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

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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

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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

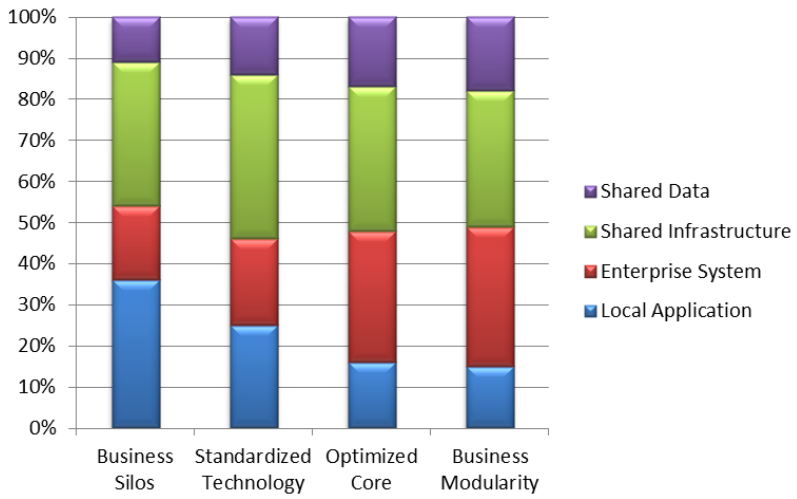

Figure 2. The four stages of architecture maturity. Source: Ross et al., 2006, p.72.

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

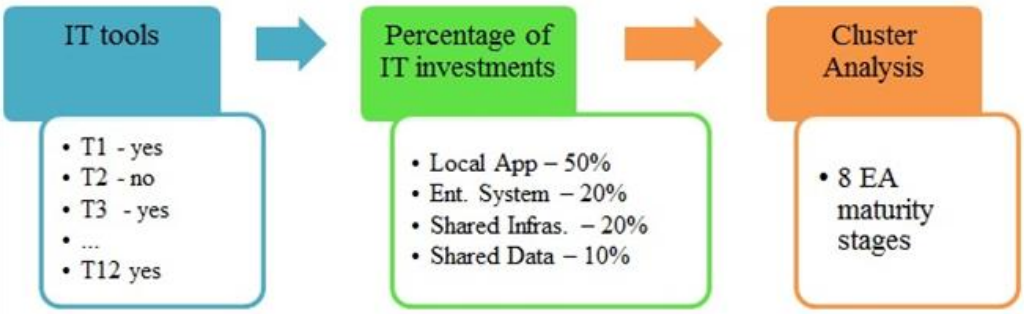

Figure 3. Methodology steps. Source: Authors.

