culture influence the digitalization of procurement. Aduwo et al. (2016) and Afolabi et al. (2022) further confirm that the financial impact of IT investments has a negative impact on companies' adoption of e-procurement.

Within the realm of the political and legal factors, delays

in the transmission of data and information and the immaturity of technology are the main obstacles. Analogous results from [Ibem and Laryea \(2015\)](#) show that data transmission delays caused by high data traffic lead to low e-procurement usage. Furthermore, [Altayyar and Beaumont-Kerridge \(2016\)](#) previously identified technology immaturity as a challenge to the adoption of e-procurement.

As far as technological factors are concerned, the main obstacles are different national approaches to the implementation of e-procurement and incorrect reassembly of data transmitted in packages. These results are consistent with the conclusion of [Eadie et al. \(2010\)](#) that SMEs find different national approaches to the introduction of e-procurement an obstacle. Eadie et al. also note that incorrect merging of the transferred data into packages prevents SMEs from adopting e-procurement.

5. Conclusions and Recommendations

The current research investigated the SMEs e-procurement implementation barriers in the Republic of South Sudan with survey data gathered between July and September 2021. Nevertheless, this study encountered several drawbacks in the form of restricted financial resources, limited access to empirical works, obsolete secondary data, and inadequate sample sizes. The research outcomes could not be generalised across SMEs in

developed nations given the emphasis on e-procurement adoption barriers in the Republic of South Sudan.

Future works should compare the key e-procurement adoption barriers perceived by SMEs in both emerging and developed nations and ensure e-procurement acceptance among the counterparts in the Republic of South Sudan by (i) attracting more IT firms to mitigate e-procurement adoption costs, (ii) optimally training relevant organisational members on e-procurement use to alleviate organisational culture-oriented barriers, (iii) establishing regional or holistic methods to minimise the variances in national e-procurement adoption strategies, (iv) creating awareness with business seminars and social media to resolve the complexities underpinning low publicity, (v) utilising IT expertise to manage the transition from paper-based approaches to e-procurement use, (vi) and developing forums to share knowledge on e-procurement and password, information encryption, and data use to prevent e-procurement document tampering. Further research should also incorporate mixed-method techniques to examine SMEs e-procurement adoption barriers and mitigation strategies. Overall, this study has expanded the current body of literature on e-procurement adoption for stakeholders and SMEs to establish contingency plans and alleviate the associated barriers.

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Declaration of Competing Interest

