Factors impacting on the adoption of biometric technology by South African banks: An empirical investigation

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A B S T R A C T

The aim of this paper was to identify factors impacting on the adoption of biometric authentication in the South African banking sector as a means of authentication. The study constitutes exploratory research and is limited to the use of biometric technology within the financial services sector. Within this sector, specific focus is placed on the four leading South African banks. A survey was conducted, and the findings show common agreement and acceptance of biometric authentication as a way to improve information security in the various banking channels despite its not being widely implemented. With regard to factors influencing the adoption of biometric authentication, the study identified three main adoption inhibitors. This study contributes to the greater body of knowledge on the use of biometrics for banking applications by providing insight into current practices and perceptions.

Key words: biometrics, authentication, financial sector, information security, empirical research, legacy systems

Introduction

At the core of information security services are identification, authentication, authorisation and non-repudiation (Reid 2004; Tipton & Krause 2008). These services are all interrelated and interdependent. Within each of these security services, three security requirements or goals need to be addressed in order to produce a secure

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computing environment, namely confidentiality, integrity and availability. They are often summarised as giving the right information, to the right party, at the right time (Pfleeger & Pfleeger 2003; Steel, Nagappan & Lai 2005).

Of all the information security services mentioned, this study focuses only on authentication. Within this service, there are many ways in which a subject can authenticate itself to a computer system. The most common ways include the use of username and passwords, tokens, biometric authentication or a combination of these (Macdonald 2002: 69–71; Perusco & Michael 2007). This study focused only on biometric authentication and excludes all other means of authentication.

Biometrics is usually integrated into security applications with the aim of strengthening security and curbing falsifications of identities. By definition, biometric authentication refers to technologies that measure and analyse human physical and behavioural characteristics for authentication purposes (Nanavati, Thieme & Nanavati 2002). Examples of physical (also known as physiological) characteristics include fingerprints, eye retinas and irises, facial patterns and hand measurements, while examples of mostly behavioural characteristics include signature, voice and typing patterns (Azari 2003).

Since a person cannot leave an eye or hand stuck on a computer monitor as they would a username and/or password, or forge deoxyribonucleic acid (DNA) as they would an identity document, many authors are of the opinion that biometric technology offers better security in applications across the board (Azari 2003; Pfleeger & Pfleeger 2003; Munilla & Peinado 2007).

Biometric technology is relatively new and as such has not fully matured (Allan & Ouellet 2006; Tipton & Krause 2008: 156–157). This immaturity is not limited only to the technology itself, but extends to other areas such as legislation, standards and corporate governance, resulting in challenges relating to interoperability (Grother et al. 2006; Cavoukian, Stoianov & Carter 2008). The disparity is evident in the discrepancies between the different legislative pieces and standards. Some of these biometric technologies cannot coexist or be integrated if they are from different vendors (Gonzalez-Agulla et al. 2007). Kreizman et al. (2007) also found the state of biometric user authentication to be lingering in the trough of disillusionment, an area where technologies that fail to meet expectations lie on Gartner's technology hype cycle. The report does, however, acknowledge biometric technologies' superior authentication strength and greater ease of use (when compared to passwords) as some of the benefits that will see this technology through the trough of disillusionment into the slope of enlightenment, where some businesses will continue to investigate and use this technology.

This study investigated perceptions of banking staff, which relate to the slow pace of adoption of biometric authentication for banking applications across the various banking channels in South Africa. In this way, the study aims to contribute to the existing body of knowledge by identifying factors that impact on the adoption of biometrics. The next section discusses the research methodology used in order to arrive at the findings presented later in this article.

Methodology

Since the scope of this article was limited to participants from four South African banks, an empirical research approach was adopted. As Black (2006) explains, "empirical indicates that the information, knowledge and understanding are gathered through experience and direct data collection". The collection of data used in this study was done systematically using scientific research instruments, as discussed in the next paragraph.

