Magalhães Correia & da Veiga, *Cogent Business & Management* (2019), 6: 1580121
https://doi.org/10.1080/23311975.2019.1580121

cogent business & management

MANAGEMENT | REVIEW ARTICLE

Management model by processes for science parks

Ana Maria Magalhães Correia[1] and Claudimar P. da Veiga[2*]

Received: 07 June 2018
Accepted: 03 February 2019
First Published: 08 February 2019

*Corresponding author: Claudimar P. da Veiga, School of Business Administration, Universidade Federal do Paraná, Curitiba, Brazil
E-mail: claudimar.veiga@gmail.com

Reviewing editor:
Robin Nunkoo, Management, University of Mauritius, USA

Additional information is available at the end of the article

Abstract: Design Science Research (DSR) purports to be a guide for research oriented to finding solutions to problems and designing artifacts. The aim of this study is to propose its use in the proposition of a management model by processes intended for science parks. Four science parks located in Paraná State, Brazil, were analyzed by conducting a comparative case study. Semi-structured interviews were held with the managers of the parks and non-participant observation was used to become more familiar with the environment to be studied. The results suggest that in order to define a management model by processes for science parks, the use of DSR is feasible. It is also important to follow its stages of construction, identifying the parks' management activities, identifying and mapping business processes and the information systems that support them and proposing this integration in the organizational logic of Enterprise Architecture. This study contributes to the field by using DSR to define a management model by processes that expresses the relationships between business processes and information systems and how these should be articulated in the development of activities in the environments under study.

Ana Maria Magalhães Correia

ABOUT THE AUTHORS

Ana Maria Magalhães Correia is a researcher and works on the main themes: Enterprise Architecture, Business Processes, Innovation Management, Business Incubators and Science and Technology Parks. She participates in research group in knowledge management, information and innovation. The general objective of the group is to develop studies and research on information systems, knowledge management and innovation management in both the public and private sectors. One line of action of the group is the studies in Enterprise Architecture, with the research project titled: Models of Management in EA - Enterprise Architecture to contribute in the performance of Brazilian organizations in which already have been realized researches in companies of services, startups, public institutions, ICT companies and the research of this article in science and technology parks.

Claudimar P. da Veiga is a Professor at the School of Administration in the Federal University of Parana - UFPR. Her research interests include marketing strategy and consumer behavior, management science, demand forecasting and retail.

PUBLIC INTEREST STATEMENT

Enterprise Architecture is defined as a high-level strategic technique or modeling, designed for business processes and information systems, reflecting the integration and standardization requirements of the company's operational model. This need to integrate business processes with information systems also includes organizations that support business development, such as science and technology parks. This research proposed a conceptual model of process management in four science and technology parks, which integrated business processes with information systems to contribute to the efficiency of management and effectiveness in achieving the expected results. These results allow the continuity of the activities of the science and technology parks in the incentive and support to the generation of micro and small technology based companies.

cogent oa

© 2019 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license..

Subjects: Management of IT; Information & Communication Technology; ICT; Business, Management and Accounting; Research

Keywords: science parks; enterprise architecture; artifacts; management model

1. Introduction

The need to integrate business processes and information systems in organizations means considering organizations that support the development of companies, such as science parks (Henriques, Sobreiro, & Kimura, 2018; Xie, Song, Zhang, Hao, & Chen, 2018). These parks constitute environments of excellence for technology transfer, with a qualified infrastructure, easy access and other factors (Associação Nacional de Entidades Promotoras de Empreendimentos Inovadores [ANPROTEC], 2008). This specific type of organization has evolved significantly in the last fifty years (Albahari et al., 2017; Allen, 2007; Díez-Vial & Montoro-Sánchez, 2016; Giugliani, 2011; Roldan, 2016; Vedovello, 2000; Vedovello, Judice, & Maculan, 2006; Xie et al., 2018) and is defined as an initiative based in a physical area, such as a set of buildings, intended to welcome innovative or knowledge-intensive companies and promote their interaction with teaching and research institutions (ANPROTEC, 2008).

Science parks are included in technological innovation environments as inductors of sustainable and innovative development. A park is an organization managed by specialist professionals. Their fundamental goal is to increase the wealth of the region, promoting a culture of innovation and competitiveness for companies and technology-based institutions (ANPROTEC, 2008; Phan, Siegel, & Wright, 2005; Veiga, Veiga, Corso, & Silva, 2018). Bellavista and Sanz (2009) add that a science park manages and encourages the flow of knowledge and technology between universities, research institutes, companies and markets through institutional arrangements and quality installations. They also encourage the creation and growth of technology-based companies through incubation and the creation of innovative businesses.

The recent systematic search for academic studies on the national and international bases of articles and dissertations and theses on Brazilian scientific and technological parks shows that these studies deal with the creation of a model of implementation and management (Wolfarth, 2004), of financing models focused on investment funds (Gargione, 2011), the creation of a multicriteria model (Oliveira Neto, 2008), of the potentialities and limits that park management confront (Correia, 2010), of the governance model (Chiochetta, 2010; Giugliani, 2011) and a business model for economic and financial sustainability (Figlioli, 2013). However, none of these deals with the proposition of a process management model for science and technology parks with the use of DSR.

It is precisely the inexistence or at least the scarcity of research on scientific and technological parks, with the use of DSR that the present research is justified. The use of DSR in this study is justified by its application in the development and projection of solutions to improve existing systems, solve problems or create new artifacts that spur better human action in society and organizations (Dresch, Lacerda, & Antunes, 2015). Thus, this study employs DSR to propose a management model by processes, intended for science parks to help managers of scientific and technological parks to integrate business processes with information systems in order to achieve better performance in the activities developed in the parks, as well as to meet the need for the lack of a formally articulated management model. It should be highlighted that DSR recognizes that existing problems in organizations tend to be specific. This specific nature precludes the generation of knowledge that can be generalized for other contexts.