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APPENDICES

Table 2: Adoption by SMEs in the Republic of South Sudan

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Lack of support from top management and system developer	33(15.5%)	30(14.1%)	47(22.1%)	50(23.5%)	52(24.4%)
Resistance to change	39(18.3%)	30(14.1%)	38(17.8%)	47(22.1%)	58(27.2%)
Lack of technical expertise	37(17.4%)	18(8.5%)	40(18.8%)	59(27.7%)	58(27.2%)
Lack of resources, such as human and finance	40(18.8%)	27(12.7%)	43(20.2%)	51(23.9%)	51(23.9%)
Lack of employee training in use of e-procurement	32(15%)	19(8.9%)	30(14.1%)	55(25.8%)	76(35.7%)
Cost involved in investing in information technology (IT)	14(6.6%)	9(4.2%)	46(21.6%)	64(30%)	78(36.6%)
Lack of flexibility	34(16%)	26(12.2%)	41(19.2%)	54(25.4%)	57(26.8%)
Perception of no business benefit realised	33(15.5%)	28(13.1%)	52(24.4%)	51(23.9%)	48(22.5%)
Lack of forum to exchange ideas on the use of e-procurement	28(13.1%)	17(8%)	38(17.8%)	51(23.9%)	78(36.6%)
Company culture	22(10.3%)	18(8.5%)	29(13.6%)	71(33.3%)	73(34.3%)
High maintenance cost	23(10.8%)	28(13.1%)	50(23.5%)	43(20.2%)	69(32.4%)
Lack of trust	38(17.8%)	35(16.4%)	36(16.9%)	44(20.7%)	60(28.2%)
Lack of interest of suppliers	39(18.3%)	40(18.8%)	50(23.5%)	34(16%)	49(23%)
Lack of national IT policy relating to e-procurement	30(14.1%)	30(14.1%)	31(14.6%)	54(25.4%)	67(31.5%)
Lack of publicity/awareness of best practices solutions	26(12.2%)	18(8.5%)	36(16.9%)	63(29.6%)	69(32.4%)
Lack of pertinent case law guiding e-procurement use	32(15%)	23(10.8%)	47(22.1%)	47(22.1%)	63(29.6%)
Different national approaches to e-procurement adoption	16(7.5%)	26(12.2%)	44(20.7%)	54(25.4%)	72(33.8%)
Inadequacies in Government policy and legislation	28(13.1%)	31(14.6%)	41(19.2%)	39(18.3%)	74(34.7%)
Lack of a widely acceptable e-procurement software solution	25(11.7%)	28(13.1%)	42(19.7%)	56(26.3%)	61(28.6%)
Prevention of possible tampering with documents	18(8.5%)	32(15%)	38(17.8%)	48(22.5%)	76(35.7%)
Limited access to the internet	27(12.7%)	24(11.3%)	38(17.8%)	39(18.3%)	84(39.4%)
Security in the process: data transmission to wrong person	33(15.5%)	27(12.7%)	34(16%)	53(24.9%)	65(30.5%)
Unauthorised viewing of confidential information	34(16%)	23(10.8%)	38(17.8%)	51(23.9%)	66(31%)
Incorrect reassembly of data transmitted in packets	34(16%)	26(12.2%)	53(24.9%)	43(20.2%)	56(26.3%)
Insufficient assessment of systems prior to installation	34(16%)	23(10.8%)	44(20.7%)	47(22.1%)	64(30%)
Partial data display and incompatible document provided	31(14.6%)	30(14.1%)	55(25.8%)	48(22.5%)	47(22.1%)
Internal and external interoperability of e-procurement software	15(7%)	21(9.9%)	63(29.6%)	63(29.6%)	50(23.5%)
Technical challenges associated with transition from paper-based method to e-procurement use	22(10.3%)	23(10.8%)	31(14.6%)	62(29.1%)	74(34.7%)
Delays in the transmission of data and information	30(14.1%)	27(12.7%)	25(11.7%)	60(28.2%)	71(33.3%)
Immaturity of technology	31(14.6%)	28(13.1%)	37(17.4%)	52(24.4%)	65(30.5%)

Table 3: Component Transformation Matrix for SMEs E-procurement Adoption Barriers

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	15.297	50.989	50.989	15.297	50.989	50.989	5.954	19.848	19.848
2	1.440	4.800	55.789	1.440	4.800	55.789	5.368	17.894	37.742
3	1.405	4.683	60.472	1.405	4.683	60.472	5.090	16.966	54.707
4	1.162	3.873	64.345	1.162	3.873	64.345	2.891	9.638	64.345
5	.942	3.139	67.484						

6	.845	2.815	70.300
7	.741	2.469	72.769
8	.698	2.326	75.095
9	.633	2.110	77.205
10	.613	2.044	79.250
11	.566	1.886	81.136
12	.531	1.772	82.907
13	.503	1.677	84.584
14	.496	1.653	86.237
15	.427	1.425	87.662
16	.379	1.262	88.924
17	.366	1.221	90.145
18	.342	1.142	91.286
19	.319	1.065	92.351
20	.293	.976	93.327
21	.280	.934	94.261
22	.260	.866	95.127
23	.237	.788	95.916
24	.229	.762	96.678
25	.201	.671	97.349
26	.197	.655	98.004
27	.177	.589	98.593
28	.163	.544	99.138
29	.143	.476	99.614
30	.116	.386	100.000

Extraction Method: PCA.

