Applying COBIT 2019 to IT Governance in Higher Education

Establishing IT governance for the collaboration of all universities and universities of applied sciences in Bavaria

Armin Gerl[1], Markus von der Heyde[2], Rainer Groß[3], Rainer Seck[4], Laura Watkowski[5]

Abstract: The Bavarian higher education environment is aiming to renew its IT strategy. The overall objective is to find an organisational solution which allows both local independence and collaborative solutions in those areas which are either commodities or which are too complex or costly to be solved several times in parallel. All Bavarian CIOs are engaged in the development of a model which respects local governance to be included into the overarching IT strategy of Bavaria, potentially Germany and Europe. As a common framework, COBIT was chosen to structure the process and guarantee completeness. The application of COBIT was started by the agreement to a common model. Further, the description of the respective responsibilities and competencies for all stakeholders was defined. We share this current state of the discussion with the broader community of higher education to promote further discussions about methods and objectives.

Keywords: IT governance, COBIT, higher education.

1 Introduction

In industry, the Chief Information Officer (CIO) belongs to the top management level (C-level) of a company. He or she is responsible for strategy in the areas of information technology (IT) and computer systems in order to support the company's goals.

At the beginning of the 2000s, the debate on the need for overall responsibility for strategy in the areas of information technology (IT) and computer systems reached German universities

[1] University of Passau, Department of Distributed Information Systems, 94032 Passau, Germany, armin.gerl@uni-passau.de, 0000-0001-9991-4539

[2] vdH-IT, Weimar, Germany, info@vdh-it.de, 0000-0002-6026-082X

[3] Nuremberg Institute of Technology, Computer Science Department, 90121 Nürnberg, Germany, rainer.gross@th-nuernberg.de, 0000-0002-6876-060X

[4] CIO CISO, University of Applied Sciences Munich, Department of Electrical Engineering and Information Technology, 80335 München, Germany, rainer.seck@hm.edu, 0000-0001-7019-489X

[5] University of Bayreuth, Department of Information Systems Management, 95440 Bayreuth, Germany, laura.watkowski@uni-bayreuth.de, 0000-0003-3706-0923

and universities of applied sciences (jointly referred to as universities) [Bo02]. This was followed by the recommendations of the *German Research Foundation* (DFG) [De06; De10]. The result was the introduction of the designation CIO at many universities, in an analogy to industry; this move was evaluated systematically in [He14; Ho15; Sc09].

[He18] aptly characterises the fact that although the designation 'CIO' is uniform, it says nothing about the actual role of the CIO at a university. As in industry, the CIO of a university is formally assigned the task of overall responsibility for strategy in the areas of information technology (IT) and computer systems for the university. However, an accepted uniform definition and description of competences of the role of the CIO at a university is still missing, despite the recommendations of the DFG.

As [He18] shows, this has led to the development of various CIO role models to date. The individually chosen form often is a mixture of factors from among the following options:

1. Strategic CIO with management functions (often included in the board of directors)
2. Strategic CIO as a staff position reporting to the board of directors
3. Operational CIO with direct responsibility for central IT supply
4. Collective CIO as a small decision-making group, in contrast to large Senate advisory commissions

In the past, the model of the CIO role mainly included local aspects of the individual university. The focus remained on the strategic alignment of the university's decision-making processes with the IT services [He18]. There was hardly any cross-university aspects included, since most of the collaboration was driven by the IT leadership on the operational level. Furthermore, the advantages of joining forces to further discussions at the political and ministerial levels has not yet been addressed by CIOs in general.

It is difficult for a single university CIO to achieve both, to both create synergies and exert influence. It stands to reason that this could probably be better organised collectively. How can such cooperation be successfully organised? Does a uniform model of a university CIO role have to be found first? And what about university central IT managers who have to translate strategies into operational business? How do you measure achieved synergies and influence?

Sustainable collaboration requires a definition of rules for collaboration, identification of the roles of all participants, and allocation of competencies and responsibilities [Su16]. It also should be guided by a shared common vision, an IT governance model for all participating universities.