DSR is based on and made operational by conducting research, the goal being an artifact or prescription. An artifact, according to Simon (1996), is understood as something constructed by man or artificial objects that can be characterized in terms of objectives, functions and adaptation. Thus, [...] "fulfillment of purpose or adaptation to a goal involves a relation among three terms: the purpose or goal, the character of the artifact and the environment in which the artifact performs" (Simon, 1996).

The field of management was introduced into studies on DSR to aid the creation of organizational artifacts (Romme, 2003), providing a prescription that helps to solve real problems and generate knowledge that can also be used in other situations (Van Aken, 2004). Thus, this study seeks to answer the following question: how can the DSR method be applied to the management of science parks in the proposal of a management model by processes?

In addition to this introduction, the study is structured as follows. Section 2 contains a literature review, with the DSR method and Enterprise Architecture (EA). The methodology and data analysis are presented in Sections 3 and 4, respectively. The final considerations are given in Section 5.

2. Literature review

2.1. The DSR method and its application to management

DSR is a rigorous process of projecting artifacts to solve problems, evaluate what is projected or what is working and communicate the results obtained (Çağdaş & Stubkjær, 2011). Inspired by Simon (1996), the concept of DSR is presented as a knowledge-oriented research strategy (Van Aken, Chandrasekaran, & Halman, 2016). This knowledge is created, used, tested and evaluated in the construction of the action (Bortolaso, 2009). Due to its pragmatic bias, it is mainly used to research problems of a pragmatic nature rather than to verify natural laws or behavioral theories (Hevner et al., 2004).

Przeybilovicz (2014) states that many researchers have focused on DSR methods such as Broadbent (1979), Cross (1980, 1984, 1993)), Hubka and Eder (1996), Bayazit (1994). Simon (1996) presented his thesis with the central theme of the study the artificial that gave rise to the book The Sciences of the Artificial. The author proposed the extensive application of the DSR scientific approach in economics, engineering and other disciplines, in which the conception of the artificial is the subject of research. The artificial here includes all kinds of man-made objects and organizations. In organizational studies, it was initiated, among others, by Romme (2003) and Van Aken (2004) and later by works published in the Journal of Applied Behavioral Science (Bate, 2007) and Organization Studies (Jelinek, Romme, & Boland, 2008). Currently, it is possible to find works that use DSR in several disciplines such as information systems, engineering, architecture, medicine, administration and other (Przeybilovicz, 2014).

This method is based on and made operational by conducting research, when the goal to be achieved is an artifact or prescription and can be used in the field of management to aid the solution of problems (Romme, 2003) and create knowledge that can be used in other situations by the organization (Van Aken, 2004). Thus, the decision maker can choose between optimal decisions in a simplified world or (good enough) decisions that he finds satisfactory in a world that is closer to reality. Consequently, solutions that are good enough are sought for problems whose optimal solutions are unknowable or unfeasible. This can be done in two ways: (i) consensus between the parties involved in the problem and; (ii) improvements to the current solution compared to the solutions generated by previous artifacts (Dresch et al., 2015).

Wastell, Sauer, and Schmeink (2009) claim that the goal of a theory based on the concept of design is to prescribe the properties that the artifact must have to achieve certain goals and the methods to construct the artifact. The work method used in this study is based on Vaishnavi and Kuechler (2004) and Manson (2006), who guide the sequence of logical steps to achieve the proposed goals of the study, as shown in Figure 1. This method is an improvement on the method proposed by Takeda et al. (1990) with the contributions proposed by Vaishnavi and Kuechler (2004) and Manson (2006), demonstrating the steps of the process and its main outputs (Dresch et al., 2015).

Regarding management, the initial condition of a study is to seek a solution to a problem. This is also the beginning of the DSR process. Awareness of the problem signals the beginning of the

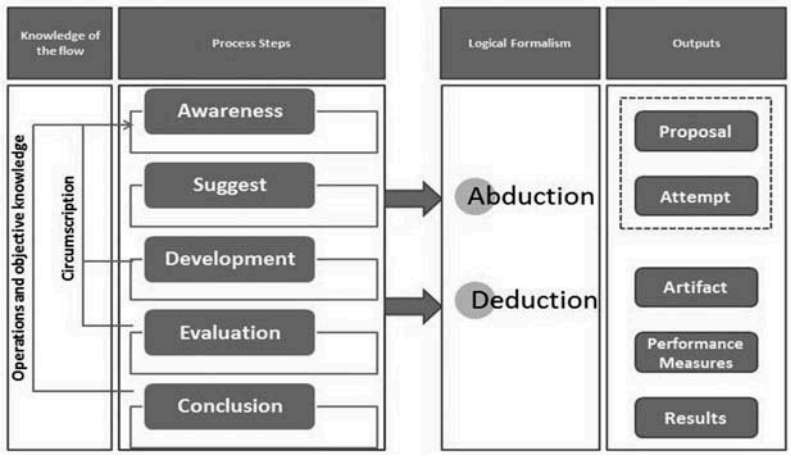

Figure 1. DSR work method.

Source: Adapted from Vaishnavi and Kuechler (2004) and Manson (2006).

formal or informal construction of the research process (Bortolaso, 2009). It is necessary to understand the nature of the problem, the context, the potentials and limitations in order to understand the environment in which the problem is embedded. In the first stage, that of awareness, it is necessary to analyze the different concepts, theories and useful relations to explain the processes and results of the organizations (Takeda et al., 1990).

