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Abstract

Service-oriented computing is an emerging IT innovation. Among its manifestations is service-oriented architecture (SOA), an architectural approach to designing and implementing IT solutions. Academic empirical research on SOA adoption is scarce, with many studies focussing on qualitative analysis. The purpose of this study is to explore SOA adoption using a quantitative approach. This study investigates organizational SOA adoption in South Africa from DOI theory and TOE framework perspectives. A comprehensive model of SOA adoption is presented along with an associated research instrument. In order to validate the instrument and to gauge the state of SOA adoption, an online survey was conducted among South African organizations. The results of the survey highlight a number of factors influencing SOA adoption. Use of multiple standards and platforms, complexity, compatibility, cost, top management support, good governance and strategy, adequate human and financial resources, vendor support for integration and development tools are all significant factors for a fruitful SOA implementation. The findings of this study can contribute to the body of knowledge on organizational SOA adoption and create opportunities for future related research in this field.

Keywords: Service-Oriented Architecture, Enterprise Architecture, SOA, IT adoption, South Africa.

1. INTRODUCTION

Modern economies are characterized by increased competitiveness, globalization and ever-faster innovation. Consequently, organisations require a higher degree of flexibility allowing them to quickly move into new markets, change their business strategies, or respond to competitive pressures (Barry, 2003). A service oriented architecture (SOA) is touted as the best architectural style to provide organizational agility, improve applications adaptability and systems interoperability, and allow the reuse of legacy assets (Lewis, Simanta, Morris, Wrage and Smith, 2007).

While more organizations across the globe start exploring the SOA paradigm, implementation issues such as complexity, cost, and the effort required for achieving even moderate improvements in the implementation of SOA can easily be underestimated (Lewis et al., 2007). While SOA may increase interoperability, extensibility, and modifiability, at the same time it can reduce systems performance, testability, auditability, and security (O'Brien, Bass and Merson, 2005).

This research focuses on the factors influencing organizational adoption and implementation of SOA and business impacts of adopting SOA. A review of SOA and other IS innovations literature yields a number of factors believed to affect SOA adoption and success. However, the literature is inconclusive as to the relative importance of these factors. Using the technology-organization-environment (TOE) framework, all uncovered factors are grouped into three major categories: technological, organizational and environmental with the aim of determining which of these factors are of significance. We empirically test the proposed framework by means of a survey of South African enterprises on factors influencing adoption of SOA at an organizational level.

Since the aim of this study is to explore factors affecting organizational adoption and implementation of SOA, the following research objectives motivate this study:

- Which critical factors for the successful adoption of SOA can be identified within the framework?
- Which implementation challenges do South African organizations face when adopting SOA?

2. SOA DEFINITION AND RELATED ADOPTION RESEARCH

2.1 SOA definition and concepts

SOA provides the foundation for an on demand operating environment (Schmidt and Kalyana, 2004). Systems built on service-orientation principles are becoming the solution of choice to "bridge the gap between business models and the technical solution to support and adapt changing business needs" (Kontogiannis, Lewis and Smith, 2007:1). Service-orientation is a "prerequisite for rapid integration of data and business processes; it enables situational development models, such as mashups; and it is the foundational architecture for SaaS and cloud computing" (Manes, 2009). Services are most commonly described using the following set of characteristics and attributes: services are reusable, composable, discoverable, autonomous, stateless, loosely coupled, hiding underlying logic and exposing a formal service contract defining the terms of information exchange (Erl, 2005).

There is no consensus on SOA definition between industry practitioners, vendors, standardization organizations such as W3C (2004), OASIS (2006) or academics (Ren and Lyytinen, 2008). In this paper, the following definition is adopted: SOA is "an open, agile, extensible, federated, composable architecture comprised of autonomous, QoS-capable, vendor diverse, interoperable, discoverable, and potentially reusable services, implemented as Web services" (Erl, 2005:54).

Web services technologies are far from mature (Phippen, Taylor and Allen, 2005) and continue to evolve. Major standards categories are business processes, management, reliability, security, transportation, interoperability, and messaging. Standards and specifications are developed by standards bodies, such as W3C, OASIS, Web Services Interoperability Organization (WS-I) and the Internet Engineering Task Force (IETF). Major IT vendors are also actively involved and promote their own specifications. Some of the specifications have become industry standards.

