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eGovernment in cities of the knowledge society. An empirical investigation of Smart Cities' governmental websites

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ABSTRACT

In view of the increased popularity of eGovernment as an important aspect of the development of Smart or Informational World Cities, we outline three research questions: (1) What is the state of maturity of eGovernments in Informational World Cities? (2) How good (or poor) is their usability? (3) How do they handle boundary documents? In order to clear up these issues empirically, we formulated an extended criteria model for the quantification of eGovernment maturity, analyzed the average quality of the information architecture of 31 identified Informational World Cities' official websites, and studied the processing of boundary documents, i.e. documents that serve different user groups. Our outcomes indicate that the maturity and usability levels of investigated cities are much differentiated, whereas the implementation of boundary documents in form of detailed information sheets is rather scarce. Considering the maturity of investigated eGovernments, there is still potential for improvement, especially regarding the aspects of communication and transaction services. The differences between the eGovernments' usability standards are substantial and the results are partially suboptimal. Our outcomes indicate that the usability levels retrieved from task-based evaluation are not directly linked to integration of boundary documents into the governmental websites.

1. Introduction

In the research on Smart or Informational Cities, eGovernment and eGovernance are one of the most important aspects to consider (Castells, 1989; Fietkiewicz & Stock, 2015; Linde & Stock, 2011; Mainka, Fietkiewicz et al., 2013; Stock, 2011). In such cities, eGovernance is one of the bases for innovation (Yigitcanlar, 2010) insofar as political programs for developing an information society impact the development of ICT infrastructures and information services. The increased use of ICT and knowledge management between authorities and citizens or businesses optimizes services in eGovernment and call on citizens and companies to actively engage in political debate and decision-making processes (Sharma & Palvia, 2010). "E-government is a generic term for web-based services from agencies of local, state and federal governments" (Sharma & Palvia, 2010, p. 1). The concept of eGovernment includes governmental websites, governmental social media channels, and other digital governmental services. In this article, we focus on governmental websites.

According to Moon (2002), eGovernment includes the interaction levels *information*, *communication*, *transaction*, *integration*, and *participation* (Linde & Stock, 2011, p. 106). "Many of the primary e-government functions towards citizens involve the web-based provision of government information and services" (Manoharan & Carrizales, 2011, p. 284). Additionally, governmental websites should serve different user groups (citizens, companies, tourists, etc.) and, therefore, can be regarded as boundary objects (Star & Griesemer, 1989).

The basis of our investigation are Informational World Cities as defined by Mainka, Hartmann, et al. (2013). According to this definition, Informational World Cities are prototypical cities of the knowledge society characterized as knowledge-, creative-, digital-, smart-, and world cities. Our article reports about three information science research studies on eGovernment in prototypical cities of the knowledge society and empirically answers three research questions: (1) What is the state of maturity of eGovernments in such cities? (2) How good (or poor) is their usability? (3) How do they handle boundary documents (i.e., documents serving different user groups)?

There already are some empirical studies on governmental websites at the municipal level (e.g., Norris & Moon, 2005; Scott, 2006), but our study is one of the first quantitative empirical analyses of eGovernment maturity at the city level focusing on the Informational World Cities of the knowledge society.

Considering the latest research by Holzer, Zheng, Manoharan, and Shark (2014), the study's methods mirror their previous research (since 2003) and are complex eGovernment maturity and usability

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analyses of 100 cities. Holzer et al.'s model consist of five components: (1) privacy and security, (2) usability, (3) content, (4) services, and (5) citizen and social engagement. In terms of usability, Holzer et al. focus on formal indicators for a "usable" website. Our approach is more practically oriented, as it examines the websites' usability while typical tasks are being fulfilled. The remaining aspects investigated by Holzer et al.—content, service and citizen participation—partially correspond with our approach. However, we consider some of their applied indicators as not comparable, e.g., within the dimension of citizen participation, such aspects as newsletters or feedback are put together with more sophisticated utilities as synchronous video or chat capabilities. Our model distinguishes between more challenging utilities from the simple ones that are nowadays very common. Therefore, we define the five pillars of eGovernment differing from each other by the level of development and sophistication (which is also reflected in the quantification of these aspects). Some of their investigated cities overlap with municipalities in the focus of our study, therefore, in the course of our results' analysis, we will compare our outcomes with the ones by Holzer et al. (2014). This way we will be able to see to what extent the investigated aspects correlate.

