



African Journal of Business Management

Volume 9 Number 12 28 June, 2015

ISSN 1993-8233



ABOUT AJBM

The **African Journal of Business Management (AJBM)** is published twice monthly (one volume per year) by Academic Journals.

African Journal of Business Management (AJBM) is an open access journal that publishes research analysis and inquiry into issues of importance to the business community. Articles in AJBM examine emerging trends and concerns in the areas of general management, business law, public responsibility and ethics, marketing theory and applications, business finance and investment, general business research, business and economics education, production/operations management, organizational behaviour and theory, strategic management policy, social issues and public policy, management organization, statistics and econometrics, personnel and industrial relations, technology and innovation, case studies, and management information systems. The goal of AJBM is to broaden the knowledge of business professionals and academicians by promoting free access and providing valuable insight to business-related information, research and ideas. AJBM is a weekly publication and all articles are peer-reviewed.

Contact Us

Editorial Office: ajbm@academicjournals.org

Help Desk: helpdesk@academicjournals.org

Website: <http://www.academicjournals.org/journal/AJBM>

Submit manuscript online <http://ms.academicjournals.me/>

Editor-in-Chief

Prof. Wilfred Isioma Ukpere

*Department of Industrial Psychology and People Management,
Faculty of Management,
University of Johannesburg,
South Africa.*

Editors

Dr. Amran Awang

*Faculty of Business Management,
02600 Arau, Perlis, Malaysia*

Prof. Giurca Vasilescu Laura

*University of Craiova, Romania
13, A.I. Cuza, 200585, Craiova, Dolj,
Romania.*

Associate Editors

Dr. Ilse Botha

*University of Johannesburg
APK Campus PO Box 524 Aucklandpark 2006
South Africa.*

Dr. Howard Qi

*Michigan Technological University
1400 Townsend Dr., Houghton, MI 49931,
U.S.A.*

Dr. Aktham AlMaghaireh

*United Arab Emirates University
Department of Economics & Finance
United Arab Emirates.*

Dr. Haretsebe Manwa

*University of Botswana
Faculty of Business
University of Botswana
P.O. Box UB 70478
Gaborone Botswana.*

Dr. Reza Gharoie Ahangar

*Islamic Azad University of Babol,
Iran.*

Dr. Sérgio Dominique Ferreira

*Polytechnic Institute of Cavado and Ave
Campus IPCA, Lugar does Aldão, 4750-810. Vila
Frescainha,
Portugal.*

Prof. Ravinder Rena

*Department of Economics
University of the Western Cape
Private Bag: X17
Modderdam Road
Bellville 7535
Cape town, South Africa*

Dr. Shun-Chung Lee

*Taiwan Institute of Economic Research
No. 16-8, Dehuei Street, Jhongshan District,
Taipei City 104,
Taiwan.*

Dr. Kuo-Chung Chu

*National Taipei University of Nursing and Health
Sciences No. 365, Min-Te Road, Taipei,
Taiwan.*

Dr. Gregory J. Davids

*University of the Western Cape
Private Bag x17, Bellville 7535,
South Africa.*

Prof. Victor Dragotă

*Bucharest Academy of Economic Studies, Department
of Finance
Bucharest, Sector 1, Piata Romana no. 6, Room 1104,
Romania*

Dr. Maurice Oscar Dassah

*School of Management, IT and Governance
University of KwaZulu-Natal
Post Office Box X54001
Durban
4000
South Africa.*

Prof. Joseph Offiong Udoayang

*University of Calabar
P.M.B 1115, Calabar. Cross River State, Nigeria.*

Prof. Robert Taylor

*University of KwaZulu-Natal
Varsity Drive, Westville
South Africa.*

Dr. Nazim Taskin

*Massey University - Albany
Quad Building A, Room 3.07
Gate 1, Dairy Flat Highway (State Highway 17)Albany,
New Zealand*

Prof. João J. M. Ferreira

*University of Beira Interior (UBI)
Estrada do Sineiro, Pólo IV 6200 Covilhã,
Portugal.*

Dr. Izah Mohd Tahir

*Universiti Sultan Zainal Abidin
Gong Badak Campus, 21300 Kuala Terengganu,
Terengganu, Malaysia.*

Dr. V. Mahalakshmi

*Panimalar Engineering College
7-A,CID Quarters, Mandaveli,Chennai-600028,
Tamilnadu,
India.*

Dr. Ata Allah Taleizadeh

*Iran University of Science and Technology
Faculty of Industrial Engineering,
Iran University of Science and Technology,
Narmak, Tehran, Iran.*

Dr. P.S. Vohra

*Chandigarh Group of Colleges, Landran, Mohali, India
#3075, Sector 40 D
Chandigarh, Pin code 160036*

Dr. José M. Merigó

*University of Barcelona
Department of Business Administration, Av. Diagonal
690, Spain.*

Prof. Mornay Roberts-Lombard

*Department of Marketing Management,
C-Ring 607, Kingsway campus, University of
Johannesburg, Auckland Park, Johannesburg, 2006,
South Africa*

Dr. Anton Sorin Gabriel

*Carol I Boulevard, No. 11, 700506, Iasi,
Alexandru Ioan Cuza University Iasi,
Romania.*

Dr. Aura Emanuela Domil

*31 Horia Creanga, zip code 300253, Timisoara,
West University from Timisoara,
Faculty of Economics and Business Administration, Romania.*

Dr. Guowei Hua

*NO. 3 Shangyuancun, Haidian District, Beijing 100044,
School of Economics and Management,
Beijing Jiaotong University, China.*

Dr. Mehdi Toloo

*Technical University of Ostrava,
Ostrava, Czech Republic*

Dr. Surendar Singh

*Department of Management Studies, Invertis University
Invertis village, Bareilly -
Lucknow Highway, N.H.-24, Bareilly
(U.P.) 243 123 India.*

Dr. Nebojsa Pavlovic

*High school "Djura Jaksic"
Trska bb, 34210 Raca, Serbia.*

Dr. Colin J. Butler

*University of Greenwich
Business School, University of Greenwich, Greenwich, SE10
9LS,
London, UK.*

Prof. Dev Tewari

*School of Economics and Finance
Westville Campus University of Kwa-Zulu
Natal (UKZN) Durban, 4001
South Africa.*

Dr. Paloma Bernal Turnes

*Universidad Rey Juan Carlos
Dpto. Economía de la Empresa
Pº de los Artilleros s/n
Edif. Departamental, Desp. 2101
28032 Madrid, España*

Dr. Jurandir Peinado

*Universidade Positivo
Rua Silveira Peixoto, 306
Zip 80240-120 Curitiba – PR – Brazil*

Prof. Fabrizio Rossi

*University of Cassino and Southern Lazio (Italy)
Via G. Di Biasio 43, Cassino (Italy)*

Editorial Team

Dr. T.S. Devaraja

*Department of Commerce,
Post Graduate Centre,
Hemagangotri Campus,
University of Mysore
India.*

Dr. Peide Liu

*Business Administration School,
Shandong Economic University, China*

Dr. Marwan Mustafa Shammot

*King Saud University, P.O.Box 28095 ,
Riyadh 11437 Kingdom of Saudi Arabia.*

Dr. Hela Miniaoui

*University of Wollongong in Dubai,
Knowledge Village, Block 15 PoBox 20183, Dubai
UAE*

Dr. Suhanya Aravamudhan

*6965 Cumberland Gap Pkwy, Harrogate, TN
USA*

Dr. Hooman Attar

*Amirkabir University of Technology
Iran*

Prof. Luis Antonio Fonseca Mendes

*University of Beira Interior –
Business and Economics Department -
Estrada do Sineiro – Polo IV – 6200-209 Covilhã
Portugal*

Wu, Hung-Yi

*Department of Business Administration
Graduate Institute of Business Administration
National Chiayi University No.580, Xinmin Rd., Chiayi City
60054, Taiwan (R.O.C.)*

Shu-Fang Luo

*No.28, Da-Ye S. Road, Lin-Hai Industrial Park,
Hsiao-Kang, 812, Kaohsiung City Taiwan*

Ahmad.M.A.Ahmad Zamil

*King Saud University, P.O.Box 28095 ,
Riyadh 11437
Kingdom of Saudi Arabia*

Olof Wahlberg

*Mid Sweden University,
851 70 Sundsvall Sweden*

Mario Javier Donate-Manzanares

*Facultad de Derecho y Ciencias Sociales Ronda de Toledo, s/n
13071 Ciudad Real Spain*

Mohamed Abd El Naby Mohamed Sallam

*Faculty of Commerce -
University of Kafr El-Sheikh
Egypt*

Dr. Bhaskar Bagchi

*Alipurduar College -
Helapurkur (Shibmandir); CHANDERNAGAR, Pin – 712136;
West Bengal
INDIA*

Dr. Pawel Tadeusz Kazibudzki

*Jan Dlugosz University in Czestochowa, The Faculty of Social
Sciences
Poland*

Dr. Cherukuri Jayasankaraprasad

*Department of Business Management
Krishna University (State Govt. of A.P.)
Machilipatnam, A.P., India-521001*

Dr. Aleksander Aristovnik

Faculty of Administration, University of Ljubljana, Slovenia

Dr. Bhavesh Parmar

*Department of Business Management, Sankalchand Patel
College of Engineering, Visnagar. (Affiliated to Gujarat
Technological University.) India.*

Prof. Paulo Alves

*Lisbon College of Accountancy and Administration and
Lusofona University Portugal*

Dr. Mathew Analogbei

*The Open University Business School UK.
Centre for Marketing & Strategy,
The Open University Business School,
Walton Hall, Milton Keynes, MK7 6AA,
United Kingdom*

ARTICLES

Research

- Enterprise architecture maturity stages: A cluster analysis in Brazilian small businesses** 501
Carlos Otávio Senff, Gustavo Dambiski Gomes De Carvalho, Claudimar Pereira Da Veiga, Luiz Carlos Duclós and Admir Pancote
- TOC, lean and six sigma: The missing link to increase productivity?** 513
Diego Augusto de Jesus Pacheco
- Improving customer complaining behaviour for loyalty in the services sector: A case of mobile telephone companies in Uganda** 521
Mabel Birungi Komunda, Francis Kibeera, Justus Munyoki and Jotham Byarugaba

Full Length Research Paper

Enterprise architecture maturity stages: A cluster analysis in Brazilian small businesses

Carlos Otávio Senff¹, Gustavo Dambiski Gomes De Carvalho¹, Claudimar Pereira Da Veiga², Luiz Carlos Duclós² and Admir Pancote²

¹Pontifical Catholic University of Paraná – PUCPR, Brazil.

²Rua Imaculada Conceição, 1155 Bloco Acadêmico - Sala 103B - Prado Velho - Curitiba, Paraná, Brazil.

Received 21 April 2015; Accepted 20 June, 2015

Enterprise Architecture - EA encompasses the core business processes, Information Technology infrastructure (IT), systems, and technologies, as well as the level of integration and standardization of data and processes. Companies that develop EA tend to migrate from local applications to systems that share infrastructure and data. In this context, the aim of this study is to identify how the SMEs – Small Enterprises from Southern Brazil are positioned in maturity levels of EA set out by their IT investments. The sample comprised 152 small businesses and the methodology employed included cluster analysis with average link between groups as linkage method and Euclidean distance as similarity measure. After the identification of eight main EA maturity stages, non-parametric tests such as Kruskal-Wallis and Mann-Whitney were employed to identify significant differences among the stages regarding their age and the number of employees. The results indicate that the average number of employees is low from stages zero to four, grows significantly in stage five and decreases moderately in the final stages, where the decrease from stage six to seven is also significant statistically. Moreover, the study suggests that small companies use less EA because they have fewer activities. On the other hand, larger companies use more EA because they are more complex and need more employees. However, after a certain point, the more they increase their EA level, the more efficient they become and the fewer employees are needed.

Key words: Information technology, infrastructure investments, small and medium enterprise SME, maturity model.

INTRODUCTION

Contemporary organizations experience increasing pressure to change, requiring organizational agility, or the ability to sense and respond continuously to changes in the environment (Fallmyr and Bygstad, 2014). EA has been proposed as an architectural and

organizational approach in order to meet this challenge (Sassa and Krisper, 2011).

Considering the significant economic and social role that small businesses represent in the countries where they operate, this research analyzes EA in the context

*Corresponding author. E-mail: carlos.senff@gmail.com.

Authors agree that this article remain permanently open access under the terms of the [Creative Commons Attribution License 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

of Small and Medium Enterprises - SMEs. In the world, according to Robu (2013), [...] small and middle enterprises represent 99% of the total active firms around the world” and they are the largest contributors to the Gross Domestic Product (GDP) of many countries, such as USA (65%), Japan (60%), China (60%) and European Union countries (52%). Additionally, SMEs are the main contributors to employment in many countries. In Brazil, the micro and small enterprises represent 99% of all existing establishments and account for about 40% of the salaries of employees in formal mass in private companies (DIEESE, 2013; Veiga et al., 2013). According to the Global Entrepreneurship Monitor (GEM, 2013), Brazil is a country that is driven by the pursuit of efficiency. There are three levels of country entrepreneurship classification: factors, efficiency, and innovation. In countries driven by factors, activities with strong dependence on labor force and predominance of natural resources. Countries driven by efficiency are characterized by the advance of industrialization and gains in scale economies. In countries driven by innovation, businesses are more knowledge-intensive and the service sector expands and modernizes.

Technology is considered to be highly important for corporations to sustain competitiveness in the dynamic environment (Prahalad and Hamel, 1990). Enterprise architecture is an integrated and holistic vision of an organization’s fundamental system, embodied in people, processes, applications, and so on, their relationships to each other and to the environment, and the principles guiding its design and evolution (IEEE, 2000). Enterprise Architecture is associated to the knowledge base that comprises elements of internal and external business environment and relations between them (Sasa and Krisper, 2010).

Hamel and Prahalad (1989) assert that there is a relationship between a corporation’s goals and its allocation of resources. In general, goals are originated from corporate strategy, which refers to how an organization plans to adapt to and/or change aspects of its environment. As the organizing logic for business processes and IT infrastructure, Enterprise Architecture reflects the integration and standardization requirements of the company’s operating model to achieve business agility and profitable growth (Ross et al., 2006).

Castells (2006) indicates that the world is in a process of multidimensional structural change associated with the emergence of a new technological paradigm, based on information and communication technologies. The increasing advancement in access to these technologies leads to radical change in the way people socialize, build knowledge, collaborate and innovate. In this context, EA enables better IT management and, therefore increases efficiency (Khayami, 2011).

Considering the bibliography research and two recent bibliometric analysis about EA literature, conducted by Simon et al. (2013) and Rouhani et al. (2015), a gap of

EA studies in the context of small businesses was identified. The main theoretical contribution of this work is the application of EA concepts for the small business context. In practice, the study suggests that the application of EA in small enterprises can lead to better efficiency.

Analyzing the EA maturity level of Brazilian SMEs is important, since it can draw new perspectives to the companies with respect to the importance of the use of IT to gain competitive advantage (Porter, 1989) in the market. The aim of this study is to identify how the SMEs – Small Enterprises from Southern Brazil are positioned in maturity levels of Enterprise Architecture set out by their IT investments. Based on the model of Ross et al. (2006), which comprises mainly large companies, this research contributes to the study of the EA in the dynamics of small enterprises, identifying eight EA SMEs maturity stages.

This research is structured in four main sections. The first was the theme introduction. The second covers the theoretical background about EA and MSEs. The third presents the methodology employed and the fourth presents the main results obtained. The last section closes the research with final considerations.

