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Biometric Authentication in Financial Institutions: The intention of Banks to Adopt Biometric Powered ATM

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Abstract

The main purpose of this study was to assess the intention of banks to adopt biometric powered ATMs in Tanzania's financial sector. The study adopted Electronic Data Interchange (EDI) model and extended it by introducing perceived risks in order to address the issue of risk which is mostly considered as the main barrier in implementing various technologies. The study used a sample of 47 banks, using ATM in Tanzania, and a multiple respondent's technique was used to collect 102 valid responses. Multiple regression analysis was used to analyze the data; the empirical result shows that external pressure and perceived benefit are positively influencing the adoption of biometric powered ATM while perceived risk has negative influence. However, organization readiness was found to be insignificant in this study. This study has provided a more holistic understanding on the factors affecting adoption of biometric powered ATM which may enable various banks managers to adopt and implement biometric powered ATMs in Tanzania's financial sector.

Keywords: *Biometric powered ATMs, ATMs, Electronic Data Interchange, Perceived Risk*

1. Introduction

The application of biometrics for human identification and verification is not a new concept, it is believed that the first use of biometrics was for identification of children in China and Babylon, thousands of years ago whereby fingerprint and palm prints were used for that purpose [1]. Recently, massive deployment of biometric systems has been witnessed in several organizations, especially for security and attendance monitoring purpose in areas such as airports, borders, and work places to mention just a few. However, the situation has been different in the Tanzania's financial sector. It is estimated that in Tanzania, financial institutions have lost about $1billion between 2013 and 2014 through electronic related frauds [2]. Most of these high tech frauds were taking place by using Automated Teller Machines (ATMs) [2]. Perpetrators of these frauds were involved in illegal ATM's transactions by hijacking different customer's accounts using special devices that are used to record customers' Personal Identification Number (PIN). In attempt to redress this situation, the central bank of Tanzania has directed all commercial banks in the country to conduct awareness raising campaigns on safely using ATMs, carefully handling of PIN and proactively deploying Closed Circuit Television (CCTV) in ATM cabins. However, the directives of the central bank of Tanzania have not been properly honored [2]. Despite the usefulness of biometric technologies, most financial institutions, especially in developing countries and Tanzania in particular, have been slow in adopting them.

The available literature on biometrics technology adoption reveals that little has been done n the adoption of the biometrics technologies in developing countries [3], [4]. To the best of our knowledge, there has been no empirical study that has been conducted so far with regard to adoption of powered biometric ATM systems in the Tanzania's financial sector. Thus, this study intends to investigate the intention of banks to adopt biometric powered ATMs in Tanzania. This study is significant because it contributes to the body of knowledge in three ways. First, it gives insights on key factors that may drive banks to adopt biometric authentication technologies in financial settings. Second, it helps to fill the literature gap on biometrics adoption in organizational settings in Tanzania. Third, the study extends the organizational adoption theory by including perceived risks construct to explain the intention of banks to adopt biometric powered ATM.

2. Biometrics Systems and Biometric Authentication

System authentication refers to the process in which the subject can be personally identified using the electronic means. This authentication can be done by using different methods: (1) something you possess (Token, ID/swipe cards), (2) something you know (password, PIN) and (3) something you are (biometric). Among those methods, the use of biometric authentication is considered to be the best method because it uses physiology and behaviour of human beings which cannot be lost, forgotten or stolen [5]. Conversely, something you possess can be stolen and something you know can be forgotten.

Biometric system uses a pattern recognition system in which data collected from an individual are used to extract required trait information which is then compared with a template already stored in a database and the truth is established through this matching system. Biometric system may operate in two modes: verification mode or identification mode. In verification mode, an individual desired to be identified uses his/her own personal traits to retrieve the stored biometric template which is then compared with the captured biometric data. In this mode, the comparison of the data is done as one-to-one comparison to determine whether the claim is true or not. The objective of verification mode is to prevent multiple users from using same identity [6]. In identification mode, the captured biometric data is compared against all biometric data found in database for match. In this later mode the comparison is considered to be one-to-many in order to establish an individual identity. The objective of the identification mode is to prevent single user from using multiple identities [6].