Hence, our results of the municipal eGovernments' maturity may shed light on a new aspect as well as give a new perspective on the development of Informational World Cities. Our comparative usability analysis is consequently based on task-based user tests of the governmental websites' information architectures (for previous research, see e.g. Choudrie & Ghinea, 2005). To our knowledge, our analysis of governmental websites as boundary documents is the first approach in this research area. All our research questions are globally oriented and focus on cities of the knowledge society. In the following, theories on eGovernment will be shortly outlined.

2. Theory

2.1. Models for measuring eGovernment

A number of stage models and indexes has been already developed in order to measure and to compare the eGovernment's advancement (Lee, 2010). One popular eGovernment index has been created by the United Nations' Division for Public Economics and Public Administration: "The Global E-Government Development Index". It presents the state of development of eGovernment for the UN Member States and is a composite measurement of the ICT infrastructures, education, information, technologies, government internet use, products, services, the level of telecommunication and human capital infrastructure in the respective countries (United Nations, 2012). For this investigation, four stages of online service development were defined: (1) the emerging information services; (2) enhanced information services (one-way or simple two-way communication like downloadable forms); (3) transactional services (like two-way communication, non-financial transaction, filing taxes online), and finally, (4) connected services (citizen-centric, tailor-made services including eServices and eSolutions). Besides the stages of online services, in the investigation, there are included the telecommunication infrastructure (e.g., internet lines) and human capital (e.g., literacy rate or education) index. In contrast, our study focuses on the advancement of the eGovernment in the municipalities disregarding the human capital. We believe that every citizen (no matter of what education) deserves and is able to use advanced eGovernment offerings. We also do not see a direct connection between the education obtained by the citizens and the ability of their government to offer them an appropriate and modern service. As our investigation concerns Informational World Cities (meaning that these cities are equipped with an advanced digital technology), we do not include indicators for digital city infrastructure. Finally, UN-index includes investigation only at a country-level; therefore, a direct comparison with the outcomes of our study is not possible.

Another stage model has been developed by Layne and Lee (2001), who classified the development of eGovernment into four measurable stages: (1) catalogue, (2) transaction, (3) vertical integration, and (4) horizontal integration. The first stage represents the one-way communication between the government and users. Transaction facilitates online transactions with government agencies. Vertical integration refers to local, state and federal governments connected for different functions or services. Horizontal integration is defined as integration across different functions and services (creating the "one-stop-shopping" opportunity for the citizens). Layne and Lee (2001) propose a stage-based growth model for eGovernment suggesting that this is an evolutionary phenomenon. Therefore, it opposes our idea of separate eGovernment pillars as further elaborated in the following paragraph.

Contrary to the four-stage model by Layne and Lee (2001); Hiller and Bélanger (2001) introduced an extended five-stage model. The additional stage is participation (i.e. voting, registration or posting comments online). This could be seen as a sub-set of the stage of two-way communication, but the authors intended to emphasize its importance by using a separate category. Moon (2002) examined the state of municipal eGovernment implementation and assessed its effectiveness. Moon (2002) explored two institutional factors that contribute to the adoption of eGovernment, namely the size and the type of government. He adopted the eGovernment stage model by Hiller and Bélanger (2001) in order to map the eGovernment framework and examine the rhetoric and reality of eGovernment at the municipal level. His study shows that many municipal governments are still at either stage one or two of their development and merely post and disseminate information or provide channels for two-way communication (public service requests).

Coursey and Norris (2008) investigated some of these models to see whether they are accurate or useful in understanding the actual development of eGovernment. The authors' criticism is based on empirical evidence from three surveys of local eGovernment in the United States. Their outcomes show that the local governments were mainly informational, with just a few transactional functions. Therefore, the authors point out that the models proposed by Layne and Lee (2001) as well as Hiller and Bélanger (2001) do not describe the development process of eGovernment accurately, at least not among American local governments. According to Coursey and Norris (2008), these models are purely speculative and have been developed without any link to the literature about government. Finally, Coursey and Norris (2008) argue that there are no recognizable steps or stages in eGovernment. Rather, governments adopt eGovernment slowly and incrementally after an initial eGovernment presence, so that organizational and political factors are likely to significantly affect the development, performance and adoption of eGovernment application.