2.2 SOA adoption research

Erl (2005) suggests that benefits of SOA adoption are the reasons "why the IT community is going through the trouble of changing so much of its philosophy and technology in an effort to adopt SOA". SOA adoption will provide organizations with improved interoperability, reuse, composability, legacy integration, organizational agility, standardized data representation and vendor-neutral communications infrastructure (Erl, 2005). Improved flexibility, increased speed to market, incremental deployments, and improved productivity were among the other expected benefits (Walker, 2007). According to Gartner (2009), SOA adoption improves an organization's business processes, shortens project life cycles, lowers cost of maintenance and development, and promotes reuse and adoption of new business models.

Often organizations embark on SOA projects without proper upfront analysis and understanding of all the implications of their decisions (Lewis et al., 2007). Some adoption challenges are: technology, program management, organization, and governance (Varadan, Channabasavaiah, Simpson, Holley and Allam, 2008). Organization and governance challenges are considered to be the most difficult as they require the entire organization to "change their methods, modes of communication, means of cooperating, and methods of reporting relationships" (Varadan et al., 2008). Some of the most common problems of adopting SOA include misunderstanding the differences between SOA and distributed architecture, building SOA in an old-fashioned way, misunderstanding SOA performance requirements and Web services security. Committing to SOA without a clear strategy and transition plan, not embracing different platforms and standards, not setting SOA standards within an organization and not using XML as a standard and a foundation for SOA architecture are among the major reasons of SOA project failures (Erl, 2005). "The lack of planning and clear business case, lack of understanding of what services are available, the lack of governance, and the lack of standards" (Ren and Lyytinen, 2008) were mentioned as reasons of dissatisfaction among organizations adopting SOA.

The CA Wily (2008) SOA adoption survey results demonstrated that different countries were at different stages of SOA adoption. The majority of the organizations in the USA (40.6%) and Australia (32.9%) had deployed a business-unit SOA application under IT control, while the majority of the organizations in the UK (40.6%) had deployed a SOA application that is part of an enterprise-wide initiative. The majority of the organizations in France (45.2%) and Germany (30.6%) had their SOA applications in the pilot stage.

There is virtually no academic research on SOA adoption in the South African context available. This research can provide valuable insights into the state of SOA adoption in the South African context.

3. THEORETICAL FRAMEWORK AND HYPOTHESES

A number of theoretical frameworks were deemed appropriate to the study of SOA adoption. We drew on a number of research models and grouped their factors using the Technology-Organization-Environment (TOE) framework.

The technological factors relate to the technology and information systems, as well as to the pool of technologies available to the organization. Technological factors often cited as important for successful adoption are: relative advantage, complexity, compatibility with existing infrastructure, and perceived benefits (Tornatzky and Klein, 1982). Organizational factors normally describe characteristics of the organization and include firm size, degree of centralization and formalization, organizational structure, skills and expertise of its human resources, and the amount of slack resource available (Hackney, Xu and Ranchhod, 2006). External factors relate to the environment in which an organization operates and include market conditions, regulatory influence, industry pressure and vendor influence (Basole, 2005).

Basole (2005) suggested that organizational factors also contain individual factors, and justified it with the fact that end-users within an organization have to adopt a technology as well. This individual technology adoption within an organization is referred to as "intra-organizational acceptance" (Frambach and Schillewaert, 2002). While the claim that an adoption decision is made on behalf of an organization by a few individuals is valid, individual factors influencing organizational adoption are out of the scope of this study.

A list of variables identified was compiled based on six key studies pertaining to Web services adoption and IS innovation literature (Table 1).

	Chen 2003	Chen 2005	Chen et al. 2006	Cigan ek et al. 2005	Cigane k et al. 2006	Wu 2004	Influe nce
Technology							
Relative advantage	X				X	X	+
Compatibility	X				X	X	+
Complexity	X			X	X	X	-
Trialability	X						+
Visibility/observability	X			X	X	X	+
Divisibility						X	+
Customizability						X	+
Tool support		X	X	X			+
Performance					X		+
Security				X	X		+
Standards maturity		X	X	X	X		+
Organization							
Company size & industry type	X						
Organizational culture	X						+
IT skills/ expertise	X		X	X	X		+
Software development effectiveness				X			+
IT architecture/ infrastructure	X	X	X	X			+
Financial justification/cost				X	X	X	+
Management awareness and support			X		X		+
Financial & technology resources			X				+
IT management maturity			X				+
Environment							
Business partners demand/readiness	X			X	X		+
Industry inertia/fragmentation				X	X		-
Vendor support	X	X			X		+

Table 1. Variables used in empirical research on Web services adoption

A further review of the literature provides additional support for these variables. Many studies of organizational innovativeness found that large organizations are more innovative (Rogers, 2003; Swanson, 1994; Frambach and Schillewaert, 2002). This finding is surprising, especially in the light of the standard perception that small companies have less bureaucratic procedures and are more flexible in their activities. To explain this contradiction, Rogers (2003) suggested that size is a surrogate measure of other variables that affect innovativeness, such as slack resources, employees' level of technical expertise, organizational structure, and so on. Another major driver for technology adoption is its perceived value and potential benefits. As a result, tangible and intangible benefits of the new technology as well as its value and impacts require a careful evaluation (Basole, 2005). Industry pressure has been recognised to have a positive effect on adoption (Iacovou et al., 1995; Lippert and Govindarajulu, 2006). Vendor support early on in an adoption process is also positively related to adoption (Zhu et al., 2006).

