Current and expected roles and capabilities of CIOS for the innovation and adoption of new technology

Gong, Yiwei; Janssen, Marijn; Weerakkody, Vishanth

DOI
10.1145/3325112.3325214

Publication date
2019

Document Version
Final published version

Published in
Proceedings of the 20th Annual International Conference on Digital Government Research

Current and Expected Roles and Capabilities of CIOs for the Innovation and Adoption of New Technology

Yiwei Gong
School of Information Management
Wuhan University, Wuhan, Hubei, China,
yiweigong@whu.edu.cn

Marijn Janssen
Faculty of Technology Policy and Management, Delft University of Technology, Delft, the Netherlands,
M.F.W.H.A.Janssen@tudelft.nl

Vishanth Weerakkody
School of Management
University of Bradford, Bradford, United Kingdom,
v.weerakkody@bradford.ac.uk

ABSTRACT

Governments across the word are under pressure to adopt new technologies and to innovate and transform their processes. Some governments have introduced the role of Chief Information Officer (CIO) to facilitate these innovations though adoption of new technologies. The traditional CIO role of improving operational efficiency is now shifting towards exploring new IT-enabled opportunities required in digital transformation. In this context, CIO capabilities are expanding to be more involved in administrative processes and digital transformation, however, their organizational role seem to lag behind. This paper is aimed at evaluating the current role of CIOs and to provide policy recommendations to strengthen their role. Data was collected during a session in which roles and capabilities of CIOs were discussed. In particular, we found that often the CIO was positioned as having an IT role, whereas a more organizational role was needed. CIOs should develop capabilities to support digital transformation and to develop architecture that is adaptive and agile. The expectations of the CIO and the role of the CIO need to be better aligned.

CCS CONCEPTS

• Applied computing→Computers in other domains • Computing in government→E-government.

KEYWORDS

CIO, Enterprise Architecture, Roles, Dynamic Capabilities, Capability, Digital Transformation, Adoption

ACM Reference format:

Yiwei Gong, Marijn Janssen, Vishanth Weerakkody. 2019. Current and Expected Roles and Capabilities of CIOs for the Innovation and Adoption of New Technology. In *Proceedings of dg.o 2019: 20th Annual International Conference on Digital Government Research (dg.o 2019), June 18, 2019, Dubai, United Arab Emirates.* ACM, New York, NY, USA, 6 pages. https://doi.org/10.1145/3325112.3325214

dg.o 2019, June 18, 2019, Dubai, United Arab Emirates

ACM ISBN 978-1-4503-7204-6/19/06...$15.00
https://doi.org/10.1145/3325112.3325214

1 Introduction

The development of Information Technology (IT) gives rise to the need to further manages the IT-landscape by governments. During the last years many governments have introduced or strengthened the role of the Chief Information Officer (CIO) in the government. A CIO is responsible for building and managing IT capabilities within a government organization, for enabling strategical business-IT alignment by combining these capabilities with business objectives, and for leading the organization to achieve new objectives supported by IT [1]. The ever-increasing role of technology driven by developments like Big and Open Linked Data (BOLD), Artificial Intelligence (AI) and the Internet of Things (IoT) demand a further strengthening of this role. Weill and Woerner [2] found that "CIO activities are expanding from providing IT services to including external customer responsibilities, working with non-IT colleagues and managing enterprise processes" (P. 65). Yet, many CIOs seem not to be ready for adopting the new roles.

The role of CIOs in government is not well-developed and only the large organizations have one [3]. Small-to-medium size cities do not have a Chief Information Officer, but have appointed officials with a wide variety of titles ranging from IT Director, IS Manager to IT Specialist among others. These officials should build operational capabilities for realizing a strategy. Within government the role of the CIO is ill-understood [4], and the readiness is low [5].

Despite its importance, the role of CIO in many organizations is often ambiguous [6, 7]. A range of responsibilities demanded from CIOs is often shared and even overlapped with other positions in specific technical areas, such as Chief Technology Officer, Chief Enterprise Architect, Chief Innovation Officer [1] and Chief Data Officer [7]. Furthermore, the role of CIO should evolve to reflect both the organization's IT infrastructure and strategy [8]. Along with the increasingly complex functions of this position, CIOs face to the pressure that their competencies are not always sufficient for the adoption of new technologies and innovations [9]. In this paper, we aim to identify the roles of

CIOs in governments and their required capabilities. This will enable CIOs in governments a clear understanding on their challenges in the innovation and adoption of new technology, and provide recommendations for them to efficiently support the digital government transformation.