Table 4: Rotated Component Matrix for SMEs E-procurement Adoption Barriers

	Component			
	1	2	3	4
Component 1: Technological Factors				
Incorrect reassembly of data transmitted in packets	.750	.266	.214	.194
Partial data display and incompatible document provided	.725	.343	.236	.132
Security in the process: data transmission to wrong person	.678	.310	.238	.144
Lack of pertinent case law guiding e-procurement use	.671	.318	.291	.176
Insufficient assessment of systems prior to installation	.640	.442	.206	.170
Prevention of possible tampering with documents	.636	.024	.330	.370
Unauthorised viewing of confidential information	.599	.258	.311	.296
Different national approaches to e-procurement adoption	.581	.268	.193	.503
Limited access to the internet	.555	.321	.330	.305
Lack of publicity/awareness of best practice	.485	.343	.438	.163
Component 2: Political and Legal Factors				
Inadequacies in government policy and legislation	.189	.745	.210	.143
Lack of employee training in use of e-procurement	.342	.689	.377	.139
Immaturity of technology	.303	.669	.098	.252
Lack of forum to exchange ideas on the use of e-procurement	.379	.661	.253	.212
Technical challenges associated with transition from paper-based method to e-procurement use	.240	.632	.300	.292
Delays in the transmission of data and information	.343	.631	.286	.151
Lack of trust	.201	.618	.237	.310
Perception of no business benefit realised	.319	.507	.489	.006
Component 3: Management Factors				
Resistance to change	.109	.118	.757	.309
Lack of support from top management and system developer	.167	.245	.735	.157
Lack of a widely acceptable e-procurement software solution	.321	.179	.688	.287
Lack of technical expertise	.412	.240	.668	.172
Lack of flexibility	.316	.389	.641	.162
Lack of interest of suppliers	.323	.342	.579	-.041

Lack of national IT policy relating to e-procurement	.397	.348	.541	.228
Lack of resources, such as human and finance	.454	.446	.474	-.022
Component 4: Organisational Factors				
Company culture	.223	.191	.063	.656
Cost involved in investing in information technology (IT)	.263	.143	.366	.644
High maintenance cost	.050	.477	.128	.592
Internal and external interoperability of e-procurement software	.441	.205	.292	.546

Extraction Method: PCA.

Rotation Method: Varimax with Kaiser Normalisation.

Table 5: The RII for SMEs E-procurement Adoption Barriers in the Republic of South Sudan

	M	SD	RII	Ranking	Importance Level
Lack of support from top management and system developer	3.2736	1.38395	0.6547	24	H-M
Resistance to change	3.2594	1.46156	0.6519	25	H-M
Lack of technical expertise	3.3915	1.41840	0.6783	21	H-M
Lack of resources, such as human and finance	3.2170	1.43090	0.6434	29	H-M
Lack of employee training in use of e-procurement	3.5849	1.43331	0.7170	9	H-M
Cost involved in investing in information technology (IT)	3.8673	1.15940	0.7735	1	H-M
Lack of flexibility	3.3491	1.40778	0.6698	22	H-M
Perception of no business benefit realised	3.2500	1.35910	0.6500	26	H-M
Lack of forum to exchange ideas on the use of e-procurement	3.6321	1.38937	0.7264	5	H-M
Company culture	3.7277	1.29623	0.7455	2	H-M
High maintenance cost	3.5023	1.34804	0.7005	12	H-M
Lack of trust	3.2488	1.46952	0.6498	27	H-M
Lack of interest of suppliers	3.0660	1.41936	0.6132	30	H-M
Lack of national IT policy relating to e-procurement	3.4623	1.42206	0.6925	15	H-M
Lack of publicity/awareness of best practice	3.6179	1.34209	0.7236	7	H-M
Lack of pertinent case law guiding e-procurement use	3.4057	1.40263	0.6811	19	H-M
Different national approaches to e-procurement adoption	3.6604	1.26855	0.7321	4	H-M
Inadequacies in government policy and legislation	3.4695	1.42593	0.6939	14	H-M
Lack of a widely acceptable e-procurement software solution	3.4717	1.34346	0.6943	13	H-M
Prevention of possible tampering with documents	3.6226	1.33102	0.7245	6	H-M
Limited access to the internet	3.6085	1.42507	0.7217	8	H-M
Security in the process: data transmission to wrong person	3.4245	1.43384	0.6849	18	H-M
Unauthorised viewing of confidential information	3.4340	1.43430	0.6868	16	H-M
Incorrect reassembly of data transmitted in packets	3.2877	1.39642	0.6575	23	H-M
Insufficient assessment of systems prior to installation	3.3962	1.42542	0.6792	20	H-M
Partial data display and incompatible document provided	3.2370	1.34191	0.6474	28	H-M
Internal and external interoperability of e-procurement software	3.5283	1.16185	0.7057	11	H-M
Technical challenges associated with transition from paper-based method to e-procurement use	3.6745	1.32876	0.7349	3	H-M
Delays in the transmission of data and information	3.5399	1.42238	0.7080	10	H-M
Immaturity of technology	3.4319	1.41465	0.6864	17	H-M

Figure 3: Hierarchical Structure for SMEs E-procurement Adoption Barriers.