THEORETICAL FOUNDATION

This section is subdivided in two parts. The former comprises EA definitions, operating models and maturity stages. The latter comprises the role of IT in MSEs processes, strategies and competitiveness.

Enterprise Architecture

According to Kappelman and Zachman (2013, p. 94), “Enterprise Architecture represents a new way of thinking about the enterprise, and a new way of managing it and all of its assets including IT”. Through a holistic specification about strategy, key processes, information, technologies and other aspects, EA permits an increase in IT manageability and, consequently, inefficiencies reduction (Khayami, 2011).

Bakhshadeh et al. (2014) point out that EA supports the analysis and design of business-oriented systems through the creation of complementary perspectives from multiple viewpoints over the business, information systems and technological infrastructure, enabling communication between stakeholders. Iacob et al. (2012) argue that major IT change processes affecting the Enterprise Architecture of an organization are also mirrored by a change in the organization’s business model. An analysis of the business model can determine whether the architecture change has value to the business. Simon et al. (2013) also point out that a considerable number of organizations face difficulties



Figure 1. Operating models. Source: Weil and Ross, 2009, p.35.

bringing strategy to execution, and suffer from a lack of structure and transparency in the strategic management of companies. The authors propose that EA is a fundamental exercise to achieve a structured description of the company and its relations to the strategic management area of the company. Point EA supports analysis and business system design by creating complementary perspectives from multiple points of view of the business, information systems and technology infrastructure, enabling communication between stakeholders (Bakhshadeh et al., 2014).

Integration and standardization are key dimensions of a company's operating model, which "[...] states the objectives of a firm's digitized platform and establishes its basic requirements" (Weil and Ross, 2009, p. 22). Integration is concerned with sharing data across different sectors within an organization or across different business units within a corporation. Integration provides benefits to companies as improved efficiency, coordination and agility, since the information is centralized and available to everybody. Standardization, on the other hand, is related to the definition of which processes will be performed the same way anywhere and independent of who is performing it. The benefits of standardization to companies include improved efficiency and predictability. However, standardization also generates a disadvantage: it limits local innovation, since local processes, programs and systems are substituted by new standards (Ross et al., 2006).

Based on these two key dimensions, four main types of operating models were proposed: Diversification, Coordination, Replication and Unification. As Figure 1 shows, the Diversification model is characterized by low levels of integration and standardization. This model is common in corporations with autonomous business units. The Unification Model, on the contrary, is characterized by high levels of integration and standardization. The Coordination model is characterized by a high level of integration, but a low level of standardization. It involves

shared data platforms to underpin management decisions. Lastly, the Replication Model is characterized by a low level of integration but a high level of standardization. It involves the standardization of processes and technologies to establish a common brand (Weil and Ross, 2009; Ross et al., 2006).

EA maturity models were proposed by institutions as the United States Government Accountability Office - GAO (2010), which proposed the EAMMF - Enterprise Architecture Management Maturity Framework, and as the National Association of State Chief Information Officers - NASCIO (2003). Ross et al. (2006) also identified a development pattern of Enterprise Architecture in firms and defined it as the four stages of architecture maturity, which encompasses Business Silos, Standardized Technology, Optimized Core and Business Modularity.

The four maturity stages and the IT investments percentages are presented in Figure 2. In the first stage, Business Silos, one of the main goals is to automate business processes. Additionally, companies concentrate their IT investments on local business applications in order to promptly seize opportunities or solve problems. However, there are some disadvantages, since Local Applications lack integration and standardization. The second stage, Standardized Technology, is characterized by the growth of IT investments in shared technology, from 35% in Business Silos to 40%, and a reduction of IT investments in Local Applications, from 36% in Business Silos to 25%. Basically, shared technologies include hardware and software standardization and the main purpose is cost reduction. In the third and in the fourth stages, Optimized Core and Business Modularity, the IT investments in Local applications and in Shared Infrastructure are reduced while the IT investments in Enterprise Systems and Shared Data increase. The Optimized Core stage is characterized by the construction of enterprise platforms that share data and the Business Modularity stage is characterized by the construction of

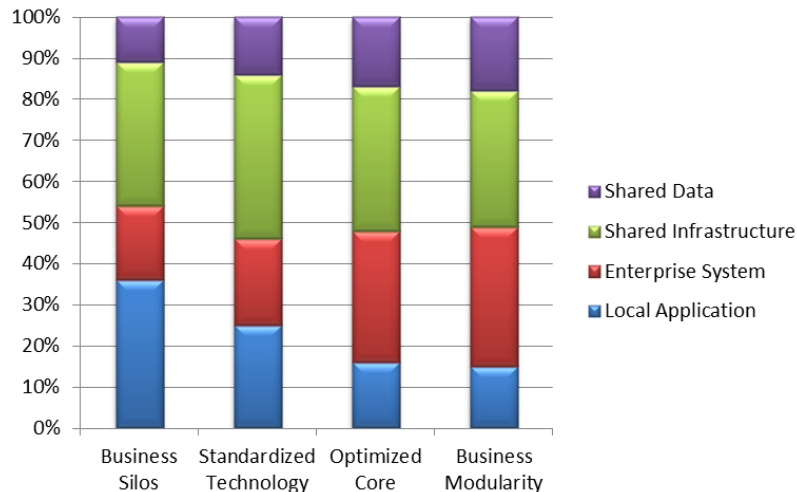


Figure 2. The four stages of architecture maturity. Source: Ross et al., 2006, p.72.

customized or reusable modules that extend the Optimized Core architecture. The model proposed by Ross et al. (2006) comprises mainly large companies, usually global enterprises. Although there are some researches about EA in the context of small enterprises (Yoganingrum et al., 2013; Menchaca et al., 2013), there are still few models to assess a small enterprise EA maturity stage, especially in the context of developing countries such as Brazil.

Small enterprises

Small business is a relatively new economic category, which became politically necessary as economic activity flowed from owner-managed enterprises to managerial corporations (Fuller, 2003; Holátová et al., 2015). Smaller businesses account for almost all businesses in developed and mature economies and generate the majority of private sector employment (OECD, 2002). In most newly industrialized and developing countries, smaller enterprises account for a majority of enterprises and for a significant share of private sector economic activity (World Bank, 2002) or are recognized as central to the future development of the economy (Li et al., 2004). Smaller enterprises have also been associated with high levels of economic adaptability and flexibility, and they are seen as creating economic opportunity through innovation (OECD, 2002).

Small companies that realize the strategic value of information technology already adopted the IT as a strategic role for the success of the business are considered mature by understanding their advantages in the management process as points Fuller (1996). Zimmerer and Scarborough (2002) highlight some advantages: (i) automation of specific tasks, which are then carried out in less time, more reliable and lower

cost; (ii) improvement in the information base for making more accurate decisions with agility, precision and greater control; (iii) improvement in customer service, with updated and dynamic entries; (iv) integration in business processes; and (v) use the internet as a communication tool with customers and suppliers as a sales channel and access to information. According to O'Brien (2002), there are three fundamental roles of information systems: support for business processes, support decision-making and support the competitive advantage.

Albertin (2010) points out that "information and communication technologies are increasingly present and available in society, whether through changes in policies and business practices, or by their cheapness and assimilation, besides the appearance of Infoway public Internet. Despite the mass use of IT, not all business owners realize the benefits that can accrue from its use. As stated by Moraes et al. (2004), many consider these investments as costs, not realizing improvements in quality, service and speed of information vital for competitive strategy, and quite an argument championed by executives to prevent its adoption is to be the IT extremely complex and represent a high cost to their business.

The Brazilian Service of Support for Micro and Small Enterprises – SEBRAE has the mission to promote the competitiveness and the sustainable development of small business and promote entrepreneurship, to strengthen the national economy. According to SEBRAE (2013), the survival rate of small and medium enterprises is growing in Brazil. The survival rate with up to 2 years of activity was 73.6% in 2005, 75,1% in 2006 and 75.6% in 2007. Additionally, the best survival indices of the industry's companies appear to be related to capital requirements, knowledge and technology (SEBRAE, 2013).

Table 1. Sample distribution per company size.

Company size (IBGE criterion)	No of employees	No of companies	% of companies	Accumulated %
Micro	9 or less	111	73%	73%
Small	between 10 and 49	37	24%	97%
Medium	between 50 and 249	3	2%	99%
Large	above 250	0	0%	99%
-	Missing	1	1%	100%

Source: Authors.

This insight can help MSEs a clear view of the importance that IT has for business, justifying their investments, which is also a constant concern of executives (Beltrame and Maçada, 2009). According to Beltrame and Maçada (2009), "IT is not only a tool for automating existing processes, but also an enabler of organizational changes that can lead to additional productivity gains."

The adoption of latest technologies has been slower among MSEs as compared to medium and large companies, but when considering investments in IT proportionally to its net income, we note that the amounts invested by small enterprises are well comparable to larger companies (Premkumar, 2003).

Beheshti (2004) stresses the importance of IT alignment to organizational strategy. Therefore, the needs of hardware and software should be designed according to the required changes in existing processes and systems. Also for Prates and Ospina (2004), the adoption of IT is related to pre-established organizational goals.

There are some reports of the increased use of IT by SMEs and its associated benefits (Cragg and Mills, 2011). Johnston et al. (2007) verified revenues growth and costs reductions and Dibrell et al. (2008) verified the importance of IT in innovation. Additionally, there are indications that a good fit between the business and IT will enable the firm to perform well (Cragg et al., 2002).

The Internet Steering Committee in Brazil (CGI.br) annually produces data and strategic information on access and use of information and communication technologies (ICT) in order to support the company with reliable and updated data on the impact of ICT and, particularly the Internet, society and the economy. According to CGI.br (2013), in the business sector, the ICT Enterprises survey confirms almost universal access to computers and the Internet in Brazilian companies: 97% of them used computers in the last year and 96% accessed the Internet. 39% of Brazilian companies with Internet access participated in social networking. It was also found that 60% of Brazilian companies present in social networks used these tools for launching new products or services, 54% for promotions and 37% for selling products and services. Regarding presence on the Internet via website, just over half of all enterprises with Internet access (56%) had websites or web pages, and

this proportion reached 89% for large companies.

SEBRAE (2014) points out that only 74% of small businesses in Brazil have a computer in the company, 92% access the Internet, and 33% have profile on social networks. Of the companies surveyed, only 48% use integrated software. 65% of entrepreneurs who use internet, realize that the use of the internet is of high importance, with 27% of these companies sold products and services and 50% purchased products and services through the Internet in the last 12 months.

Based on this literature and mainly on the use of IT tools in SMEs, this research proposes an Enterprise Architecture maturity model, which is discussed in the next sections.

METHODOLOGY

This study is characterized by a descriptive, cross-sectional and qualitative research with the objective to better understand the level of maturity of micro and small Brazilian companies regarding the use of information technologies.

After the questionnaire about IT tools had been designed, it was conducted by one of the researchers from September to October 2013. The questionnaire was collected on paper-and-pencil. The sampling was non probabilistic by adhesion. The 152 companies surveyed are located in four cities in the South region of Brazil: 104 are located in the Santa Catarina State, about 68% of the sample, and the 48 remaining companies are located in the Parana State. Adopting the IBGE's company size classification, Table 1 shows that most of the companies surveyed are Micro Enterprises, about 73% of the sample, almost one quarter of the sample are Small Enterprises and only 2% of the sample are Medium Enterprises.

Table 2 shows the sample distribution per activity area. There are 92 companies, about 61% of the sample, performing exclusively in the Commerce. This number is even greater when considering companies performing in the commerce and in other activity area, such as service or industry: 84% of the sample.

The questionnaire was adapted from the research on the use of information and communication technologies in Brazil - ICT Households and ICT Enterprises (2013), conducted by the Brazilian Internet Steering Committee (CGI.br). Basically, the companies marked the different types of IT tools that they employ continuously. All these IT tools were identified by the authors as Local Applications, Enterprise Systems, Shared Infrastructure and Shared Data in the MSEs context. Table 3 summarizes the IT tools classification. IT tools such as (1) Word processor, (2) Spreadsheet application, (3) Queries on the Internet, (4) Purchases on the Internet and (5) Social Networks were classified as Local

Table 2. Sample distribution per activity area.

ID	Activity area	No of companies	% of companies	Accumulated %
1	Service provider	23	15%	15%
2	Service provider and Commerce	22	14%	30%
3	Commerce	92	61%	90%
4	Industry and Commerce	13	9%	99%
5	Industry	1	1%	99%
6	Missing	1	1%	100%
ID	Activity area	No of companies	% of companies	
1 and 2	Total Service provider	45	30%	
2,3 and 4	Total Commerce	127	84%	
4 and 5	Total Industry	14	9%	

Source: Authors.

Table 3. IT tools classification.

N	IT Tools	Local application	Enterprise System	Shared Infrastructre	Shared data
1	Word processor	x			
2	Spreadsheet application	x			
3	Queries on the Internet	x			
4	Purchases on the Internet	x			
5	Social networks	x			
6	Own webiste	x		x	
7	Accounting software		x		
8	Relations with government		x		
9	Sales via Internet		x	x	x
10	Management software		x	x	x
11	Customer Relationship Management – CRM		x	x	x
12	Supply Chain Management – SCM		x	x	x
	Total	6	6	5	4

Source: Authors.

because they are used separately in each company's sectors and because they do not share data or infrastructure. Other IT tools such as (9) Sales via Internet, (10) Management software, (11) Customer Relationship Management (CRM) and (12) Supply Chain Management (SCM) were classified as Enterprise Systems that also share infrastructure and data among a company's sectors. Information about the year of foundation and the number of employees of each company were also collected.

As Figure 3 shows, the questionnaires were processed to compute the companies' percentages of each IT investment types (Local application, Enterprise System, Shared Infrastructure and Shared Data). After the percentages computation, a hierarchical cluster analysis was performed in IBM SPSS Statistics 21 to identify different maturity stages. According to Hair et al. (2010, p. 495), "the primary goal of cluster analysis is to partition a set of objects into two or more groups based on the similarity of the objects for a set of specified characteristics (cluster variate)".

There are two main cluster methods: hierarchical and non-hierarchical. The former starts with all observations as individual clusters and it combines the two most similar based on a similarity measure such as distance or correlation coefficient. This procedure

continues step-by-step forming a treelike structure until all observations are clustered. On the other hand, the latter method starts with the specification of the number of clusters by the researchers. The initial points, also defined as cluster seeds, are selected manually or in a random process and the algorithm assigns the observations to the clusters based on a similarity measure.

This research used the hierarchical approach because it produces a complete set of clustering solutions. In regard to the similarity measure, the Euclidean distance was chosen, since it is the most common measure of distance (Hair et al., 2010). In relation to the agglomeration algorithm, the Average linkage within groups was chosen because it "combines clusters so that the average distance between all cases in the resulting cluster is as small as possible" (Norusis, 2011, p. 387). Lastly, to determine the number of clusters three ad hoc criteria were employed such as: (i) percentage changes in heterogeneity less than 10%; (ii) the identification of at least 4 and at most 10 main groups; and (iii) the formation of similar size groups. The cluster analysis results will be presented in the next section.