In order to establish stable, efficient and effective IT services, cooperation and collaboration between universities is not just an option but a requirement [GPT11], [De06; De10; De16], [DS15], [He17]. To coordinate collaboration not only between scientists, but at the level

of guaranteed services described ideally by service level agreements or similar contracts, universities also need to collaborate in the decision making for and steering of joint services. Previous publications have called for IT governance to be applied at two levels: first at the level of the individual university, and second at the level of cooperation between universities [He16]. It had also been suggested that a model should be chosen that would ensure both individual freedom to organise local needs and the exchange of services across institutional boundaries. In order to reflect necessary decisions at the institutional level before adding the level between universities, we have to take into account the constitution of decision-making rights within universities. A statistical analysis of decision rights revealed typical constellations observed at German universities [HB18].

In the literature, various reference models and standards for the implementation of IT governance and IT compliance can be found. Some of these reference models deal with the performance aspect of IT governance. Other reference models primarily consider the compliance aspect of IT governance. The reference model *Control Objectives for Information and Related Technology* (COBIT 2019) offers a methodical approach by which, using a process reference model, governance processes within and between universities can be considered and recommendations for action for organisations can be derived. An agreement was reached on this approach for the derivation of recommendations for the responsibilities and tasks of those involved in IT governance within and between Bavarian universities. Using both approaches described in the previous paragraph in addition to the COBIT framework has led the Bavarian universities towards a collective IT service supply and demand model. It should be noted here that the same approach would not necessarily lead to the same result in another federal state.

Following this argumentation, we focus on the core research questions:

- Which method can be utilised to structure the definition of a collaborative IT governance model for Higher Education in Bavaria?
- How can the initial review completely cover the existing services, demand and collaborative structures?
- How can an overarching model of the CIO role be established? How can the common understanding of competencies and responsibilities be moderated between all stakeholders of the collaboration?

To answer these questions, the remaining of the paper is structured as follows: Section 2 introduces the current state of IT governance in Bavaria. Section 3 details how the reference model COBIT 2019 is used as a guideline to determine a common understanding of the Bavarian IT governance Model. This model is then detailed in Section 4, where roles with their responsibilities and competencies are defined. Section 5 takes the key findings from a specific view to a more generally applicable level before the work is concluded in Section 6.

2 State of the Art within Bavaria

As of 2020, IT governance structures with a CIO or a CIO board have been introduced at all universities in Bavaria in accordance with their statutes. However, the CIO function has not yet been fully anchored as a department within the university management. In some cases, the office of CIO is linked to the department of a vice president; in others, the CIO is a permanent member of the university management (but not linked to a vice president's office), or the CIO is anchored in the university administration or as a staff unit and reports directly to the university management. An analysis of Germany-wide CIO models by Von der Heyde [He18] finds a total of 7 models: operative CIO, collective CIO (CIO board), three versions of a strategic CIO (with and without membership on the board of directors), Chief Digital Officer (CDO), or a mix of these models. In this context, the analysis in [He18] advocates a consistent development of responsibilities and tasks within the IT governance structures with regard to technical developments, digital challenges and the demands of society on universities.

Since 2010, the universities have devoted themselves to defining the responsibilities and tasks within their IT governance structures at varying speeds. At all Bavarian universities, the CIO or CIO board has the task of determining the fundamental issues of IT deployment and the digitisation goals at the university. The CIO proposes how to and what resources are needed to achieve these goals. In this context, Hechler and Pasternack [HP17] discuss possible digitisation strategies and policies at universities.

Together with the StMWK (Bavarian State Ministry of Sciences and Arts), the Bavarian universities have defined a series of digitisation targets in the 2022 university development plan, which are implemented in the current individual target agreements with the universities. The Bavarian State Ministry is an important stakeholder in the IT governance framework. The 2010 IT strategy of the Bavarian universities [CI10] also laid the foundation for cooperation across university borders. The institutional exchange among CIOs has been successfully established in the respective CIO boards of the University of Bavaria e.V. and the Bavarian University of Applied Sciences e.V., as recommended in the 2010 strategy.

3 Methodology

In four meetings, the editorial focus group, set up by the CIO boards of the universities and universities of applied sciences in Bavaria, collaboratively discussed the need for a Bavarian-wide IT governance model. The aim of the editorial focus group is to institutionalise the existing informal exchange between CIOs in order to improve adequate digitisation across Bavaria and to create added value for all stakeholders through synergies. In order to achieve this, the editorial focus group proposes a IT governance model, which describes the tasks and the interaction of those responsible. In addition, the cooperation will ultimately lead to Bavaria-wide IT service centres. The improvement of the Bavaria-wide digitisation, fostering of synergies, and engagement of stakeholders is in progress and already partially

implemented. The synergies will ultimately be created by cooperation with Bavaria-wide *Cooperative IT Service Providers*, which are already partly set up.