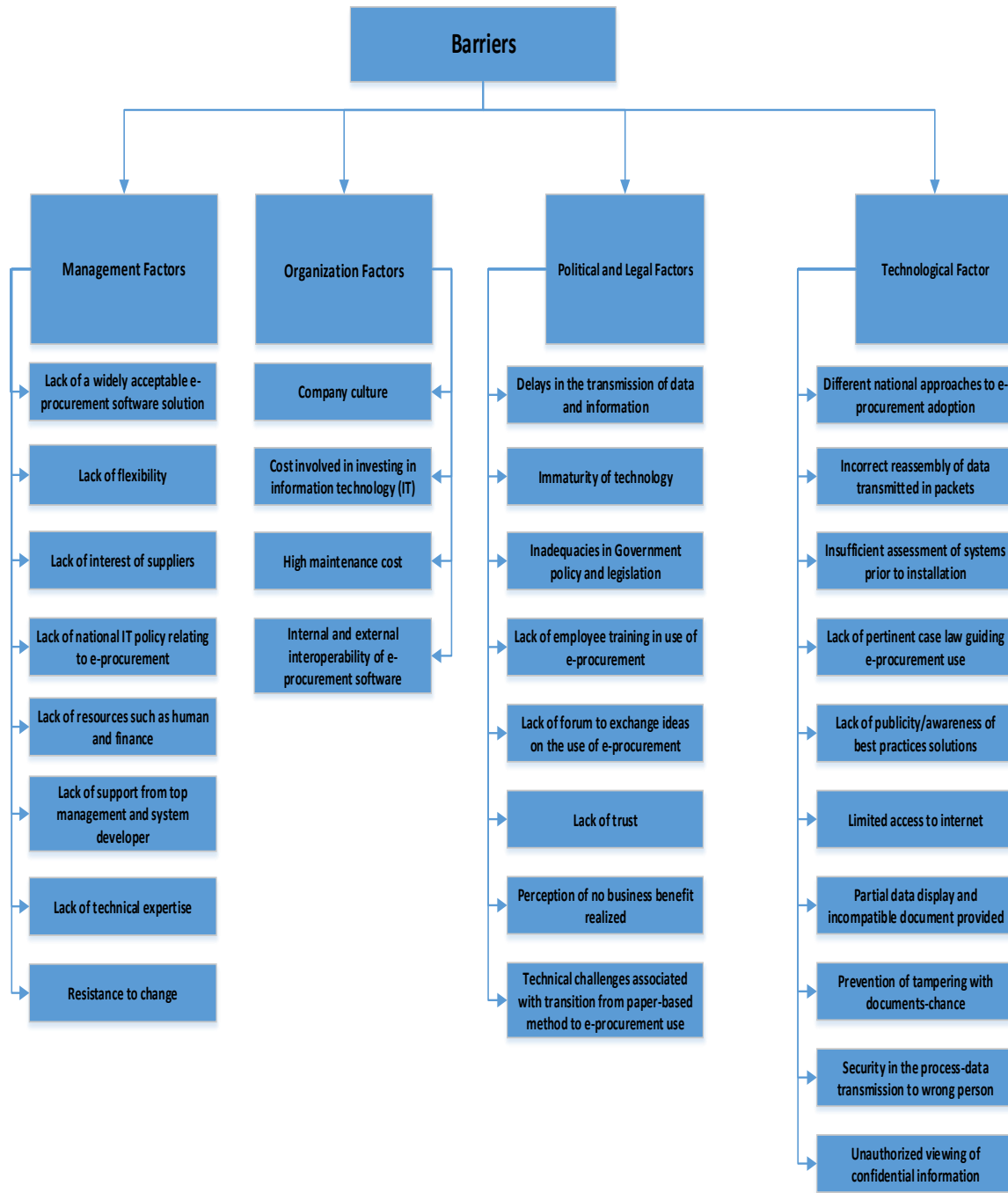


Table 7a: Pairwise Comparison of Technological factors

Objective	Criteria	Sub Criteria	RII	Barriers	Barriers	Barriers	Barriers	Barriers	Barriers	Barriers	Barriers	Barriers	
				F1 C1	F1 C2	F1 C3	F1 C4	F1 C5	F1 C6	F1 C7	F1 C8	F1 C9	F1 C10
Barriers	F1	C1	0.7321	1	7	7	7	7	7	7	8	8	9
Barriers	F1	C2	0.6575	0.1428571	1	5	6	6	6	6	7	7	8
Barriers	F1	C3	0.6792	0.1428571	0.2	1	6	6	6	6	7	7	8
Barriers	F1	C4	0.6811	0.1428571	0.1666667	0.1666667	1	6	6	6	6	5	8
Barriers	F1	C5	0.7236	0.1428571	0.1666667	0.1666667	0.1666667	1	7	6	6	6	7
Barriers	F1	C6	0.7217	0.1428571	0.1666667	0.1666667	0.1666667	0.1428571	1	5	6	6	7
Barriers	F1	C7	0.6474	0.1428571	0.1666667	0.1666667	0.1666667	0.2	1	6	7	7	7
Barriers	F1	C8	0.7245	0.125	0.1428571	0.1428571	0.1666667	0.1666667	0.1666667	0.1666667	1	6	6
Barriers	F1	C9	0.6849	0.125	0.1428571	0.1428571	0.2	0.1666667	0.1666667	0.1428571	0.1666667	1	7
Barriers	F1	C10	0.6868	0.1111111	0.125	0.125	0.125	0.1428571	0.1428571	0.1428571	0.1666667	0.1428571	1

Table 7b: Pairwise Comparison of Political and Legal factors

Objective	Criteria	Sub Criteria	RII	Barriers	Barriers	Barriers	Barriers	Barriers	Barriers	Barriers	Barriers