The second step is suggestion, or defining the goals to achieve a solution. This is a creative step, in which functionality serves a base in a new configuration of new or existing elements (Vaishnavi & Kuechler, 2004). Imperative and fundamental propositions are made. These produce new projects or reinvent existing ones. This is followed by development, constructing the artifact, which is developed and implemented at this stage. Following the development, the artifact needs to be evaluated. It has to be analyzed and tested in accordance with the conditions established for this purpose, aiding its improvement (Bortolaso, 2009; Vaishnavi & Kuechler, 2004). Finally, the conclusion involves analyzing and interpreting the results, consolidating the artifact. Thus, the findings of the study of Dresch et al. (2015) conclude that the mere awareness of the problem is incomplete or insufficient.

2.2. Enterprise Architecture (EA)

Enterprise Architecture (EA) has been used successfully to reduce organizational complexity, improve communication, align businesses with information technology (IT) and spur organizational change (Alwadain et al., 2015). The term originated from an article by John A. Zachman, published in 1987, entitled *A framework for information systems architecture*. Ross, Weill, and Robertson (2006) later described EA as communication between high-level business processes and the information technology requirements of a company's operational model. Zachman (1987) claimed that with the increasing size and complexity involved in implementing information systems, it is necessary to use logical constructions to define and control interfaces and the integration of components of the organizational system. EA proposes to do this. According to Bradley et al. (2012), it directs the alignment of information systems, organizational processes and company strategy, and can be defined as the organizing logic for the IT infrastructure of an organization and its business processes.

In the literature, researchers have defined EA as a set of models and definitions that describe the structure of a company, its subsystems and the relationships between them. These include relationships with the external environment, the terminology used to employ the guiding principles for the concept and its future evolution. Furthermore, EA includes tools, techniques, descriptions of artifacts, models of processes, reference and orientation used by

architects to provide a description of the specific company architecture (Alaeddini, Arash, Gharibi, & Rad, 2017).

EA defines the components and the relationships between them in the organization. These components are constituted by strategy to define decisions on the organization and the use of resources to achieve goals, identify human resources and skills and how to use them (Tarcisius, Al-Ekran, & Ping, 2002). They include the organizational structure that defines the hierarchical and geographical organization, functions consisting of tasks and organizational processes, information through knowledge and data used by people, processes and technologies and infrastructure represented by equipment, machinery, methods and tools required to achieve organizational goals.

Zachman (1987) claims that Architecture defines the set of design artifacts, or descriptive representations that are important when it comes to preparing an object that can be produced according to requirements and maintained throughout its life cycle. Thus, the goal of EA is to integrate the entire company through coherent principles, methods and models. To Iyamu and Mphahlele (2014), its implementation provides holistic views that are sometimes used to deal with the structure of the organization, business processes, information flow, information system and infrastructure. The benefits are knowledge of the infrastructure for communication and analysis by all interested parties and the possibility of designing new conditions in an organized manner (Lankhorst et al., 2009).

There is a variety of positive results of EA when it is widely used in an organization. These include better organizational alignment, improved decision-making, reduced costs and higher performance levels (Tamm et al., 2011). However, the development of EA must be supported by a governance process that ensures that the interests of the stakeholders are considered and that the components of EA are complementary and managed in order to stimulate its development and implementation. Thus, EA is important for promoting the alignment between business and IT (Strnadl, 2006). Nevertheless, like any new initiative, it can take time, costs and effort to project, initiate and incorporate it within the organization.

In the scope of this work, together with Design Science Research, EA can be identified as a set of relevant descriptive representations used to describe the organization and serve as a basis for organizational changes (Zachman, 2007). In this way, the artifact is a process management model that expresses the relationships between business processes and information systems based on the EA concept for science and technology parks. In DSR activities, this model can be seen as a description, that is, as a representation of how the processes should be articulated in the search for a better performance in the activities developed in the parks, as well as to supply the need for the lack of a model formally articulated management.

It should be kept up-to-date throughout the time it is used. It can also be used to identify problems resulting from processes of interoperability (Anaya & Ortiz, 2005; Hjort-Madsen, 2006), such as support for the development of information systems and the development of organizational reengineering (Zachman, 2007), and to support innovation processes and improvements in management (Limberger, 2010).

3. Methodology

This study is qualitative and descriptive in nature, using the comparative case study method. The choice of method was due to the adaptation of the case study to conduct in-depth research on contemporary social phenomena in their context (Bruyne, Herman, & Schoutheete, 1977; Yin, 2010). The study was conducted at four science parks in Paraná State. This choice was motivated by interest in gaining further knowledge of organizations with a different organizational structure from commercial companies, but which also enable the application of the DSR method.

The data were collected from semi-structured interviews with the managers of the parks in question and during non-participant observation *in loco* to gain better knowledge of the context and the reality of the environment under study. The secondary data were collected by analyzing documents made available by the managers that were pertinent to the proposed objective. Information was also collected on the websites of the four parks and from publications related to these ventures.

The following criteria were used to choose the science parks: (a) they had to be operational in accordance with the Brazilian Association of Science Parks and Business Incubators (ANPROTEC, 2008) and the Ministry of Science, Technology and Innovation (Ministério da Ciência, Tecnologia e Inovação [MCTI], 2013); (b) they had to be located in Paraná State; (c) there had to be someone legally responsible for the park; (d) there had to be a management model, defined or not, and (e) the park had to allow the access required to obtain data. Together, these criteria led to the choice of parks in the following locations in Paraná State: Pato Branco, Cascavel and two in Curitiba.

Due to the aims of the study, the DSR method was chosen for the proposal of the artifact, as it was for a management model by processes intended for science parks. The DSR process begins when the researcher seeks to solve a problem as an initial research condition. The data analysis stages are described in Tables 1 and 2, aligned with the steps of the DSR work method.