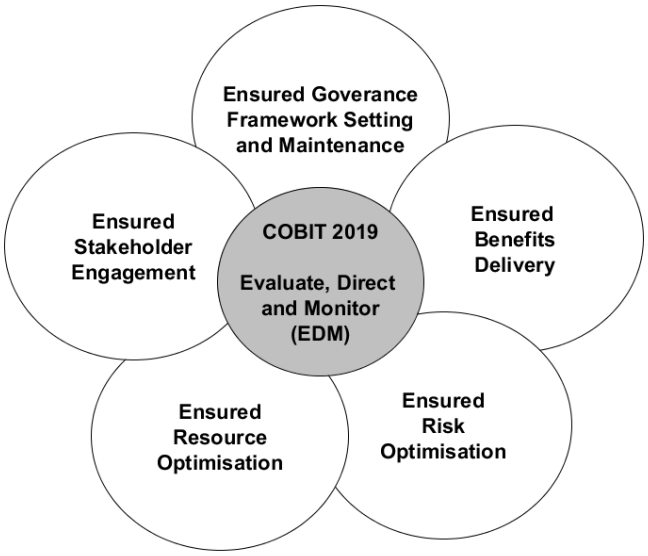

Fig. 1: Focused topics derived from COBIT 2019 were used as guidelines in the interview.

In the literature, diverse reference models and standards for the implementation of IT governance and IT compliance exist [JG07]. But in higher education only a few implementations of frameworks are known [FL09]. Implementations in Germany are rare, an example is [KIT17]. Overall, some reference models deal with the performance aspect of IT governance, while other reference models primarily consider the compliance aspect of IT governance. The reference model *Control Objectives for Information and Related Technology (COBIT 2019)* offers a guideline in which governance processes have to be addressed. These guidelines were utilised to conduct a qualitative survey, i.e., structured interviews (n=6) with a total of 85 distinct tasks, with CIOs and Heads of IT in Bavaria. The interviews were structured according to the governance *Domain* of 'evaluate, direct and monitor' (EDM; see Fig. 1). The COBIT 2019 *Objectives* used for the interviews were *Ensured governance Framework Setting and Maintenance*, *Ensured Benefits Delivery*, *Ensured Risk Optimisation*, *Ensured Resource Optimisation* and *Ensured Stakeholder Engagement*, for which each the corresponding *Practices* was discussed in the context of the Bavarian IT governance by the interviewees. Based on the interviews, recommendations for the responsibilities and tasks of those involved in IT governance within and between Bavarian universities have been derived. Thus, the diverse perspectives of IT governance were structured by using COBIT 2019.

4 A Proposed Bavarian Higher Education IT Governance Model

The results of the survey were summarised, structured and discussed within the editorial focus group, which resulted in a proposed IT governance model for the Bavarian higher education system (see Fig. 2). Along with the use of COBIT 2019, the principles of *Demand*- and *Supply*-IT are considered Wulf et al. [WWB12]. Accordingly, all strategic tasks of the university's IT organisation would fall within the scope of *Demand*-IT, while *Supply*-IT encompasses the management tasks within the university and *Cooperative IT Service Providers*.

The next section shows a detailed list of tasks for each role, e.g., *Universities* or *Stakeholders*, and their interaction and communication with each other. The survey showed that in particular, the integration of the university CIOs of Bavaria, *CIO-Boards*, *Demand*- and *Supply-Boards* and *Cooperative IT Service Providers* can offer sustainable added value and synergy effects for Bavarian IT governance.

4.1 Governance Interaction

To ensure a consistent and efficient implementation of IT requirements and their optimisation, governance relationships between and within the clusters *Stakeholders*, *CIOs Bavaria*, *Universities* and *Cooperative IT Service Providers* were defined.