The paper is structured as follows. In Section 2, we briefly discuss the background of CIO roles and organizational capabilities. Thereafter, the research method is explained in Section 3. In Section 4 we present research findings. In Section 5, we discuss policy recommendations for government CIOs. Section 6 contains the conclusion.

2 Background

Weill and Woerner [2] identify four main activities of CIOs in their work, including IT services, embedded, external customer and enterprise process activities. *IT Services activities* concern with the management of the IT organization including its people and external partners to ensure delivery of IT infrastructure, applications, projects and related services across the entire enterprise. *Embedded activities* refer to work with non-IT colleagues, such as business units, to address issues like business strategy, business process optimization, new product or service development, regulatory compliance and risk, and IT investment prioritization. *External Customer activities* are about meeting with the company's external customers, partners and colleagues as part of the sales or service delivery process. *Enterprise Process activities* are needed to enable the management of enterprise processes and the associated digital platforms, including shared services, product development, operations, corporate responsibility, green issues and a range of special projects. The allocation of time among these four types of activities could be used for indicate the different roles of CIOs.

2.1 CIO Roles

The role of the CIO is missing in many public organizations [10]. The role was introduced to give stewardship over the information assets [8]. The CIO role is often operational and dealing with daily problem solving, instead of contributing to the digital strategy. CIOs should be overseeing operational areas such as security, budgets, performance and staffing as well as having a vision and contributing to standardization and organizational objectives [4]. According to Dawson, Ho and Kauffman [11] the core competencies of CIOs in government is similar to those in private firms. Based on the four main activities and the allocation of time among them, Weill and Woerner [2] identify four types of CIOs in their work:

1. IT Services CIO. The main focus of the IT Services CIO is to provide the needed IT services, including delivery of IT infrastructure, applications and projects, as well as enabling collaboration and online services across the enterprise for its employees or customers with the desired cost and quality and acceptable risk.
2. Embedded CIO. This type of CIO participates daily in strategic conversations and overviews enterprise-wide business operations. They deal with almost all the main issues of the enterprise, such as hiring, building of organizational culture and capabilities, external partnerships, budgets, acquisitions, product development, globalization, risk management and compliance.
3. Enterprise Process CIO. The primary focus of a CIO in this type is overseeing and operating key enterprise business processes as well as IT. Enterprise Process CIOs are often found in organizations where business processes are increasingly digitized, such as financial service providers or electronic commerce firms, or where IT is part of shared services.
4. External Customer CIO. The primary focus of the External Customer CIO is to strengthen the relationships between the enterprise and its customers to deliver products or services.

Although the four roles show the distinct focus of the CIOs, these roles do not capture aspects related to digital transformation. In the paper about the ambiguous role of the CIOs, Peppard, Edwards and Lambert [6] identify five different roles:

1. Utility IT director. This type of CIO is often IT supply orientated, report to CFO and has strong technical bias. They focus on maintaining service levels and ensuring the integrity of IT infrastructure.
2. Evangelist. CIOs in this type strive for changing mindsets about information and identifying sources of competitive advantage by educating their peers on the potential for information to be a potent business driver.
3. Innovator. This type of CIO identifies and develops opportunities to deploy new IT-enabled processes and products or services which bring a clear source of competitive differentiation to the organization. Information resource is proactively used as an integral part of strategic growth and innovation.
4. Facilitator. The Facilitator CIO is responsible for empowering and enabling the business with information capabilities. By levering IT assets, they ensure that every department, function, and division within the organization can define, integrate, and exploit information.
5. Agility IT director. CIOs in this type are responsible for the supply of technology and systems to satisfy the demands defined by the business. They focus on developing agile infrastructure and coordinating organizational information and technology requirements.

The roles show the way CIOs can approach digital transformation. Hence, the latter roles will be used in this paper to understand the current roles of CIOs.

2.2 Organizational Capabilities

In the nineties, the CIO functions related to technology planning and IT-control, enterprise architecture, standards development,

and human resource management were introduced [8]. The functions resulted in higher costs, whereas the capabilities needed to create value were not clear. This resulted in a discussion about the capabilities needed.