Following Lee (2010), the eGovernment stage models seem to be incongruent to each other, because they take different perspectives or use different metaphors. He reviewed and analyzed twelve stage models found in the literature between 2000 and 2009. Accordingly, he defined the underpinning perspectives and concepts in order to identify the common frame of reference across the different models. The resulting common frame can be presented as a diagram and includes stages from the citizens/services' perspective (y-axe) and the operation/technology perspective (x-axe); the connecting points of these two perspectives are the government services (presenting, assimilation, reforming, morphing, eGovernance) (Lee, 2010). The stages from citizens' perspective are interaction, transaction, participation and involvement (Lee, 2010). Hence, the model we have chosen for our research is consistent with the common framework for stage models identified by Lee (2010).

The barriers identified by Coursey and Norris (2008) are not as significant for the development of Informational World Cities since such cities either have or aim to build up an advanced ICT infrastructure in the future. Those cities have launched projects to become a *digital city*, *ubiquitous city*, or *smart city* with the goal of better supporting their knowledge society. This implies that Informational World Cities have a

very high penetration of ICT in all areas (government, business, and citizens) and, therefore, we do not analyze the cities' ICT infrastructures. We base our study on a modification of the five-stage model of eGovernment following Hiller and Bélanger (2001) and Moon (2002), which is consistent with the common framework for different stage models identified by Lee (2010).

2.2. Five pillars of eGovernment

In contrast to the assumption that eGovernments must complete a certain stage before the next one can be achieved, we perceive those steps as almost individual challenges, which can be solved separately from each other or in parallel. Our approach supports Coursey and Norris (2008) arguments that there are no recognizable steps or stages in eGovernment development. Therefore, an eGovernment will not be deadlocked at stage one or stage two, but may skip, for example, the *transaction* stage and first develop its *vertical and horizontal integration*. According to this interpretation, the stages will be seen as pillars of eGovernment. It is obvious that the first step of this model, aiming to support a website with information, must be established before any other function can be implemented. For this reason, the aspects of usability and the existence of boundary documents will be analyzed additionally for the pillar of *information* (also labeled *catalogue*). The remaining pillars do not necessarily have to be accomplished in a strict order. Some eGovernments may be very advanced in terms of participation or transaction but still have the potential for improvement regarding the communication and social media aspects.

2.2.1. Pillar 1: information dissemination (catalogue)

Of importance at this point is the content published online, usability, and accessibility. The latter one is an important factor on any website. Poor accessibility can exclude many disabled people from the provided services. Existing investigations of the accessibility of local government websites by the U.K. Cabinet Office (2005); Chen, Chen, and Shao (2006); Shi (2007) or Al-Khalifa (2010) have revealed some major accessibility issues. Moreover, the authors emphasize the need for accessibility standards in order to provide equal access to every citizen.

2.2.2. Pillar 2: communication

The second pillar concerns the (two-way) communication, which nowadays revolves more and more around social media (Hartmann, Mainka, & Peters, 2013). Social media has become an acceptable information and communication channel in the public sector (Mergel, 2013). The use of online social networking services, such as Facebook, YouTube, Twitter, blogs or other digital media sharing sites entered the practices in the public sector (Mergel, 2013). For instance, Bonsón, Torres, Royo, and Flores (2012) conducted a study aiming to create an overview of the use of Web 2.0 and social media tools in local governments of the EU. There are also other studies comparing the use of social media between different countries (e.g. Yi, Oh, & Kim, 2013), or analyzing the adoption and use of social media in general (e.g. Mergel, 2013).