Given the extensive literature review, the following research hypotheses are proposed and classified by technological, organizational and environmental factors according to the TOE framework. Related to the technological context, it is hypothesised that: SOA adoption will be positively influenced by (1) a greater the degree of utilization of multiple standards and platforms, (2) a lower perceived complexity of SOA, (3) a higher compatibility between SOA and the existing enterprise architecture and infrastructure, (4) a lower cost of SOA implementation, (5) lower perceived implementation challenge; and/or (6) a greater relative advantage of SOA as a technology.

In relation to the organizational context, the following influencing factors are hypothesized: SOA adoption will be positively associated with (7) a larger firm size, (8) dependent on the organisation's industry or sector and positively influenced by (9) lower perceived risks of SOA implementation, (10) high levels of IT skills and expertise with the organization, (11) higher levels of top management support for SOA initiatives, (12) more effective organizational SOA strategies, (13) more effective

SOA governance procedures, (14) higher availability of financial and technological resources for the SOA initiatives, and/or (15) greater perceived SOA benefits by the organization.

The following influencing factors related to the environmental context are hypothesized: SOA adoption will be positively influenced by (16) higher levels of support from vendors, (17) increased industry pressure, and/or (18) stronger perceived IT media influence.

4. RESEARCH HYPOTHESES AND METHODOLOGY

For the purpose of studying factors influencing SOA adoption in the South African context, this research examines the problem from a realist position in terms of ontology, and takes a positivist stance in terms of epistemology. This research is explanatory in its research purpose and adopts deductive approach to theory. The research hypotheses are listed above under the theoretical framework discussion. They were tested using a survey research strategy and a quantitative approach to data collection and subsequent data analysis. It is cross-sectional in its time-frame.

In order to guide the questionnaire design, a number of available industry questionnaires were reviewed. They included the questionnaire from the Wily TechWeb survey (CA Wily, 2008), the IBM SOA Maturity Assessment Tool (IBM, n.d.), the 2008 AmberPoint "State of SOA Adoption Survey" (AmberPoint, 2008), and the "SOA Implementation Survey" conducted by Forrester Research and the TechTarget Application Development Media Group (TechTarget, 2010). A questionnaire from the Master's Thesis "A Stage Maturity Model for the Adoption of an Enterprise-wide Service-Oriented Architecture" (Veger, 2008) was also reviewed. *Top management support* was adapted from Boh and Yellin (2006). *Complexity* was adapted from Bradford and Florin (2003). *Industry pressure* was adapted from Kuan and Chau (2001). The remaining questionnaire items were developed by the author, taking into account the South African context using the guidelines suggested by Moore and Benbasat (1991). A 7-point Likert scale was used for the non-demographic questions. The instrument was then piloted with two industry practitioners. The validity and reliability of the added questions is further ascertained in section 5.3 below. The final version of the questionnaire is available from the authors on simple request.

A definitive and consolidated publically available database of South African businesses does not exist. In order to maximize the number of responses a non-probabilistic sampling approach was taken using a combination of purposive and self-selection sampling. The survey was targeting IT executives, the decision makers initiating SOA projects, IT architects, and senior IT staff members implementing SOA projects. It is believed that these would be most knowledgeable about their organisation's SOA implementation and a further self-selection in responding to the questionnaire would assist in this respect: people not knowledgeable about their organisation's SOA efforts were unlikely to respond. It must be noted that South Africa is a relatively small and concentrated economy, we were hoping to get at least 100 responses.

The Computer Society of South Africa (CSSA) agreed to include the survey link in their newsletter; the two monthly newsletters were sent out to 2789 society members in June and July 2010. A respected private provider of IT Architecture courses, the Faculty Training Institute (FTI), also agreed to send out emails with the survey linked to their former "Practical TOGAF" course delegates. However, this did not yield a noticeable number of responses. Finally, South African members on the professional social network site LinkedIn (http://www.linkedin.com) were contacted. The criterion was to have a job title "architect" or "development manager" or to be a member of a relevant South African special interest group such as the "Enterprise Architecture Forum", "The Enterprise Architecture Network", "iCMG Architecture World", "SOA Group", "Service Oriented Architecture Special Interest Group", "Cloud Computing", and others.