Research instrument

An online-administered questionnaire was used to gather data. The main reason for adopting this method over traditional methods of self-administration was to speed up the distribution of the questionnaire and collection of data. This was important owing to the time constraints of this project. As explained by Greenfield (2002: 178–179) and Devlin (2006: 131–135), internet-based surveys can be done in two ways:

- By using email to distribute and collect questionnaires. The format for such a method could be in one or more of the following:
  - Plain text questions inserted as part of the email
  - The actual email message formatted in Hyper Text Markup Language (HTML)
  - A formatted questionnaire sent as an email attachment
  - An interactive questionnaire from an executable file that can be sent as an attachment to the email.

- By using web pages. This method entails the administration of the questionnaire through internet web pages hosted on a server. Respondents visit the website using a web browser, and responses are captured in real time.

For the purposes of this study, a mixture of the two methods was used. The Uniform Resource Locator (URL) of the hosting website was sent to potential respondents by

email. The reason for this is that through emails, participants could be informed that the questionnaire was available online. Through the use of a website, the collection of data and monitoring of the progress of the respondents in completing the survey could then be simplified (Burns 2000; Williman 2005). This was important given the project time constraints and the need to speedily reach groups of respondents in different locations.

It was decided that making use of email alone might not prove as successful, as the survey might not reach all the intended recipients. The potential problem was emails being rejected by firewalls that were set to block email messages with certain types of attachments or HTML content.

Using the website alone could also make it difficult to ensure that all respondents were notified of the survey and its URL. Moreover, it would also be more difficult to remind potential respondents of the completion date if this was done online only. To counter these challenges, email was used to communicate with the respondents, and the website was used to host the survey, ensuring that the HTML content was not blocked by firewalls.

Survey

A comprehensive questionnaire consisting of 17 questions was used to gather the data. The survey was limited to four large banks in South Africa:

- First National Bank employs over 42 882 staff and has a footprint of 766 branches (FNB 2008).
- Standard Bank employs over 42 000 staff and has over 712 branches (Standard Bank 2008).
- ABSA has 36 893 employees and over 892 branches (ABSA 2008).
- Nedbank has a staff complement of 24 034 and over 441 branches (Nedbank 2008).

The reason for selecting theses four banks is that they are the largest banks in South Africa (Department of Trade and Industry 2006) based on the investment in products and services (Highbeam 2006), the number of staff and the number of branches. The next section provides background on how the respondents were selected.

Respondents

The participants in this study were a combined total of 40 respondents from the four selected South African banks. The gender composition was 70% male and 30%

female. Owing to the scope of this study, only employees from departments linked to biometric technology were invited to participate in the survey. These respondents represented a mix of information technology (IT) and non-IT professionals.

A judgemental or purposive sampling method was used to validate the sample size and usability of data collected (Frink 2006). As argued by Kosecoff and Fink (1998: 57) and Fowler (2002: 42), there is no agreed universal standard for an acceptable response rate or sample size. If a survey is relatively simple, in that it focuses on a specific population, it is up to the researcher to decide how many responses are needed for the results to be acceptable. Based on this, a sample size of 40 was considered sufficient. The following section discusses how the questionnaire was structured.

Questionnaire

The aim of the questionnaire was to capture facts, opinions and perceptions of the respondents on the use of biometric technology and the factors influencing its adoption, specific to the banking industry in South Africa. The questionnaire was organised into the following five main sections:

- Background: The purpose of this section was to capture the background of the respondents, including limited biographical data. This was important as it could yield valuable information relating to ethnic or gender preferences when it comes to biometric technology.
- General knowledge of biometrics: The purpose of this section was to establish if the respondent was aware of, or had interacted with, biometric devices before, as this could influence perceptions. The aim was to determine whether knowledge and exposure to biometric technology impacts on its adoption in South Africa.
- Organisational research: The purpose of this section was to ascertain whether the employing organisation of the respondent had investigated, or was investigating, biometric authentication within any of the various banking channels. This information could be used to find a correlation between what is being investigated and what is used.
- Current usage: The purpose of this section was to establish whether the employing organisation of the respondent was already using biometric authentication in any of the banking channels. This information could be used to measure the extent to which specific biometric technology is used within the various banking channels.
- Perceptions: The purpose of this section was to capture the perceptions of the respondents with regard to the future use of biometric authentication in their organisation. These views could provide an understanding of the level of awareness of and buy-in to biometric authentication.