The cluster analysis resulted in the identification of eight main

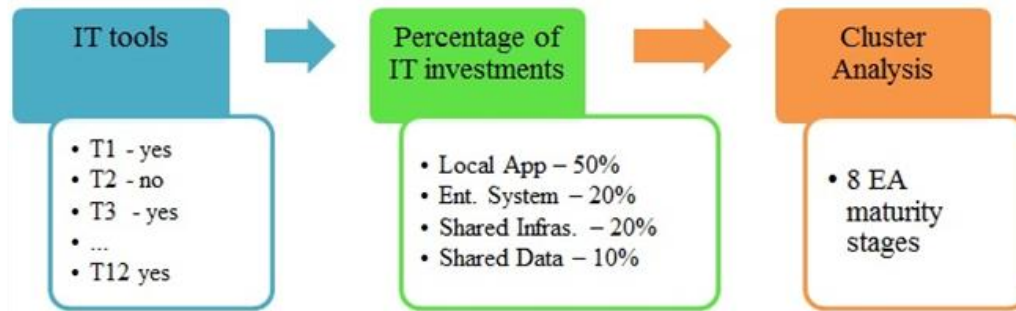


Figure 3. Methodology steps. Source: Authors.

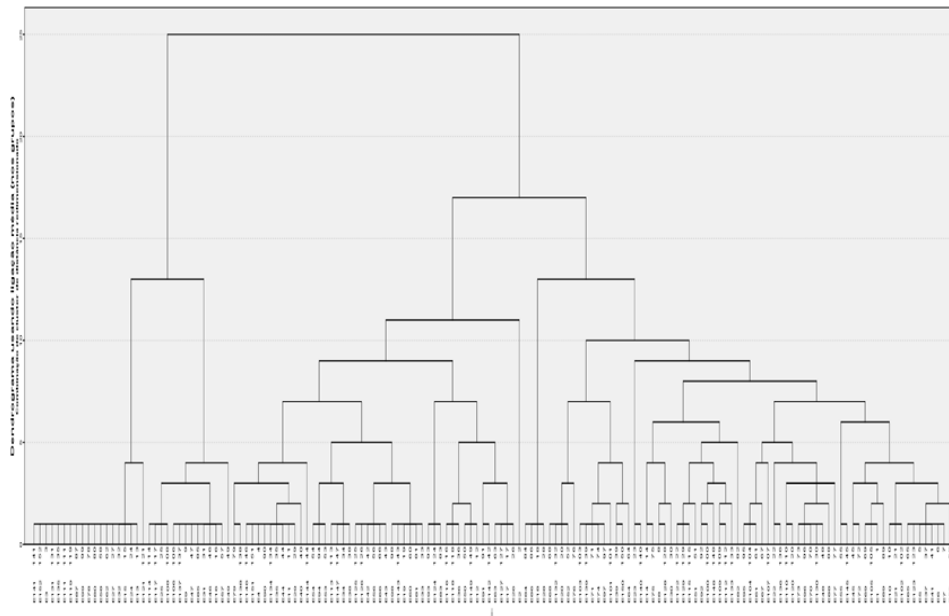


Figure 4. Dendrogram. Source: Authors.

maturity stages. These clusters were then compared regarding the age and the number of employees in order to identify statistical differences among them. First, the normality test (Kolmogorov-Smirnov) verified the non-normal distribution of the variables in some clusters, constraining the subsequent tests to be non-parametric. Therefore, the Kruskal-Wallis and the Mann-Whitney tests were performed in order to verify statistical differences regarding the number of employees and the age among the identified clusters, i.e., among the identified EA maturity stages.

ANALYSIS AND DISCUSSION

The cluster analysis in SPSS generates graphics, as dendrogram and icicle plot, and tables, as proximity matrix and agglomeration schedule. Figure 4 shows the dendrogram generated by the hierarchical cluster analysis with the Average linkage within groups method. The dendrogram was turned 90° for better viewing. All the MSMEs are located on the bottom of the Figure 4 and are agglomerated from bottom to top.

Since this dendrogram has too many observations, an adapted dendrogram, which is illustrated in Figure 5, was elaborated to simplify the data interpretation. The adapted dendrogram shows the last ten steps of the agglomeration process and the number of observations in all clusters.

Similarly, Table 4 was elaborated based mainly on the agglomeration schedule generated by the hierarchical cluster analysis.

The first criterion concerns with low heterogeneity coefficients variation. The researchers established the first criterion as coefficients variation less or equal to 10%, since it avoids big variations between agglomerations steps. The second criterion concerns with the identification of at least four and at most ten clusters, since the original model proposed by Ross et al. (2006) contains four maturity stages and ten was a limit imposed by the researchers as a maximum limit of stages to a simplified maturity model. Lastly, the third criterion

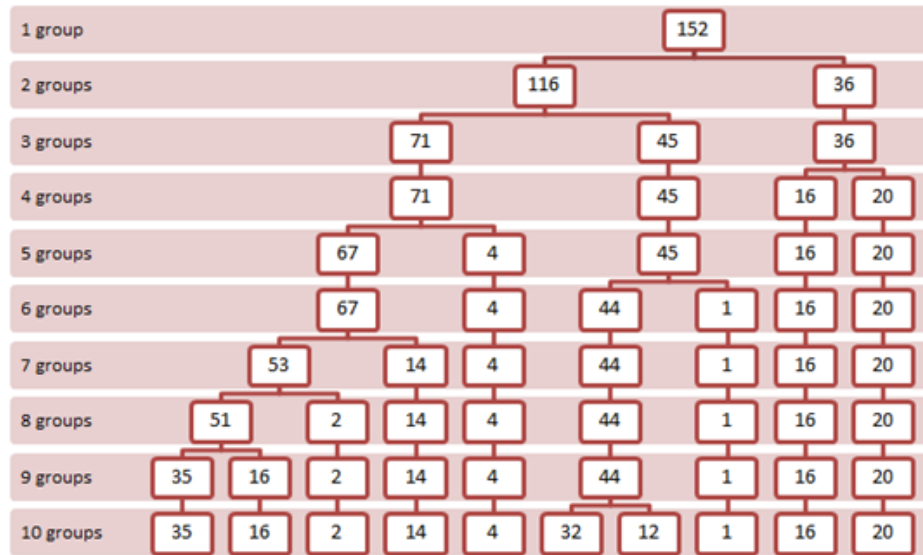


Figure 5. Adapted dendrogram. Source: Authors.

Table 4. Number of clusters criteria. Source: Authors

N. groups	Coefficients		Observations			Criteria			Result
	Value	Variation	average per group	standard deviation	Relative standard deviation	coef. variation < 10%	4 ≤ n ≤ 10	groups size similarity	
10	,095	3%	15,2	11,0	72%	true	true	medium	ok & medium
9	,106	11%	16,9	13,8	82%	false	true	low	no
8	,106	0%	19,0	17,8	93%	true	true	low	ok & low
7	,127	19%	21,7	18,2	84%	false	true	low	no
6	,144	14%	25,3	23,3	92%	false	true	low	no
5	,146	1%	30,4	22,7	75%	true	true	medium	ok & medium
4	,185	27%	38,0	22,1	58%	false	true	medium	no
3	,207	12%	50,7	14,8	29%	false	false	high	no
2	,236	14%	76,0	40,0	53%	false	false	medium	no
1	,362	54%	152,0	0,0	0%	false	false	high	no

concerns with the formation of similar size groups, therefore basic statistics as the observations average per group and standard deviation were employed to calculate the relative standard deviation - RSD of the observations number per group, which permits to compare the standard deviations of different distributions. Low relative standard deviation values indicate high similarity between the observations. Following this rule, the group size similarity was classified by the researchers as low when the RSD was inferior to 30%, medium when the RSD was between 30% and 80% and high when RSD was superior to 80%.

Only three numbers of groups fulfilled all the proposed criteria. However, the number of ten groups was selected, since it avoids the dissimilarity generated by the next

agglomerations steps and, in comparison to the other two, it has the lowest relative standard deviation, 72%. After this selection, the variables means were calculated to all the ten clusters and, based mainly on the Local Application indicator, they were set from the least mature to the most mature.

In total, eight maturity stages were identified, since two groups were considered special groups, or outliers, due to the singular results of the variables means and due to the low number of cases in each group: 2 cases in Special A group and only 1 case in the Special B group. Figure 6 shows the IT investments percentages to all the maturity stages and Figure 7 shows the sample distribution along the stages.

The IT investment maturity stages model begins with

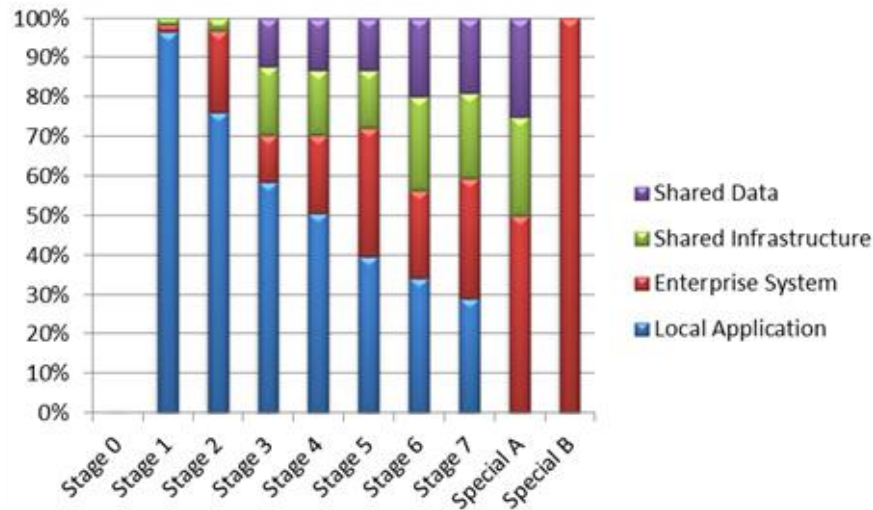


Figure 6. IT investments maturity stages.

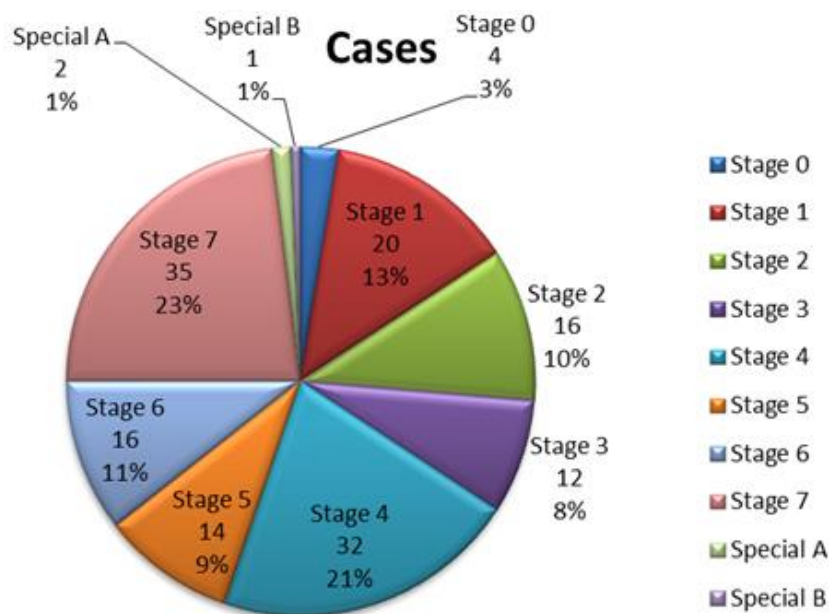


Figure7. IT Investment maturity stages distribution.

the stage zero, composed of 4 companies which do not use any type of IT tools in their businesses. The first stage and the second stage are characterized by a very high level of Local Application investments, greater than 75%, and the absence of Shared Data investments. The first stage contains 20 enterprises, about 13% of the sample, and the second stage contains 16 enterprises, about 10% of the sample. Together, stages zero, one and two contain more than one quarter of the sample, about 26%.

The third and the fourth stages are characterized by a

high level of Local Applications investments, between 50 and 60%, and a low level of Shared Data investments, approximately 12.5%. In these stages the Shared Infrastructure investments are around 17%, but the Enterprise Systems investments increase gradually from 12.1% in stage three up to 19.8% in stage four. Together, stages three and four contain almost 30% of the sample: 8% in stage three and 21% in stage four.

The last three stages, five, six and seven, are the most mature in terms of IT investments. These stages have the lowest levels of Local Applications investments: stage

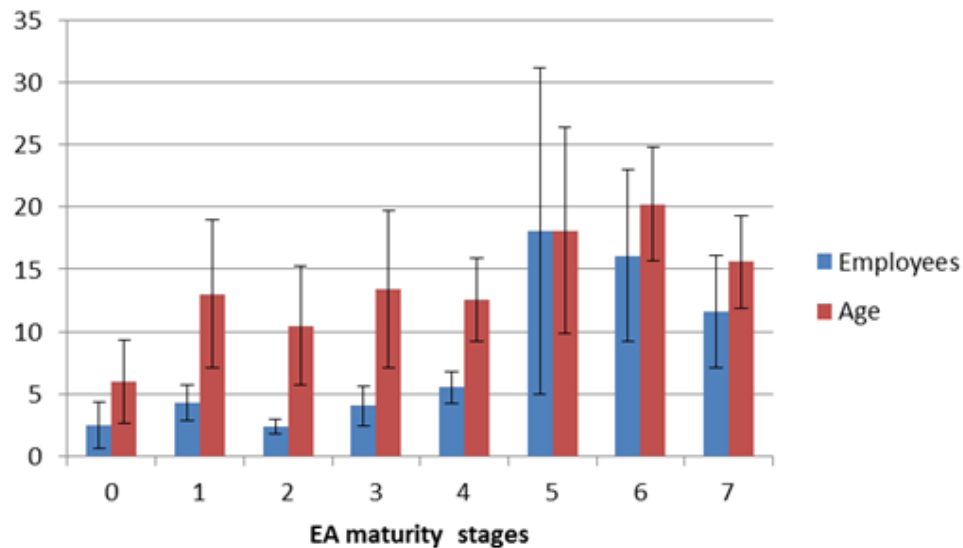


Figure 8. Mean number of employees and age per maturity stage. Source: authors.

Table 5. Results of Mann-Whitney test.

Variable	Clusters	4 and 5	5 and 6	6 and 7
Employees	Mann-Whitney U	149	94	200,5
	exact significance (1 tailed)	0,036*	0,232	0,077[†]

* 0,05 significance level; [†] 0,10 significance level. Source: Authors.

five has 40%, stage six has 34% and stage seven has only 28.9%. In the other way, they have high levels of Shared Data, Shared Infrastructure and Enterprise Systems investments. Together, they represent 43% of the sample: stage five has 9%, stage six has 11%, and stage 7 has 23%.

In order to validate the identified maturity stages, they were compared regarding the number of employees and the age. Figure 8 shows these variables average to each maturity stage and the margin of error to a 95% confidence interval. Additionally, non-parametric tests were performed to compare statistically the identified maturity stages. Non-parametric tests were chosen because some maturity stages had non-normal distributions according to the Kolmogorov-Smirnov test ($p > 0,05$).

The Kruskal-Wallis results were significant to the number of employees ($H = 39,171$, 8 d.f., $p = 0,000$) and partially significant to the age, since $p < 0,1$ ($H = 11,863$, 8 d.f., $p = 0,098$). The Monte Carlo approach was used to calculate the significance level. The results indicate that there are significant differences among the maturity stages regarding the number of employees of the companies. In order to refine the Kruskal-Wallis results regarding the number of employees, the Mann-Whitney

test was performed between stages four and five (4 and 5), five and six (5 and 6), and six and seven (6 and 7). These three comparisons were chosen because they are few, only three in the total of twenty-eight possible comparisons, and they seem to be most different based on the results of Figure 8. The results are presented in Table 5 and indicate significant differences between stages four and five ($U = 149$, $p = 0,036$) and partial significant differences between stages six and seven ($U = 200,5$, $p = 0,077$) regarding the number of employees of companies. The result between stages five and six ($U = 94$, $p = 0,232$) was not significant, although stage six had fewer employees on average than stage five. Therefore, they still could be considered similar in terms of number of employees. One possible explanation for the non-significance result is the small number of companies in stages five and six, that is, the small number of companies in the statistical test.