Teece, Pisano and Shuen [12] define dynamic capabilities as "the ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (p. 516). Dynamic capabilities are needed to adopt new technology in the organization and reconfiguring is needed to learn from the experiences. Eisenhardt and Martin [13] define dynamic capabilities as "the organizational strategic routines by which firms achieve new resources configurations as markets emerge, collide, split, evolve and die" (p. 1107). Willcocks and Feeny [14] define a capability as "a distinctive set of human resource-based skills, motivations, and behaviors that have the potential, in suitable contexts, to contribute to achieving specific activities and influencing business performance" (p. 29). They further argued that "a core IS capability is a capability needed to facilitate the exploitation of IT, measurable in terms of IT activities supported, and resulting in business performance". In their view, a capability can be regarded as a concept encompassing the possession of skills/knowledge for the effective execution of specific activities.

CIOs need a number of capabilities to be effective. Willcocks and Feeny [14] define 9 core capabilities, e.g. IS/IT governance, business system thinking, relationship building, designing technical architecture, making technology work, informed buying, contract facilitation, contract monitoring and vendor development. Chen and Wu [15] developed a framework for investigating the capability of IT management personnel and its impact on the performance of a CIO. Their focus of the CIOs capability is on the integration of IT functions with business operations. Chen and Wu [15] identified 3 main domains for CIOs.

- IT infrastructure skills/knowledge: The ability of a CIO to configure, implement, apply, and evaluate the existing and emerging information and communication technologies to create an IT infrastructure.
- business applications skills/knowledge: the ability of a CIO to assemble the infrastructure to support business objectives.
- IT–business integration skills/knowledge: the ability of a CIO to determine how of technologies can contribute to the organization's performance.

In the current digital age, the focus of CIOs has shifted towards facilitating the move to the digital society and making the architecture landscape ready for this. Given the capabilities of Willcocks and Feeny [14] and domains of Chen and Wu [15], we expect that the following capabilities are needed to move to the information society.

1. Renovate IT-core: There is a lot of legacy that is not suitable for dealing with the digital society and there is the need to be update and renovate the IT-core systems to prepare them for the digital society.
2. Create flexible IT execution platform: How the digital society will look like is not clear. There is a need for the ability to be flexible and adapt the IT-execution platform to the changes in the environment.
3. Align Business & IT: The ability to understand the business need and to translate them into the existing IT-landscape.
4. Develop talent: Governments suffer from being less attractive to talents and therefore need to focus on developing the talent within the own organizations.
5. Balance exploitation and innovation. Both the current systems and business processes need to be modified as new innovations need to be adapted. An ambidexterity is needed [16].
6. Champions digital business strategy: If IT or business should take the lead in s innovating and moving to the digital society is subjective to discussion. This is the ability of CIOs to champion the move to the digital society.
7. Manage digital transformation: Digital transformation is needed to be prepare for the digital society. Also, here the question is if the IT or administrative staff should manage the transformation.
8. Manage portfolio/budget/value risk: There are a large number of systems. Old systems should be removed and new systems be added by managing a portfolio of systems. This requires the budgeting for prioritizing investment in combination with the value that it might need a trade-off with the risks of the current landscape (for example legacy systems stop working) and developing new systems.

The capabilities range from internal till external focused capabilities. These 8 key capabilities were used in our research.

3 Research Approach

The goal of this policy research is to evaluate the types of CIOs roles and their capabilities. This was done by organizing a session with government representatives involved in Enterprise Architecture (EA) and IT projects in the Netherlands. The session participants were part of the IT and business course in which the CIO roles and capabilities were important topics. The session participants ranged from human resource management, to information managers to line managers and business developers. In this way covering various important organizational functions. This allowed us to include different views and capture a rich understanding. Although the participants were not the CIOs of their organizations, their input reflected on the existing and expected roles of the CIO in their organizations, as research has already indicated the applicability and reliability for surveying senior managers to understand the roles and types of CIOs [17].

In a total of 21 session participants scored their CIOs roles and capabilities using Menti-meter

(https://www.mentimeter.com/). Menti-meter is a software tool in which presentation and all kind of voting features can be created. Participants can vote using their mobile phone or any other electronic device by going to the webpage, entering the code and vote. Most of the participants used their mobile phone for voting, two persons used a computer and one person used a Tablet.

The session was facilitated by one of the authors and was held in December 2018 in the Netherlands. Most participants were from the Netherlands. The session participants were working in a management functions in the IT. During the session, the main steps followed were:

1. Introduction and background.
2. Score of the current role of the CIOs. All participants were asked to score the projects they had knowledge of based on the questionnaire. There were 10 questions for EA and the same number of questions about risk management. For each question, one point could be gained, resulting in a maximum score of 10 for risk management and 10 for EA.
3. Discussion of the desired role of the CIO. Each of the participants positioned the project they scored on a whiteboard displaying the matrix. All scores were discussed and in case of a deviation among scores for one project consensus was sought.
4. Scoring of the existing capabilities.
5. Discussing of the capabilities.
6. Policy recommendations. Finally, the findings were summarized and participants were asked to formulate policy recommendations.