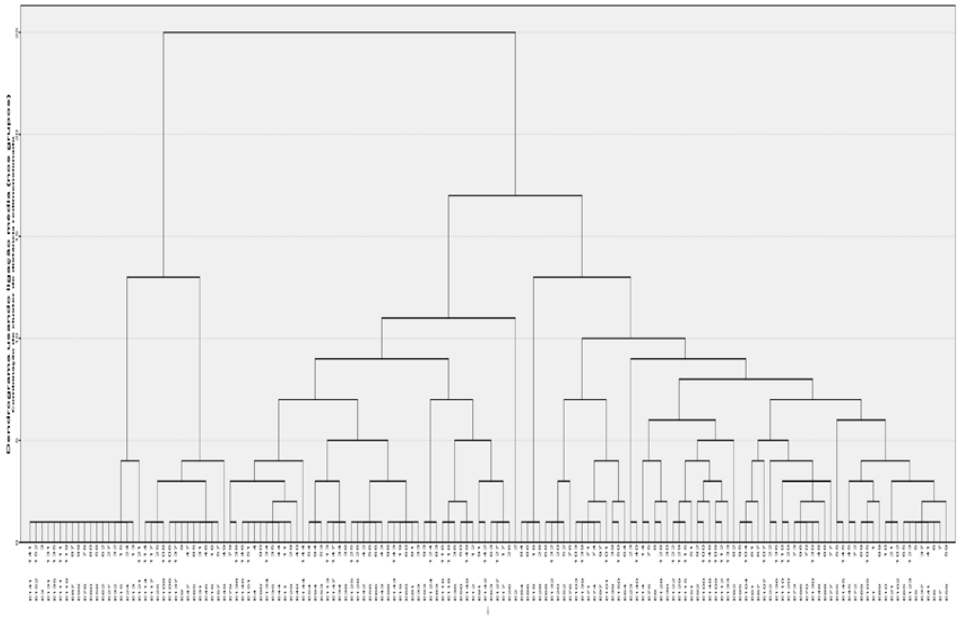

Figure 4. Dendogram. Source: Authors.

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

Since this dendogram has too many observations, an adapted dendogram, which is illustrated in Figure 5, was elaborated to simplify the data interpretation. The adapted dendogram 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 at 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

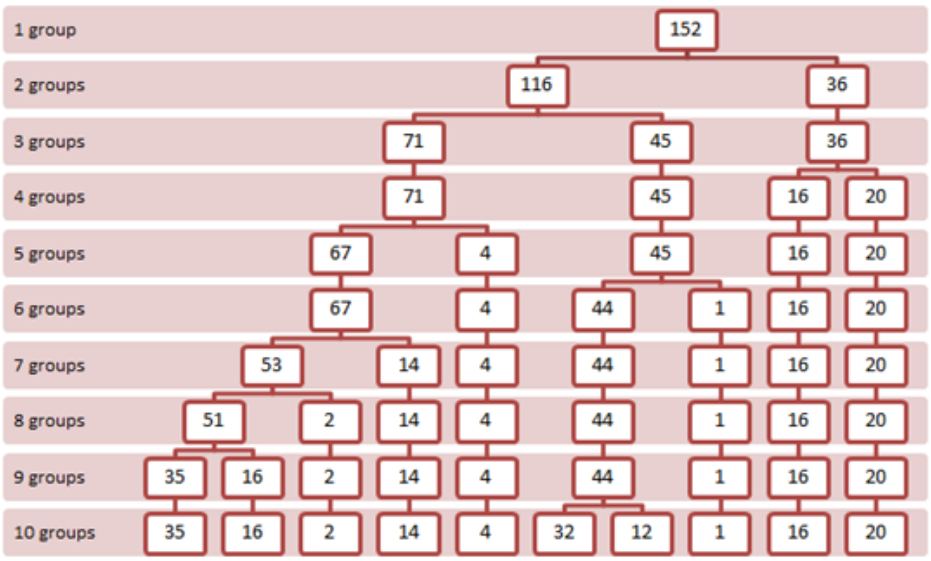

Figure 5. Adapted dendogram. Source: Authors.

Table 4. Number of clusters criteria. Source: Authors

N. groups	Coefficients		Observations			Criteria			Result
	Value	Variation	avarage 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

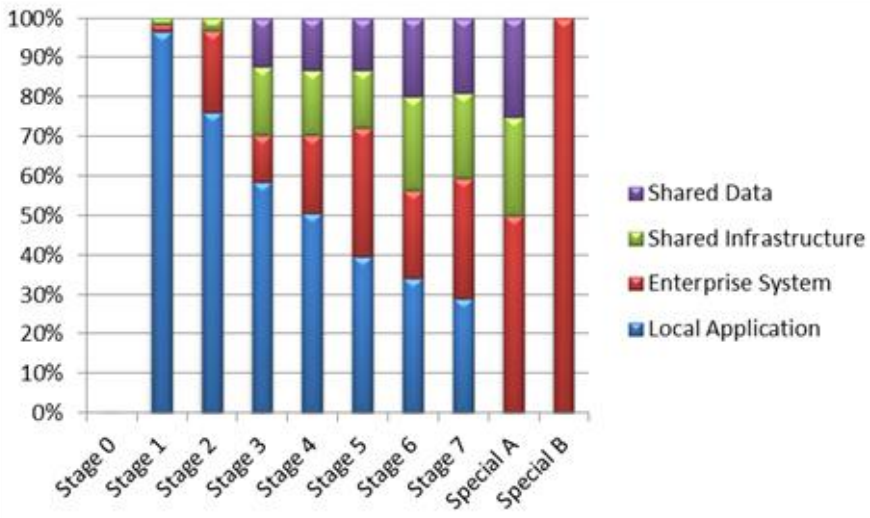

Figure 6. IT investments maturity stages.