In summary, the results indicate that the identified maturity stages have partial significant differences among them regarding the age and they have significant differences among them regarding the number of employees. In stage zero, the average age is the lowest when compared to the other maturity stages. From stage one to four, the average age is medium and

in the most EA mature stages, i.e., from stages five to seven, the average age is higher. This result suggests that the companies' survival is related to EA maturity level, corroborating SEBRAE (2011, 2013) that stresses the importance of technology to the SMEs survival.

In the first five stages, that is, from stage zero to stage four, the average number of employees is low. These stages are the less mature in terms of EA, since their IT investments in Local Applications are equal or greater than 50%. These results indicate that the smallest companies have difficulties in implementing EA.

From stage four to stage five, the number of employees grows significantly, as verified by the Mann-Whitney test ($p < 0,05$). Stage five is one of the most mature in terms of EA and it is the first maturity stage with Local Application investments equal or lower than 40%. This result indicates that larger companies utilize more EA. Although, it is not possible to infer that size cause improved EA or the opposite.

Though stage six has less employees than stages five, this difference is not statistically significant ($p > 0,2$). On the other hand, there are partial significant differences between stages six and seven regarding the number of employees ($p < 0,10$). This result indicates that after a certain point of EA maturity, the more mature a company is, the fewer employees it has.

This result suggests that small companies use less EA because they have fewer activities. On the other hand, larger companies use more EA because they are more complex and need more employees. However, as they increase their EA level, the number of employees tends to continue the same or decrease. This suggests that the use of improved IT tools generates more efficiency and fewer employees are necessary. This result corroborates the benefits of EA maturity level presented in the literature (Zimmerer and Scarborough, 2002; Beltrame and Maçada, 2009; Cragg and Mills, 2011).

Final considerations

The aim of this study was accomplished, which was to identify how the SMEs from southern Brazil are positioned in maturity levels of Enterprise Architecture set out by their IT investments. The methodology comprised cluster analysis to identify the SMEs EA maturity stages and non-parametric tests regarding differences among the identified groups. The non-parametric tests included the Kruskal-Wallis test, which identifies differences among three or more independent groups, and the Mann-Whitney test, which identifies differences between two independent groups.

The results of the cluster analysis showed eight main SMEs Enterprise Architecture maturity stages. The model was adapted from the research of Ross et al. (2006), which presented four stages to the context of large companies. The stage zero was characterized by the lack

of IT tools utilization. Stages one, two, three and four were characterized by a high use of Local Applications investments, even though it decreased to each following stage. The last three stages, five, six, and seven, were the most mature in terms of EA and they possess a similar pattern of IT investments when compared to the first stages of large companies presented in the model of Ross et al. (2006). Additionally, the identified maturity stages were significantly different among them regarding the number of employees and the age of the companies, corroborating the literature and confirming the proposed EA maturity model to SMEs.

In summary, the results suggest that small companies have fewer activities and use less EA while larger companies are more complex and use more EA. However, after a certain point, the more they increase their EA level, the more efficient they become and the fewer employees are needed. These results are important because they show that investments in IT can sustain competitiveness in the dynamic environment as stated by Prahalad and Hamel (1990) and Khayami (2011).

Regarding the practical implications, the model can direct the efforts of small businesses in the researched region to improve efficiency and business competitiveness. Therefore, policies are needed to awaken entrepreneurs to this reality so that they can enjoy the benefits that may accrue from investments in IT. Regarding the theoretical implications, this research proposes an EA maturity model for small businesses, contributing to bring the EA concepts for the SMEs context.

Some limitations of the research are the context of small and medium enterprises of Southern Brazil, which do not permit results generalization to other countries' contexts. Future researches could use the proposed model to assess SMEs' EA maturity stages in other countries or could fill the gap of the relation between EA maturity stages and firms' performance in the context of SMEs.

ACKNOWLEDGEMENTS

We thank CAPES, PUCPR, UnC and SEBRAE for their support. We also thank the Enterprise Architecture Working Team in PUCPR for the many reviews and proposed ideas during this research development.

Conflict of Interests

The authors have not declared any conflict of interests

REFERENCES

- Albertin AL (2010). *Comércio Eletrônico. Modelo, Aspectos e Contribuições de sua Aplicação*. 6 ed. São Paulo: Editora Atlas, 2010.

- Bakhshadeh M, Morais A, Caetano A, Borbinha J (2014). Ontology Transformation of Enterprise Architecture Models. 5th IFIP WG 5.5/SOCOLNET Doctoral Conference on Computing, Electrical and Industrial Systems, DoCEIS 2014, Costa de Caparica, Portugal, April 7-9:423:55-62.
- Beheshti H (2004). The impact of IT on SMEs in the United States. *Inf. Manag. Computer Security* 12(4):318-327.
- Beltrame MM, Maçada, ACG (2009). Validação de um Instrumento para medir o Valor da Tecnologia da Informação (TI) para as organizações. Ano 5, n. 9. Rio Grande do Sul: Universidade Federal do Rio Grande do Sul.
- Castells M. (2006). The Network Society: From Knowledge to Policy. In: M. Castells & G. Cardoso (edt.) *The Network Society From Knowledge to Policy*. Washington, Center for Transatlantic Relations.
- Cragg P, Mills A (2011). IT support for business processes in SMEs. *Bus. Process Manag. J.* 17(5):697-710.
- Dibrell C, Davis PS, Craig J (2008). "Fueling innovation through information technology in SMEs", *J. Small Bus. Manag.* 46(2):203-18.
- DIEESE (2013). Departamento Intersindical de Estatística e Estudos Socioeconômicos. Anuário do Trabalho na Micro e Pequena Empresa. São Paulo.
- Fallmyr T, Bygstad B (2014). Enterprise Architecture Practice and Organizational Agility: An Exploratory Study. 47th Hawaii International Conference on System Sciences, {HICSS} 2014, Waikoloa, HI, USA, January 6-9:3788-3797.
- Fuller T (2003). If you wanted to know the future of small business what questions would you ask? *Small Bus. Futures* 35(4):305-321.
- Fuller T (1996). Fulfilling IT needs in small businesses; a recursive learning model. *Int. Small Bus. J.* 14(4):25-44.
- GAO (2010). A Framework for Assessing and Improving Enterprise Architecture Management (Version 2.0). Retrieved December 15, 2014, from <http://www.gao.gov/assets/80/77233.pdf>
- GEM (2013) Empreendedorismo no Brasil. Coordenação de Simara Maria de Souza Silveira Greco ; autores: Mariano Macedo Matos... [et al] -- Curitiba: IBQP, 170 p. : il.
- Hair JFJ, Black, WC, Babin BJ, Anderson RE (2010). *Multivariate Data Analysis Seventh Edition* Prentice Hall.
- CGI.br (2013). Pesquisa sobre o uso das Tecnologias de Informação e Comunicação - TIC Centros Públicos de Acesso 2013. <http://cgi.br/publicacao/pesquisa-sobre-o-uso-das-tecnologias-de-informacao-e-comunicacao-tic-centros-publicos-de-acesso-2013/>
- Hamel G, Prahalad CK (1989). Strategic intent. *Harvard Bus. Rev.* 64:63-76.
- Holáťová D, Brezinová M, Kantnerová L (2015). Strategic Management of Small and Medium-Sized Enterprises. *WSEAS Trans. Bus. Econ.* 12:65-73
- Iacob ME, Meertens LO, Jonkers H, Quartel DAC, Nieuwenhuis LJM, Van Sinderen, MJ (2012). From Enterprise Architecture to Business Models and Back. *Softw Syst Model.* December: 1-25. doi: 10.1007/s10270-012-0304-6
- IEEE (2000). Std 1471-2000 IEEE Recommended Practice for Architectural Description of Software-Intensive Systems. Doi: 10.1109/IEEESTD.2000.91944.
- Johnston DA, Wade M, McClean R (2007). "Does e-business matter to SMEs? A comparison of the financial impacts of internet business solutions on European and North American SMEs". *J. Small Bus. Manage.* 45(3):354-61.
- Kappelman LA, Zachman JA (2013). The Enterprise and its Architecture: Ontology and Challenges. *J. Comput. Inform. Syst.* 53(4):87-95.
- Khayami R (2011). Qualitative characteristics of enterprise architecture. *Proc. Comput. Sci.* 3:1277-1282.
- Li S, Vertinsky I, Zhou D (2004). The emergence of private ownership in China. *J. Bus. Res.* 57(10):1145-1152..
- Menchaca AGV, Lebrun CV, Benitez EO, Garcia JCP, Garza OA, Martinez OMP, Alvarado SRC (2014). Practical application of Enterprise Architecture, study case of SME metalmechanic in Mexico. *Euro. Scientific J.* 9(10):233-241.
- Moraes G, Terence A, Escrivão Filho E (2004). A tecnologia de informação como suporte à gestão estratégica da informação na pequena empresa. *Revista de Gestão da Tecnologia e Sistemas de Informação*. [S.l.]. 1(1).
- NASCIO (2003). Enterprise Architecture Maturity Model. Retrieved December 15, 2014, from <http://www.nascio.org/publications/documents/nascio-eamm.pdf>
- Norusis MJ (2011). *IBM SPSS Statistics 19 Advanced Statistical Procedures Companion*. Prentice Hall.
- O'Brien JA (2002). *Introduction to information systems: essentials for the e-business enterprise*. McGraw-Hill, Inc.
- OECD (2002). *Organisation for Economic Co-operation and Development, OECD SME Outlook*.
- Porter M (1989). *Vantagem competitiva: criando e sustentando um desempenho superior*. 15. ed. Rio de Janeiro: Campus, 1989.
- Prahalad CK, Hamel G (1990). The core competence of the corporation. *Harvard Bus. Rev.* 68(3):79-91.
- Prates G, Ospina M (2004). Tecnologia da informação em pequenas empresas: fatores de êxito, restrições e benefícios. *Revista de Administração Contemporânea* 8(2):9-26.
- Premkumar GA (2003). Meta-analysis of research on information technology implementation in small business. *J. of Organizational Computing and Electronic Commerce.* 13(2):91-121.
- Robu M (2013). The Dynamic and importance of smes in economy. *The USV Annals of Economics and Public Administration* 13(1 &17):84-89.
- Ross JW, Weill P, Robertson DC (2006). *Enterprise architecture as strategy: Creating a foundation for business execution*. Harvard Business Press. EUA.
- Rouhani BD, Mahrin MN, Nikpay F, Ahmad, RB, Nikfard P (2015). A systematic literature review on Enterprise Architecture Implementation Methodologies. *Inform. Software Technol.* 62:1-20.
- Sasa A, Krisper M (2010). Analitski vzorci za poslovno-informacijske arhitekture. *Uporabna informatika XVIII. letnik 18. številka 3*:129-143.
- Sasa A, Krisper M (2011). Enterprise architecture patterns for business process support analysis. *J. Syst. Software* 84(9):1480-1506.
- SEBRAE -(2011). As pequenas empresas do simples nacional. Núcleo de Estudos e Pesquisas. http://www.sebrae.com.br/Sebrae/Portal%20Sebrae/Anexos/As_pequenas_empresas_SN.pdf. Accessed 10/05/2015.
- SEBRAE (2013). *Sobrevivência das empresas no Brasil, Coleção de Estudos e Pesquisas*.
- SEBRAE (2014) *As Tecnologias de Informação e Comunicação (TICs) nas MPE brasileiras*.
- Simon D, Fischbach K, Schoder D (2013). An Exploration of Enterprise Architecture Research, Communications of the Association for Information Systems: Vol. 32, Article 1.
- SEBRAE (2013). Enterprise architecture management and its role in corporate strategic management. *Inf. Systems and E-Business Management Online First.* 12:5-42. DOI 10.1007/s10257-013-0213-4.
- Smith J (1998). *The book, The publishing company*. London, 2nd edition.
- Veiga CRV, Da Veiga CP, Catapan A, Tortato U, Silva WV, Leinig AKG (2014). Institutional Theory and Resource Dependency in the Alteration of Distribution Channels. *Int. Bus. Manage.* 8:240-250.
- Weill P, Ross JW (2009). *IT Savvy: What top executives must know to go from pain to gain*. Harvard Business Press.
- World Bank (2002). *World Development Report 2002: Building Institutions for Markets*, Oxford University Press, Oxford, p.57.
- Yoganingrum A, Sensuse DI, Murni A (2013). A Taxonomy of Enterprise Architecture Framework for Indonesian SMEs. *Int. J. Comput. Sci. Issues* 10(2):445-452.
- Zimmerer T, Scarborough NM, Wilson D. (2002). *Essentials of entrepreneurship and small business management*. Upper Saddle River, NJ: Prentice Hall.

Full Length Research Paper

TOC, lean and six sigma: The missing link to increase productivity?

Diego Augusto de Jesus Pacheco

Federal University of Rio Grande do Sul, UFRGS, Postgraduate Program in Production Engineering and Transports, Department of Production and Transport Engineering, Av. Oswaldo Aranha 99, 90035-190, Porto Alegre, RS,

Received 21 December, 2014; Accepted 20 June, 2015

The objective of this study is to analyze the points of convergence and divergence between the Theory of Constraints, Lean Manufacturing and Six Sigma in an integrated manner when used for continuous improvement of manufacturing systems. This research also aimed to advance a better understanding of the fundamental principles of such methodologies by performing a comparative analysis of critical issues. The focus of discussion of this study was to search the literature to identify characteristics of exclusion and similarities between the three approaches when applied in an integrated way in productive systems. The results of this study suggest that the Theory of Constraints, Lean Manufacturing and Six Sigma have many complementary elements that overlap the divergent points and there is a big space of research to be explored on this issue. As a result, this study presents a critical analysis of 28 comparative criteria relevant to the three approaches.

Key words: Theory of constraints, lean manufacturing, six sigma, continuous improvement, manufacturing systems.

INTRODUCTION

The main objective of this paper is to investigate the convergence and divergence factors between Lean Manufacturing, Theory of Constraints and Six Sigma methodologies, when they are used together in manufacturing environments for continuous improvements. The present discussion is that the use of the above approaches focuses on continuous improvement as being done by several organizations, and as a rule, such approaches have reached their limit of performance concerning the current competitiveness

and complexity of some markets (Khadem et al., 2008; Lu et al., 2011; Myrick, 2009; Valles, 2009). Moreover, it is necessary to find elements of other approaches that turn more robust than the current strategies for continuous improvement. Gains in reducing inventory and lead time applying the Theory of Constraints in production systems, for example, were identified by Phruksaphanrat et al. (2011) and Adetunji and Yadavalli (2012).

Thus, some authors have studied the combination of

E-mail: diego.pacheco@producao.ufrgs.br. Tel: (51) 3308-3491. Fax: (51) 3308-4007.

Author agree that this article remain permanently open access under the terms of the [Creative Commons Attribution License 4.0 International License](http://creativecommons.org/licenses/by/4.0/)

approaches in order to provide integrated models of continuous improvement. Stamm et al. (2009) analyzed the evolution and fundamental differences between TQM (Total Quality Management), TPM (Total Productive Maintenance), TOC (Theory of Constraints), Lean and Six Sigma, contrasting these approaches with the Fordist production model. It was found that: i) Lean Manufacturing presents a higher paradigm based on production drawn when compared to that based on pushed production ii) it is possible to develop models integrating Lean and other methodologies of quality management, and iii) the combination of TOC with other approaches indicates superior results when compared to other models. Nave (2002) compared the Theory of Constraints, Lean Manufacturing and Six Sigma, identified common assumptions among the three philosophies and obstacles to their deployment, and pointed that the greatest challenge for organizations is choosing the strengths of each approach.