Apart from the CSSA newsletter, a total of 468 potential respondents were contacted over the period 26 May to 21 August 2010. A total of 154 survey responses were collected, of which only 109 were fully completed, and two had only demographic data missing. As a result, the final data sample of 111 responses was obtained.

Due to the non-probability sampling technique used, the results of the study cannot reliably be generalised to the whole population of the South African organizations. Given the anonymity, it was unfortunately not possible to ensure that each organisation represented in the sample was unique.

However, a check reveals that there 87 of the 111 responses have a unique combination of organisational demographic attributes (the three size variables and industry) and most of the remaining can also be assumed to represent different but similarly sized companies in the same industry. The questionnaire used in the study was approved by the University's Ethics Committee. The respondents were informed that their participation in the study was voluntary and their anonymity protected.

5. DATA ANALYSIS AND FINDINGS

5.1 Profile of respondents

More than one-third of the responses (34.2%) came from IS/IT/Technical architects. The next largest groups of respondents were IT staff (17.1%) and CIO, CTO, and other C-level executives (16.2%). Consultants formed 12.6% of the respondents, while IS managers, directors, and planners were represented by 9%, and other IT managers in IS departments by 7.2% of the respondents.

Nearly 60% of all the respondents were from large and very large companies: 27.5% (500 to 5000 number of employees) and 32.1% (5000+ employees) respectively. Medium size companies were represented by 22.5% of the respondents: 11.0% (50 to 99) and 11.9% (100 to 499) respectively. Small companies constituted 17.4% of the respondents. There was a strong correlation between *total number of employees* and *total revenue* as well as *total number of IT staff*.

The largest number of responses (27.0%) came from financial services/banking industry. IT vendors represented 18.0% of the responses, consulting and business services 14.4%, telecommunications/ISP 9.9%, and government organizations 8.1%. The remaining 22.6% of the responses were from various industries with less than 5% representation each.

5.2 Overview of survey results

A small majority of the respondents (60, 54%) indicated that their SOA implementations are in production. Seven respondents (6.3%) have their SOA projects in single department use, 17 respondents (15.3%) in multiple department use, and 36 respondents (32.4%) in enterprise-wide use. Nineteen respondents (17.1%) said that their SOA implementations are in development, while 10 respondents (9%) have their SOA projects in pilot stage. Nine respondents (8.1%) stated that they will pursue SOA within the next 6 months, and 13 respondents (11.7%) indicated that they have no SOA plans. These figures suggest the presence of the adopter's bias in the results: organizations that did not implement SOA were less likely to participate in the survey.

The majority of the respondents (68.4%) indicated that their SOA projects are either successful (37.8%) or partially successful (30.6%). Only 2.7% of respondents described their SOA projects as unsuccessful, while 28.8% of respondents said it is too early to tell. Given the large number of dimensions and possible viewpoints, no attempt was made to define success in an academically rigorous sense, i.e. the measure of success used in the survey is the degree of SOA success as perceived by the respondent.

Of the SOA projects risks examined in the questionnaire (security, performance, interoperability, reliability, and testing), the most important project risks identified were reliability (78.4%), security (73.9%), and performance (72.9%).

Ten SOA implementation challenges were offered to the respondents in the questionnaire. A summary of the results is provided in Figure 1. The top five challenges, with more than 50% of the respondents identifying them as being extremely important and very important, are testing and deploying services, designing SOA security, ensuring run-time governance, designing high quality services, and standards stability and maturity. Note that SOA security is not only viewed as a major SOA implementation risk, but is also considered by the respondents to be a SOA implementation challenge.