Finally, the results were discussed and reported. One of the authors made notes of the discussions and the results in Menti-meter were recorded.

4 Findings

In the workshop the current roles of CIOs were analyzed followed by the identification of the capabilities desired for moving towards the information society.

4.1 Existing CIO Roles

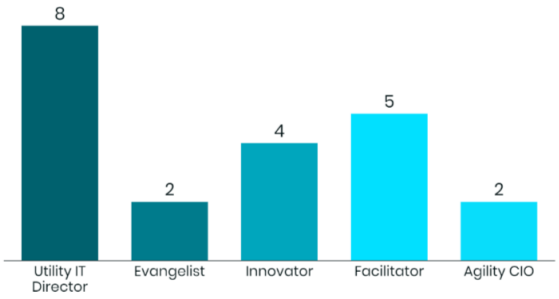

Figure 1: Roles of the CIOs

The overview of existing roles (Figure 1) shows that here is no single dominating role. Most of the time they have the role of IT-director which is not considered as a real CIO role by [6]. Thereafter the facilitator role is the most common. In total they account for more than 60% of the roles.

Less than 40% or the roles are related to evangelist innovator and agility CIOs. One interviewee commented that the evangelist role is important as an initial driver, but 'Evangelist promotes new technology, but does not prepare the organization for being agile and adaptive'.

Some CIOs have limited links with enterprise architecture efforts. They merely use EA as a way to promote standards and ensure uniformity. EA is hardly used as a tool for technology adoption and innovation. Furthermore, they merely view EA as a technical tool, whereas EA should capture also the organizational elements. One interviewee mentioned that "*I have added several new standards to the architecture. I cannot recall using the architecture of making an impact analysis or integrating new technology in the organization, although EA might be used in that way bye the architects*". This shows also that there is a gap between CIOs and architects. Both perform boundary spamming functions to overcome the gap between IT and organization.

4.2 Capabilities Needed by CIOs

The capabilities needed were asked for in the sessions and the results of the polling are shown in Figure 2. Also, it was discussed whether capabilities were missing in this list. The participants thought that most aspects were covered as the capabilities were described in a broad way. In the session we wanted to know which were considered as most important for a CIO to develop and to initiate the discussion about what was really needed. Therefore, the capabilities were scored as shown in the figure below. The purpose of the scoring was used as a step towards having a broader discussion than the capabilities which were surveyed. In this way a deeper insight into the roles and need for capabilities of CIOs was gained.

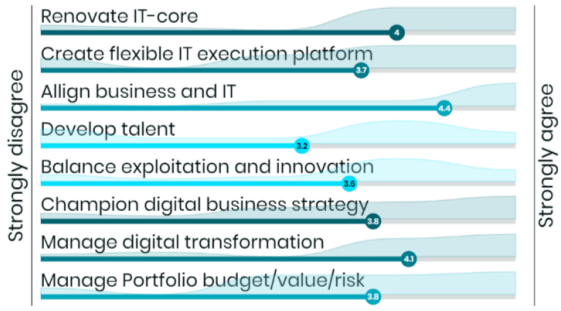

Figure 2: Capabilities desired

The capability to align business and IT followed by management digital transformation and renovate IT-core were viewed as the most important capabilities. The focus on these capabilities suggests a shift of roles from ensuring business operation to innovating business. During the discussion one

person commented that "*most important is a strong vision about how the digital society will look like … then stakeholders need to accept this vision and help to develop a roadmap to move towards this vision*". Most of the people think that the IT-development in the past, like cloud computing, were merely within the IT-organization and changes the IT-provisioning, whereas nowadays technologies are fundamentally changing the society.

The last important capabilities were considered as developing talent, balancing exploitation and innovation and managing the portfolio budget, value or risk. This is surprising as traditional CIOs often have limited IT knowledge and have a financial background and often focus on managing finance, keeping within budget, allocating money to projects and so on [18].

The analysis of the capabilities suggests a shift from a traditional, more control-oriented roles towards CIOs who understand the digital society. One of the participants commented that "*it is not about ensuring the we stay in budget anymore, we are moving towards the digital society and CIOs should help. Leave the budget and finance to the CFO and the humans to HRM. Develop a strong vision on what should be done*". This statement was supported by most of the participants.