A bipolar scaling method using a five-point Likert scale was adopted for all the questions (Blaikie 2003). The advantage of this style is that it captures both the negative and positive responses and, as research has shown, a five-point scale has similar characteristics in terms of mean, variance, skewness and kurtosis after rescaling is applied (Frink 2006).

The number of questions in the five sections was limited to ensure that the survey could be completed within 20 minutes. Research has found that people are more likely to complete a short survey as opposed to one that requires over 30 minutes to complete (Frink 2006; US Census Bureau 2008). The questions in this survey were designed and structured to gather as much relevant data as possible while remaining easy to answer (Bryman 2004).

The scope of this paper is limited to the fifth section focusing on perceptions. As defined in the *Oxford Dictionary* (1995), a perception is a way of seeing, understanding or interpreting something. In the case of this paper, these perceptions relate to how the respondents interpreted and understood certain factors that influence the adoption of biometric authentication within the South African banking sector.

The *Oxford Dictionary* (1995) defines opinion as a belief or judgement of something, not necessarily based on fact or knowledge.

Respondents provided opinions on various aspects relating to the adoption of biometric technology. These aspects include the culture of the organisations where the respondents were employed, the culture of the people of South Africa, the available legislation, standards and various other aspects relating to existing technology. The statistical analysis tools used to interpret the results are discussed in the next paragraph.

Statistical analysis

The analysis of the data collected was based on two statistical methods, namely frequency and cross-tabulation analysis (Frink 2006). Based upon the collected data, frequency analysis involves the choice of a frequency distribution to describe the phenomena of interest and the estimation of the parameters of that distribution (Burns 2000; Brewerton & Millward 2001). This frequency distribution has two elements, namely the categories of response and the frequency with which respondents are identified within each category. This makes it possible to obtain a description of the relationship between different values of a variable and their exceedance probability (Balnaves & Caputi 2001).

The cross-tabulation analysis is used to study the relationship between two or more variables. With the latter, it was possible to establish relationships between

several linked questions from the survey and to deduce various facts from the results produced (Blaikie 2003; Frink 2006). The two statistical methods were the most appropriate given the volume and type of data collected. The results of this analysis process are discussed in the next section.

Findings

This paper reports only on section five of the questionnaire. The focus is specifically on the perceptions around seven key biometric adoption factors (Pooe 2009). The seven factors are:

- Legacy systems: This refers to computer hardware and software that has been superseded but not replaced because of its wide use within the banking sector
- South African banking culture: The general culture of people employed within the South African banking sector. This culture refers to sharing of information, cooperation and adoption of common banking solutions
- Legislation: The South African legislation governing the use of biometric technology
- Standards: National standards that define the technical specifications of biometric authentication
- Human culture: The general culture of South African nationals that use banking services (excluding those working in the banking sector)
- Own bank culture: The general culture within the specific bank in which the respondent is employed. This represents the sub-atomic level of the macro South African banking culture
- Technology maturity: This refers to technology that has been in use for long enough that most of its initial faults and inherent problems have been removed or reduced through evolutionary development.

An in-depth discussion of the findings relating to the impact of each of the seven key aspects on the adoption of biometrics follows in the next section.
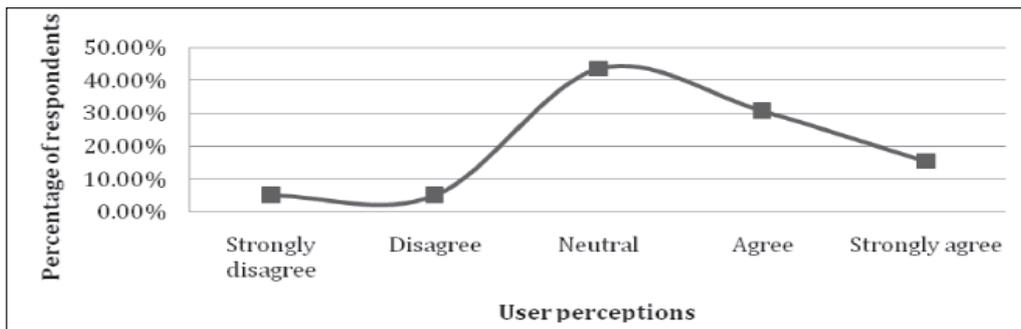
Legacy systems

Responses relating to the impact of legacy systems on the adoption of biometric authentication are given in Table 1.