However, from the literature review in the databases searched, there was an absence of a comparative study done from the standpoint of logical review that discussed TOC, Lean and Six Sigma concerning the research possibilities and limits of integration in order to achieve continuous improvement. In order to highlight this gap in operations management literature, this study researched publications in the following databases: Emerald, Springer Link, Scopus, Ebsco, Proquest and Scielo International. The gap resulting from the lack of scientific articles discussing these three traditional approaches was therefore one of the main reasons for the development of the present work. By making a critical comparative analysis involving such approaches, this research also sought to objectively show their main similarities and differences and thus contribute to management decision making.

TOC, LEAN AND SIX SIGMA

According to Arnheiter and Maleyeff (2005), both Lean and Six Sigma implement a culture of continuous improvement at all levels within the company. And the advantage of the approach lies on the use of integrated scientific and quantitative quality provided by Six Sigma, in relation to the techniques of Lean. The Six Sigma projects focus their efforts on reducing the variation from the proposed standard, which at times may not be focusing on the customers' requirements, but only in a cost-cutting exercise. Therefore, it is suggested to simultaneously adopt the flow view of Lean (Bendell, 2006). For Harrison (2006) the use of this approach isolated in such way may not be effective, and they can create two subcultures within the company, fighting for the same human and financial resources.

Dettmer (2001) indicated the following points of similarity between the TOC and Lean approaches: they

have the common goal of increasing profits; the value is defined by the customer; the quality factor is essential for both; they support the production in smaller batches, they aim continuous stream and increased capacity, they seek to minimize inventory and the labor force participation plays an important role in the successful deployment of the method and tools.

According to Scheinkopf and Moore (1998), common points between TOC and Lean approach are: (i) the perception of value from the customer perspective: the Lean value is clearly defined in TOC and the customer perceptions of value are a key factor to increase the gain of the product, (ii) Value Stream: Lean adopts the term value stream and TOC adopts the term value added to clarify that the value perceived by the customer is defined by a chain of interdependencies between the factory and the suppliers (iii) flow and pull production: they offer techniques to control flow using the concept of pulling the market demand. Lean pulls sequentially, since the feature is not expected to produce until the resource downstream signal (kanban) is received. Pulling is the essence of DBR (Drum-Buffer-Rope) to synchronize the neck with market demand and promote the release of material into the system, iv) the pursuit of perfection: according to Goldratt (1984) the only way that a company will prosper after a change is from continuous improvement. This idea is expressed in Step 5 Process Focus of TOC and Lean Kaizen philosophy.

The Six Sigma approach identifies projects driven by the reduction of defects in the process and operational improvements. However, it does not fully involve operators and it lacks a systemic view to understand how these projects will affect the overall system performance. According to Husby (2007) this aspect can lead not only to project prioritization with no financial impact for the company as well as to the elimination of the positive impacts on other processes. Therefore, the main objective of this study is to analyze the points of convergence and divergence between the Theory of Constraints, Lean Manufacturing and Six Sigma when used for continuous improvement of manufacturing systems. We wanted advance in a better understanding of the fundamental principles of such methodologies by performing a comparative analysis of critical issues, searching in the literature characteristics of exclusion and similarities between the three approaches.

MATERIALS AND METHODS

Data collection is a key aspect in qualitative research, especially in researches that perform comparative analysis between different approaches. In scientific research, it is believed that the first step is in general to look for similar concerns in previous work (Silva, 2009). Thus, an important source of data collection for this study was a systematic review of the literature. According to Gil (2010, p. 29), the literature is prepared based on previously published material, whether printed or digital as: articles, theses, journals,

dissertations etc. Virtually all academic research requires some time to carry out a work that could be characterized as literature. For Khan et al. (2001) the main advantage of using a method of systematic review is that it provides information on interventions effectiveness to identify, evaluate, and summarize the results of an amount of data not treatable otherwise. The research presented here used the work of Smith (2009) and the study of Tranfiel et al. (2003) as a basis.

The procedure adopted here for the literature review was: i) to extract keywords from the search problem: the words selected are: Lean Manufacturing, Toyota System, Lean Production, Six Sigma and Theory Of Constraints; ii) to define the databases where to search for publications. The databases researched were: Emerald, Springer Link, Scopus, Ebsco, Proquest, Scielo International; iii) to set time horizon for the search: the search performed here ranged from year 1995 to 2012; iv) to examine titles and abstracts of publications: 836 papers were analyzed and the number analyzed in each database is detailed in Table 1; v) to decide between the inclusion or exclusion of the publication in the search; vi) to make analysis, synthesis and inclusion of information in the search: this discussion is consolidated in the section four of this paper where the works with their focus aligned to the discussion of this research were chosen. That the research on databases shows a greater number of publications dealing on Lean and Six Sigma than the number of publications on TOC and Lean and Six Sigma. Integration between TOC and Six Sigma seemed to be recent in the literature so that it brings only a few studies on the subject thus becomes an opportunity for further research.

RESULTS AND DISCUSSION

TOC and Lean

Some works of computational simulation comparing JIT, currently named Lean, and TOC were performed by Miltenburg (1997); Chakaravorty and Atwater (1996); Cook (1994) and Watson and Patti (2008). Miltenburg (1997) showed that JIT operates with less inventory and lead times while TOC generates higher productivity. Chakaravorty and Atwater (1996) concluded that TOC is suitable for systems with variability and downtime (unavailability of produce) relatively high, while JIT is better to lower system variability and downtime. Cook (1994) concluded that the performance of TOC is better and that the JIT would have to eliminate virtually all the variability of the system to make the performance similar to TOC. The work conducted by Sale and Inman (2003) showed that the combined use of JIT and TOC can result in a higher performance if compared to the use of the individual approaches. Patti and Watson (2008) concluded that TOC is more tolerant of variability, has less lead time and needs on average 50% less than the JIT inventory for the same productivity. This information is based on the strategy of focusing on the management of production bottlenecks system, and rather than manage equally all the resources of the productive system.

According to Antunes (1998), the main convergences regarding logistics approach are: (i) there two central

concerns: the need for synchronization of production and the establishment of a systematic process of continuous improvement, (ii) there are specific techniques for addressing the problem of synchronization, logic Drum-Buffer-Rope (DBR) for TOC and kanban for lean production, (iii) both are concerned with the continuous improvement of Productive Systems. In TOC this appears in Step 4 (increase the capacity of restriction) based on the analysis already carried out in Step 1 of TOC (identify constraints).

According to Dettmer (2001), TOC and Lean philosophy evolved into a systemic view and it is suggested that a hybrid of the two approaches is more robust, more productive and easier to implement and that the main aspect is the selection of elements to the model. Dettmer (2001) suggests the following points of congruence: they are systems methodologies, both aim at continuous improvement and continuous flow, the value stream extends beyond production, and leads to release of hidden capacities. However, Dettmer (2001) proposes that the greatest differences lie in two aspects: how each one treats the variability and uncertainty and how they treat costs. While Lean aims to reduce fixed and variable costs, for TOC the cost reduction is limited, and the generation of gain is not. TOC accepts the variability and instability of demand and strategic operations using buffer (physical, time, capacity), while Lean constantly seeks to reduce variability. Overall, Dettmer (2001) considers that there is a substantial overlap between the paradigms of lean thinking and TOC, where TOC provides a framework to guide efforts and Lean avoids the pitfalls of applying them where they are not necessary.

TOC and Six Sigma

Husby (2007) suggests that the five focusing steps of TOC can fulfill this gap. However, the author points out that the thinking process of TOC analysis and troubleshooting makes use of a language that requires complex intellectual guidance by skilled experts and a different approach for management and for operators. From the point of view of Jin et al. (2009), the focus of Six Sigma is the client and the the focus of TOC is the organization and although they are different philosophies, both have been used by various industries for process improvement because while Six Sigma requires solutions in depth, TOC can reveal bottlenecks and avoid them. According to Nave (2002), the common way of integration between TOC and Six Sigma is to identify the restriction of the company and use Six Sigma to reduce its variation or to solve this problem.

According to Jin et al. (2009), the main advantages of the combination of the two approaches are: (i) the restriction is analyzed, measured and controlled by a set of statistical tools, thus increasing the understanding of

Table 1. Summary of comparative critical analysis of TOC, lean and six sigma.

Criteria	Theory of Constraints	Lean Manufacturing	Six Sigma
Source	Goldratt (1980)	Toyota (Toyoda, Ohno and Shingo-1950's)	Motorola e General Electrics (1980's)
Theory	Manage constraints and generate gains	Elimination of losses and increase profit	Reduce variability
Application structure	1. Identify the constraint 2. Explore the constraint 3. Subordinate 4. Increase the constraint 5. Return to step 1	1. Specify value 2. Identify the value stream 3. Flow 4. Pull 5. Seeking perfection	1. Define 2. Measure 3. Analyse 4. Improve 5. Control
Focus	On constraints	On the flow	On the problem
Goal	Continuous increase in profits	Maximize productivity	Maximize business results
Strategic objective	Synchronize	Simplify	Stabilize
Assumptions	- Emphasis on speed and volume - Analyzes existing systems - There is interdependence between processes	- The reduction of wastes increases business performance - Several small improvements are better than the overall analysis system	- There is a problem - Statistical tools are used - Improvements in the rate of output of the system by reducing the variation in processes
Primary effects	Increases gain rapidly	Flow time reduction	Rate uniform process output
Side effects	- Reduction of inventories and losses - Gain is the meter system performance - Improvement in quality - New accounting system	- Reduces the variability - Generates uniform process outputs - Reduced inventory. - Flow meter is the performance of managers - Improves quality and productivity	- Reduces losses. - Reduces inventory - Variability is the meter performance of managers - Improves quality - Culture change
Deficiencies	Ignore parts of the organization to focus on manufacturing and the restriction	- Does not apply statistical tools or systems analysis - Focus on limited losses	- Does the interdependence within the system - Improvements made processes independently. - Creates elite employees
Ease of implementation	Greater difficulty	Minor difficulty	Medium difficulty
Managerial level application	Top management	First leve	Technical level and middle management
Structure implantation	It does not refer	It does not refer	Belts and Champion
Effect on the variability	Absorbs variation	Reduces	Reduces
Major contributions	Systemic view of the restrictions	Pull, takt time, Heijunka, one-piece flow, value stream mapping and respect for people	Organizational structure with experts improvements, projects and guided quantification of cost reductions

Table 1. Cond.

Process Aspects	- Metric specific accounting. - Focus on systematic restriction	- Management of the workflow by JIT - Optimization of processes	- Tools specific statistics. - Specific Terminologies - Structure specific expert
17. Batch Size	Larger batches for restriction and lower non bottlenecks	Small batches throughout the system	It does not refer
Production Control	The algorithm Rope Drum-Buffer-Rope is used to free stuff	Kanban triggers the production release	It does not refer
Production Planning	Detailed planning for the restriction and less detailed non-bottlenecks DBR (Drumm, Buffer and Rope)	- Detailed planning of final assembly - Other operations are driven to meet the assembly through the Kanban	It does not refer
Distribution of knowledge	Knowledge is centered and focused on constraints	Knowledge is shared as a reduction of losses and is the responsibility of all	Knowledge centered in Belts and training is highly focused
Culturally dominant aspects	- Requires a change in approach - Extends in all parts of business	- Culture of minimum waste - Emphasis on continual improvement	- Empowerment of employees - Changes philosophy - Focus on Customers
Leadership style	Leader of driver profile	Leader facilitator profile	Leader of driver profile
Data requirements	Amount and accuracy of data is less critical compared to traditional production methods	Amount and accuracy of data is partly critical of traditional production methods	Requires large quantity and accuracy of data for decision making
Inventory	- Inventory is needed to facilitate the production, but the goal is to minimize inventory - Buffers are placed in front of the neck and the intersection between paths of non-bottlenecks and the path of a bottleneck to their production orders	Stock is zero and the target depends on the number of kanbans in the system	It does not refer
Capacity planning	- Consider finite capacity - It is planned by computer simulation	- Did finite capacity - It is planned by Kanban	It does not refer
Information Technology	Computational resources are needed for deployment	Low need	Computational resources used mainly for statistical
Stability Requirements for deployment	- Indifferent, but performs best in environments of medium or low stability	Environment with high stability	Indifferent
Indicators of performance management	- Global Indicators: Net Profit, Return on Investment, CashFlow; - Local Indicators: Gain, Inventory, Operational Expenses	- Cost Target - Cost-Kaizen	DPMO (Defects Per Million Opportunities)

the problem and decisions, (ii) the bottleneck is the first point to be analyzed, thus generating increased financial gain for the company and the Six Sigma project will not be chosen by a single

business area, but by the overall view that the TOC will generate the project outcomes throughout the system. On the other hand, according to Jin et al. (2009), the disadvantages

are: (i) not always the variation reduction will increase the constraint capacity (ii) when the variation reduction increases the production rate of the bottleneck, downstream processes can

generate higher rates of rejection since the focus was solely laid on the neck, (iii) the uncertainty of applying the principles of TOC and then the six sigma design or vice versa. The integration model of Six Sigma and TOC proposed by Jin et al. (2009) assumes an environment with limited budget for improvements and application of Six Sigma in post-bottleneck resources in order to assure quality and efficiency. This model has been replicated in a motor manufacturing company with satisfactory results.

To Ehie and Sheu (2005), there are similarities between the improvement processes of Six Sigma (DMAIC) and TOC (Five Focusing Steps). The authors proposed an integrated model where the initial step of constraint identification is the same for both approaches. The next step follows the logic of TOC using its capacity to exploit the Six Sigma phases of measure and analyze as a support. The following step also adopts the capacity to explore the TOC logic by using their "Improve phase" of Six Sigma and its statistical tools to eliminate the problems and the causes indicated in the previous step; step four uses Subordinate step of TOC and "Control" of Six Sigma in order to assure that all actions taken previously are applied in the system. In step five, efforts are made to increase the capacity of the constraint and the last step evaluates the next constraint to avoid the inertia of the system. To refine the model, the authors suggested incorporating the TOC Thinking Process to understand the cause-effect interactions in the system as well as add other approaches aimed at continuous improvement.

Lean and Six Sigma

There is a limit of integration because the strategy used for the improvement depends on the problem to be solved, and therefore there must be alignment between the two approaches in order to achieve effective results (Banelas and Antony, 2004). According to Sharma (2003), Six Sigma should be used to boost the implementation of Lean efforts. For Bendell (2006), balance is the creation of value from the point of view of the customer in order to focus on the market and, at the same time, reduce the variation to acceptable levels while reducing costs. Bendell (2006) also argues that the two paradigms are catalysts of change and that they can be a powerful tool to align with cultural aspects of Lean Six Sigma projects. There is enormous potential for a sustainable organizational change and process improvement integrating Lean and Six Sigma (Bendell, 2006).

According to Snee (2010), Six Sigma is typically used to solve complex problems for which the solution is unknown. It is important to remember that the goal is to find the causes of the low performance and not just focus on the symptoms. In this case, the view of lean flow

contributes to the use of Six Sigma and suggests the simultaneous use of approaches. Snee (2010) listed eight key features that contribute to the performance when Lean and Six Sigma are synergistically applied: they create financial results, they activate the involvement of top leadership, they use a disciplined approach (DMAIC) their projects are quickly concluded, there is clear definition of success, the human infrastructure (belts) created, the focus on customers and processes and the use of a statistical approach.