2.2.3. Pillar 3: transaction

This pillar consists of financial and non-financial transactional eGovernment services such as renewing a driver's license, voter registration, state park information, and reservation, paying taxes and penalties etc. (Cook, 2000). A critical success factor for all transactional services is the users' trust (OECD, 2009). Kumar, Mukerji, Butt, and Persaud (2007) investigated the factors for successful eGovernment in Canada. Important website design variables are “perceived usefulness” and “perceived ease of use” (i.e., the classical dimensions of the Technology Acceptance Model; Davis, 1989); in other words, how easy and useful it is for the user to access, navigate, and consume the relevant information. Another study on satisfaction with eGovernment was conducted by Reddick and Roy (2013) and focused on the businesses as the stakeholder (G2B). Nam (2011) studied Open Government and Government 2.0 as a new goal of the U.S. eGovernment. Nam learned that citizens who use eGovernment and who value the potential benefits of already existing services are supportive of the next development stages. Venkatesh, Chan, and Thong (2012) identified that the most important attributes for transactional services are usability and security provision. There are also further studies on building Open Government (e.g. McDermott, 2010) or measuring its maturity (e.g. Lee & Kwak, 2012).

2.2.4. Pillar 4: interoperability (integration)

Pardo, Nam, and Burke (2011) claim that the key component of eGovernment initiatives is the ability of multiple governmental and non-governmental organizations to share and integrate information across their organizational boundaries. Interoperability refers to a property of diverse systems and organizations, enabling them to work together (Gottschalk, 2009). However, it is still difficult for most governments to achieve interoperability among multiple governmental organizations (Klischewski & Askar, 2012). The importance of interoperability was also stressed by Gascó (2010), who claims that there is a need to design more sophisticated and complex eGovernment services. She points out many obstacles to meeting the newly emerging demands of the citizens, which cannot be covered by just one organization. Furthermore, public libraries should be considered as a provider of public technology access, training and support (Jaeger, Greene, Bertot, Perkins, & Wahl, 2012).

2.2.5. Pillar 5: participation

eParticipation focuses on democracy and includes services such as political surveys, political discussion forums or online voting. Contributions in online participation could be divided into three groups: actors and activities, contextual factors and effects, evaluations and methods (Medaglia, 2012). It should be mentioned that the research in eParticipation is limited by the immaturity of the research field, by topical gaps and by biased assumptions (Susha & Grönlund, 2012). However, there are some specifications on the ways in which governments should handle eParticipation. For example, an investigation into political discussion forums by Saebo, Rose, and Molka-Danielsen (2009) identified some key design challenges for governments, e.g. the identification of major user groups and the need for addressing them during development. Another challenge is the involvement of certain politicians and administrators in the participation process in clearly defined roles. Finally, there is the development of user competencies (including technological literacy, but also information literacy and the competency of political participation).

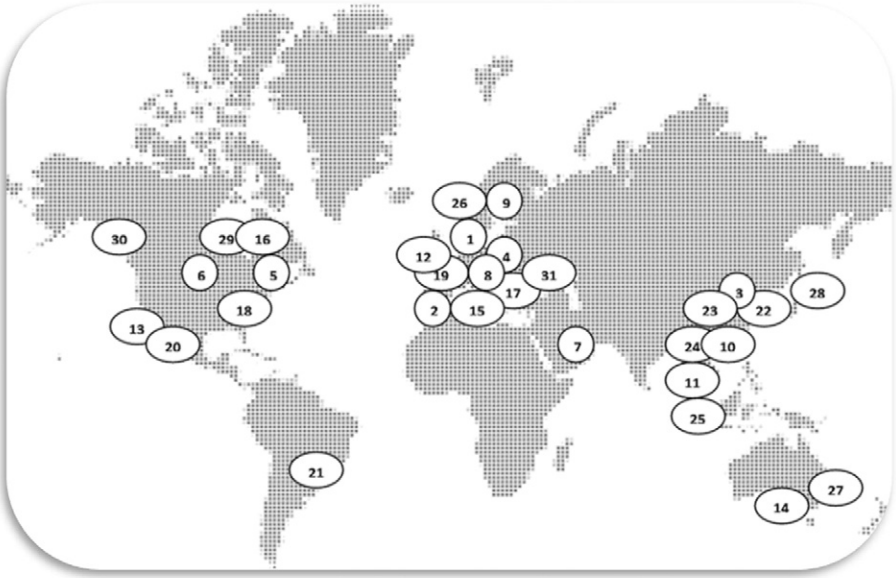
Founded by the Five-Pillars-Model, our instrument for evaluating Informational World Cities' government websites consists of three components: (1) Maturity, (2) Usability, and (3) Handling of Boundary Documents. We applied three different methods during the empirical analysis of these components. In the following, we will explain these methods and present the results for the three research questions.