Further analysis and representation of the data shown in Table 1 is illustrated in Figure 1, where the number of respondents is shown by the Y-axis and the strength

of the respondents' perception (agreement or disagreement with the expressed view) is plotted on the X-axis.

Table 1: User perceptions of the impact of legacy systems on the use of biometric authentication

To what extent do you agree with the following statement:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Legacy systems are impacting on the organisation's ability to fully adopt biometric technology for banking applications	5.10%	5.10%	43.60%	30.80%	15.40%	100.00%
	10.20%			46.20%		
	Cumulative value			**Cumulative value**		

Figure 1: User perceptions regarding the impact of legacy systems on the use of biometrics

Figure 1 shows that 43.60% of the respondents remained neutral on the view that legacy systems were impacting on their organisation's ability to fully adopt biometric technology for banking applications. Furthermore, 10.20% of the respondents had a negative view, while a cumulative total of 46.20% had a positive view.

What can be derived from these data is that the majority of respondents were of the opinion that national banks do in fact still have legacy systems in use and that these systems prevent the banks from fully adopting biometric authentication due to compatibility issues.
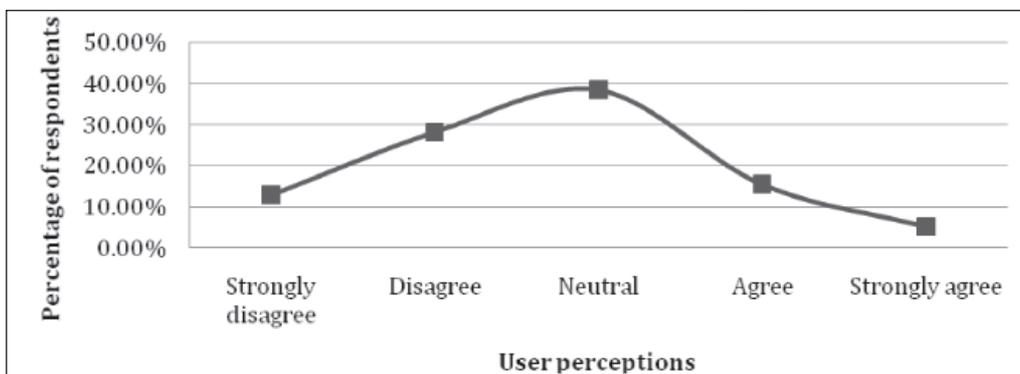
South African banking culture

Table 2 shows responses relating to the effects of the national banking culture on the use of biometric authentication.

Table 2: User perceptions regarding the impact of the South African banking culture on the use of biometrics

To what extent do you agree with the following statement:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
The culture in the South African banking sector is against the use of biometric technologies	12.80%	28.20%	38.50%	15.40%	5.10%	100.00%
	41.00%			20.50%		
	Cumulative value			**Cumulative value**		

Further analysis of the findings, as illustrated in Figure 2, shows that a cumulative total of 41.00% of respondents disagreed with the statement that the culture in the South African banking sector is against the use of biometric technologies. A further 38.50% of the respondents remained neutral, while a cumulative total of only 20.50% of the respondents agreed with the statement.

Figure 2: User perceptions regarding the impact of the South African banking culture on the use of biometrics

The majority of respondents disagreed with the statement. The findings thus show that the South African banking culture is an enabling factor in the use of biometric authentication in the national banking sector.
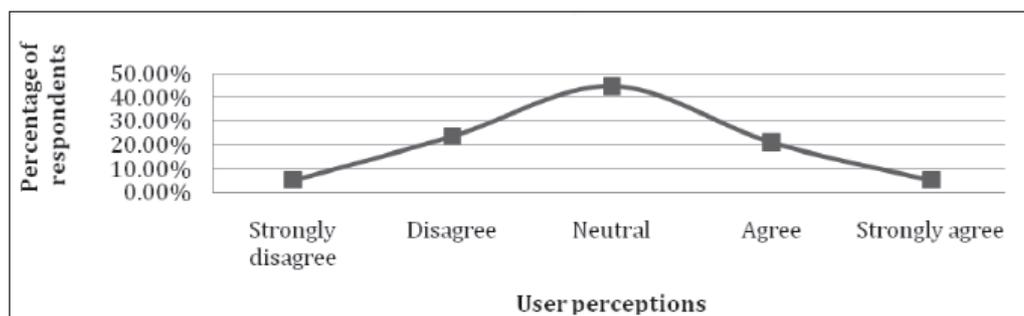
Legislation

Table 3 shows data relating to the impact of legislative concerns on the adoption of biometric authentication.