For Montgomery (2010) Lean improvement projects can be managed using the DMAIC methodology. Montgomery (2010) supports the use of Six Sigma and Lean as a model that captures the philosophy of continuous improvement and the system of deep knowledge proposed by Deming. Higgins (2005) sets a difference between the two systems arguing that Six Sigma is run by a few specific individuals within a company, whereas in Lean, training involves all levels of the company to identify and eliminate non-value added activities. Moreover, Arnheiter and Maleyeff (2005) point out the aspects between the approaches: Lean companies should adopt the use of quantitative data to make decisions and a more scientific approach to assess the quality within the system, meanwhile companies using Six Sigma, need a broader systems approach, considering the effects of waste on the system as a whole.

Bendell (2006) mentions that Lean and Six Sigma philosophies have become poorly defined, resulting in reduced effectiveness and very often the presented methodologies are put together without a logical explanation and without any explanation or theoretical basis for the choice of techniques. Spector and West (2006) point out that by adopting the Lean and Six Sigma, practitioners can find a variety of projects with insufficient results for the amount of time needed to finish them.

From the above considerations it seems, in short, that: (i) the two approaches are complementary and it is feasible to evaluate the integration between the two approaches, (ii) integration, project management and corporate strategy need to be aligned together in order to avoid having separate systems with Lean and Six Sigma approaches, (iii) it was noticed also that, if Lean is implemented individually, specific tools to leverage its full potential according to the complexity of the problem under analysis will be missing. Likewise, if a Six Sigma project is implemented without a systemic vision of lean, the focus on the global flow is forgotten and the improvement project performance is compromised.

Therefore, in order to meet the main objective of this research that is to analyze the points of convergence and divergence between the three approaches from the standpoint of continuous operational improvement and to broaden the understanding of their fundamental principles,

Table 1 was elaborated. From the literature review and the discussions in the previous sections, it presents a summary of the review comparing the three approaches and showing 28 analysis criteria. It was considered that these criteria are fundamental to the understanding of the comparative approaches, thus contributing to academic and practitioners understanding.

Moreover, Table 1 provides important insights for decision making in production systems. The main implications for practice implementation of TOC, Lean and Six Sigma are shown in a comparative analysis of 28 different criteria for the three approaches. Recently, research analyzing the evolution of TOC has been performed. Boyd and Gupta (2008) investigated the extent of TOC performing an analysis with Operations Management and obtained the following findings: (i) the TOC offers a new paradigm in Operations Management which replaces an outdated consensus to seek to achieve the goals of efficiency of company; and thus the pursuit of the goal from a global perspective would be more consistent to this new paradigm in the management of operations; (ii) TOC has in scope definition criteria and guidelines as a valid theory in operations management; however, more empirical tests are needed to validate the TOC as a valid theory in Operations.

So, the general conclusion is that, due to the improvement and evolution of the scope of the TOC over the years, it needs to be discussed and analyzed at the prospect of becoming a valid theory in the field of operations management.

The results of Table 1 also showed that the implications for implementation of TOC, Lean and Six Sigma are according to the research of Atunes (1998), which cites the logic proposed by TOC and Lean has a high degree of agreement as proposed vision of the production system as a whole. The main similarities are: (i) TOC and Lean have vision of an open system with respect to the design of production systems and are linked to Paradigm of Processes Improvement. In this topic, it is necessary to say that Six Sigma also seeks continuous improvement by reducing variability; (ii) Six Sigma, Lean and TOC use scientific method for the solution of many problems related to production management and run a deductive logic to develop specific technical solutions for the improvement; (iii) The three approaches privilege management from subsystem improvements, give priority emphasis to subsystem management improvements and innovation management; (iv) the main objective of the three proposals is to seek continuous improvement of indicators. In TOC this is done by monitoring the Global and Local Indicators. Lean uses the logical of Target Cost and Kaizen Cost. Six Sigma uses Defects per Million Opportunities (DPMO).

The results of this study suggest that the Theory of Constraints, Lean Manufacturing and Six Sigma have many complementary elements that overlap the divergent

points and there is a big space of research to be explored on this issue and improve the theory and practice about industrial engineering for increase the productivity of production systems.

Conclusion

This study aimed to analyze the points of convergence between Theory of Constraints, Lean Manufacturing and Six Sigma when used with a view to continuous improvement of processes in manufacturing systems. The discussion also tried to contribute to a better understanding of the fundamental principles of such methodologies by performing a comparative analysis of aspects considered critical. After the analysis, it was found that the purposes of analyzing the points of convergence and exclusion between the three approaches and contribute to a better understanding of its fundamental principles have been met. It was found generally that there are more points of overlap between the three approaches than exclusion and it is viable to think in constructing an integrated continuous process improvement system which will enhance competitiveness.

However, there are critical factors that must be considered in constructing models by integrating the three approaches without which the development of a holistic model will lose its strength. Among the main critical factors, the literature still does not have a clear definition on such aspects: i) how to choose the correct elements of each approach according to the real needs of the organization, ii) the company must precisely define what is their priority: reduce variability or reduce losses or improve the flow or remove the constraints? ii) the correct diagnosis on culture, goals, strengths and weaknesses of the organization should also be considered as an aspect of integration of the three approaches and revealed a lack of research on this topic, iii) the principles of construction of a model incorporating such approaches must necessarily be aligned with the company's strategy and goals.

ACKNOWLEDGEMENT

This research was conducted with support from CNPq/Brazil (National Council for Research and Development) to which the author expresses gratitude.

Conflict of Interests

The authors have not declared any conflict of interests

REFERENCES

Adetunji OAB, Yadavalli V (2012). An integrated utilization, scheduling and lot-sizing algorithm for pull production, *Int. J. Ind. Eng.* 19(3).

- Antunes Junior JAV (1998). Em direção a uma teoria geral do processo na administração da produção: uma discussão sobre a possibilidade de unificação da teoria das restrições e a teoria que sustenta a construção dos sistemas de produção com estoque zero. 1998. 407f. Tese (Doutorado) - Programa de Pós-Graduação em Administração, Escola de Administração, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, 1998.
- Arnheiter ED, Maleyeff J (2005). The integration of lean management and six sigma. *TQM Magazine* 17(1):5-18.
- Banuelas R, Antony J (2004). Six sigma or design for six sigma? *The TQM Magazine*, York, Inglaterra, GB, 16(4):250-263.
- Bendell T (2006). A review and comparison of six sigma and the lean organization. *The TQM Magazine*, York, Inglaterra, GB, 18(3):255-262.
- Boyd L, Gupta M (2004). Constraints management: what is the theory? *Int. J. Oper. Prod. Manage.* 24(4):370-371.
- Chakaravorty SS, Atwater BJ (1996). A comparative study of line design approaches for serial production systems. *Int. J. Oper. Prod. Manage.* 16(6):91-108.
- Cook DP (1994). A simulation comparison of traditional, JIT and TOC manufacturing Systems in a flow shop with bottlenecks. Falls Church, Va. US., *Prod. Invent. Manage. J.* 35:73-78.
- Dettmer W (2001). *Beyond Lean Manufacturing: Combining Lean and the Theory of Constraints for Higher Performance*. Goal System International, Port Angeles, USA. 2001. In: <http://www.goalsys.com/books/documents/TOCandLeanPaperrev.1.pdf>.
- Ehie I, Sheu J (2005). Integrating six sigma and theory of constraints for continuous improvement: a case study. *J. Manuf. Technol. Manage.* 16(5):542-553.
- Ghinato P (1996). *Sistema Toyota de produção: mais do que simplesmente Just-In-Time*. Caxias do Sul: Ed. Universidade de Caxias do Sul.
- Gil AC (2010). *Como elaborar projetos de pesquisa*. São Paulo: Atlas.
- Goldratt EM (1991). *A síndrome do Palheiro: Garimpando informações num oceano de dados*. São Paulo: Educator.
- Goldratt EM, Cox JF (1984). *A Meta*. 1.ed. São Paulo: Nobel.
- Gupta MC, Boyd LH (2008). Theory of constraints: a theory for operations management, *Int. J. Oper. Prod. Manage.* 28(10):991 – 1012.
- Husby P (2007). Competition or Complement: Six Sigma and TOC. *Material Handling Management*. pp.51-55..
- Inman RA, Sale MLW, Green Jr. KW (2009). Analysis of the relationships among TOC use, TOC outcomes, and organizational performance. *Int. J. Oper. Prod. Manage.* 29(4):341-356.
- Jin KJ, Hyder AR, Elkassabgi Y, Zhou H, Herrera A (2009). Integrating the Theory of Constraints and Six Sigma in Manufacturing Process Improvement. *Proc. World Acad. Sci. Eng. Technol.* Vol. 37.
- Khadem MSk, Ahad A, Seifoddini H (2008). Efficacy of Lean Metrics in Evaluating the Performance of Manufacturing Systems. *Int. J. Ind. Eng.* 15(2).
- Kruger DJ, Randass JK (2010). Assessment of the Reasons for Failure and Critical Success Factors Implementing CI Projects: Case Study Results from the South African Apparel and Manufacturing Industry. *IEEE*.
- Lu X, Jia Z, Yang J, Liu H (2011). Design and implementation of Lean Facility Layout System of a Production Line. *Int. J. Ind. Eng.* 18(5).
- Miltenburg J (1997). Comparing JIT, MRP and TOC, and embedding TOC into MRP, *Int. J. Prod. Res.* 35(4):1147-1169.
- Myrick J, Burkhardt T, Nelms L, Patch S, Yearout R (2009). Professional Perceptions of Six Sigma's Value, *Int. J. Ind. Eng.* 16(3).
- Montgomery DC (2010). A modern framework for achieving enterprise excellence International, *J. Lean Six Sigma* 1(1):56-65.
- Nave D (2002). How to compare Six Sigma, Lean and the Theory of Constraints. *Quality Progress* pp.73-79.
- Phruksaphanrat B, Ohsato A, Yenradee P (2011). Aggregate production planning with fuzzy demand and variable system capacity based on TOC measures, *Int. J. Ind. Eng.* 18(5).
- Sale ML, Inman RA (2003). Survey-based comparison of performance and change in performance of firms using traditional manufacturing, JIT and TOC. *Int. J. Prod. Res.* 41(4):829-844.
- Sharma U (2003). Implementing Lean principles with the six sigma advantage: how a battery company realized significant improvements. *Journal of Organizational Excellence*. Summer.
- Scheinkopf L, Moore R (1998). *Theory of Constraints and Lean Manufacturing; Friend or Foes?* Chesapeake Consulting.
- Shingo S (1996). *O Sistema Toyota de Produção: Do ponto de vista da engenharia de produção*. Bookman.
- Silva ÉRP (2009). *Método para revisão e mapeamento sistemático da literatura (DEI-POLI/UFRJ)*. Trabalho de conclusão de curso em Engenharia de Produção.
- Snee RD (2010). Lean Six Sigma: getting better all the time. *Int. J. Lean Six Sigma* 1(1):9-29.
- Spector RE (2006). How constraints management enhances Lean and Six sigma. *Supply Chain Management Review*. pp.42-46.
- Stamm ML, Neitzert TR, Darius PK (2009). TQM, TPM, TOC, Lean and Six Sigma – Evolution of manufacturing methodologies under the paradigm shift from Taylorism/Fordism to Toyotism? *International Annual Euroma Conference, Gothenburg, Sweden, 2009*.
- Tranfield D, Denyer D, Palminder S (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *Br. J. Manage.* 14:207-222.
- Valles A, Sanchez J, Noriega S, Gómez Nuñez B (2009). Implementation of Six Sigma in a Manufacturing Process: A Case Study, *Int. J. Ind. Eng.* 16(3).
- Watson JK, Patti A (2008). A comparison of JIT and TOC buffering philosophies on system performance with unplanned machine downtime. *International Journal of Production Research*, 46(7):1869-1885.

Full Length Research Paper

Improving customer complaining behaviour for loyalty in the services sector: A case of mobile telephone companies in Uganda

Mabel Birungi Komunda^{1*}, Francis Kibeera¹, Justus Munyoki¹ and Jotham Byarugaba²

¹University of Nairobi, Kenya.

²Makerere University Business School, Uganda.

Received 25 April 2014; Accepted 20 June, 2015

This study focuses on the concept of customers' complaining behaviour in the mobile telephone company sector. The mobile telephone company in Uganda is competitive and being a service sector, it is complex in nature. A descriptive cross-sectional survey was used. Primary data were collected using questionnaires from Makerere University mobile telephone subscribers who were students, academic staff, administrative staff and support staff. Stratified random sampling was used and the study used cross sectional survey method. A sample of 384 was used in the study where a response of 332 was attained, with 86% response rate. A pilot study was done. Data were analyzed using descriptive statistics, correlations and regression analysis. The results of the study revealed that customers' complaint behaviour influences customer loyalty. Further, the results revealed that service quality directly influences customer loyalty and also has a positive significant relationship with customers' complaint behaviour. The study has made contribution to theory, policy and practice in relation to customer complaint behaviour and to marketing in general. The study offered further clarification into the relationship between customers' complaint behaviour, service quality and customer loyalty. The limitations of the study included the selection of the study variables which was not exhaustive. On the one hand, the cross-sectional survey research design was used where the study was carried out at a specific moment in time and, as a result, causality can only be inferred from these data.

Key words: Customers' complaint behaviour, mobile telephone companies, customer loyalty.

BACKGROUND

During the past decade, mobile telephone companies have changed not only at the corporate and business

levels but also in terms of consumer engagement. The companies have introduced the use of electronic

*Corresponding author. E-mail: mbirungi@mubs.ac.ug. Tel: +256 712 848 377, +256 774 721 345.

Author agree that this article remain permanently open access under the terms of the [Creative Commons Attribution License 4.0 International License](http://creativecommons.org/licenses/by/4.0/)

commerce activities like making telephone calls, using short message services (SMS), using internet services and sending/receiving money using mobile telephones. While such changes have facilitated innovative business strategies, they have also created many challenges to the user experience. Mobile telephone companies in Uganda are faced with the problem of increasing competition leading to fear of losing customers to competitors. These companies are concentrating on strategies to win customers which may have an influence on customer loyalty. Gee et al. (2008) assert that the mobile telephone industry has not been analyzed in the context of customer loyalty with respect to the integration of variables namely customers' complaint behaviour and service quality. Knowledge about these variables may help to identify common service challenges like improving service quality to achieve customer loyalty (Tronvoll, 2012).

Customers' complaint behaviour refers to the responses triggered by perceived dissatisfaction that is neither psychologically accepted nor quickly forgotten in consumption of a product or service (Homburg and Fürst, 2005). When customers decide to complain, they have previously passed through two distinct steps already identified by Hirschman (1970): they value positively the balance between costs and benefits. Both costs and benefits are not only economic, but also psychological. It is clear that the perceived benefit may not be big enough to lead a consumer to complain, even if considerable dissatisfaction exists. On the contrary, a consumer can complain even with a low level of dissatisfaction if the perceived benefit is remarkable (Day and Landon, 1977, p. 32); they value worthwhile the complaining action because they esteem positively the likelihood of obtaining a favourable solution.

A number of studies have been done on customers' complaint behaviour (CCB) and customer loyalty namely: Osarenkhoe and Komunda (2013); Komunda (2013); Tronvoll, (2012); Komunda and Oserankhoe, (2012). The main objective of the study was to establish the relationship between the study variables of CCB, service quality and customer loyalty.