Information Communication Technology (ICT) has been integrated into our daily life to the extent that ICT users own as many as possible system accounts which need authentication in order to access the system contents. This means that users have to own different passwords for them to access various systems. This has become a challenge due to the fact that, people tend to use simple passwords such as birth date, first name, pet name, etc. in order to remember them easily; such kind of passwords are very easy to be hacked. This poses challenges to the system account owners and the organization owning the system. The use of biometrics in authentication therefore is considered to be the best and secure option since biometrics uses unique personal biological traits such as face, finger, hand, iris, and voice recognition which may be very difficult to be accessed by intruders [7]. Biometric technologies have been integrated into various information systems to strengthen the security of these systems. Various systems in banks, health, and government institutions are using biometric system such as fingerprints or voice recognition to provide authentication to their customers. A study conducted by [7] shows that 66% of the services consumers worldwide prefer the use of biometric systems in providing securities to various systems.

3. Technology adoption theories

Adoption of biometric technology in strengthening security has become an important area of research in financial institutions due to the increased online fraud particularly in ATMs [8]. Decision to adopt biometric technology in providing security in any organization may involve a number of factors. These factors are identified in various adoption theories such as Technology Acceptance Model (TAM) [9], Theory of Planned Behaviour (TPB) [10], Theory of Reasoned Action (TRA) [11], Diffusion of Innovation (DOI) [12], Unified Theory of Acceptance and Use of Technology (UTAUT) [13] and Electronic Data Interchange (EDI) adoption Model [14]. To understand the biometric technology adoption behavior in Tanzania financial institutions, the current study adopts EDI model to develop the conceptual framework. EDI model has been adopted because it is one of the models which allow the inter-organization relationship in data interchange among business entities [14]. Therefore, it may allow individual bank or collaborate banks to implement biometric technology in strengthening security while using ATMs.

4. Research model and Hypotheses Development

Research model for this study is adopted from the electronic data interchange (EDI) model as developed by [15] to explain key influencing issues for adoption of biometric powered ATM in banks. Unlike other adoption models which focus on technology adoption by individuals such as TAM and DOI, this model is best applied to study technology adoption in organization context [14], [16], [17]. Biometric technology is a relatively new technology in Tanzania and has not yet been deployed in Tanzania's financial institutions thus, DOI is preferred in studying adoption of a new technology which is considered to be an innovation [18]. However, DOI will not be used because of its inability to explain the adoption of new technologies in organizational context [14].

Adoption of biometrics powered ATM is an organizational decision, which should consider both organizational and inter-organizational factors [15], [19]. The model consists of three independent variables: external pressure,

organizational readiness, and perceived benefits. Furthermore, during investment decisions, organizations often perform a risk assessment among other things before investing on a particular technology [20]. If risks can be mitigated clearly, an organization would likely adopt the technology. In this study we introduced perceived risks construct to enable organizations to conduct risk assessment as a step towards technology investment decision. Past studies have incorporated some barriers to technology adoption within the organizational readiness construct [15]. However, barriers such as perceived risks have not yet been covered. Thus, this study extends the organization technology theory by including the perceived risk construct. The proposed conceptual research model is presented in figure 1.

External pressure comprises of influences from competitors, customers, regulators and the industry itself [21]. The pressure exerted by the above listed entities may influence the organization to adopt more advanced ICT systems. For example, customers may demand deployment of biometric powered ATM to control ATM related frauds, regulators such the central bank may require banks to adopt ICT system such as biometrics to cope with increased financial frauds, also an organization may adopt ICT system in order to out play business rivals. Several studies have shown that external pressure tends to influence adoption of various technologies [22], [23]. Based on this, we predict that:

H1: *External pressures have positive and direct influence on the intention to adopt biometric powered ATM in banks.*

In the current context, organizational readiness refers to the ability and capacity of an organization to undertake IT project, it is measured in terms of IT sophistication, human resources and financial resources [24]. Adoption of ICT technology is mostly considered to be influenced by organizational readiness among other factors [25], [26]. The influence of organizational readiness in ICT technology is also seen in other studies (Chong et al., 2009; Jeyaraj, Rottman & Lacity, 2006). We also anticipate that, if an organization is ready in terms of infrastructure, management support, human resource, and financial resources, it is in a good position to adopt biometric powered ATM. Therefore we hypothesize that:

H2: *Organizational readiness has positive and direct influence on the intention to adopt biometric powered ATM in banks.*

Perceived benefits refers to perceptions with regard to advantages gained as a result of adopting technology in an organization [14]. Literature suggests that higher perceived benefits of a technology lead to higher chances of the technology adoption [27]. In this study, consistent with previous studies [3], [28], we anticipate that perceived benefits of biometrics in terms of increasing performance, increasing privacy and security of customer's transactions will motivate banks to adopt biometrics powered ATM. Thus, we predict that:

H3: *Perceived benefits have positive and direct influence on the intention to adopt biometric powered ATM in banks*

Perceived risk refers to anticipated negative consequences of venturing into ICT project, in this context, biometric powered ATM [29]. Negative consequences may be in terms of loss of customer trust if the ICT system fails to protect customer's information [30], loss of organization finances, if the implemented ICT system failed to return financial benefits to the organization. A decision to adopt ICT systems in organizations is always based on an assessment of the anticipated risks on the ICT investment. Literature in IT adoption suggests that perceived risks has direct and negative effect on the adoption of ICT system in organizations [31], [32]. Therefore, the adoption of biometrics powered ATM in banks is negatively influenced by risks perceptions. Thus, we hypothesize that,

H4: *Perceived risks have negative and direct influence on the intention to adopt biometric powered ATM in banks*

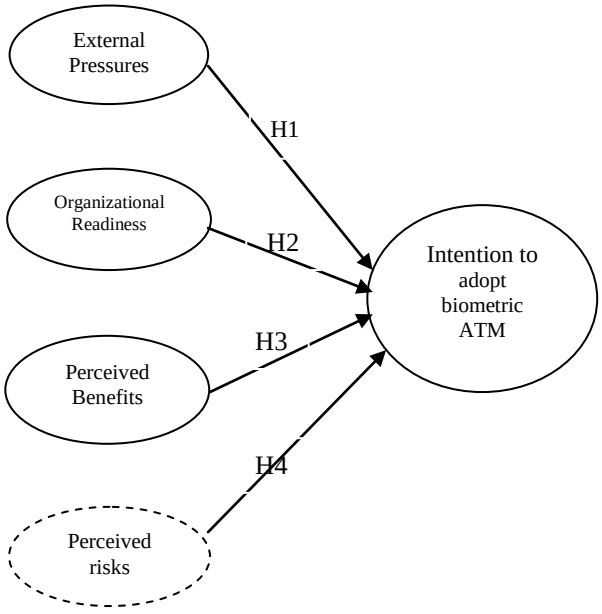

Figure 1: Proposed Research Model

5. Research Approach

This study used descriptive design with mainly quantitative approach. Participating organizations were obtained from the list of registered banks from the Bank of Tanzania (BOT) database. 141 questionnaires were distributed to 47 Banks and Financial Institutions which uses ATMs purposively selected. Three respondents from each Bank participated in the study. Respondents were senior employees from ICT departments. This category of respondents were chosen for two reasons: (i) biometric technology is part of ICT technology thus, ICT personnel are likely to have more knowledge of the technology as compared with other respondents in the bank; and (ii) ICT department plays a key role to advice the management on the issues pertaining to ICT particularly during ICT technology acquisition, development and deployment. Multiple respondents approach was used to avoid desirability bias which may weaken the validity of the research estimates [33], [34]. Furthermore, using single respondent from each bank may not reasonably reflect the belief of the entire Bank [35]. In order to ensure data representativeness, respondents were selected using simple random sampling technique from each participating Bank and Financial Institution [36].

Data were collected through questionnaires that were physically administered to respondents. Questionnaire was crafted based on items that form constructs of the study. Most of the items were adapted from past studies with slight changes in order to suite our study and few were self-developed based on the IS literature (see table 1). Constructs of this study are external pressures, organizational readiness, perceived benefits, perceived risks, and behaviour intention to adopt biometrics powered. The items were measured on 5 – Likert point scale, ranging from 1= Strongly Disagree to 5 = Strongly Agree.

The data collected were analyzed using Statistical Package for Social Sciences (SPSS) software version 20. Multiple regression analysis was used to assess the relationship between independent variables (external pressure, organization readiness, perceived benefit, and perceived risk) and dependent variable which is intention to adopt biometric powered ATM.