Table 3: User perceptions regarding the impact of legislative concerns on the use of biometrics

To what extent do you agree with the following statement:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Legislative concerns in South Africa negatively affect banks' adoption of biometric technology	5.30%	23.70%	44.70%	21.10%	5.30%	100.00%
	29.00%			26.40%		
	Cumulative value			**Cumulative value**		

Further analysis of the data, as shown in Figure 3, shows that a majority of the respondents (44.70%) remained neutral on the view that legislative concerns in South Africa negatively affect the banks' adoption of biometric authentication, while a cumulative total of 26.40% of respondents agreed with the statement. Further findings, as detailed in Figure 3, reveal that a cumulative total of 29.00% of the respondents did not support the statement.

Figure 3: User perceptions regarding the impact of legislative concerns on the use of biometrics

It is interesting that the graphical representation of these data (Figure 3) show an almost perfect bell-curve profile, suggesting that the majority of respondents did not have strong opinions on the subject and that the rest were divided as to whether

legislative concerns are an enabling or inhibiting factor in the speedy adoption of biometric authentication in various banking environments.
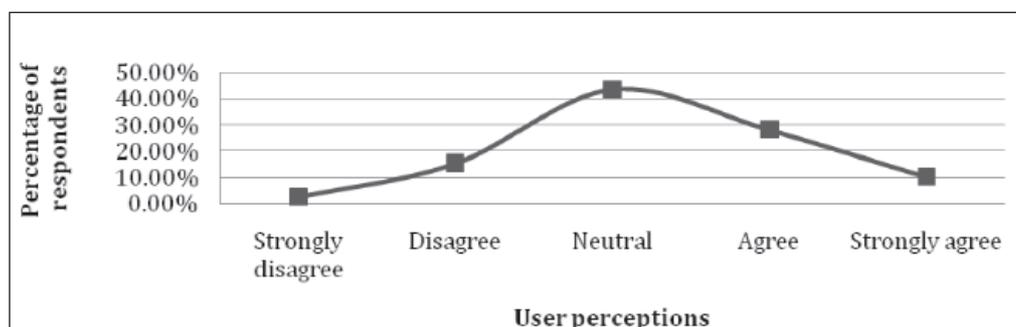
Standards

Table 4 shows data relating to the impact of available biometric standards on the adoption of biometric authentication.

Table 4: User perceptions regarding the impact of available standards on the use of biometrics

To what extent do you agree with the following statement:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Available standards in South Africa in biometrics negatively affect banks' adoption of biometric technology	2.60%	15.40%	43.60%	28.20%	10.30%	100.00%
	18.00%			38.50%		
	Cumulative value			**Cumulative value**		

Analysis of the data shows that a majority of 43.60% of the respondents remained neutral on the view that biometric standards in South Africa negatively affect the banks' adoption of biometric authentication.

As illustrated in Figure 4, 18.00% of the respondents opposed the statement, while a cumulative total of 38.50% maintained a positive view.

Figure 4: User perceptions regarding the impact of available standards on the use of biometrics

The data show a general tendency towards the perception that available biometric standards are an inhibiting factor in the adoption of biometric authentication in the national banking sector. This is based on the majority of respondents that did have an opinion agreeing with the statement.
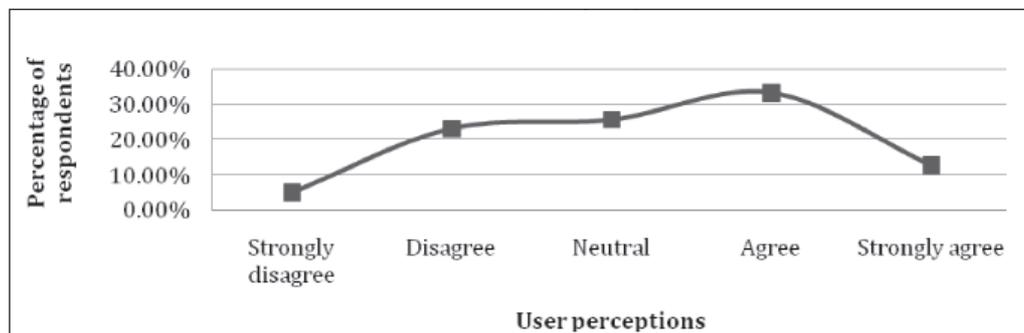
Human culture