LITERATURE REVIEW

Customers' complaint behaviour refers to the responses triggered by perceived dissatisfaction that is neither psychologically accepted nor quickly forgotten in the consumption of a product or service (Homburg and Fürst, 2005). Research by Casado et al. (2011) suggest that customers' complaint behaviour (CCB) is a complex phenomenon which is reflected in the number of alternative definitions proposed to explain this kind of behaviour. Traditionally, the common determinant of complaining behaviour was described as dissatisfaction due to inadequacies of integrity, reliability,

responsiveness, availability and functionality (Tronvoll, 2012). Hence, consumer dissatisfaction is a result of the discrepancy between expected and realized performance (Gruber, 2011). Dissatisfaction is based on disconfirmation of expectation (Oliver, 1997) and it is a customer experience that is less than the perceived expectation. Tronvoll (2007) described customers' complaint behaviour as a function of dissatisfaction. Homburg and Fürst (2005) and Orisingher et al. (2010) assert that dissatisfaction is a significant factor that attributes to complaints. Kau and Loh (2006) articulated that dissatisfaction was caused by negative disconfirmation of purchase expectations that led to legitimate complaint behaviour. Many studies concerning consumer satisfaction and dissatisfaction have employed the disconfirmation paradigm (Oliver, 1999). According to this paradigm, consumer satisfaction or dissatisfaction is a function of perceived discrepancies between prior expectations of the product or service and its actual performance (Oliver, 1997). Consumer complaint behaviour is linked to negative disconfirmation – whereby the perceived performance falls short of expectation, causing the consumer to become dissatisfied (Atalik, 2007).

The disconfirmation paradigm was the basis of Hirschman's (1970) theory concerning exit, voice and loyalty – which provides a theoretical framework for understanding CCB. A dissatisfied customer may voice a complaint, exit or remain committed to the company (Hirschman, 1970). Despite the strategic importance of listening to and managing CCB, the current understanding of customer complaints like poor network quality, poor customer care and lack of explanation about service failure is limited (Tronvoll, 2012). Marketing literature has focused on identifying various determinants of CCB; including perceived costs; attitude towards complaining; environmental and demographic variables and the likelihood of a successful complaint (Singh, 1988). Reviewing literature reveals the major gaps: firstly, most literature focuses on identifying determinants of CCB. Secondly, the role of attitudinal and perceptual variables has not been the focal point in explaining CCB; and most studies focus on CCB as an outcome, which may not be predicted by attitude and perception (Seawright et al., 2008). The inconsistent relationship between attitude and behaviour explains why CCB cannot be accounted for fully by attitudinal and perceptual variables in consumer behaviour theories (Parasuraman et al., 2005). This calls for the integration of other variables like service quality and CCB where customer loyalty is a dependent variable.

Further, the existing models of customers' complaint behaviour focused on the separation of private action from public action (Day and Landon, 1977). This categorisation has become increasingly irrelevant (and maybe even misleading) because of recent advances in Information and Communication and Technological (ICT)

systems. In the past, when a customer experienced an unfavourable service experience, he or she talked to relatively few people; in contrast, the advent of the internet (such as Facebook, Twitter, YouTube, linkedin, WhatsApp, Myspace, Tagged, Meetup and Pinterest) has dramatically increased the number of people available for negative communication (Tax and Brown, 1998). In these circumstances, it becomes difficult to maintain a separation of the concepts of private action and public action. In response to these developments, the proposed model suggests new categories of complaining behaviour in terms of communication complaint responses and action complaint responses. This schema facilitates a categorisation of a wide range of complaint responses over time.

Dissatisfied customers may not voice their complaints but exit the company services because of the mistakes made by the company, billing errors and service catastrophes. Further, others may exit because of the unfavourable service encounter like uncaring, impolite, unresponsive and unknowledgeable employees. If customer complaints are not handled properly, the negative consequences may be far-reaching. Dissatisfied customers will not only discontinue their patronage, but are also likely to spread a negative message, jeopardizing the company's image (Gruber, 2011). On the other hand, Khan (2010) explained that switching mobile phones was because of voice quality and network coverage. Since it is cheaper to retain than win new customers; and service failure is inevitable, it is crucial for management of mobile telephone companies to understand CCB in order to effectively manage it. Further, the most common complaint motives include: Seeking corrective actions, followed by asking for an explanation, seeking an apology, expressing emotional anger and with low rating for compensation and seeking redress (Heung and Lam, 2003).

Complaint handling has been recognized as a critical task for service managers in mobile telephone services. There is a need to enhance the trustworthiness of mobile phone operators by keeping customers' best interest at heart, providing customized services and exemplary behaviour of contact personnel to make the interaction a memorable experience. Based on post complaint behaviour, customers who are satisfied with complaint handling engage in positive word of mouth and are more loyal than customers who are dissatisfied with complaint handling of service quality of mobile telephone service providers.

The objectives of the study are to

i) Investigate the relationship between customers' complaint behaviour and customer loyalty of mobile telephone subscribers in Makerere University.

ii) Examine the relationship between customers' complaint behaviour and service quality.

iii) Establish the relationship between service quality and customer loyalty.

iv) Assess the mediating effect of service quality on the relationship between customers' complaint behaviour and customer loyalty.

METHODOLOGY

The proposed study used the descriptive cross sectional design. A research design is defined as the way a study is planned and conducted, as well as the procedures and techniques employed to answer the research problem or question. Descriptive studies attempt to obtain complete and accurate description of situations, persons or events. It allows description of phenomena as well as collection of a large amount of data from a sizeable population in a highly economic way. Further, a cross sectional approach was used because it facilitates data collection from different respondents at one point in time (Babbie, 2010). Cross sectional studies are appropriate where the overall objective is to establish a significant relationship among variables at some point in time (Mugenda and Mugenda, 2003). A descriptive cross-sectional research was used and it offers an opportunity to establish the relationships between CCB and customer loyalty and to determine the influence of service quality on this relationship.

The population of the study embraced the subscribers to mobile telephone service operators who were students, academic staff, administrative staff and support staff of Makerere University. The choice of population of study was Makerere University because it is one of the oldest universities in East Africa; most people in the university are well educated and informed of their rights as consumers, are multicultural; are knowledgeable about how to go about complaining and can complain through various channels to mobile telephone companies. The University has a cosmopolitan people from all parts of the country (Uganda). The mobile telephone subscribers use mobile telephones for making telephone calls, social media and mobile money banking. The total population of Makerere University was 50,949 (academic year 2011/2012) mobile telephone subscribers.

The sampling technique used in the study was stratified random sampling. The unit of analysis was the subscribers to mobile telephone companies, specifically Makerere University students, academic staff, administrative staff and support staff. The researcher ascertained proportionate representation of the sample size for the two categories of students and staff (academic, administrative and support) of Makerere University. A list of all students and staff in Makerere University was got from the Human Resource and Registrar's offices and was used to determine the respondents for the study. Cronbach alpha was used to test the measurement scales to ascertain the reliability of the five point likert type scale which was used in the survey (Kothari, 2005). According to Nunnally (1978), a cut off alpha coefficient point of 0.70 is sufficient enough that the item scales are consistent and dependable. The overall Cronbach's alpha for customers' complaint behaviour was (.740), service quality (.936) and customer loyalty (.784). Further, parametric assumptions were tested for, which included normality, linearity, homogeneity and multicollinearity and these were all met. The pertinent results are in Table 1:

Based on Table 3, data were adequate for running other tests. The data were put in SPSS version 19 and factor analysis was run to reduce data to manageable level.

Table 1. Results of tests of statistical assumptions.

Variable	Measure	Sample size	Reliability	Normality	Linearity	Independence D/W	Homogeneity	Colinearity
	Assumptions		0.6 Min	p>0.05	p>0.05	1.5 to 2.5	p>0.05	VIF 10 max
Customer Complaint Behaviour	Exit, voice, redress and Commitment	336	.740	.200	.038	1.987	.945	1.395
Service Quality	Service quality dimensions	336	.936	.200	.000	1.987	.349	1.967
Customer Loyalty	Word of mouth and making re-buy decisions	336	.784	.200	N/A	N/A	N/A	N/A

Source: Primary Data.

Table 2. Demographic profile of respondents.

Profile of respondents	Frequency	Percent
Age	20-29	189 57.0
	30-39	101 30.4
	40 and above	42 12.7
Gender	Male	183 55.2
	Female	149 44.8
Marital Status	Single	214 64.5
	Married	118 35.5
Level of Education	Certificate	20 6.0
	Diploma	35 10.5
	Undergraduate	163 49.1
	Masters	99 29.8
	PhD	15 4.5
	Total	332 100.0

Source: Primary Data.

respondent are presented. The age of the respondent was an important measure to try to understand the issues about CCB of the individual subscribers. Relevant results for age, gender, marital status and level of education are presented in Table 2.

From Table 2, most subscribers to the mobile telephone companies of Makerere University fall within the age bracket 20-29 with 57%. This means that the majority of respondents mainly fall in the age group of students. The lowest response was within the age bracket of 35 and above with 21.7%. All respondents were twenty and above years of age, which implies that the respondents were mature enough to ably respond to questions in the study. This is because the respondents had adequate knowledge about the operations and services of mobile telephone companies and therefore the responses of the subscribers are considered to be adequate.

Based on the gender of the subscribers to Mobile Telephone operators, most subscribers to the companies of Makerere University by gender were males (55.2%) and the females were 44.8%. These results were confirmed by the findings of Manikas and Shea (1997) who concluded that male customers complained more than their female counterparts. In earlier surveys, Heung and Lam (2003); Kau and Loh (2006) contradicted the findings that majority of female complainers were more likely to voice their complaints than their male counterparts. This contradiction needs further research. Further, basing on marital status respondents were asked to indicate their marital status and the response indicated that the single people had the highest response with 64.5%. Since a big percentage of the respondents were students with the age group of 20-24, it gives the explanation why majority of them were single. In a nutshell, the study is consistent with the existing literature

Findings of the Study

Demographic profile of a respondent

The demographic factors of the respondents were an important measure to try to understand the issues about customers' complaint behaviour of the individual subscribers. Relevant results for gender, age bracket, education level acquired and marital status of the

Table 3. Correlations of study variables.

Variable	CCB	CL	SQ
Customer Complaint Behaviour (CCB)	1		
Customer Loyalty (CL)	.260**	1	
Service Quality (SQ)	.240**	.662**	1

** . Correlation is significant at the 0.01 level (1-tailed). Source: Primary Data

where customer complainers have been typified as being young with higher than average income and education (Heung and Lam, 2003).

Further, respondents were required to indicate their level of education based on certificate, diploma, undergraduate, masters and the Doctor of Philosophy (PhD). This was important as it would indicate whether the respondents were competent to give credible responses about customer complaint behavior in the mobile telephone companies. The education level of the respondent is indicated in Table 1. Majority of respondents were at undergraduate level, explaining 48.8% and the least was PhD level with 4.5%. The mobile telephone subscribers surveyed were therefore people with different levels of study from the certificate up to the PhD level. This gives confidence that the understanding of the variables of study were not biased to any single level of education. Further, majority of the respondents were highly qualified and competent enough to provide accurate responses. Kau and Loh (2006) assert that customers with a higher level of education were more likely to complain, with the explanation that better educated customers may be more knowledgeable about their rights.

Bivariate correlation analysis was used to establish both the direction and magnitude of the relationship between the study variables. Correlation analysis was therefore run using Pearson Product Moment Correlation Coefficient technique to establish the relationship between CCB, service quality and customer loyalty. The results are presented in tabular and graph formats and discussed in line with the literature in order to establish the extent to which they relate to existing knowledge. The correlation coefficient provided a numerical summary of the direction and strength of the linear relationship between the variables. All the Pearson Correlation Coefficients (r) ranged within -1 and +1. The pertinent results are indicated in Table 3.

The results indicate that the relationship between customers' complaint behaviour and customer loyalty of

mobile telephone subscribers was positive and statistically significant.

H₁: There is a relationship between Customers' complaint behaviour and Customer Loyalty

The results depicted in Table 3 indicate that there was a positive significant correlation between customers' complaint behaviour and customer loyalty ($r=.260^{**}$, P-value =000). The study finding suggests an improvement in handling customers' complaint behaviour, will lead to an increase in customer loyalty. The hypothesis 1 which tests the relationship between customers' complaint behaviour and customer loyalty is therefore supported. The result implies that CCB improvement (subscribers voicing their complaints about their dissatisfaction as well as asking for an explanation) will lead to improved customer loyalty.

H₂: There is a relationship between Customers' complaint behaviour and Service Quality

The results depicted in Table 3 indicate that there was a positive significant correlation between customers' complaint behaviour and service quality ($r=.240^{**}$, P-value =000). The findings imply that improved CCB (voicing, seeking redress, using selected services of the MTC) will lead to an improved service quality. The hypothesis 2 was therefore supported.

When customers have quality service, they remain committed and keep subscribing to the MTC even when they may be disappointed by the MTC services as it relates with service quality. This means that when the MTC has often been offering qualitative service, service failure that may lead to disappointment will not lead to the customers de-subscribing (exiting), but will try to seek redress and understanding from the service providers because they already have good feeling and commitment to the MTC.

H₃: There is a relationship between Service Quality and Customer Loyalty

Respondents had been asked to indicate the extent to which staff of the MTC responded to the subscribers in case of a dissatisfaction based on the CCB and service quality dimensions. The results depicted in Table 3 indicate that there was a positive significant correlation between customers' complaint behaviour and service quality ($r=.662^{**}$, P-value =000) where service quality directly predicts customer loyalty. The findings mean that service quality will lead to an improvement in customer loyalty, which signifies that qualitative services are associated with loyalty of customers to the mobile telephone subscribers. The hypothesis 3 which establishes the relationship between service quality and

Table 4. Regression of Customer loyalty on Customers' complaint behaviour and Service Quality.

4a. Goodness of Fit.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.263 ^a	.069	.066	.61144
2	.592 ^b	.350	.346	.51180

Source: Primary Data.

4b ANOVA^c

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.073	1	9.073	24.267	.000 ^a
	Residual	121.880	326	.374		
	Total	130.952	327			
2	Regression	45.822	2	22.911	87.468	.000 ^b
	Residual	85.130	325	.262		
	Total	130.952	327			

Source: Primary Data. a. Predictors: (Constant), Customer Complaint Behaviour, service Quality. b. Dependent Variable: Customer Loyalty.

4c. Coefficient of determination.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.329	.152		15.313	.000		
	CCB	.293	.060	.263	4.926	.000	1.000	1.000
2	(Constant)	1.052	.167		6.302	.000		
	CCB	.151	.051	.135	2.938	.004	.945	1.058
	SQ	.524	.044	.545	11.845	.000	.945	1.058

Source: Primary Data. a. Predictors: (Constant), Customer Complaint Behaviour, b. Predictors: (Constant), Customer Complaint Behaviour, service Quality. c. Dependent Variable: Customer Loyalty

customer loyalty was therefore supported. From Table 3, all the variables with linear relationships had positive and significant relationships.

In a nutshell, the highest independent relationship in the study was between SQ and customer loyalty. The linear associations were all significant and positive, whereby as one independent variable increased, so did the dependent variable. Apart from the direction, the correlation provided information on the strength of the relationship and the size of the absolute value as indicated in Table 4.

Table 4 shows that service quality explains 6.9% of the variation in customer loyalty ($R^2 = .069$). At step 2, customers' complaint behaviour adds significantly to

customer loyalty as the variation increased from .069 to .350 (R^2 change=.281, p-value=.000). The results reveal that the variance explained by service quality is significant ($F=24.267$, p-value=.004). The results further revealed that the regression coefficients for CCB, increased from .135 to .545 ($F=87.468$ to ; P-value= .000) when service quality were added to the regression suggesting that service quality may be exerting a partial mediating effect.