Table 1: Constructs, Items and Source

Item Code	Measurement items	Source
External pressure		
EXP1	Banking industry is pressurising our bank to adopt biometrics powered ATM	[16] and [37]
EXP2	Customers have asked my bank to adopt biometrics powered ATM	[16] and [37]
EXP3	Social influence are important for my bank intention to adopt biometrics powered ATM	[16] and [21]
EXP4	Customers have voiced concerns over the use of biometric authentication in my bank	[16]
EXP5	Competition is a key factor in my bank intention to adopt biometrics powered ATM	[38]
Organizational Readiness		
OR1	We are the first bank to adopt new financial related technologies	[16] and [37]
OR2	We are the first bank to recognize and develop new markets	[16] and [37]
OR3	We are the leading edge in financial related technological innovations	[16] and [37]
OR4	If we heard about a new technology, we would look for ways to experiment with it	[39]
OR5	Top managers repeatedly tell managers that the bank must gear up to meet changing technology trends	[16]
OR6	Top managers are always enthusiastic about intention to adopt biometric powered ATM	[38]
OR7	Top managers always encourage employees to develop and implement new technologies	[16]
OR8	Top managers in this bank are frequently the most ardent champions of new technologies	[16]
OR9	Our bank has financial resources to adopt biometric powered ATM	[38]
OR10	Our bank has technological resources necessary to adopt biometric powered ATM	[38], [40]
OR11	Our bank perceive that biometric powered ATM is consistent with bank's culture, values and preferred work practices	[38]
Perceived benefits		
PBE1	Biometric powered ATM enhanced ability of my bank to compete	[16]
PBE2	Biometric powered ATM will reduce ATM related fraud cases in my bank	Self - developed
PBE3	Biometrics powered ATM will improve work performance in my bank	[16] and [39]
PBE4	Biometric powered ATM will increase customers bank's account security	[16]
PBE5	Biometrics powered ATM will help customers to accomplish ATM based transaction securely	[16]
Perceived Risks		
PBR1	It is risky in terms of reputation for	Self -

	my bank if biometrics powered ATM project fails	developed
PBR2	Investing on biometric powered ATM will involve a great deal of uncertainty in my bank	Self-developed
PBR3	There is uncertainty on which law to apply when collecting and using biometric samples for authentication	Self - developed
	Adoption intention	
B11	We intend to use biometric powered ATM in my bank	[39]
BI2	We anticipate that we will use biometric powered ATM in my bank	[39]
BI3	We intend to apply biometric powered ATM in my bank	[39]

6. Results and Discussion

One hundred and ten (110) questionnaires were collected back which denotes 78% response rate. Eight (8) cases were discarded due to incomplete and missing data, 102 cases were found to be complete and valid for subsequent analyses. We conducted data normality assessment to ascertain whether the collected data are normally distributed and therefore appropriate for running regression [41]. If data are not normally distributed, it is impossible to generalize the study findings. To verify that data items were normally distributed, standard deviation, skewness and kurtosis was computed. Results of the data normality assessment are presented in table 2. The results show that data are normally distributed since skewness and kurtosis score are within the acceptable range of -1 to +1 and -3 to +3 respectively [42]. Adequacy and suitability of the data for performing factor analysis were tested by using Kaiser-Meyer-Olkin Measure (KMO) of Sampling Adequacy and Bartlett's Test of Sphericity. The results show that KMO is 0.725 which is above threshold of 0.6 and Bartlett's Test was found to be significant ($\chi 2 = 1705$ $\rho < 0.01$). This means the data were good enough for factor analysis (Hair, Anderson, Tatham, & Black, 1995).

Table 2: Data normality assessment

	Mean	S.D	Skew	Kurt
Construct	Stat.	Stat.	Stat.	Stat
External Pressure	3.48	.956	-.341	-.870
Organization Readiness	3.11	.978	.113	-1.118
Perceived Benefit	3.49	.954	-.384	-.788
Perceived Risk	3.24	1.054	-.260	-.550
Behaviour Intention	3.31	.977	-.123	-.544

Key: M Mean; S.D: Standard Deviation; Stat; Statistics; Skew; Skewness; Kurt; Kurtosis

Reliability analysis was conducted to assess questionnaire items consistency in measuring what is supposed to be measured [43]. According to [43], widely acceptable range of Cronbach's alpha is 0.70. Reliability analysis results show that overall Cronbach's alpha (α) for all items was 0.840 which is well above the acceptable level. This indicates that questionnaire items were reliable enough. Results of reliability analysis are shown in table 3.