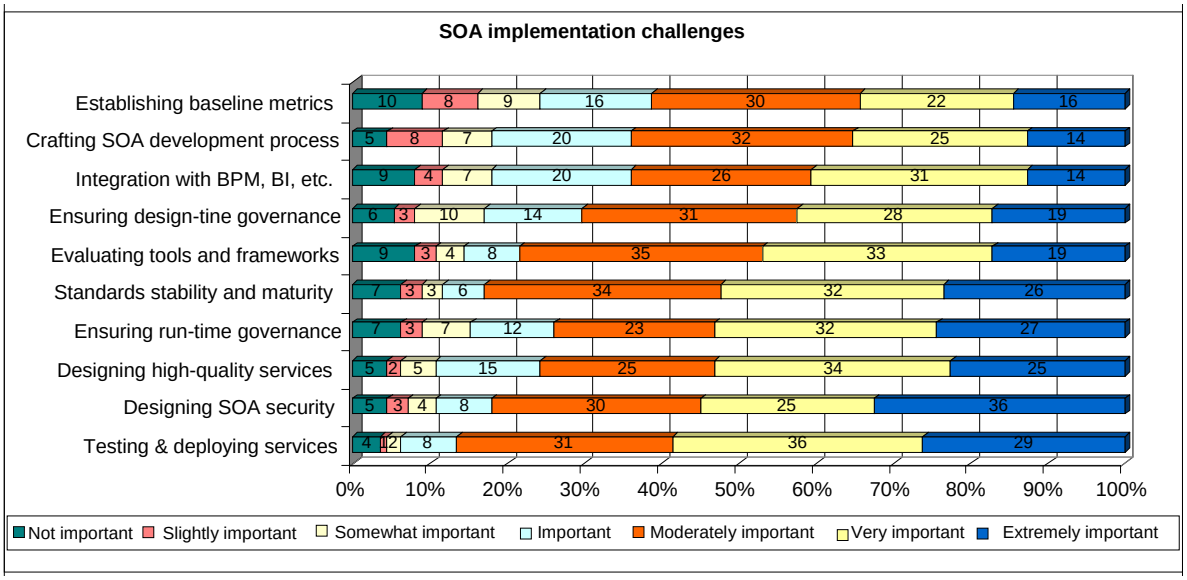

Figure 1. SOA implementation challenges (N=111)

One intention of the questionnaire was to examine whether SOA is viewed as a solution to existing IT issues, such as lengthy application development cycles, high cost of application development, inflexible, hard to integrate systems and restricted information flow. More than half of all the respondents (56.7%) rated addressing of inflexible and hard to integrate systems as extremely important and very important, in terms of influencing their organization's decision to pursue SOA. High cost of application development and restricted information flow was rated as extremely and very important by 45.9% of respondents.

A number of SOA benefits were examined in the questionnaire. The top five benefits, with more than 50% of the respondents identifying them as being extremely important and very important, are improved organizational agility (63%), reuse (58%), legacy application integration (54%), standardised data representation (54%), and improved business processes (53%).

5.3 Distribution, item reliability analysis and construct validity

To examine the distribution of the test items and variables, Kolmogorov-Smirnov and Lilliefors and Shapiro-Wilk tests for normality were conducted on each of the test items and variables. The results show significant p-values ($p < .05$), which means that the null hypothesis H_o about normality of data distribution is rejected for almost all test items and variables. Although the distribution in the data set is skewed and not normal, it has to be noted that Likert scales can generate skewed or polarised distribution (Jamieson, 2004). This normally happens when respondents have strong opinions about a particular aspect of the model.

In order to evaluate inter-item reliability, Cronbach alpha test was performed for each test construct. For each construct, the correlations between the respective item and the total sum score and the internal consistency of the scale (alpha) were examined. Implied reliability of the Cronbach alpha scores was evaluated according to DeVellis (1991). Almost all constructs have reliability that is "respectable" (0.7-0.8) or "very good" (>0.8). Two of the constructs (COMPL and VENDS) have "minimally acceptable" reliability (0.65-0.7), while the other two (STAND and ITMED) have "undesirable" reliability (0.6-0.65). Given that this is still above the 0.6 criterion used in some other studies (Ngai, Cheng and Ho, 2004), those two constructs were kept in the instrument.

To analyse the structure of the relationships between the variables and to test for a possibility of data reduction, factor analysis was conducted on the set of 62 items. Factor rotation Varimax normalised was used with a minimum required eigenvalue of 1 as per the Kaiser criterion. Fourteen factors, which explain 74.98% of the variance in the data, were identified during the analysis. Nunnally (as cited in Ngai et al., 2004) suggested that an item is considered to load on a factor when the factor loading is 0.4 or greater. Using this criterion, factor loadings were analysed, and the instrument variables were adjusted to match newly discovered factors.

On the whole, most test items loaded nicely onto their respective constructs. However, the test items for some similar variables loaded onto the same factor, and some test items for some constructs loaded onto different variables. This is not surprising since the survey instrument was composed from different sources and additional items were added. In the light of the validity analysis, the initial model was reviewed slightly. SOA *implementation challenges* were separated between pure *technological implementation challenges* and *implementation challenges requiring organizational* change. Some SOA *perceived benefits* can be realised inside an organization (intra-organizational benefits), while the other benefits, such as increased B2B integration and organizational agility (time to market) can only be realised at the *inter-organizational* level.