Responses relating to the impact of human culture on the adoption of biometric authentication are given in Table 5.

Table 5: User perceptions regarding the impact of human culture on the use of biometrics

To what extent do you agree with the following statement:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Human cultural habits affect South African banks' adoption of biometric technology	5.10%	23.10%	25.60%	33.30%	12.80%	100.00%
	28.20%			46.10%		
	Cumulative value			Cumulative value		

The findings show that 12.80% of the respondents strongly agreed that human cultural habits affect the South African banking sector's adoption of biometric technologies, while 33.30% of respondents agreed, giving a total of 46.10% of respondents that supported the view. As shown in Figure 5, 25.60% of the respondents remained neutral, while a cumulative total of 28.20% of respondents opposed the view.

Figure 5: User perceptions regarding the impact of human culture on the use of biometrics
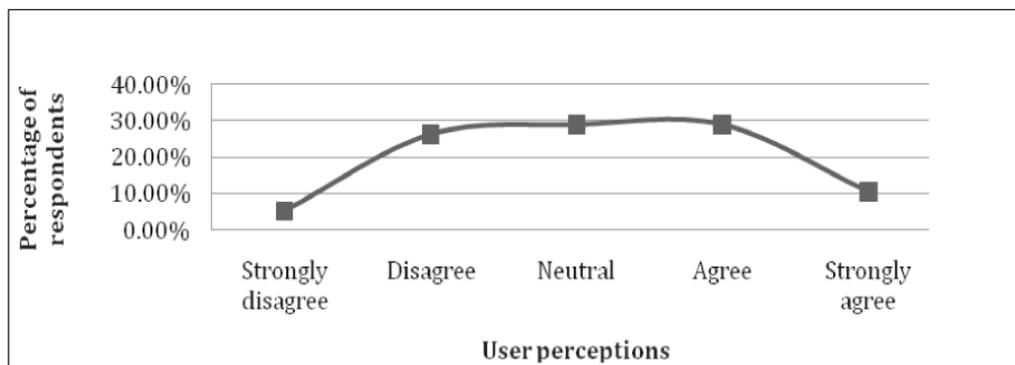
The findings show that the majority of respondents perceived the human culture of those external to the bank to be an inhibiting factor in the speedy adoption of biometric authentication by national banks.

Own bank culture

Statistical summaries of respondents' perceptions of the effects of their own bank culture on the adoption of biometric authentication are given in Table 6. The findings show that 10.50% of the respondents strongly agreed and 28.90% agreed, bringing the cumulative total to 39.40% of respondents that supported the view. As seen in Table 6, 28.90% of the respondents remained neutral. As further illustrated in Figure 6, the findings show that a cumulative total of 31.60% of the respondents did not support the view.

Table 6: Perceptions regarding the impact of the respondents' own bank culture on the use of biometrics in banking applications

To what extent do you agree with the following statement:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Bank cultural habits affect South African banks' adoption of biometric technology	5.30%	26.30%	28.90%	28.90%	10.50%	100.00%
	31.60%			39.40%		
	Cumulative value			**Cumulative value**		

Figure 6: Perceptions regarding the impact of the respondents' own bank culture on the use of biometrics in banking applications