In order to address higher-level strategic IT requirements by the *Stakeholders*, there are governance relationships with the *CIOs Bavaria* ❶ on the one hand and with the *Universities* ❸ on the other hand . The former ❶ also serves to inform *CIOs Bavaria* about strategic IT requirements in a timely manner so that they can develop meaningful and cooperative proposed solutions by using the respective boards of *CIOs Bavaria*.

The governance relationship between *CIOs Bavaria* and *Universities* ❷ intends to identify cross-university synergy effects and efficiently solve common challenges. The *Demand Board* of every university regulates the exchange between the *Board of Directors* and the respective university organisation ❹. The goal is to identify synergies within the universities and to prioritise IT projects.

On the basis of the directives from the governance relationships with *Stakeholders* and *Universities* ❸, *CIOs Bavaria* regulates the demand-oriented development of cross-university IT services in close exchange with *Cooperative IT Service Providers* ❽.

The governance relationship between the *Board of Directors* and the university's *Central IT* ❺ is intended to ensure the adequate development of internal IT services and the efficient use of the university's IT resources. In addition to the governance relationships, there are operational relationships in *Supply*-IT between *Cooperative IT Service Providers*, the universities' *Central IT* ❼ and individual decentralised IT organisations ❻ in order to fulfil

day-to-day business. This includes operational coordination between *t*he Demand Board and *Supply Board* ❿.

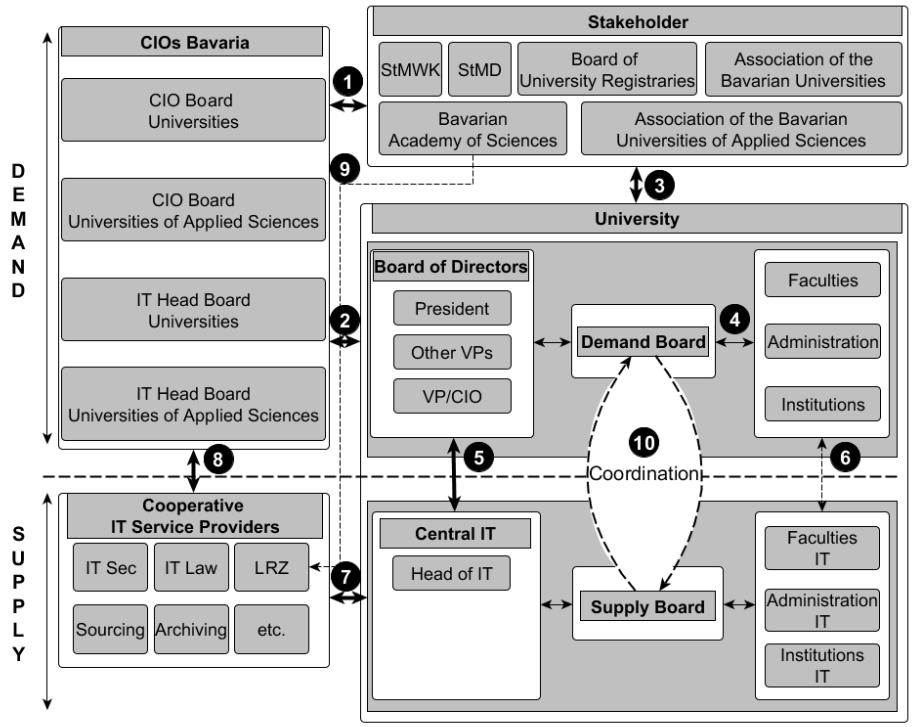

Fig. 2: Proposed IT governance model for the Bavarian higher education system. The numbered governance interaction levels are referred to within the text.

4.2 Governance Role Descriptions

Within the proposed IT governance model, the *Stakeholders* are comprised of Ministries, e.g., *StMWK* and *StMD*, and strategic institutions for higher education in Bavaria, i.e., *Association of Bavarian Universities* and *Association of Bavarian Universities of Applied Sciences*, *Board of University Registraries*, and *Bavarian Academy of Sciences*. The *Stakeholders* define and communicate the framework conditions for the *Universities* ❸ and *CIOs Bavaria* ❶, e.g., announcing new laws and regulations, or applying for funds from the Bavarian state parliament.