A number of constructs were merged, as it appeared that they measure similar concepts. *Resources* and *IT skills & expertise* were merged into one construct. Additionally, *governance* and *strategy & plan* constructs were considered to be measuring similar concepts, and, therefore, were merged into *governance & strategy* construct. Similarly, *industry pressure* and *IT media influence* were considered to represent industry pressure, whether it is coming from competitors, business partners or IT media. Hence, the two constructs were merged into the *industry pressure & IT media influence* construct.

5.4 Overall model testing

To test simultaneous effects of the independent variables on the dependent variable, and to use the most parsimonious model possible, a multiple regression analysis was conducted. This results in relatively parsimonious model (Table 2) where the variables STAND (standardization), COST, and ORIMPLC (Organisational change implementation challenges) explain 31.96% of original variability (the original model: 31.38%). The relationship between SOA Use and the independent variables STAND and ORIMPLC is positive, while the relationship between SOA Use and the COST variable is negative as expected.

	R= .58150569 R^2= .33814887 Adjusted R^2= .31959230 F(3,107)=18.223 p<.00000 Std.Error of estimate: 1.7611					
	b*	Std.Err. of b*	b	Std.Err. of b	t(107)	p-value
Intercept			3.121781	0.785315	3.9752	0.000128
STAND	0.407545	0.079719	0.531816	0.104027	5.11228	0.000001
COST	-0.332195	0.079683	-0.458367	0.109947	-4.16897	0.000062
ORIMPLC	0.240349	0.080752	0.381529	0.128186	2.97638	0.003607

Table 2. Multiple regression summary for "Use of SOA"

In order to find the 'best' regression model, forward and backward stepwise regression analyses were conducted. Forward stepwise analysis showed that four variables, STAND, COST, ORIMPLC, and HFRSRC, represent the "best" model with a correlation coefficient of 0.607 and 34.32% of the explained variance. Backward stepwise analysis identified a different model, consisting of STAND, COMPA, COST, and ORIMPLC, with r = 0.603 and 33.95% of the explained variance. However, the inclusion of a fourth variable in either model adds less than 0.5% of explained variance.

5.5 Individual Hypothesis Testing

Due to the nature of the test data (ordinal variables with non-normal distribution), Kruskal-Wallis one-way analysis of variance test was used for hypotheses testing. Kruskal-Wallis ANOVA, being a non-parametric test, does not allow testing for the direction of the hypotheses effects, but only testing for differences or lack thereof. A Pearson Chi-square test was used to test relationships between independent and dependent nominal variables and to test differences in groups. When a statistically significant relationship is found, then differences in groups are confirmed.

Adoption of SOA is measured by two variables: *use of SOA*, which identifies stages of SOA adoption, and *SOA project success* as perceived by the respondent. *Use of SOA*, originally a nominal variable, was transformed to the ordinal variable with stages ranging from 1 (no SOA plans) to 7 (deployed in production for enterprise-wide use). As a result, both variables describing SOA adoption, *Use of SOA - Nominal* and *Use of SOA - Ordinal*, were used in the statistical analysis. *(Perceived) SOA project success* is a nominal variable with five categories: successful, partially successful, unsuccessful,

fiasco, and too early to tell. The variable was also transformed to ordinal with the following ranks: 1 (fiasco), 2 (not successful), 3 (too early to tell), 4 (partially successful), 5 (successful).

5.5.1 Technological context

Six ordinal variables, use of standards and platforms, complexity, compatibility, cost, technology implementation concerns, and relative advantage form part of the technological context of the model. A summary of the hypotheses testing for the technological context is provided in Table 3. The results suggest significant relationships between *use of SOA* and two independent variables, *use of standards & platforms* and *compatibility*. The results of the multiple regression analysis also confirm the existence of these relationships (p<.001). Although the results of the simple regression and multiple regression analyses also suggested the existence of a significant relationship for variable *cost* (p<.01), hypothesis testing does not support this. One possible explanation for the lack of significance for *cost* variable may be lower power (sensitivity) of the non-parametric test (Kruskal-Wallis ANOVA) when compared to the parametric simple regression analysis. It is possible that a bigger sample could have yielded slightly different results.