3. Methods

In the following, we introduce our methodology to measure the maturity of eGovernment, the usability of the navigation systems, and finally, to investigate the boundary documents available on the governmental websites. We focused our research on the 31 Informational World Cities identified by Mainka, Hartmann et al. (2013) (Fig. 1).

3.1. Maturity of eGovernment

To quantify the maturity of eGovernment, based on the five pillars model, we formulated a criteria model (see Appendix A). Each eGovernment pillar is divided into several sections based on Hiller and Bélanger's as well as Moon's model, and on several surveys analyzing the user's information need regarding the eGovernment (Friedrichs,



1. Amsterdam	8. Frankfurt	14. Melbourne	20. San Francisco	26. Stockholm
2. Barcelona	9. Helsinki	15. Milan	21. Sao Paulo	27. Sydney
3. Beijing	10. Hong Kong	16. Montreal	22. Shenzhen	28. Tokyo
4. Berlin	11. Kuala Lumpur	17. Munich	23. Seoul	29. Toronto
5. Boston	12. London	18. New York	24. Shanghai	30. Vancouver
6. Chicago	13. Los Angeles	19. Paris	25. Singapore	31. Vienna
7. Dubai				

Fig. 1. The investigated 31 Informational World Cities adapted from Mainka, Hartmann et al. (2013).

Hart, & Schmidt, 2002; Cook, 2000; Mainka, Fietkiewicz et al. 2013). Each pillar is valued at 100 points, leading to a maximum score of 500 points. The investigation is based on the official governmental websites of each of the 31 Informational World Cities in their native language or in English, translated with Google Translate. In addition, we sent emails to the official email contacts and asked about the horizontal and vertical integration in their cities. Further information was conducted using eGovernment programs, the press and the official websites of the Informational World Cities. The evaluation was conducted by the authors between December 2012 and January 2013.

3.2. Usability of the navigation systems

In order to evaluate the usability of the 31 eGoverments a usability test was performed.

For evaluation, we chose the method introduced by Röttger and Stock (2003), where the mean quality of information architecture is used as the indicator for a comparative analysis of websites. The quality measure is based upon click rates and break-off rates in task-based user tests. The users' click rates allow us to calculate the mean quality of navigation systems for each governmental website. Röttger and Stock (2003) created a parameter that involves three values: the minimum number of clicks (starting from the homepage and arriving at the target site while using the optimal, i.e. the shortest, path), the number of break-offs (dropping the search after not finding the target site), and finally the number of clicks required by the test users to solve a task.

We formulated ten search and navigation tasks to check if users were able to access the core information or core services on the websites without any problems. We designed ten typical tasks, e.g. "Who is the head of government?" or "Find information about the Public Library", and presented them to our test persons. All in all, 44 test users took part in this study. Each website was evaluated by 10 to 16 users, except for the Chinese websites, which were evaluated by 4 native speakers. Additionally, a pre-test with 5 users was conducted.

Starting from the homepage, the test users had to record the required number of clicks to arrive at the target site. For each task, the target website was specified by the examiner. A handling time of 3 min was set for each task. After exceeding this maximum time, a "break-off" was recorded. The usability tests were performed in November and December 2012.

3.3. Boundary documents

Documents are never an end in themselves but act as means of asynchronous knowledge sharing for the benefit of an audience. This audience consists of factual or (in future situations) of hypothetical users. Like the documents' creators, the documents' users may have different intellectual backgrounds and speak different jargons. Where an author and a user share the same background, Østerlund and Crowston (2011) speak of "symmetric knowledge", where they do not, of "asymmetric knowledge". The asymmetric knowledge of heterogeneous communities leads to the conception of "boundary objects", a term coined by Star and Griesemer (1989). Boundary objects inhabit several intersecting social worlds and satisfy the informational requirements of each of them. Boundary objects form bridges between different user groups (Fong, Valerdi, & Srinivasan, 2007) so that users can work together without a consensus (Star, 2010). Boundary objects are "infrastructures" that have arisen due to certain "information needs" and "information and work requirements" of different groups (Star, 2010, p. 602).