The *CIOs Bavaria* association is comprised of the *CIO and IT Head Boards of Universities and Universities of Applied Sciences*, which is envisioned to be established. The *CIOs Bavaria* has an advisory function for *Stakeholders*, *Universities* and *Cooperative IT Service*

Providers. The association acts as an information body, an advisory body, and a focus group for CIO concerns. Besides these roles, the *CIOs Bavaria* acts as a driving force for innovative IT and digitisation ideas and projects by collecting the Bavarian universities' *Demands*, evaluating them, and proposing appropriate *Cooperative IT Service Providers* for implementation, e.g., by applying for starting funds from the *Stakeholders* ❶.

Each *University* as an institution makes its own IT governance decisions. It defines the strategic orientation of IT in its university development plan and establishes a continuous improvement process.

Within each *University*, the *President* ultimately is the decision-making authority at the university. He or she commissions and decides on the creation of IT guidelines and also issues a set of basic rules that define the tasks of the CIO. The university *President* decides on strategic IT and digitisation goals and provides sufficient resources to achieve them. In particular, he or she bears responsibility for IT risks (IT security, data protection, etc.) and decides on the procedure for dealing with them, e.g., by establishing IT risk management systems. Furthermore, the *President* comes to agreements to achieve certain strategic objectives with the science ministry, i.e., *StMWK*, is decided ❸ and the implementation of the agreed measures, e.g., with internal target agreements, are controlled.

The CIO acts as an intermediary between university stakeholders (*Faculties*, *Administration*, *Institutions*, and *Central IT*). The CIO, in any form [He18], must be represented on the *Board of Directors*[6] and has the exclusive right to propose all IT related initiatives. In addition, the CIO coordinates the university's *Demand* management of the *Demand Board*, which is also comprised of representatives of the university stakeholders ❹. Part of the CIO's tasks is to represent the university on relevant committees (*CIO Bavaria* and *CIO Board*) ❷, such that *Demand* requirements are shared Bavaria-wide. The CIO proposes and further develops IT relevant organisational structures. Furthermore, the CIO is responsible for updating the university's IT strategy and participates in the design of internal and external target agreements.

The *Demand Board* develops and recommends strategic IT and digitisation goals of the university. All IT requirements throughout the university are collected, evaluated and prioritised based on the relevant university-internal strategies. The *Demand Board* is in close coordination with the *Supply Board* ❿.

The *Head of IT* is responsible for the *Central IT* of the university. The *Central IT* ensures the secure and sustainable operation and provision of the university's IT infrastructure. The central IT department is responsible for the use and procurement of IT and IT services; it can delegate parts of the tasks to decentralised IT departments of the universities' stakeholders.

[6] Putting the CIO in close proximity to the board of directors within each individual university refers back to the recommendation of [De06] and following publications. However, in reality, a multitude of CIO forms have been established, as shown by [He18]. The discussion and adoption of the agreed model of the role needs to be implemented over the upcoming months/years.

Furthermore, the *Head of IT* is a member of the Bavaria-wide *IT Head Board* ❷, which fosters an exchange on the IT management level.

The *Supply Board* controls the implementation of the actions decided upon by the university and the operational coordination of IT. It consists of the *Head of IT* as well as representatives of the universities' stakeholders IT ❻, such that both centralised and decentralised IT is managed. A close coordination with the *Demand Board* ❿ is established.

Cooperative IT Service Providers aggregate standardised tasks, e.g., those which do not require a *University* specific specialisation. They provide cross-university IT services ❼. IT services can be of both an operational and a conceptual nature. The specifications are defined and updated by *CIOs Bavaria* in coordination with the *Stakeholders* ❶. The implementation of the *Cooperative IT Service Providers* is recommended throughout Bavaria with the involvement of the Ministry (StMWK). Established *Cooperative IT Service Providers* regularly provide information on the use of their inter-university services to the *CIOs Bavaria* ❽. Examples of already established or planned *Cooperative IT Service Providers* are:

- Staff Unit Information Security of Bavarian Universities of Applied Sciences and Universities [Ho20]
- Staff Unit IT Law, License Management, E-Procurement [Ju20a]
- Cloud Storage Services (Sync and Share (LRZ) [Le20] and FAUbox (RRZE) [Re20])
- Maintenance, expansion and digitisation of cooperative IT procurement [Ju20b]
- Digital Archiving by the DIMAG Coordination Office [Un19]
- Coordination office and IT service centre for data processing in the university administration for the universities of applied sciences in Bavaria (KDV) [Ko13]

In Bavaria, the Leibniz-Rechenzentrum (LRZ) offers cross-university services like other IT service centres. However, the LRZ has its own management and is subject to the control structure of the *Bavarian Academy of Science* ❾.