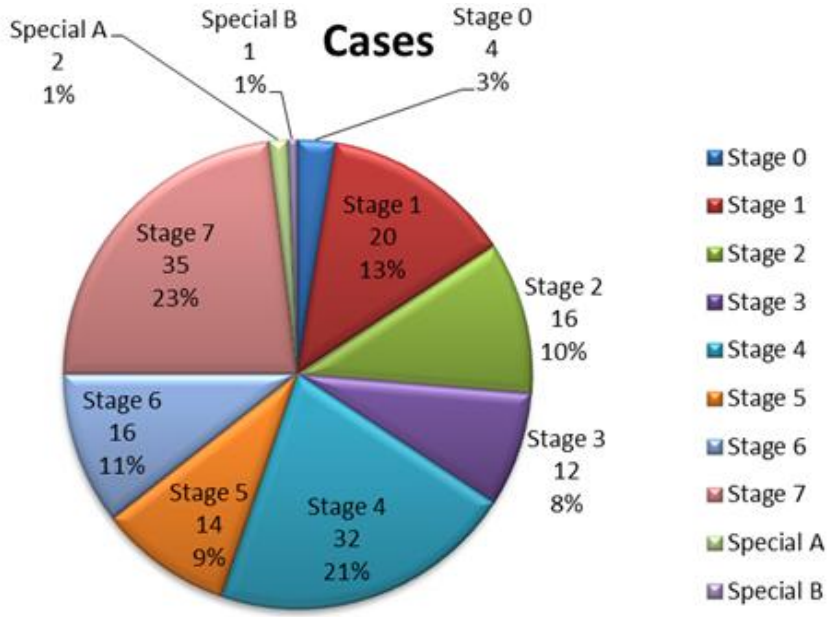

Figure7. IT Investment maturity stages distribution.

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

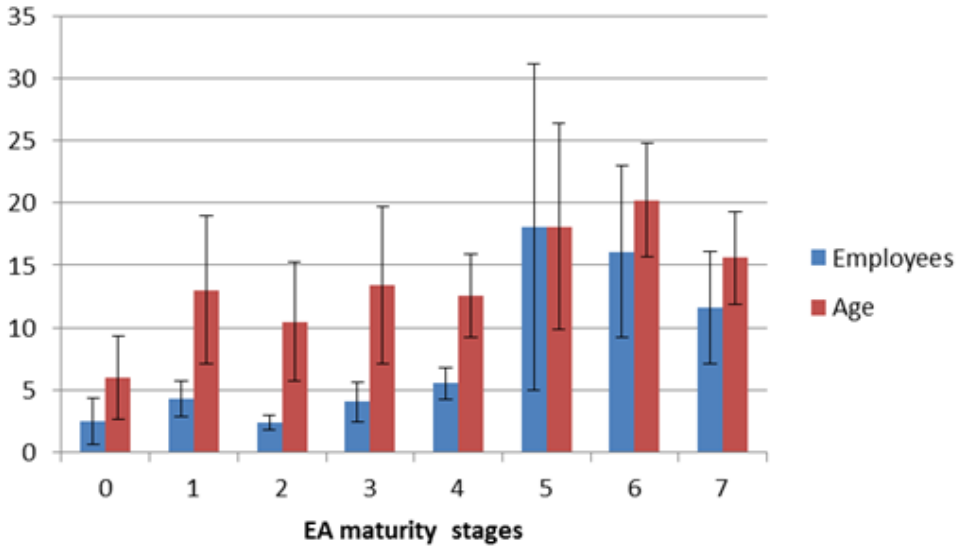

Figure 8. Mean number of employees and age per maturity stage. Source: authors.

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 Kruskall-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 Kruskall-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.

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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 Brasi. 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.

Holátová 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.I.]. 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.