				F2	F2	F2	F2	F2	F2	F2	F2
				C11	C12	C13	C14	C15	C16	C17	C18
Barriers	F2	C11	0.708	1	6	6	7	7	7	7	8
Barriers	F2	C12	0.6864	0.1666667	1	5	6	6	6	6	7
Barriers	F2	C13	0.6939	0.1666667	0.2	1	6	7	6	5	6
Barriers	F2	C14	0.717	0.1428571	0.1666667	0.1666667	1	6	6	6	7
Barriers	F2	C15	0.7264	0.1428571	0.1666667	0.1428571	0.1666667	1	6	6	7
Barriers	F2	C16	0.6498	0.1428571	0.1666667	0.1666667	0.1666667	0.1666667	1	67	6
Barriers	F2	C17	0.65	0.1428571	0.1666667	0.2	0.1666667	0.1666667	0.0149254	1	5
Barriers	F2	C18	0.7349	0.125	0.1428571	0.1666667	0.1428571	0.1428571	0.1666667	0.2	1

Table 7c: Pairwise Comparison of Management factors

Objective	Criteria	Sub Criteria	RII	Barriers	Barriers	Barriers	Barriers	Barriers	Barriers	Barriers	
				F3	F3	F3	F3	F3	F3	F3	
				C19	C20	C21	C22	C23	C24	C25	C26
Barriers	F3	C19	0.6943	1	5	4	6	4	5	5	5
Barriers	F3	C20	0.6698	0.2	1	4	6	3	4	4	4
Barriers	F3	C21	0.6132	0.25	0.25	1	5	2	4	4	4
Barriers	F3	C22	0.6925	0.1666667	0.1666667	0.2	1	2	3	3	3
Barriers	F3	C23	0.6434	0.25	0.3333333	0.5	0.5	1	3	4	4
Barriers	F3	C24	0.6547	0.2	0.25	0.25	0.3333333	0.3333333	1	4	4
Barriers	F3	C25	0.6783	0.2	0.25	0.25	0.3333333	0.25	0.25	1	4
Barriers	F3	C26	0.6519	0.2	0.25	0.25	0.3333333	0.25	0.25	0.25	1