5 Discussion

The findings derived from the detailed process support the previously mentioned findings of [HB18], and further develop them by not only considering the institutional level of the university, but the higher education environment of the state, i.e., Bavaria. The federal state level has been omitted in this model, because the critical decision-making boundary for IT governance is on the level of the state, like Bavaria. On the *Supply*-level, the definition and establishment of *Cooperative IT Service Providers* is a desired outcome to establish synergy

effects and and sustainable IT across university boundaries. Primarily, these services, which are negotiated and recommended by the *CIO Boards*, should be provided by university *Central IT* on a 'One for all' principle.

Visible results of the initiative in the application of COBIT are:

- The intense discussion within the established CIO boards of the universities and universities of applied sciences in Bavaria led to an increased level of trust between the collaborating partners with their commitment to a joint collaboration.
- As other federal states (e.g., Baden-Wuerttemberg, Thuringia) have suggested with their models, integrating the ministry and the *Cooperative IT Service Providers* into the discussion seems a crucial success factor.
- A consistent model of the CIO role (based on COBIT, refined by interviews) was finally agreed upon and constitutes the baseline of mutual understanding of competencies and responsibilities on the individual and shared levels.
- Both extant and newly established *Cooperative IT Service Providers* started to provide services based on the mutual agreement of a joint need.
- The application of the model has so far guaranteed a constant, structured and visible progress.

Bootstrapping collaboration required a joint initiative, which is commonly a reaction to external influence. The project gained momentum at the stage where the visibility across the majority of the participating institutions was high enough to focus attention, even at the political level, on the ongoing process.

This model is neither complete nor validated to its final implementation. Due to the nature of step-wise implementation of collaborative approaches, it might provide insights and document a good practice.

6 Conclusion

The participation of all stakeholders in the development of the proposed IT governance model together with the application of the COBIT 2019 approach is a prerequisite for the Bavaria-wide implementation of the model. However, the proposed model lacks aspects related to the dynamics between *Demand and Supply* on one hand and IT projects on the other. Often, sudden insights from the business operations drive the strategic discussions in the short term and vice versa. The strategic decision-making process is rather dynamically interwoven with the insights gained from the business operations. A further aspect that has been neglected is the importance of IT projects, which has been defined in [He16], and their organisational embedding and visibility in the overall IT governance. IT projects as an

organisational form are best practice in the implementation and testing of new IT strategies, and thus have a direct influence on the demand and supply levels in terms of content and personnel. A core question remains: how are project-driven activities embedded into the implementation of the IT governance model? As Ross et al. [RWR06] pointed out, this also depends on the enterprise architecture model of the Bavarian universities as a group, which in fact maybe more similar to the structure of a holding company.

The application of COBIT 2019 to the higher education sector seems promising. Central aspects of IT governance are able to couple autonomy with central aspects of collaborative IT service management. How the currently proposed model reacts to overall change remains open. The requirement for risk management, change management and other frameworks will be more obvious once the effect of the coupling between universities is visible. Changing the core - the culture of universities - towards a professional management will prove to be a key asset.

7 Acknowledgements

We thank all participating CIOs, CIO Boards, the distinct editorial team of the Bavarian IT Strategy 2025. This research is supported by the funding of the *Bayerisches Staatsministerium für Wissenschaft und Kunst (StMWK)*. We also thank the reviewers for valuable input to the manuscript.

References

[Bo02] Bode, A.: Universitat im Wandel: Die Rolle des CIO bei der Erneuerung der Prozesse. Information Consulting & Management 17/, pp. 43–47, 2002, URL: http://gcc.uni-paderborn.de/www/WI/WI2/wi2_lit.nsf/35ae96bebc983d53c12573e70058bbb2/458d4f298d370fe4c1256c8e002e5914/%5C$FILE/CIO-unis.pdf.

[CI10] CIOs of Bavaria: IT-Strategie der bayerischen Hochschulen - Leitlinien für die Weiterentwicklung der IT-Infrastruktur, Last accessed: 13.07.2020, 2010, URL: https://w3-mediapool.hm.edu/mediapool/media/zak_2/lokal_zak/formulare_4/it_strategie_hochschulen_bayern_2010.pdf.