Table 1. Information and method employed

Information analyzed	Design Science Research work method
Characterization, actions of management and identification of business processes and information systems	Awareness
Mapping of business processes	Suggestion
Proposal of management model by processes	Development
Final analysis of the proposed model by professionals from the ANPROTEC (Brazilian Association of Science Parks and Business Incubators)	Conclusion

Source: Research data

Table 2. Proposed model

Stages	Description
Stage 1	Considers the science parks as the focus of research. The parks are ventures created and managed with the permanent goal of promoting research and technological innovation (ANPROTEC, 2008).
Stage 2	Maps the business processes of the parks in question. These guide the actions executed at the parks together with the actors involved in search of their development and sustainability. These are the administrative process, support for projects, space management and mediation of strategic partnerships
Stage 3	Identifies how information systems can execute activities and generate information to aid the integration and management of the parks' business processes.
Stage 4	A model that promotes the integration of business processes with activities and information generated by the information systems.
Stage 5	Nominates Enterprise Architecture as an organizational logic of the business processes and information systems.

Source: Research data

4. Data analysis

4.1. Awareness

In the four cases under study, the phase in which the park is found was called the operation phase by the managers. Luger and Goldstein (1991) complement that the operation phase can be measured when the occupation rate of the park, guarantees its sustainability, as an enterprise, and its capacity of overflow is manifested in terms of backward and forward linkages with institutions research and business out of the park. Thus, its effect is perceptible on growth and the regional economic structure, the multiplication of new companies and the greater local industrial agglomeration.

Two important observations were made by the interviewees from Tecnoparque and the Pato Branco Science Park. In the case of the former, the manager addressed subjects related to the operation phase and possible phases of expansion. In the latter case, the manager spoke of the structure of the park, which was still in the implementation phase. These answers showed that the managers intend to expand their activities and consequently the workings of the parks. Thus, they are characterized as being in a state of expansion as they point to a possible expansion of the constructed area of the parks and the infrastructure necessary to install new companies and make an expressive contribution to improving the social and economic benefits of the region.

In the case of the four parks, the organizational structure is intended to promote the creation and consolidation of technology-based companies, incubated or installed in the parks, with the description of their departments and respective positions and functions. The Open Group (2009) emphasizes that the design and realization of the organizational structure articulated with the business processes contributes to the definition of EA as a coherent set of principles, methods and models that should be used in an organizational context.

Of the four parks, two are managed by a public managing institution: the Western Agro-industrial Park, with the Municipal Government of Cascavel, and the Pato Branco Science Park, with the Municipal Secretariat of Science, Technology and Innovation, with further participation from a Municipal Council for Science, Technology and Innovation from the municipality of Pato Branco. The other two have a private managing institution. The Software Park is managed by the APS (Association of Companies and Agency of the Curitiba Software Park. Tecnoparque is managed by the APC (Paraná Culture Association).

A public managing institution views the park as an instrument for economic development (Rosenblum, 2004). In these cases, both managing institutions are directly responsible for the resources for the structures and services for the parks, such as infrastructure, financial resources and human resources. Moreover, in all the cases studied, there is also the support, participation and availability of resources based on the cooperation network formed by the players involved. These include not only the municipal, state and federal governments, but also universities, research centers, funding and risk capital institutions, unions and agencies supporting national and international business development. Each has its own interests and role in the operationalization and development of the parks.

4.2. Suggestion—Mapping of business processes

The composition of the four fundamental business processes for the functioning of the parks' activities are: (i) the administrative process, (ii) support for projects, (iii) space management and (iv) mediation of strategic partnerships. The identification and mapping of these processes follow the line of executing actions mentioned by Belloquim (2011) for the proposal of the model of management by processes. According to the author, to use the concepts of EA, it is necessary to map the whole organization, beginning with the organizational strategy, in order to map the business processes and how these processes execute the strategy. The next step is the information

systems, which make these business processes automatic and identify the technological infrastructure available for the execution of these systems.

The administrative process is a macro process with a team in charge and administrative assistance that help the team to promote the analysis of projects. These projects are in their early stages or in progress and stem from others linked to the incubated and/or installed companies, with partnerships that the park makes with funding institutions and universities in the region. This monitoring is important for the parks to obtain knowledge of the feasibility and potential of the projects in their environments.

The macro process of support for projects includes actions that the park must offer to support its incubated and/or installed companies in search of funding for innovation through bulletins and public announcements. Bulletins and public announcements are issued by funding and innovation agents. They offer opportunities for technology-based companies and research institutions to present their projects, apply for resources and seek cooperation from other institutions. The science park also identifies the main innovation funding programs, focusing on companies and the ST&I (science, technology and innovation) community, and the main sources of funding for innovation, working with the actors involved and external investors.

Space management is a macro process related to the real estate dimension of the park to promote the entry of new incubated and/or installed companies, manage the provision of space and managerial support provided in the park for companies to develop with high quality space and installations. Thus, this space should serve as an inductor to concentrate technology-based companies and provide advantages for companies to set up in this environment in relation to the market, especially by facilitating relationships and cooperation with other companies and players involved in the park.

The mediation of strategic partnerships is a macroprocess that deals with the relationship, through partnerships, that the park must establish with its actors involved, so that its operation is possible. In this relationship, the scientific and technological park acts as a "bridge" between the research that is developed and the market that absorbs these technologies. Without the relationship with governments, universities, private companies, development institutions, investors and the incubated and/or installed companies themselves, the necessary interaction is not possible for the activities to take place and for the resources to be allocated to the park.

4.3. Development

The model for management by processes for science parks was based on the literature on EA and its frameworks, Business Architecture (BA) and Information Architecture (IA). It was also based on an analysis of the context of the parks compared with the specific structure of a science park, especially concerning the managing institutions, actors involved and the management team promoting the activities of this type of venture. This theoretical/conceptual and practical framework enabled a literature review and an analysis of the internal and external environment, an analysis of the strategy of the parks and their objectives and goals. It was then possible to obtain information on the business processes and information systems that support these processes. It was then possible to propose the management model by processes in accordance with the following stages of construction.