Variables	Use of SOA	SOA project success
STAND	*H (6, N= 111) =28.65329 p =.0001*	*H (3, N= 111) =11.68504 p =.0085*
COMPL	H (6, N= 111) =2.053026 p =.9148	*H (3, N= 111) =8.859564 p =.0312*
COMPA	*H (6, N= 111) =20.99164 p =.0018*	*H (3, N= 111) =12.64224 p =.0055*
COST	H (6, N= 111) =12.17025 p =.0583*	*H (3, N= 111) =16.42628 p =.0009*
ITIMPLC	H (6, N= 111) =9.916471 p =.1282	H (3, N= 111) =1.871930 p =.5994
RELADV	H (6, N= 111) =5.353865 p =.4993	H (3, N= 111) =1.182537 p =.7572

*Table 3: Summary of hypotheses testing: technological context (*significant for combined adoption groups, p=.017)*

5.5.2 Organizational context

Seven ordinal variables and two nominal variables form part of the technological context of the model. Among them are *organization size*, *industry*, *perceived risks*, *human & financial resources*, *top management support*, *governance & strategy*, *organizational change implementation challenges*, *intra-organizational benefits*, and *inter-organizational benefits*.

A summary of the hypotheses testing for the organizational context variables is provided in Table 4. It shows highly significant results for *top management support*, *governance & strategy*, and *human & financial resources* constructs. The hypothesis testing results confirm the results of the simple regression analysis which also demonstrated highly significant relationships for these variables.

Variables	Use of SOA	SOA project success
Organization size	Chi-square: 5.85971, df=6, p=.439094	Chi-square: 13.7216, df=9, p=.132595
- # of employees	H (6, N= 109) =8.481898 p =.2049	H (6, N= 109) =10.97362 p =.0892
- # of IT staff	H (5, N= 109) =1.994885 p =.8499	H (5, N= 109) =2.623704 p =.7578
- total revenue	Chi-square: 12.7668, df=14, p=.544968	Chi-square: 27.1582, df=21, p=.165715
	H (7, N= 111) =7.739322 p =.3561	H (7, N= 111) =15.04588 p =.0354
Industry	Chi-square: 11.2745, df=6, p=.080267	Chi-square: 10.7386, df=9, p=.294067
	H (12, N= 111) =20.99620 p =.0504	H (12, N= 111) =13.00329 p =.3688
ORIMPLC	H (6, N= 111) =10.11023 p =.1201	H (3, N= 111) =2.696217 p =.4409
RISK	H (6, N= 111) =5.272500 p =.5094	H (3, N= 111) =2.107954 p =.5503
TMSP	*H (6, N= 111) =33.38803 p =.0000*	*H (3, N= 111) =17.23194 p =.0006*
GVRNSTRAT	*H (6, N= 111) =28.03933 p =.0001*	*H (3, N= 111) =25.09960 p =.0000*
HFRSRC	*H (6, N= 111) =24.89509 p =.0004*	*H (3, N= 111) =28.09315 p =.0000*
RELADV	H (6, N= 111) =5.353865 p =.4993	H (3, N= 111) =1.182537 p =.7572
INTRABENEF	H (6, N= 111) =10.48993 p =.1055	H (3, N= 111) =3.542163 p =.3153
INTERBENEF	H (6, N= 111) =11.38583 p =.0772	H (3, N= 111) =.7031779 p =.8725

Table 4. Summary of hypotheses testing: organizational context

5.5.3 Environmental context

Environmental context of the model includes the following three ordinal variables: *vendor direct influence*, *vendor support for integration and development tools*, *industry pressure and IT media influence*. This section examines results of the hypotheses testing of these variables.

A summary of the hypotheses testing for the environmental context is provided in Table 5. The results suggest the existence of a significant relationship ($p<.05$) between *use of SOA* and *vendor support for integration and development tools* variable. The results of the multiple regression analysis also showed highly significant relationship ($p<.01$) for this variable.

Variables	Use of SOA	SOA project success
VENDI	H (6, N= 111) =4.565600 p =.6006	H (3, N= 111) =6.711995 p =.0817
VENDS	*H (6, N= 110) =15.41727 p =.0172*	*H (3, N= 110) =11.99006 p =.0074*
INDSP	H (6, N= 110) =4.219740 p =.6470	H (3, N= 110) =3.114682 p =.3743

Table 5. Summary of hypothesis testing for environmental context

5.6 Summary of findings

The results of the hypotheses testing reveal significant differences between various stages of SOA adoption (*use of SOA*) regarding medians in *use of standards & platforms*, *compatibility*, *top management support*, *governance & strategy*, *human & financial resources*, and *vendor support for integration & development tools*. While population medians of *complexity* and *cost* do not differ between stages of SOA adoption (*use of SOA*), they show significant differences in medians between *SOA project success* groups. When the population is grouped by *SOA project success*, the following variables show significant differences in medians: *use of standards & platforms*, *complexity*, *compatibility*, *cost*, *top management support*, *governance & strategy*, *human & financial resources*, and *vendor support for integration & development tools*. A summary of the hypotheses testing is provided in Table 6.