Some websites include such standardized forms (Fong et al., 2007), which they use to serve different communities of users. Boundary documents "seem to explicate their own use in more detail" (Østerlund & Crowston, 2011, p. 7). Thus a boundary website will consist of an instruction sheet detailing its use. We searched for such instructions on

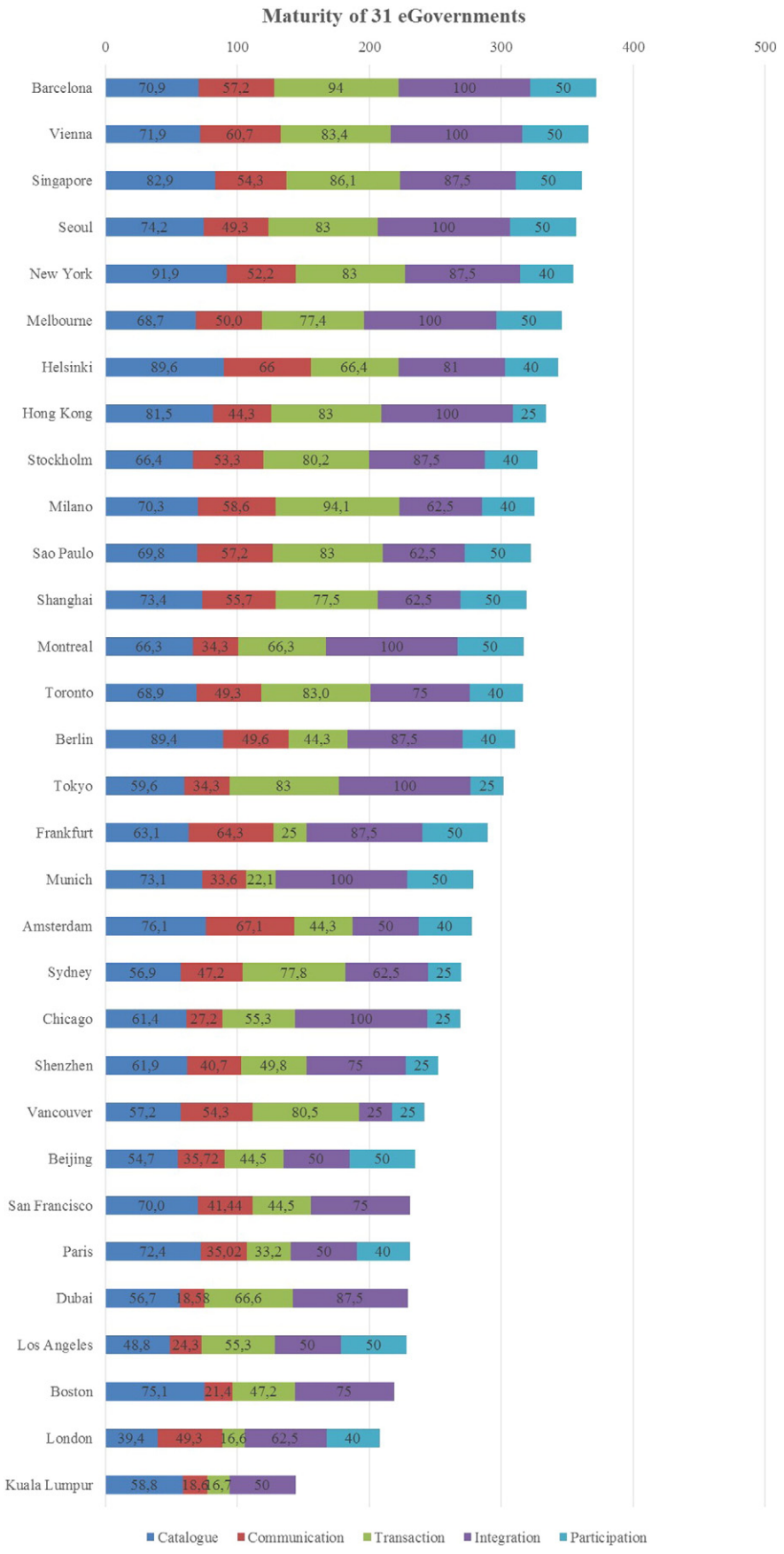


Fig. 2. The maturity of eGovernments according to the five pillars model.