The CIO role is not a standalone role and it was mentioned that the capabilities should be viewed as organizational capabilities. A CIO cannot develop a vision on the digital society and how to transform the government on its own, but is probably the best qualified to understand what is going on. The CIO should work in a network of stakeholders to develop these as organizational capabilities. There was agreement about the crucial role of 'enterprise architects'. A CIO does not know the ins and outs of the system, instead architects should ensure that project contribute to the creation of a flexible IT-execution platform and in this way help to realize the transformation towards the digital society.

5 Policy Recommendations

Based on the results, five recommendations are formulated. The analysis show that many CIOs play the role of Utility IT-director, whereas the need is on supporting business and IT alignment and digital transformation. This imbalance results in our first recommendation. CIOs should not focus primarily on the operation of their systems, but rather should focus on how to help the non-IT organization to move towards the digital society. This requires a deep understanding of the organizational needs, strategy and how the organization functions in addition to understanding the role of IT.

Recommendation 1: CIOs should be positioned more as an organizational role rather than an IT role

This recommendation suggests that the focus of the CIO should be much more on understanding the organization and helping the organization to ensure that IT will contribute to the competitive advantage and firm performance. CIOs should be much more focused on understanding the business.

The participants see the move to the digital society as the main contemporary challenges that should be supported by the CIOs. They suggest that if a CIO would play an important role in the organization, (s)he should focus on making this happen. CIOs cannot realize digital transformation on their own. Transformation requires changes in the IT-organizations and new capabilities need to be developed to support the innovation and adoption of new IT by the organization. This brings us to our second recommendation.

Recommendation 2: CIOs should focus on developing capabilities for digital transformation

The participants show a strong role for enterprise architecture models and principles. Often an architecture focuses on the ensuring a consistent IT-landscape and ensuring standardization to avoid the creation of a fragmented landscape. The participants saw a strong role for EA to move to digital transformation. They say the EA should be used to facilitate the process of moving towards the digital society. In addition to the product view (blueprints, principles and models), the process view becomes important, in which the focus is on managing the improvement process supported by architectural instruments [19].

Recommendation 3: Enterprise Architecture should support digital transformation rather than focus on technology standardization

The current landscape is viewed as hindering the move towards the digital society. There is a need to support agility due to the new technology developments that need to be incorporated. The current architecture should be made ready to act as modules and facilitate the move to the digital society. One of the participants mentioned "the CIO should ensure that the basic building blocks are available and can be used for a variety of purposes. This requires collaboration with other organizations as a single organization has not all the building blocks". Some building blocks are general and should be used by all organizations (for example identification module), whereas others are highly specific and can be used by single organization (for example, profiles of tax payers for detecting fraud). Collaborating with other organizations is key, as the module of others should be reused in a secure and scalable manner. This requires the making of agreements and standardization of interfaces.

Recommendation 4: CIOs should ensure that their architecture is agile and adaptive by collaborating with other organizations

There is a gap between the knowledge of CIOs and enterprise architects. The have both similar functions, but operate at different levels. Both function as boundary spanners between IT and organization and by better collaborating between CIOs and enterprise architects they can strengthen each other. A CIO is not a standalone role and (s)he needs others to help them. The participants saw a big role for enterprise architects to support the CIO function. Whereas CIO is a high-level decision maker and should ensure the translation of strategy into the IT infrastructure, ensure standardization and ensure that the IT-landscape is prepared for the digital society. In many countries, enterprise architects play a minor role, however, in the

Netherlands they play an important role in business-IT alignment and the governance of the IT. By collaborating between CIOs and enterprise architects, business and IT can be better aligned. This brings us to our last recommendation.

Recommendation 5: CIOs and enterprise architects should strengthen each other in Business-IT alignment

The recommendations show that the emphasis has shifted from focusing on managing the information assets towards managing the digital transformation. The above policy recommendations should help to change the role and position of the CIO as the person who facilities the move to the digital society.

6 Conclusions

The literature review shows that many CIOs perform their role as utility IT director or facilitator and the IT function seems to be separated from the administrative processes and policy-making activities. In contrast our empirical findings show the need for CIOs to focus on government-IT alignment and digital transformation. The participants in the session recommend CIOs to adopt a more organizational role and help the organization to develop capabilities for digital transformation. It was suggested that the collaboration with enterprise architects and the use of architecture as an instrument for developing capabilities. The latter is a novel insight which is hardly addressed in the literature. By aligning CIOs and enterprise architects, this research provides an insight into the roles and capabilities needed of CIOs. The findings suggest that making more effective use of enterprise architecture can result into innovations and adoption of new technology.