Hypo-thesis	Explanation	Use of SOA	SOA project success
H1	Use of standards and platforms affects SOA adoption positively	Supported	Supported
H2	Complexity affects SOA adoption negatively	Not supported	Supported
H3	Compatibility affects SOA adoption positively	Supported	Supported
H4	Cost affects SOA adoption negatively	Not supported*	Supported
H5	Technology implementation challenges affect SOA adoption negatively	Not supported*	Not supported
H6	Relative advantage affects SOA adoption positively	Not supported	Not supported
H7	Size of an organization affects SOA adoption positively	Not supported	Not supported
H8	Industries show different SOA adoption patterns	Not supported	Not supported
H9	Perceived risks affect SOA adoption negatively	Not supported*	Not supported
H10	Organizational change implementation challenges affect SOA negatively	Not supported*	Not supported
H11	Top management support affects SOA adoption positively	Supported	Supported
H12	SOA governance & strategy affect SOA adoption positively	Supported	Supported
H13	Human and financial resources affect SOA adoption positively	Supported	Supported
H14	Intra-organizational SOA benefits affect SOA adoption positively	Not supported	Not supported
H15	Inter-organizational benefits affect SOA adoption positively	Not supported	Not supported
H16	Vendor influence affects SOA adoption positively	Not supported	Not supported
H17	Vendor support for integration and development tools affect SOA adoption positively	Supported	Supported
H18	Industry pressure and IT media affect SOA adoption positively	Not supported	Not supported

Table 6. Summary of hypothesis testing (= supported using Pearson correlation, $p < 0.05$)*

6. CONCLUSION

To date, there is a paucity of academic research on the topic of SOA adoption. To the best of authors' knowledge, no survey on SOA adoption in South Africa has been conducted before. A number of researchers highlighted the need for a conceptual model which would help to explore SOA adoption, its drivers and inhibitors, and could be used as a basis for future studies on SOA adoption. This study developed a model of SOA adoption, which was built on the basis of DOI theory, TOE framework, and extensive review of IT diffusion and SOA literature. Based on the suggested model of SOA adoption, a survey research instrument was developed and validated, and a survey of organisational adoption of SOA in South Africa was conducted.

The results presented in the study give some insight into the state of SOA adoption among South African enterprises and are consistent with previous industry surveys on SOA adoption conducted in developed countries. For example, similar to the results of the "State of SOA Adoption Survey" (AmberPoint, 2008), the South African respondents view SOA as a solution to inflexible and hard-to-integrate systems. Consistent with the "State of SOA Survey 2010" (TechTarget, 2010), organizational agility, improved business processes, reuse, reduced TCO, data integration and legacy application integration are among the most important benefits the South African respondents are expecting to achieve in their SOA implementations. The most pressing challenges of SOA adoption are issues related to SOA lifecycle: designing high quality services, testing and deploying services, ensuring run-time governance, designing SOA security, and issues related to SOA standards stability and maturity.

The research findings improve our understanding of important factors affecting SOA adoption. Use of multiple standards and platforms, compatibility, top management support, good governance and strategy, adequate human and financial resources, vendor support for integration and development tools are significant factors for both SOA adoption and SOA project success, while complexity and cost are only significant for SOA project success. Therefore, organizations pursuing SOA need to ensure these factors are properly addressed and not overlooked. Perhaps an equally important finding, quite a number of factors proposed in previous research were found *not* to have a significant impact on SOA adoption or perceived SOA success in the South African sample. This presents both a challenge and an opportunity for the research community to reflect on our current adoption models and this research should hopefully contribute towards a more parsimonious SOA adoption model to be validated in future research.

Limitations and further research

One of the main limitations of the study is that, due to the non-probability sampling technique used, the results of the study do not represent the general population of the South African organizations. However, despite the adopter's bias in the final sample, the researchers are of the opinion that the sample is representative of the companies that have adopted SOA or are in the process of adoption. Interestingly, some factors believed to be of critical significance, including relative advantage, were not found to be significant. This calls for further empirical validation.

The results of this study open opportunities for further research in the field of SOA adoption in South Africa. One of the promising options is a combination of quantitative and qualitative cross-sectional analysis. Rich data could supplement quantitative research results and allow reviewing of the SOA adoption research model. Another option is to conduct a longitudinal case study of organizational adoption of SOA in the South African context. Finally, an in-depth exploration of subsequent organizational change which is triggered by the technology adoption process would shed light on the ultimate business value of SOA.

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