Table 7D: Pairwise Comparison of Organizational factors

Objective	Criteria	Sub Criteria	RII	Barriers	Barriers	Barriers	Barriers
				F4	F4	F4	F4
				C27	C28	C29	C30
Barriers	F4	C27	0.7455	1	5	4	4
Barriers	F4	C28	0.7735	0.2	1	3	3
Barriers	F4	C29	0.7005	0.25	0.3333333	1	3
Barriers	F4	C30	0.7057	0.25	0.3333333	0.3333333	1

Table 8a: Normalized Matrix of Technological Factors

Criteria	Sub Criteria	ROW TOTAL	E1	Eo	Diff
			NORMALIZED	NORMALIZED	
Technological Factor	Different national approaches to e-procurement adoption	446146.5488	0.3620	0.3011	0.0608
Technological Factor	Incorrect reassembly of data transmitted in packets	252673.7268	0.2050	0.1995	0.0055
Technological Factor	Insufficient assessment of systems prior to installation	181836.2246	0.1475	0.1610	-0.0135
Technological Factor	Lack of pertinent case law guiding e-procurement use	118816.0004	0.0964	0.1168	-0.0204
Technological Factor	Lack of publicity/awareness of best practices solutions	83114.2910	0.0674	0.0889	-0.0215
Technological Factor	Limited access to internet	52332.3747	0.0425	0.0547	-0.0122
Technological Factor	Partial data display and incompatible document provided	40046.4353	0.0325	0.0383	-0.0058
Technological Factor	Prevention of tampering with documents-chance	26133.7528	0.0212	0.0209	0.0003
Technological Factor	Security in the process-data transmission to wrong person	19600.4481	0.0159	0.0117	0.0042
Technological Factor	Unauthorized viewing of confidential information	11835.7779	0.0096	0.0070	0.0026
SUM		1232535.5805	1.0000	1.0000	0.0033

Table 8b: Normalized Matrix of Political and Legal Factors

Criteria	Sub Criteria	ROW TOTAL	E1	Eo	Diff
			NORMALIZED	NORMALIZED	
Political and Legal Factors	Delays in the transmission of data and information	344595.7046	0.3629	0.2707	0.0923
Political and Legal Factors	Immaturity of technology	206520.4178	0.2175	0.1943	0.0232
Political and Legal Factors	Inadequacies in Government policy and legislation	144297.0126	0.1520	0.1661	-0.0141
Political and Legal Factors	Lack of employee training in use of e-procurement	86645.3240	0.0913	0.1322	-0.0410
Political and Legal Factors	Lack of forum to exchange ideas on the use of e-procurement	53643.9871	0.0565	0.1075	-0.0510
Political and Legal Factors	Lack of trust	86111.9810	0.0907	0.1125	-0.0218
Political and Legal Factors	Perception of no business benefit realized	16238.0130	0.0171	0.0090	0.0081
Political and Legal Factors	Technical challenges associated with transition from paper-based it	11438.9293	0.0120	0.0077	0.0043
SUM		949491.3693	1.0000	1.0000	0.0000

Table 8c: Normalized Matrix of Management Factors

Criteria	Sub Criteria	ROW TOTAL	E1	Eo	Diff
			NORMALIZED	NORMALIZED	
Management Factors	Lack of a widely acceptable e-procurement software solution	44101.7320	0.3628	0.3464	0.0164
Management Factors	Lack of flexibility	26245.5050	0.2159	0.2255	-0.0096
Management Factors	Lack of interest of suppliers	16859.1706	0.1387	0.1487	-0.0101
Management Factors	Lack of national IT policy relating to e-procurement	9308.5069	0.0766	0.0823	-0.0057
Management Factors	Lack of resources such as human and finance	10039.3381	0.0826	0.0844	-0.0018
Management Factors	Lack of support from top management and system developer	6862.2850	0.0564	0.0546	0.0019
Management Factors	Lack of technical expertise	4788.7809	0.0394	0.0338	0.0055
Management Factors	Resistance to change	3360.0658	0.0276	0.0242	0.0034
SUM		121565.3843	1.0000	1.0000	0.0000