Table 3: Results of reliability analysis

Construct/ Item Code	Cronbach's α If item deleted
External pressure	
EXP1	.833
EXP2	.833
EXP3	.829
EXP4	.836
EXP5	.834
EXP1	.833
Organization Readiness	
OR1	.832
OR2	.830
OR3	.829
OR4	.828
OR5	.829
OR6	.835
OR7	.832
OR8	.836
OR9	.835
OR10	.843
OR11	.845
OR12	.848
Perceived Benefits	.
PB1	.832
PB2	.832
PB3	.830
PB4	.829
Perceived Risks	
PR1	.842
PR2	.837
PR3	.842
Behaviour Intention	
BI1	.832
BI2	.832
BI3	.836

Factor analysis was achieved through Principal Component Analysis (PCA) as a factor extraction method. PCA is a common factor extraction method that is widely used in social science studies. Eigenvalues greater than 1 and Varimax rotation with Kaiser Normalization were used to select the factors [44]. The main purpose of factor analysis is to ensure that each item loads correctly on its construct [45] and [46]. Five factors were produced and accounted for 64.15% of the total variance. The retained items and loading value for each factor are shown in table 4.

Table 4: Constructs factor loadings

Items	Factors				
	1	2	3	4	5
OR3	.900				
OR4	.866				
OR2	.865				
OR5	.853				
OR6	.773				
OR1	.753				
OR8	.535				
OR7	.491				
PB1		.853			
PB2		.843			
PB3		.737			
PB4		.607			
PB5		.543			
EXP2			.804		
EXP1			.764		
EXP4			.750		
EXP3			.729		
EXP5			.620		
BI2				.730	
BI3				.722	
BI1				.679	
PR2					.866
PR3					.766
PR1					.731
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.					
a. Rotation converged in 6 iterations.					

Key: 1-Organization Readiness, 2-Perceived Benefit, 3-External Pressure, 4- Behavior Intention, 5 Perceived Risks

After making sure that all necessary conditions are satisfactory met, the proposed model hypotheses were tested by using multiple regression analysis. The model constructs which are External Pressure (EXP), Organizational Readiness (OR), Perceived Benefit (PB) and Perceived Risk (PR) was regressed on Behavior Intention (BI). The research findings shows that, EXP (t = 2.741, p < 0.01) and PB (t = 2.26 p < 0.05) are found to be have direct and positive influence while PR (t = 2.13, p < 0.05) is found to have direct and negative influence on intention to adopt biometric powered ATM in banks. However, different from our expectation, organization readiness was found to be insignificant on the intention to adopt biometric powered ATM in banks. Furthermore, the findings show that the overall model was statistically significant (R^2= 0.23 p < 0.01). See table 5 to 7.

Table 5: Model Summary

Model	R	R^2	Adjusted R^2	Std. Err.
	.483[a]	0.233	0.2	0.874

Table 6: Anova results

	Sum of Squares	df	Mean Square	*F*	Sig.
Regression	21.783	4	5.446	7.136	.000[b]
Residual	71.732	94	0.763		
Total	93.515	98			

Key: Dependent Variable: Behavior Intention

Table7: Regression coefficient results

	UC		SC		
	B	**S.E**	**Beta**	***t***	**Sig.**
C	0.88	0.492		1.788	0.077
EP	0.271	0.099	0.265	2.741	0.007
OR	0.033	0.094	0.033	0.347	0.729
PB	0.229	0.101	0.224	2.264	0.026
PR	-0.182	0.086	-0.196	-2.128	0.036

Key: *C*: Constant; EE: External Pressure; OR: Organizational Readiness; PB: Perceived Benefit; PR: Perceived Risk; UC: Unstandardized Coefficient; SC: Standardized Coefficient; S.E: Standard Error
Dependent Variable: Behavior Intention

7. Discussion of Findings

The key purpose of this study was to assess the intention of banks to adopt biometric powered ATMs by determine the antecedents that affect the adoption of biometric powered ATM in banking sector. Based on literature review, we have developed a research model and hypotheses which stated that external pressure, organization readiness, and perceived benefit have direct and positive influence while perceived risk has direct and negative influence on intention to adopt biometric powered ATM.