In the model, the science parks are innovation environments, characterized according to their specific features. To do this, it must present a physical infrastructure, containing the area of use of the park, as its own and adjacent land, infrastructure of technological services, managerial and operational support, to support incubated and/or installed companies, in addition to having a team manager responsible for managing the park's business processes, to offer, according to Spolidoro

and Audy (2008), conditions that ensure the institutional, political, operational, environmental and economic-financial viability of the park.

The parks define the operational and financial sustainability strategy as a promotor of actions to be executed for them to remain operational. In this strategy, the actions of the actors involved are important for the functioning of the parks. Vedovello (2000) and Zen, Hauser, and Vieira (2004) classify these actors as operators and promoters. Operators are the actors that act in the enterprise, aiming at the production of knowledge and technological innovation of a good or service, material or intellectual. The promoters work to facilitate, raise funds and encourage operators to carry out their tasks. In this way, Giugliani (2011) states that operators and promoters are responsible for sharing knowledge, cooperating in activities and establishing joint and convergent actions.

The model defines the administrative process, support for projects, space management and the mediation of strategic partnerships as the parks' business processes. These are integrated with the activities and information from the information systems that support these processes with patterns, policies, procedures and stipulated principles for better execution. Ross et al. (2006) argue that the standardization of business processes and related information systems defines exactly how processes will be performed regardless of who will perform or where it will be completed. Integration, according to the authors, associates the efforts of organizational units through shared data, linked to the sectors that promote the business processes of the parks. This data sharing can be between the processes, to allow the processing of transactions, or through the processes, to allow the park to present a single interface with the incubated and/or installed companies and the actors involved.

In this integration, EA acts as organizational architecture, connecting the business processes identified in the BA framework and information systems based on IA. Thus, EA seeks to promote the standardization and integration of the business processes and information systems, aligned with the strategy and preparing the parks to develop and reconfigure internal and external competences in times of change. The Open Group. TOGAF (2009) adds complementary information that EA is then used to identify a coherence set of patterns, policies, principles, procedures and models at the current and in future stages. These are used in the conception and achievement of the organizational structure, business processes, information systems and infrastructure of the parks.

The management model by processes proposed for science parks is intended to help the parks' managers understand and map the business processes and the possibility of integrating these processes with their information systems. These can provide support, thus composing EA amidst the organizational complexity of the ventures. There then arises a need to apply the EA methodology to enable this integration process to be achieved adequately and the processes to be duly mapped and treated, connected to the information systems. This will aid help managers with any necessary changes at all levels and in all areas in an organized manner.

Gartner (2014) then defines EA as the process of translating the business vision and strategy for effective business change to create, communicate and improve the fundamental requirements, principles, and models that describe the future state of the business and enable its evolution. Thus, the essential conception of EA is to align information, technology, standards, procedures, processes, policies and principles with the park's objectives and strategies in order to promote the integration, consistency and compliance of the organizational environment.

4.4. Final analysis of the proposed model

The final analysis of the proposed model is intended to make any possible adjustments suggested by the specialists from the ANPROTEC, enabling a better adaptation to the context of science parks. The possible suggestions in the business processes, provided by the specialists, were adjusted to the final proposed model for a better adaptation. The concept of a science park as an environment

related to business and science through technology and innovation is viewed from the origin of the project to its current phase of making the business processes operational. This initial intervention is promoted by an instituted governance, with a close and strong relationship with the actors involved. These actors are identified as the government, universities, funding institutions, the private sector and investors to aid the development and evolution of the parks' processes. The relationship with the market, from the outset, also aids this evolution and promotes bilateral cooperation in business with other countries.

In the administrative process, the suggested monitoring with indicators to measure the local and national impact of investment and the contribution of each incubated and/or installed company could be done in the planning process if it is integrated into the current management system or if a specific management system is used that provides this information for later analysis. It falls to the managers to realize the need to measure the high impact indicators related to the environment of the parks. They also have to measure the internal indicators of each incubated and/or installed company to analyze their contribution to the scientific development of the region. The suggestion in the space management process, as a far more complex real estate management process, is pertinent. To adapt better to the environment in question, the real estate management should focus on the parks as a real estate complex with a view to gaining financial returns and productive returns in terms of science, technology and innovation.

These adjustments allowed the management model by processes to adapt better to the context in question in order to contribute to the literature, proposing to map the business processes and sub-processes of the science parks through the administrative process, support for projects, real estate management and mediating strategic partnerships integrated with the support from the information systems. This integration results in EA in a framework made up of BA and IA to configure new control and support mechanisms for the management of the parks at times of change, adaptation to new technologies and the easy adoption of new innovation processes. Therefore, this management model for science parks enables business processes to be integrated with information systems from the perspective of influencing factors. These factors include the legal status, the players involved, strategic aims and goals and the physical infrastructure and infrastructure of quality services in the creation of incubated companies. Other factors involve attracting installed companies that add value to the park and seek to improve the scientific and technological development of the region.

5. Final considerations

The aim of this study was to use Design Science Research to propose a management model by processes for science parks. The analysis was conducted by identifying the processes of the activities and procedures that were required to complement the activities for the functioning of the park and the business processes defined as axes for the operations in general. In other words, the lines of action that guide the activities by position, function or department of the parks. This analysis showed that the managers, despite succeeding in defining the activities and axes of operation, do not have access to the mapping of these processes, as they claim that the actions and activities are executed according to demand and without planning.