[De06] Deutsche Forschungsgemeinschaft: Informationsverarbeitung an Hochschulen - Organisation, Dienste und Systeme: Empfehlungen der Kommission für Rechenanlagen für 2006-2010, Bonn, Germany: Deutsche Forschungsgemeinschaft, Oct. 2006, URL: http://www.dfg.de/download/pdf/foerderung/programme/wgi/wgi_kfr_empf.pdf.

[De10] Deutsche Forschungsgemeinschaft: Informationsverarbeitung an Hochschulen - Organisation, Dienste und Systeme: Empfehlungen der Kommission für IT-Infrastruktur für 2011-2015, Bonn, Germany: Deutsche Forschungsgemeinschaft, 2010, URL: http://www.dfg.de/download/pdf/foerderung/programme/wgi/empfehlungen_kfr_2011_2015.pdf.

[De16] Deutsche Forschungsgemeinschaft: Informationsverarbeitung an Hochschulen - Organisation, Dienste und Systeme: Empfehlungen der Kommission für IT-Infrastruktur für 2016-2020, Bonn, Germany: Deutsche Forschungsgemeinschaft, Mar. 2016, URL: http://www.dfg.de/download/pdf/foerderung/programme/wgi/kfr_stellungnahme_2016_2020.pdf.

[DS15] Degkwitz, A.; Schirmbacher, P., eds.: Informationsinfrastrukturen im Wandel. Informationsmanagement an deutschen Universitäten. BOCK + HERCHEN Verlag, 2015, 390 pp., ISBN: 978-3-88347-254-6, URL: http://www.dini.de/fileadmin/docs/DINI_Informationsinfrastrukturen.pdf, visited on: 08/20/2016.

[FL09] Fernández, A.; Llorens, F.: An IT Governance Framework for Universities in Spain. In. EUNIS 2009. 2009, URL: http://www.gti4u.es/pdf/an_it_governance_framework_for_universiti%20es_in_spain.pdf, visited on: 08/20/2016.

[GPT11] Görl, S.; Puhl, J.; Thaller, M.: Empfehlungen für die weitere Entwicklung der Wissenschaftlichen Informationsversorgung des Landes NRW. epubli GmbH, Berlin, 2011, ISBN: 978-3-8442-0694-4.

[HB18] von der Heyde, M.; Breiter, A.: Factorial analyses in IT governance reveal constellations of decision shares and their consequences on IT in higher education institutions. EUNIS Journal of Higher Education/, 2018, URL: https://www.eunis.org/download/2018/EUNIS_2018_paper_35.pdf.

[He14] von der Heyde, M.: CIOs und IT-Governance an deutschen Hochschulen, Dec. 2014, URL: https://www.zki.de/fileadmin/zki/Publikationen/ZKI_CIO-Studie_final.pdf, visited on: 08/20/2016.

[He16] von der Heyde, M.: Replikations- und Diversifikationsmodelle für IT-Governance in Hochschulverbünden. In: Kooperation von Rechenzentren Governance und Steuerung - Organisation, Rechtsgrundlagen, Politik. De Gruyter, Berlin, Boston, pp. 303–309, 2016, ISBN: 978-3-11-045975-3, URL: https://doi.org/10.1515/9783110459753-025, visited on: 11/01/2016.

[He17] von der Heyde, M.; Auth, G.; Hartmann, A.; Erfurth, C.: Hochschulentwicklung im Kontext der Digitalisierung - Bestandsaufnahme, Perspektiven, Thesen. In: INFORMATIK 2017. GI Jahrestagung 2017. Vol. 275. Lecture Notes in Informatics (LNI) - Proceedings, ISSN 1617-5468, Chemnitz, Germany, pp. 1757–1772, Sept. 28, 2017, ISBN: 978-3-88579-669-5.

[He18] von der Heyde, M.: Mehr oder weniger CIO - Überblick zu CIO-Formen an deutschen Hochschulen. In: INFORMATIK 2018. GI Jahrestagung 2018. Vol. Lernen und Arbeiten im Wandel 2018. Lecture Notes in Informatics (LNI) - Proceedings, ISSN 1617-5468, Springer, Berlin, Germany, Sept. 24, 2018, ISBN: 978-3-88579-669-5.