The findings showed that external pressure positively and directly influences the intention to adopt biometric powered ATM. External pressure was found to be a strong predictor compared to other variables, this means that most of the banks are more concerned with external pressure from various stakeholders who demand for the implementation of biometric powered ATM in order to improve the ATMs' security. Furthermore, increased pressure from competitors by introducing a more secured ATMs technology may increase the pressure to banks [47]. This means that as the external pressure increases there is high chance for the bank to adopt biometric powered ATMs. The importance of external pressure as shown in this study is consistent with other previous findings of Thong & Yap (1996) and Webster (1994). Although these studies were conducted in different countries, they show that external pressure is an important factor in implementation of various technologies.

Our results also show that organization readiness has no significant effect on intention to adopt biometric powered ATMs. This result is also consistent with [47], but inconsistent with most of the studies which show that organization readiness directly and positively influences adoption of technology [48], [49]. As shown from literature, this factor has been a major determinant of technology adoption, however, in this study, this is not the case. This result may be attributed to the respondents involved in this study. The decision to adopt technology in most of the banks is the responsibility of senior managers. Therefore, IT experts involved in this study may not be well informed on whether the organization is ready or not, since one of their responsibility is to advise only senior managers on proper implementation of various technological strategies. This provides the room for further investigation of this construct by using senior managers as respondents.

The effects of perceived benefit on intention to adopt various technologies in banks have been discussed in various studies (e.g. Alam & Noor, 2009) in which they confirmed the direct and positive influence on intention to adopt various technologies. The findings of the current study show that perceived benefit as a key determinant on intention to adopt biometric powered ATMs in Tanzania's banking sector. This means that most of the banks evaluate the benefits they will acquire once biometric powered ATMs have been installed. The higher the benefit, the higher the chance to adopt biometric powered ATM.

Perceived risk was also found to be directly and negatively influencing the intention to adopt biometric powered ATM. This means that most of the banks in Tanzania are more concerned with negative consequences which may happen once they have implemented biometric powered ATMs. This finding is consistent with other previous studies which showed that perceived risk is one of the determinant factors in implementation of various ICT security [31], [32]. However, these results were too general compared to the current one which is more specific on adoption of biometric powered ATMs.

8. Implication of the research

In recent years, there has been an increased demand to study the implementation of biometric ATM particularly in developing countries where ATM related frauds are increasing. It is generally accepted that biometric ATMs may improve the security of the ATM by reducing the frauds conducted through ATM machine [47]. Therefore, our research contributes to the literature in the following areas: (i) by providing more understanding on the factors which may influence the adoption of biometric powered ATM in Tanzania's financial sector; (ii) limited studies have been conducted in this area to address the issue of perceived risk. Therefore, by studying this factor, this study improves the knowledge on the effects of perceived risks on intention to adopt biometric powered ATMs in Tanzania.

Furthermore, the current study provides implications and recommendations to bankers. The study has identified three main factors namely external pressure, perceived benefit and perceived risk which may be used as the benchmark in making decision to adopt biometric ATMs. We suggest much emphasis to be placed on addressing perceived risks before adopting biometric powered ATM technology.

9. Conclusion

This study integrates perceived risk into Electronic Data Interchange model to address the intention to adopt biometric powered ATMs in Tanzania's financial sector. This model represents unique elements of perceived risk in adoption of biometric powered ATMs. The findings show that perceived risks which may occur due to implementation of biometric ATM hinder the adoption of biometric ATMs. Since the banking technology and the need of more secured ATMs keep on increasing, there is a need for the banks to find the way to address and manage the foreseen risks. This will enable them to implement biometric powered ATMs with less risk. Furthermore, banks should make all necessary initiatives to invest in biometric ATMs in order to acquire more advantages which may include more security of the customer's money as well as improving their performance.

This study has focused on biometric powered ATMs in general, it does not specifically point out on the type of biometric modality. Therefore, a further research is important to study the use of specific biometric such as finger, iris, voice, palm etc in adoption of ATM in Tanzania's banking sector.

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