DSR can be applied to the management of the science parks, with a proposal for a management model by processes. This is because the information analyzed with this method promotes the integration of business processes with and the activities and information generated by the information systems. However, this model is not intended to be definitive and applicable to all parks, as it was derived at operational parks located in Paraná State, with a simplified reality. Thus, it may be concluded that to define a management model by processes for science park, Design Science Research is a valid method, as is following the stages of construction. The first stage is to identify the current management actions of the parks, followed by identifying and mapping the business processes and information systems that support them, and proposing this integration into the organizational logic of EA.

This study contributes to the theory by addressing the DSR method in management, a theme that has been studied little in the literature. It also furthers knowledge of organizations with an organizational structure that differs from that of commercial businesses by applying the method to science parks. The practical and managerial contribution of the study is to assist the park managers with an understanding and mapping of the business processes and the possibility of integrating these processes with the information systems that can support, thus composing Enterprise Architecture in a medium to the organizational complexity of enterprises, helping managers to any changes that are necessary at all levels and areas and in an organized way.

A limitation of the study is the use of the DSR method. As it is new to management, it posed a challenge regarding the theoretical framework to address this specific field and help to create organizational artifacts, offering a prescription that helps to solve real problems and create knowledge that can be used in other situations. Despite this limitation, all the steps were followed to propose an organizational artifact to achieve the goal of the study.

With regard to future studies, it is important to integrate and expand the focus of analysis, which so far has extended to integrating business processes and information systems in a macro perspective of information. The suggestion is therefore to study EA as an organizational logic for the development of further empirical studies on the theme and its frameworks of Business Architecture and Information Architecture. Other studies could also involve science parks. These studies are necessary to obtain more knowledge on these innovation habitats and to address other theoretical and practical aspects regarding entrepreneurship, dynamic capabilities, internationalization of partnerships, competitiveness, technological cooperation, business strategy and defining and measuring indicators to measure the performance of their environments. Another suggestion would be to study parks in the project and implementation stage to develop actions that favor their successful evolution.

Funding
The authors received no direct funding for this research.

Author details
Ana Maria Magalhães Correia[1]
E-mail: ammagalhaescorreia@gmail.com
Claudimar P. da Veiga[2]
E-mail: claudimar.veiga@gmail.com
ORCID ID: http://orcid.org/0000-0002-4960-5954
[1] Department of Applied Social Sciences, Universidade Federal do Semi-Árido, Mossoró, Brazil.
[2] School of Business Administration, Universidade Federal do Paraná, Curitiba, Brazil.

Citation information
Cite this article as: Management model by processes for science parks, Ana Maria Magalhães Correia & Claudimar P. da Veiga, *Cogent Business & Management* (2019), 6: 1580121.

References

Alaeddini, M., Arash, H., Gharibi, A., & Rad, M. R. (2017). Leveraging business-it alignment through enterprise architecture: An empirical study to estimate the extents. *Information Technology and Management*, *18*(1), 55-82. doi:10.1007/s10799-016-0256-6

Albahari, A., Pérez-Canto, S., Barge-Gil, A., & Modrego, A. (2017). Technology parks versus science parks: Does the university make the difference? *Technological Forecasting and Social Change*, *116*, 13–28. doi:10.1016/j.techfore.2016.11.012

Allen, J. (2007). *Third generation science parks* (pp. 22). Manchester: Manchester Science Park Ltd.

Alwadain, A., Fielt, E., Korthaus, A., & Rosemann, M . (2015, September 25). Empirical insights into the development of a service-oriented enterprise architecture. *Data and Knowledge Engineering*, *105*, 39-52. doi:10.1016/j.datak.2015.09.004

Anaya, V., & Ortiz, A. (2005). *How enterprise architectures can support integration. Proceedings of the first international workshop on Interoperability of heterogeneous information systems – IHIS 05. Anais*, Bremen, Germany.

ANPROTEC - Associação Nacional de Entidades Promotoras de Empreendimentos Inovadores. (2008). Retrieved from http://www.anprotec.org.br/ArquivosDin/portfolio_versao_resumida_pdf_53.pdf

Bate, P. (2007). Bringing the design sciences to organization development and change management. Editorial to the special issue. *Journal of Applied Behavioral Science*, *43*(1), 8–11. doi:10.1177/0021886307299885

Bayazit, N. (1994). *Introduction to design methods in industrial product design and architecture*. Istanbul: Literatur Yayinevi.

Bellavista, J., & Sanz, L. (2009). Science and technology parks: Habitats of innovation: Introduction to special section. *Science and Public Policy*, *36*(7), 499–510. doi:10.3152/030234209X465543

Belloquim, A. (2011). Arquitetura corporativa: muito mais do que TI. Retrieved from http://blog.gnosisbr.com.br/arquitetura-corporativa-e-mais-do-que-ti/

Bortolaso, I. V. (2009). *Proposta de construção de um modelo de referência para avaliação de redes de cooperação empresariais. 172 f* (Dissertação de Mestrado em Engenharia de Produção de Sistemas). Universidade do Vale do Rio dos Sinos – UNISINOS, São Leopoldo/RS.

Bradley, R. V., Pratt, R. M. E., Byrd, T. A., Outlay, C. N., Wynn, Jr, D. E. (2012). Enterprise architecture, IT effectiveness and the mediating role of IT alignment in US hospitals. *Information Systems Journal*, *22*(2), 97–107. doi:10.1111/j.1365-2575.2011.00379.x

Broadbent, G. (1979). The development of design methods. *Design Methods and Theories*, *13*(1), 41–45.

Bruyne, P., Herman, J., & Schoutheete, M. (1977). *Dinâmica da pesquisa em ciências sociais: os pólos da prática metodológica*. Traduzido por Ruth Joffily. Rio de Janeiro: Francisco Alves.