Based on Table 4, the results show that CCB had a statistically significant influence on customer loyalty where $R^2=43.8\%$, Beta=.636 $F=251.140$; t- statistic =14.927 and P-value=.000. After mediation with service quality, the results improved to 45% of its variation

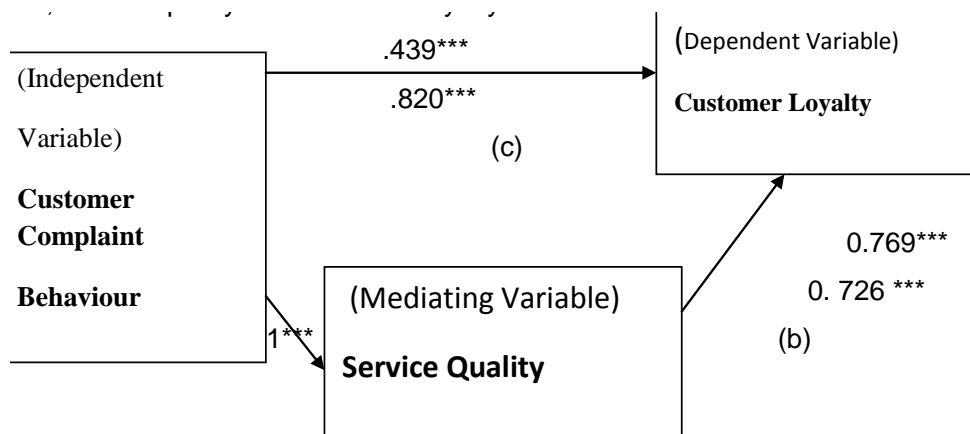


Figure 1. MedGraph of mediation of service quality. Source: Primary Data.

($R^2=.450$). The standardized regression coefficient (b) value of the computed scores of service quality was $Beta=.110$, $F=131.073$; and with a t -statistic= 2.573 ; and significance level of p -value= $.000$. The standardized regression coefficient was used because it removes the unit of measurement of the predictor and outcome variables, and this consequently enables one to compare the relative effect of predictors measured on different scales. The mediated relationship is represented in Figure 1.

H₄: Mediation between Customers’ complaint behaviour and Customer Loyalty

The relationship between Customers’ complaint behaviour and Customer Loyalty was mediated by Service Quality and this is presented in a medGraph in Figure 1:

The mediation of service quality between the relationship between customers’ complaint behaviour and customer loyalty was further confirmed by use of a medGraph which generated results. The type of mediation is Sobel Z value 0.444851 , $P=<0.656428$. There was 95% symmetrical confidence interval where the lower was -0.49259 ; Higher 0.78183 .

The results imply that the Sobel z value is large and significant, it further confirmed that service quality mediates the relationship between customers’ complaint behaviour and customer loyalty. Service quality is therefore a significant mediator in the association between customers’ complaint behaviour and customer loyalty, and this reduces the relationship between the two variables by 1% in the mobile telephone company. This means that the presence of service quality weakens the direct relationship between service quality and customer loyalty. While service quality accounts for 61.7% of the indirect relationship, yet the direct relationship accounts for 61.8%. The main conclusion to be drawn from the

relationship was that service quality partially mediates the relationship between service quality and customer loyalty in Uganda Mobile telephone companies. Service quality slightly weakens the direct association between customers’ complaint behaviour and service quality signify that the direct relationship between customers’ complaint behaviour and customer loyalty. Service quality has a direct relationship with customer loyalty with $Beta = .769$. Customers’ complaint behaviour and customer loyalty is significantly mediated by service quality where $Beta=.726^{***}$; sig = $.000$. There is a relationship between service quality and customer loyalty with $Beta = 0.577^{***}$; after the mediation effect, Beta increased ($Beta=0.769$).

DISCUSSION AND CONCLUSION

The study established a positive and significant relationship between customers’ complaint behaviour and customer loyalty of Makerere University Mobile Telephone subscribers. This implies that customers’ complaint behaviour was correlated with customer loyalty and the results indicated a positive and significant relationship between the study variables. The significant relationship between CCB and customer loyalty of mobile telephone companies suggest that for MTC to achieve customer loyalty, they ought to seek redress and voice their complaint, meaning that they could complain when the MTC is the source of disappointment, seek for an explanation from the mobile telephone company why there was a dissatisfaction and their expectations were not met. This happens when complaining becomes easier and redress becomes more certain, that consumers may be more likely to speak up.

However, there are some dissatisfied customers who do not even voice their complaints but just stay committed to the MTC by keeping subscribing to the

company services as it relates with service quality. This means that when the MTC has often been offering qualitative services, the one off time service failure will not lead to subscribers exiting or un-subscribing from the MTC. This is because they already have a positive attitude towards the company. From the survey, there was a weak correlation on exit. This means that some few MTC subscribers whose expectations are not met may exit from the MTC. Such happens when MTC subscribers make a mental judgement of 'worth it' or 'not worth it'; where they may conclude that complaining is not worth the effort and to choose other means of dealing with their unhappiness like exit.

From the consumer's perspective, the very act of complaining gives the customers an opportunity to vent their unhappiness. Some research suggests that consumers are more likely to complain when they perceive that they will have a successful outcome without spending much effort. On the other hand, they will be less likely to complain when they perceive that the marketer was at fault or that the problem is likely to reoccur/stable (Priluck and Lala, 2009). Companies should therefore encourage dissatisfied customers to complain so that they can provide information to solve the problem and retain the customer. Unfortunately, companies who do not rise to the challenge of complaining customers are turning down the important opportunity of getting information on performance of the service and on reclaiming and improving a relationship with the customers (Gruber, 2011).

There was a positive significant relationship between CCB and service quality, meaning that with an improvement in CCB, this will lead to a better quality service. Previous studies show that service quality had a positive and statistically significant relationship with customer loyalty. Mobile telephone companies in Uganda which have not handled customer complaints to the satisfaction of the customers lose customers to competitors. Basing on service quality dimensions of reliability, empathy and assurance, MTC services were not reliable and therefore subscribers kept using a few selected services implying lack of commitment to the service operators. Complaining customers do not want employees who just smile to show friendliness when handling customer complaints but those who truly mean it. In this case, subscribers lack assurance to proactively know when their complaints will be responded to. Mobile telephone operators need to develop empathy through anticipating the needs and preferences of their customers and taking steps to satisfy them through provision of customised services. Unfortunately, poor service quality and ineffective service recovery may threaten the long-term survival of the organisation (Michel et al. 2009). However, the mobile telephone companies which carry out effective complaint handling may attain service quality improvement.

On the other hand, disappointed customers may not complain because they wish to avoid confrontation with the person responsible for the failure but they may be uncertain about their rights and the obligations of the organization (Heung and Lam, 2003), or because of concerns about the time and costs associated with complaining (Bamford and Xystouri, 2005). The costs of complaining include the customer taking the initiative to contact the seller, explain the problem and arrange for an acceptable resolution. Priluck and Lala (2009) suggest that the decision to complain is based on a cost-benefit analysis and the costs include time, effort and ego-involvement. However, when dissatisfied consumers fail to tell management about something that went wrong, the company stands to lose because such customers may simply disappear, defecting to competitors, spreading negative WOM to friends and denying the company an opportunity to correct mistakes. Researchers have proposed some methods to mitigate the effort to complain, including instructional literature, toll free telephone numbers, signs at point of service and internet websites (Kim et al., 2010).

Dissatisfaction that results from an unsatisfactory experience like rude and unapologetic staff as well as inadequate compensation will incite consumers to undertake another form of action like complaining to family and friends (negative word of mouth) or be disloyal (Grewal et al., 2008). Negative WOM is very dangerous to the MTC especially with the use of the social media; where one word can be spread to millions of people through twitter, facebook, a problem the mobile telephone companies should avoid.

On the other hand, based on equity/perceived justice theory, complaining customers who spent money on a product or service of the MTC which does not meet their expectations and invest time and effort in bringing the problem to the attention of the company through making a complaint expect fair treatment. This means that MTC staff need to spend time and show real effort to solve the problem and compensate customers for the "costs" they have incurred. Equity theory indicates that consumers weigh inputs against outputs across various situations and seek a fair outcome to their problem. The greater the benefits received by the consumer relative to the time and effort of complaining, the more satisfied the complainant should be (Priluck and Lala, 2009). After all, if the compensation for product failure is larger, the customer should be happier when at the end of service recovery justice prevails.

RECOMMENDATIONS AND LIMITATIONS

The study confirms previous studies where dissatisfaction causes complaints, but that dissatisfaction is not a necessary condition for complaining. This means that

some customers may complain for various reasons even when they are satisfied. Therefore, more research is needed to establish why satisfied customers may still complain in a developing country context, particularly within MTC services. Firstly, staff who do not provide a logical explanation to the customer are unable to recover failure. Therefore, staff should be trained in adequate communication skills to be critical listeners to the subscribers to have good interpersonal skills to have an understanding with the mobile telephone operators. More still, service operators should put in place convenient hours of operation and operators' outlets to access pay-way vending machines for reload package services. Further, MTC should establish channels of communication for customers (like 24 hour customer care centres) to handle customer complaints.

Further, it has been established that complaining behaviour is more common among dissatisfied customers than satisfied ones. This means that customers need to develop effective customer focused/centred strategies in order to improve service quality and consequently reducing on complaints as well as trying to help identify problematic areas of service delivery and to improve them. Moreover, the study found out that though complaining behaviour is influenced by previous dissatisfaction, if handled effectively, it may not have adverse effect on customer loyalty. Management should encourage customer complaints where they are dissatisfied in order to understand their feelings and establish how best to address them. Otherwise, most customers are eager to discourage family and friends from using the services if their complaints are not handled well. Therefore, management should further put in avenues through which customers can easily voice out their complaints, like customer care centres and automated services on frequently asked questions instead of complaining quietly or privately to their social groups.

The important implications are that once a company has recognized and understood what complaining customers expect from management in the MTC, it can ensure that the right employees are recruited, mentored, trained and monitored effectively. Companies can then manage their employees' behaviours appropriately to match their subscribers underlying expectations. Such behaviour should have a positive effect on handling customer complaints to attain qualitative services. Complaining customers especially desire a speedy problem solution as they "have already been inconvenienced by the company once" and just want their problem solved with the minimum of delay.

Finally, it is necessary to present both the limitations of our empirical results and the opportunities for future research. On the one hand, the cross-sectional nature of the data; i.e. the study was carried out at a specific moment in time and, as a result, causality can only be

inferred from these data. Consequently, it would be necessary to carry out a longitudinal study to reaffirm the causal relationships. Future research should seek to address these limitations by inclusion of the additional factors, use of a longitudinal research design and the use of methodological triangulation. Replication of the study and examining the relationship between study variables could serve as a useful reference for future research.

Conflict of Interests

The authors have not declared any conflict of interests

REFERENCES

- Atalik O(2007).Customer complaints about airline service: A preliminary study of Turkish frequent flyers. *Manage. Res. News* 30(6):409-419.
- Bamford D, Xystouri T (2005). A case study of service failure and recovery within an international airline, *Manag. Service Q.* 15(3):306-322.
- Casado AB, Nicolau JL, Mas FL (2011). The harmful consequences of failed recoveries in the banking industry. *Int. J. Bank Market.* 29(1):32-49.
- Day RL,Landon ELJ(1977). Toward a theory of consumer complaining behaviour, In: Woodside, A.G., Sheth, J.N., Bennett, P.D. (Eds), *Consumer and Industrial Buying Behavior*, North-Holland Publishing, New York, NY, pp.425-437.
- Gee R, Coate G, Nicholson M(2008). Understanding and profitably managing customer loyalty. *Market Intelligence plan.* 4:359-374.
- Grewal D, Roggeveen AL,Tsiros M(2008). The effect of compensation on repurchase intentions in service recovery. *J. Retail.* 84(4):424-434.
- Gruber T (2011). I want to believe they really care: How complaining customers want to be treated by frontline employees. *J. Service Manage.* 22(1):85-110.
- Heung VCS, Lam T (2003). Customers' complaint behaviour towards hotel restaurant services, *Int. J. Contemp. Hosp. Manage.* 15(5):283-289.
- Hirschman AO (1970). *Exit, Voice, and Loyalty: Responses to Decline in Firms, Organizations, and States*, Harvard University Press, Cambridge, MA.
- Homburg C, Furst A (2005). How firm complaint handling drives customer loyalty: an analysis of the mechanistic and the organic approach. *J. Market.* 69:95-114.
- Kau AK, Loh EWY (2006). The effects of service recovery on consumer satisfaction: a comparison between complainants and non-complainants. *J. Services Market.* 20(2):101-111.
- Khan MA(2010). An empirical assessment of service quality of cellular mobile telephone operators in Pakistan. *Asian Soc. Sci.* 6(10):164-177.
- Kim MG, Wang C, Mattila AS (2010). The relationship between consumer complaining behaviour and service recovery: An integrative review. *Int. J. Contemp. Hosp. Manage.* 22(7):975-991.
- Komunda M (2013). Customer Complaints Behaviour, service recovery and behavioural intentions: Literature review. *Int. J. Bus. Behav. Sci.* 3(7):1-29.
- Kothari CR(2005).*Research Methodology: Methods and Techniques*. New Delhi: Wiley Eastern Ltd, p.468.
- Michel S,Bowen,S, Johnston R(2009). Why service recovery fails: tensions among customer, employee and process perspectives. *J. Service Manage.* 20(3):253-73.
- Mugenda OM, Mugenda AG (2003). *Research Methods: Qualitative and Quantitative approaches*. African Culture for Technology Studies, Nairobi, Kenya.

- Nunnally JC(1978). *Psychometric Theory* (2nd ed.) New York: McGraw-Hill Book Company.
- Orisingher C, Valentini S, Angelis MD (2010). A meta analysis of satisfaction and complaint handling services. *J. Acad. Market. Sci.* 38(1):169-186.
- Osarenkhoe A, Komunda MA (2013). Redress for Customer Dissatisfaction and Its Impact on Customer Satisfaction and Customer Loyalty. *J. Market. Dev. Competitiveness* 7(2):102-114.
- Parasuraman A, Zeithaml V, Malhotra A (2005). SERVQUAL: A multiple item scale for assessing electronic SQ. *Journal of Service Research.*
- Priluck R,Lala V(2009). The impact of the recovery paradox on retailer customer relationships. *Manag. Service Q.* 19(1):42-59.
- Seawright KK, DeTienne BK, Bernhisel PM, Larson HCL(2008). An empirical examination of service recovery design. *Market. Intelligence Plann.* 26(3):253-74.
- Singh J (1988). "Consumer complaint intentions and behavior: definitional and taxonomical issues", *J. Market.* 52(1):93-107.
- Tax SS, Brown SW (1998). "Recovery and learning from service failure", *Sloan Manage. Rev.* 40:75-88.
- Tronvoll B (2007). Complainer characteristics when exit is closed. *Int. J. Service Ind. Manage.* 18:25-51.
- Tronvoll B(2012). A dynamic model of Customers' complaint behaviour from the perspective of service dominant logic. *Euro. J. Market.* 46:284-305.

African Journal of Business Management

Related Journals Published by Academic Journals

- Journal of Geography and Regional Planning
- Journal of Economics and International Finance
- Journal of Hospitality Management and Tourism
- International Journal of Sociology and Anthropology
- Journal of Public Administration and Policy Research
- African Journal of Marketing Management