[Ho15] Hotzel, H.; Lang, U.; Wimmer, M.; von der Heyde, M.: CIOs at German Universities–a Survey by ZKI. European Journal of Higher Education IT 3/2015, Oct. 2015, ISSN: 2519-1764, URL: http://www.eunis.org/download/2015/papers/EUNIS2015_submission_54.pdf, visited on: 08/20/2016.

[Ho20] Hochschule Augsburg: Stabsstelle Informationssicherheit bayerischer Hochschulen und Universitäten, Last accessed: 01.09.2020, 2020, URL: https://www.hs-augsburg.de/Rechenzentrum/Stabsstelle-Informationssicherheit.html.

[HP17] Hechler, D.; Pasternack, P.: Digitalisierungstrategien und Digitalisierungspolicies an Hochschulen. Die Hochschule: Journal für Wissenschaft und Bildung 26/2, pp. 84–105, 2017.

[JG07] Johannsen, W.; Goeken, M.: Referenzmodelle für IT-Governance. d-punkt, Heidelberg, 2007.

[Ju20a] Julius-Maximilians-University of Wuerzburg: IT-Recht, Last accessed: 01.09.2020, 2020, URL: https://www.rz.uni-wuerzburg.de/dienste/it-recht/.

[Ju20b] Julius-Maximilians-University of Wuerzburg: WebShop-Anleitung, Last accessed: 01.09.2020, 2020, URL: https://www.rz.uni-wuerzburg.de/dienste/shop/webshop-anleitung/.

[KIT17] IV-Governance-FrameworkGovernance der digitalen Informationsverarbeitung und -versorgung des KIT, 2017, URL: https://www.kit.edu/downloads/cio/IV-Gov-Framework.pdf, visited on: 07/13/2020.

[Ko13] Koordinierungsstelle für Datenverarbeitung in der Hochschulverwaltung an den staatlichen Fachhochschulen in Bayern: Die Koordinierungsstellefür die Datenverarbeitung in der Hochschulverwaltung an den staatlichen Fachhochschulen in Bayern (KDV), Last accessed: 01.09.2020, 2013, URL: https://www.kdv-fh-bayern.de/cms/.

[Le20] Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities: Leibniz Supercomputing Centre, Last accessed: 01.09.2020, 2020, URL: https://www.lrz.de/english/.

[Re20] Regional data center Friedrich-Alexander-University of Erlangen-Nuremberg: FAUbox, Last accessed: 01.09.2020, Sept. 2020, URL: https://www.rrze.fau.de/serverdienste/server/faubox/.

[RWR06] Ross, J. W.; Weill, P.; Robertson, D.: Enterprise Architecture As Strategy: Creating a Foundation for Business Execution. Harvard Business Review Press, Boston, Mass, 2006, ISBN: 978-1-59139-839-4.

[Sc09] Schwabe, G.: IT-Governance an Universitäten in Deutschland, Schweiz und Österreich. VM Verwaltung & Management 15/6, pp. 317–325, 2009, URL: http://www.zki.de/fileadmin/zki/Archiv/tagungen/cottbus-2010/02_Schwabe_IT-Governance_VM_Teil_2.pdf, visited on: 08/20/2016.

[Su16] Suchodoletz, D. v.; Schulz, J. C.; Leendertse, J.; Hotzel, H.; Wimmer, M.: Kooperation von Rechenzentren: Governance und Steuerung - Organisation, Rechtsgrundlagen, Politik. Google-Books-ID: CXCtDgAAQBAJ, Walter de Gruyter GmbH & Co KG, 2016, ISBN: 978-3-11-045975-3.

[Un19] University of Regensburg: Investition in die Infrastruktur, Last accessed: 01.09.2020, 2019, URL: https://www.ur.de/pressearchiv/pressemitteilung/1017752.html.

[WWB12] Wulf, J.; Winkler, T. J.; Brenner, W.: Organisationsgestaltung der Demand-IT. In (Goltz, U.; Magnor, M.; Appelrath, H.-J.; Matthies, H. K.; Balke, W.-T.; Wolf, L., eds.): INFORMATIK 2012. Gesellschaft für Informatik e.V., Bonn, pp. 746–758, 2012.