The findings show that respondents agreed with the statement, meaning that they identified their own bank culture as an inhibiting factor in the adoption of biometric authentication.
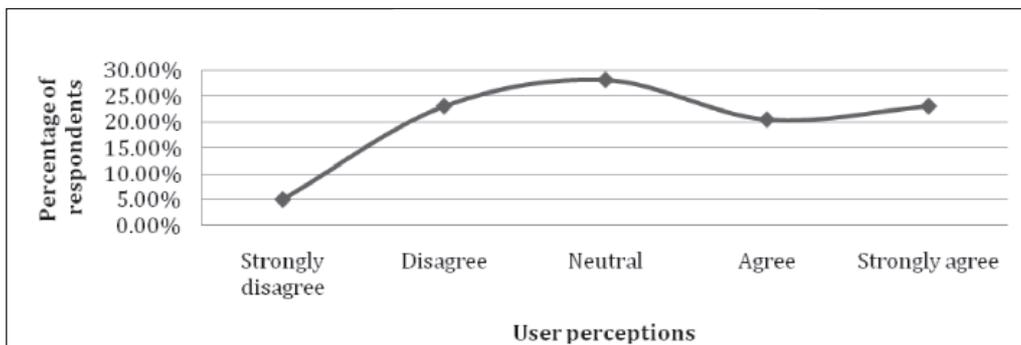
Technology maturity

Table 7 illustrates responses relating to the impact of the maturity of biometric technology, or lack thereof, on its overall adoption and use for authentication in the financial sector.

The view that biometric technology is still immature for full adoption by South African banks was held by 28.20% of the respondents. A cumulative total of 43.60% of the respondents agreed with the statement.

Table 7: Perceptions regarding the impact of the maturity of biometric technology on the use of biometrics

To what extent do you agree with the following statement:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Biometric technology is still immature for full adoption by South African banks	5.10%	23.10%	28.20%	20.50%	23.10%	100.00%
	28.20%			43.60%		
	Cumulative value			**Cumulative value**		

Figure 7: Perceptions regarding the impact of the maturity of biometric technology on the use of biometrics

The findings show that the majority of respondents agreed with the statement, making the maturity of biometric technology an inhibiting factor in the speedy adoption of this method of authentication in the various banking environments.

The next section summarises the findings and discusses their potential implications.

Summary of responses

Table 8 summarises the opinions expressed by the respondents in relation to factors that may affect the adoption of biometric authentication. The impact of each of the seven factors is indicated by a symbol in the relevant column to the right of each factor. The descriptions for each symbol in Table 8 are explained in the legend below the table.

Table 8 shows that the respondents identified five out of seven factors as inhibiting the adoption of biometric authentication. Only one enabling factor was identified, while perceptions of the impact of available legislation governing the use of biometric authentication were neutral.

Table 8: General user perceptions of the seven factors influencing adoption of biometric authentication

Factor	Inhibiting	Neutral	Enabling	Theme
Legacy systems	●			Technology
South African banking culture			◑	Culture
Legislation		◑		Governance
Standards	◑			Governance
Human culture	◑			Culture
Own bank culture	❍			Culture
Technology maturity	❍			Technology

Note: Legend for Table 8

Number of respondents that agreed with the statement	Symbol
More than three quarters	●
Approximately three quarters	❍
Approximately half	◑

Table 8 shows that the adoption of biometric authentication is affected by more than one factor. Three distinct themes can be derived from the factors, namely:

- The impact of *technology,* comprising legacy systems and technology maturity
- The impact of *culture,* comprising the South African banking culture, the human culture and the respondents' own bank culture
- The impact of *governance,* comprising legislation and standards.

Impact of technology

Pooe (2009: 115–117) found that biometric technology was immature for use in the banking sector, and this study adds to this finding by showing that technology as a whole is an area that requires more attention than may seem obvious. Respondents in this study unanimously identified technology as an inhibiting factor in the overall adoption of biometric authentication in the banking sector.

Inherent in most banking technology infrastructure are legacy systems, the value and functions of which are rooted deep in the core of the banking business. The reality for the banking sector is that these systems are not as easily replaceable as the idea may sound.

The solution is not only in understanding the technology challenges that lie in the hardware and software used, but also in the architecture of the data stored on these legacy systems. In addition, this technology integration dilemma must not be thought of in isolation from the very business processes and functions that are so highly reliant on existing legacy systems.

Impact of culture

The impact of culture as an inhibiting factor on the adoption of biometric authentication in the national banking sector becomes noteworthy when looking at the respondents' mixed perceptions. While respondents almost unanimously agreed on the impact of human culture and own bank culture, there were opposing views on the impact of South African banking culture as a whole. It is interesting to note that the majority of respondents identified the latter as an enabling factor.