Table 8d : Normalised Matrix of Organisation Factors

Criteria	Sub Criteria	ROW TOTAL	E1	Eo	Diff
			NORMALIZED	NORMALIZED	
Organization Factors	Company culture	1399.7333	0.5708	0.5798	-0.0090
Organization Factors	Cost involved in investing in information technology (IT)	536.6622	0.2189	0.2251	-0.0062
Organization Factors	High maintenance cost	325.7972	0.1329	0.1238	0.0090
Organization Factors	Internal and external interoperability of e-procurement software	189.8861	0.0774	0.0713	0.0061
SUM		2452.0789	1.0000	1.0000	0.0000

Table 9: Consistence Ratio for Barriers to e-procurement adoption

Barriers							
Management Factors		Organization Factors		Political & Legal Factors		Technological Factors	
Lambda Max	9.4925	Lambda Max	4.3809	Lambda Max	13.6004	Lambda Max	14.1266
Consistency index	0.0305	Consistency index	0.0423	Consistency index	0.1143	Consistency index	0.0509
Random Consistency Index	1.4300	Random Consistency Index	0.8900	Random Consistency Index	1.4300	Random Consistency Index	1.5000
Consistency Ratio	0.0213	Consistency Ratio	0.0476	Consistency Ratio	0.0799	Consistency Ratio	0.0340

Table 10: AHP Weightages and Ranking of Barriers to E-Procurement Adoption

Objective	CRITERIA	SUB CRITERIA	AHP Weightage	AHP Ranking
Barriers	Management Factors	Lack of a widely acceptable e-procurement software solution	0.3628	1
Barriers	Management Factors	Lack of flexibility	0.2159	2
Barriers	Management Factors	Lack of interest of suppliers	0.1387	3
Barriers	Management Factors	Lack of national IT policy relating to e-procurement	0.0766	5
Barriers	Management Factors	Lack of resources such as human and finance	0.0826	4
Barriers	Management Factors	Lack of support from top management and system developer	0.0564	6
Barriers	Management Factors	Lack of technical expertise	0.0394	7
Barriers	Management Factors	Resistance to change	0.0276	8
Barriers	Organization Factors	Company culture	0.5708	1
Barriers	Organization Factors	The cost involved in investing in information technology (IT)	0.2189	2
Barriers	Organization Factors	High maintenance cost	0.1329	3
Barriers	Organization Factors	Internal and external interoperability of e-procurement software	0.0774	4
Barriers	Political and Legal Factors	Delays in the transmission of data and information	0.3629	1
Barriers	Political and Legal Factors	Immaturity of technology	0.2175	2

Barriers	Political and Legal Factors	Inadequacies in Government policy and legislation	0.1520	3
Barriers	Political and Legal Factors	Lack of employee training in the use of e-procurement	0.0913	4
Barriers	Political and Legal Factors	Lack of forum to exchange ideas on the use of e-procurement	0.0565	6
Barriers	Political and Legal Factors	Lack of trust	0.0907	5
Barriers	Political and Legal Factors	Perception of no business benefit realized	0.0171	7
Barriers	Political and Legal Factors	Technical challenges associated with the transition from paper-based method to e-procurement use	0.0120	8
Barriers	Technological Factor	Different national approaches to E-procurement Adoption	0.3620	1
Barriers	Technological Factor	Incorrect reassembly of data transmitted in packets	0.2050	2
Barriers	Technological Factor	Insufficient assessment of systems before installation	0.1475	3
Barriers	Technological Factor	Lack of pertinent case law guiding e-procurement use	0.0964	4
Barriers	Technological Factor	Lack of publicity/awareness of best practices solutions	0.0674	5
Barriers	Technological Factor	Limited access to the internet	0.0425	6
Barriers	Technological Factor	Partial data display and incompatible documents provided	0.0325	7
Barriers	Technological Factor	Prevention of tampering with documents-chance	0.0212	8
Barriers	Technological Factor	Security in the process-data transmission to the wrong person	0.0159	9
Barriers	Technological Factor	Unauthorized viewing of confidential information	0.0096	10

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