Çağdaş, V., & Stubkjær, E. (2011). Design research for cadastral systems. *Computers, Environment and Urban Systems*, *35*(1), 77–87. doi:10.1016/j.compenvurbsys.2010.07.003

Chiochetta, J. C. (2010). *Proposta de um modelo de governança para Parques Tecnológicos. 2010. 208 f* Tese (Doutorado em Engenharia de Produção). Universidade Federal do Rio Grande do Sul, Porto Alegre. doi: 10.1094/PDIS-94-7-0915B

Correia, A. M. M. (2010).*Potencialidades e limites para o desenvolvimento econômico e inovativo local: uma análise comparativa em parques tecnológicos da região Nordeste. 2010. 279 f* (Dissertação de mestrado em Engenharia de Produção). Universidade Federal da Paraíba, João Pessoa. doi:10.1094/PDIS-94-7-0915B

Cross, N. (1980). The recent history of post-industrial design methods. In R. Hamilton (Ed.), *Design and industry* (pp. 1-27). London: The Design Council. https://monoskop.org/images/6/66/Cross_Nigel_1993_A_History_of_Design_Methodology.pdf

Cross, N. (1984). *Developments in design methodology*. Chichester: Wiley.

Cross, N. (1993). History of design methodology. In M. J. De Vries, N. Cross, & D. P. Grant (Eds.), *Design methodology and relationship with science, NATO ASI series* (p. 327). Dordrecht: Kluwer Academic Publishers.

Díez-Vial, I., & Montoro-Sánchez, A. (2016). How knowledge links with universities may foster innovation: The case of a science park. *Technovation*, *50–51*, 41–52. doi:10.1016/j.technovation.2015.09.001

Dresch, A., Lacerda, D. P., & Antunes, J. A. V. (2015). *Design Science Research: método de pesquisa para avanço da ciência e tecnologia*. Porto Alegre: Bookman.

Figlioli, A. (2013). *Em busca da sustentabilidade econômico-financeira de organizações gestoras de parques tecnológicos: proposta de modelo de negócio no contexto brasileiro. 2013. 310 f* Tese (Doutorado em Ciências). Universidade de São Paulo, São Paulo.

Gargione, L. A. (2011). *Um modelo para financiamento de parques tecnológicos no Brasil: explorando o potencial dos fundos de investimento. 2011. 328 f* Tese (Doutorado em Engenharia de Produção). Universidade de São Paulo, São Paulo.

Gartner, Inc. (NYSE: IT). (2014). Enterprise architecture. Retrieved from http://www.gartner.com/technology/consulting/enterprise-architecture.jsp

Giugliani, E. (2011). *Modelo de governança para parques científicos e tecnológicos no Brasil. 2011. 310 f* Tese (Doutorado em Engenharia e Gestão do Conhecimento). Universidade Federal de Santa Catarina, Florianópolis.

Henriques, I. C., Sobreiro, V. A., & Kimura, H. (2018). Science and technology park: Future challenges. *Technology in Society*, *53*, 144–160. doi:10.1016/j.techsoc.2018.01.009

Hevner, A. R., March, S. T., Park, J., Ram, S. (2004). Design science in information systems research. *MIS Quaterly*, *28*(1), 75–105. doi:10.2307/25148625

Hjort-Madsen, K. (2006). *Enterprise architecture implementation and management: A case study on interoperability. 39th Hawaii International Conference on System Sciences. Anais*, Hawaii.

Hubka, V., & Eder, E. (1996). *Design science*. London: Springer Verlag.

Iyamu, T., & Mphahlele, L. (2014). The impact of organizational structure on enterprise architecture deployment. *Journal of Systems and Information Technology*, *16*(1), 2–19. doi:10.1108/JSIT-04-2013-0010

Jelinek, M., Romme, A. G. L., & Boland, R. J. (2008). Organization studies as a science for design: Creating collaborative artifacts and research. Introduction to the special issue. *Organization Studies*, *29*, 317–329. doi:10.1177/0170840607088016

Lankhorst, M. (2009). *Enterprise architecture at work: Modeling, communication and analysis the enterprise engineering series* (2nd ed.). Berlin: Springer-Verlag.

Limberger, S. J. (2010). *Uma teoria substantiva para o alinhamento da unidade de tecnologia da informação com a organização. 2010. 251 f* Tese (Doutorado em Engenharia de Produção). Universidade Federal de Santa Catarina, Florianópolis. doi:10.1094/PDIS-94-7-0915B

Luger, M. I., & Goldstein, H. A. (1991). *Technology in the garden: Research parks and regional economic development*. Chapel Hill: The University of Carolina Press.

Manson, N. J. (2006). Is operations research really research? *ORiON*, *22*(2), 2, 155–180. doi:10.5784/22-2

MCTI – Ministério da Ciência, Tecnologia e Inovação. (2013). *Estudos de projetos de alta complexidade: indicadores de parques tecnológicos*. Brasília: Centro de Apoio ao Desenvolvimento Tecnológico, CD T/UnB.

Oliveira Neto, J. L. (2008). *Aplicação de modelo multicritério em apoio à seleção de empresas de base tecnológica candidatas à incubação: uma abordagem a partir da "capacidade empreendedora" com uso da Metodologia e do Software Macbeth. 2008. 254 f* (Dissertação de mestrado em Administração). Univesidade de Fortaleza, Fortaleza.

Phan, P. H., Siegel, D. S., & Wright, M. (2005). Science parks and incubators: Observations. Synthesis and future research. *Journal of Business Venturing*, *20*(2), 165–182. doi:10.1016/j.jbusvent.2003.12.001

Przeybilovicz, E. (2014). *E-participação e E-transparência: uma investigação sobre o monitoramento orçamentário e financeiro de políticas públicas sob o paradigma de Design Science. 2014. 109 f* (Dissertação de mestrado em Administração). Pontifícia Universidade Católica do Paraná, Curitiba.