At the macro level, the South African banking culture appears to be an enabling factor, but when one unpacks the individual components making up this greater culture, it becomes evident that some challenges exist. These micro-level individual components, namely the human culture and own bank culture, both offer a deeper

understanding of the cultural problem inhibiting the adoption of biometrics for banking.

While it is clear that some effort would be required for the banks to ensure that the benefits of biometric authentication are understood by all stakeholders, initiatives such as training, awareness campaigns and stakeholder involvement are just some of the activities that can contribute towards changing the culture to one that promotes the use of biometric authentication. It is imperative to investigate the problem of culture in more depth (in relation to people external and internal to the bank) in order to ensure a sustainable solution leading to broader acceptance of biometric authentication as a way of banking in South Africa.

Impact of governance

The findings related to the impact of governance also present an interesting mix of opinions. While the majority of respondents identified standards to be an inhibiting factor, the majority remained neutral about the impact of legislation on the overall adoption of biometrics for the national banking sector. The latter could be attributed to the respondents' lack of knowledge or understanding of legislation relating to biometrics as a whole, or it could simply be that respondents chose to reserve their opinions by giving a neutral response.

Regardless of the reasons for a neutral point of view, this uncertainty suggests that banks need to ensure that those directly involved in technology research and development and other technical areas of banking receive in-depth training and exposure to governance and legal matters pertaining to their area of work. Involvement with focus groups aligned with the South African Bureau of Standards (SABS), for example, could assist in ensuring that such governance structures take into consideration the special needs of the national banking sector. This is another area that requires further investigation in order to develop better understanding of the biometric governance challenges.

Integration of themes

Figure 8 shows that while challenges exist in each individual theme, the problems also relate to how these three distinct themes fit together harmoniously to overcome the integration problems identified in this study. The white triangle in the centre of the three equilateral triangles represents the highly significant point of integration. Most attempts at addressing the adoption of biometric technology take a singular view or approach leading to an unconvincing outcome. A different approach is

therefore required to address the integration challenges. Future research will be aimed at developing a better understanding of the integration of the three themes.
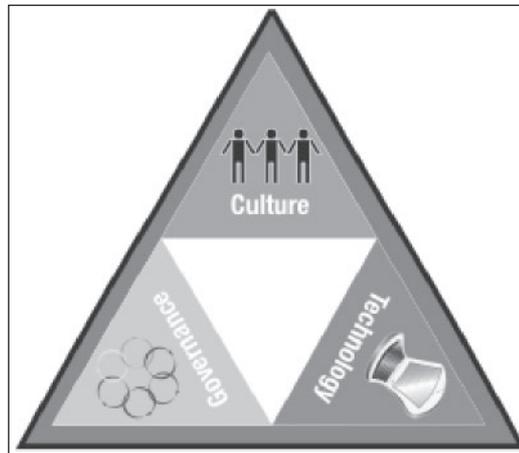
Figure 8: Relationship between culture, governance and technology

Conclusion

The article presents the partial results of a survey that was undertaken to develop a better understanding of the slow adoption of biometric authentication despite suggestions in the literature that propose this as a solution. An online questionnaire was used to gather 40 usable responses. The data were analysed and presented results that gave new insight into the challenge. This insight could be of value to banks and other institutions that are grappling with the decision whether to implement biometric authentication.

Understanding how culture, governance and technology (individually) impact on the adoption of biometric authentication gives new insight, making it possible to look at the problem more holistically. Figure 8 shows the interdependence of the three themes identified in this study as well as the focus of future research.

While this study shows that social and technological challenges have a direct impact on the adoption of biometric authentication for banking applications, it has also established that biometric authentication remains a future solution in the national banking community. In the words of Karen Drop, the head of physical banking channels at Nedbank, biometric authentication is a "futuristic option" (Pieterse 2006). The findings of this article have also enforced and validated the observation by Cairns (2008) that in South Africa, "financial institutions are slow adopters" of biometric authentication. Cairns maintains that maturity of the technology is not the

reason for this, but rather that technology integration challenges and lack of awareness may be preventing banks from fully implementing biometric authentication.

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