This research was conducted within the context of the Netherlands and with a limited set of participants. As such, the representativeness might be limited and other countries might have other approaches. Nevertheless, for the organizations the results provide relevant and interesting policy recommendation. We recommend conducting more research to generalize the result and validate the recommendations. Furthermore, we recommend case study research in the relationship between CIOs and enterprise architectures. In particular how they can strengthen each other.

7 ACKNOWLEDGMENTS

This work is supported by the National Natural Science Foundation of China (Grant No. 71501145).

REFERENCES

[1] Estevez, E. and Janowski, T. Landscaping Government Chief Information Officer Education. In *Proceedings of the 46th Hawaii International Conference on System Sciences* (Wailea, Maui, HI, USA, 2013). IEEE.

[2] Weill, P. and Woerner, S. L. The Future of the CIO in a Digital Economy. *MIS Quarterly Executive*, 12, 2 (2013), 65-75.

[3] Tuya, M. D., Cook, M., Sutherland, M. and Luna-Reyes, L. F. The leading role of the government CIO at the local level: Strategic opportunities and challenges. *Government Information Quarterly* (2017).

[4] Auffret, J.-P., Estevez, E., Marcovecchio, I. and Janowski, T. Developing a GCIO system: enabling good government through e-leadership. In *Proceedings of the 11th Annual Conference on Digital Government Research* (Puebla, Mexico, 2010). ACM.

[5] Estevez, E., Janowski, T., Marcovecchio, I. and Ojo, A. Establishing government chief information officer systems: readiness assessment. In *Proceedings of the 12th Annual International Digital Government Research Conference* (College Park, MD, USA, 2011). ACM.

[6] Peppard, J., Edwards, C. and Lambert, R. Clarifying the Ambiguous Role of the CIO. *MIS Quarterly Executive*, 10, 1 (2011), 31-44.

[7] Gerth, A. B. and Peppard, J. The dynamics of CIO derailment: How CIOs come undone and how to avoid it. *Business Horizons*, 59, 1 (2016), 61-70.

[8] Chun, M. and Mooney, J. CIO roles and responsibilities: Twenty-five years of evolution and change. *Information & Management*, 46, 6 (2009), 323-334.

[9] Joia, L. A. and Correia, J. C. P. CIO Competencies From the IT Professional Perspective: Insights From Brazil *Journal of Global Information Management*, 26, 2 (2018), 74-103.

[10] Estevez, E. and Janowski, T. A comprehensive methodology for establishing and sustaining government chief information officer function. In *Proceedings of the 8th International Conference on Theory and Practice of Electronic Governance* (Guimaraes, Portugal, 2014). ACM.

[11] Dawson, G. S., Ho, M.-W. and Kauffman, R. J. How are C-suite executives different? A comparative empirical study of the survival of American chief information officers. *Decision Support Systems*, 74 (2015), 88-101.

[12] Teece, D. J., Pisano, G. and Shuen, A. Dynamic capabilities and strategic management. *Strategic management journal* (1997), 509-533.

[13] Eisenhardt, K. M. and Martin, J. A. Dynamic capabilities: What are they? *Strategic Management Journal*, 21, 10-11 (2000), 1105-1121.

[14] Willcocks, L. P. and Feeny, D. It Outsourcing and Core is Capabilities: Challenges and Lessons at Dupont. *Information Systems Management*, 23, 1 (2006).

[15] Chen, Y.-C. and Wu, J.-H. IT management capability and its impact on the performance of a CIO. *Information & Management*, 48, 4-5 (2011), 145-156.

[16] Raisch, S. and Birkinshaw, J. Organizational ambidexterity: Antecedents, outcomes, and moderators. *Journal of management* (2008).

[17] Gonzalez, P. A., Ashworth, L. and McKeen, J. The CIO stereotype: Content, bias, and impact. *The Journal of Strategic Information Systems*, 28, 1 (2019), 83-99.

[18] Pang, M.-S., Tafti, A. and Krishnan, M. S. Do CIO IT Budgets Explain Bigger or Smaller Governments? Theory and Evidence from U.S. State Governments. *Management Science*, 62, 4 (2016), 1020-1041.

[19] Spewak, S. H. Enterprise architecture planning. Developing a blueprint for data, applications and Technology. John Wiley, New York, 1992.