Roldan, L. B. (2016). *Análise das condições favoráveis para a inovação e seus resultados nas empresas residentes em Parques Tecnológicos. 2016. 169 f* Tese (Doutorado em Administração). Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre.

Romme, A. G. L. (2003). Making a difference: Organization as design. *Organization Science*, *14*(5), 558–573. doi:10.1287/orsc.14.5.558.16769

Rosenblum, L. (2004, November). Profiting from research. *American School & University*, Overland Park. *77*(3), 334–337.

Ross, J. W., Weill, P., & Robertson, D. C. (2006). *Enterprise architecture as strategy: Creating a foundation business execution*. Boston, MA: Harvard Business School Press.

Simon, H. A. (1996). *The sciences of the artificial* (3th ed.). Massachusetts: MIT Press.

Spolidoro, R., & Audy, J. L. N. (2008). *Tecnopuc: parque científico e tecnológico da PUCRS*. Porto Alegre: EDIPUCRS.

Strnadl, C. (2006). Aligning business and IT: The process-driven architecture model. *Information Systems Management*, *23*(4), 67–77. doi:10.1201/1078.10580530/46352.23.4.20060901/95115.9

Takeda, H., Veerkamp, P., & Yoshikawa, H. (1990). Modeling design process. *AI Magazine*, *11*(4), 37–48.

Tamm, T., Seddon, P. B., Shanks, G., & Reynolds, P. (2011). How does enterprise architecture add value to organisations? Communications of the association for

information systems *28*(1), Article 10, 141-168. Available at: http://aisel.aisnet.org/cais/vol28/iss1/10

Tarcisius, G., Al-Ekran, R., & Ping, Y. (2002). *Enterprise architecture: An overview* (Project Report for CS 798). http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.201.3749&rep=rep1&type=pdf

The Open Group. TOGAF. Version 9 – The open group. [Online]. (2009). Retrieved from http://www.opengroup.org/architecture/togaf9-doc/arch/

Vaishnavi, V., & Kuechler, B. (2004). Design science research in information systems. Retrieved from http://desrist.org/desrist/content/design-science-research-in-information-systems.pdf

Van Aken, J. (2004). Management research based on the paradigm of the design sciences: The quest for field tested and grounded technological rules. *Journal of Management Studies*, *41*(2), 219–246. doi:10.1111/joms.2004.41.issue-2

Van Aken, J., Chandrasekaran, A., & Halman, J. (2016, July 1). Conducting and publishing design science research. *Journal of Operations Management*, doi:10.1016/j.jom.2016.06.004

Vedovello, C. (2000, December). Aspectos relevantes de parques tecnológicos e incubadoras de empresas. *Revista do BNDES, Rio de Janeiro*. *7*(14), 273–300.

Vedovello, C. A., Judice, V. M. M., & Maculan, A. M. D. (2006). Revisão crítica às abordagens a parques tecnológicos: alternativas interpretativas às experiências brasileiras recentes. *Revista de Administração e Inovação*, *3*(2), 103–118.

Veiga, C. P., Veiga, C. R. P., Corso, J. M., & Silva, W. V. (2018). Brazil in the research and development of vaccines: Innovation policies and measurable results. *International Journal of Business Innovation and Research*,15, 188. doi:10.1504/IJBIR.2018.089143

Wastell, D., Sauer, J., & Schmeink, C. (2009). Time for a "design turn" in IS innovation research? A practice report from the home front. *Information Technology & People*, *22*(4), 335–349. doi:10.1108/09593840911002441

Wolfarth, C. P. (2004). *Parques Tecnológicos: uma proposta de modelo de gestão a partir do estudo de caso do Pólo de Informática de São Leopoldo. 2004. 221 f* (Dissertação de mestrado em Economia). Universidade Federal do Rio Grande do Sul, Porto Alegre.

Xie, K., Song, Y., Zhang, W., Hao, J., & Chen, Y. (2018). *Technological forecasting and social change*. Article "In press".

Yin, R. K. (2010). *Estudo de caso: planejamento e métodos* (4th ed.). Porto Alegre: Bookman.

Zachman, J. A. (1987). A framework for information systems architecture. *IBM Systems Journal*, *26*(3), 276–292. doi:10.1147/sj.263.0276

Zachman, J. A. (2007). Architecture Is Architecture Is Architecture. EIMInsight, 1(1), Enterprise Information Management Institute. http://www.eiminstitute.org/library/eimi-archives/volume-1-issue-1-march-2007-edition

Zen, A. C., Hauser, G., & Vieira, C. R. B. (2004). *Parques Tecnológicos: Três modelos internacionais e a perspectiva para o movimento no Brasil. XIV Seminário ANPROTEC. Anais*, Porto de Galinhas: ANPROTEC.

© 2019 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license..

You are free to:
Share — copy and redistribute the material in any medium or format.
Adapt — remix, transform, and build upon the material for any purpose, even commercially.
The licensor cannot revoke these freedoms as long as you follow the license terms.

Under the following terms:
Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
No additional restrictions

You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

Cogent Business & Management **(ISSN: 2331-1975) is published by Cogent OA, part of Taylor & Francis Group.**

Publishing with Cogent OA ensures:

- Immediate, universal access to your article on publication
- High visibility and discoverability via the Cogent OA website as well as Taylor & Francis Online
- Download and citation statistics for your article
- Rapid online publication
- Input from, and dialog with, expert editors and editorial boards
- Retention of full copyright of your article
- Guaranteed legacy preservation of your article
- Discounts and waivers for authors in developing regions

Submit your manuscript to a Cogent OA journal at www.CogentOA.com