the entry page of governmental websites. Since boundary documents serve different communities of users, boundary websites may have different tabs on their homepage, each leading to user-specific information. We thus analyzed the eGovernments' entry pages with regard to flags representing different user groups.

4. Results

In this chapter we present our results, answering the three research questions: (1) What is the state of maturity of eGovernments in Informational World Cities? (2) How good (or poor) is their usability? (3) How do they handle boundary documents? In order to better elaborate the results we present the outcomes of a statistical analysis and evaluate the means, standard deviations and correlation coefficients of the five pillars and eGovernments' total scores for their maturity and usability.

4.1. Maturity of the eGovernment

Our results (Fig. 2) indicate that Barcelona (Spain), Vienna (Austria) and Singapore are the top-ranked Informational World Cities with regard to the maturity of their eGovernment.

Fig. 2 shows the maturity scores of Informational Word Cities' eGovernments divided into the five pillars. All Informational World Cities' eGovernments obtained a score of about 50 points in the first pillar (except for London). This shows that the most eGovernments provide their residents with basic information. For the second pillar (*two-way communication*) the scores differ from each other. Amsterdam, Frankfurt and Vienna's eGovernments are ahead with about 60 points, whereas Dubai and Kuala Lumpur get less than 20 points. The points' allocation for the third pillar (*transaction*), where we analyzed the financial and non-financial transactions, is similar to the points' allocation for the second one. Barcelona and Milan's eGovernments exceed 90 points, while London and Kuala Lumpur's eGovernments acquire less than 20 points. The fourth pillar contains *horizontal and vertical integration*. As seen in Fig. 2, all Informational Word Cities' eGovernments, except for Vancouver, score about 50 points. Only 9 out of 31 eGovernments obtain the maximum amount of points (100). For the fifth pillar (*participation*), which gives citizens the opportunity of leaving feedback, making a complaint, or participating in an opinion survey, the diversity is greater than for the other pillars. Some eGovernments (Kuala Lumpur, Boston, and Dubai) get zero points, while eGovernments in such cities as Beijing, Paris, and Melbourne score the total 50 points.

The results show that the eGovernments of the Informational World Cities achieve different levels of maturity across the different pillars. Most eGovernments make basic data publicly available, but regarding other pillars, such as transaction and participation, some of them could enhance their services.

Barcelona's eGovernment is very mature since all important aspects—a personalized portal, vertical integration—are accessible via the homepage. The website offers the possibility of taking part in political and social decision surveys and provides access to a variety of cultural (libraries, museums), educational, environmental and civil services. It is a good example of "one-stop-Government", where different tasks can be carried out and where information from different institutions is available. Also important are the aspects of transaction and citizens' participation. A counter-example is an eGovernment focusing solely on information dissemination and non-transactional services, hence, maintaining the original bureaucratically charged image of official agencies.

4.2. Usability of the navigation systems

The results indicate that Vienna (Austria), Seoul (South Korea) and Shanghai (China) are the top-ranked Informational World Cities concerning the usability of their government websites (Appendix B). The level of usability differs gravely between the different websites. Vienna's eGovernment is very user-friendly and all the important aspects tested in the usability test are accessible via the homepage. The good mixture of text and images gives the website a simple but comprehensible design. Basic tasks can be accomplished easily even while browsing the website for the first time. The elaborate and comprehensible information architecture and the breadcrumbs permanently show the users where they are or where they were on the website. A counter-example is a website with information overload on the home page, making a quick orientation almost impossible. The lack of categorization of the information by its types or by user groups makes it even more difficult.

4.3. Statistical analysis

The maturity and usability results for the investigated eGovernments were statistically analyzed in order to better elaborate the outcomes (Table 1). Considering the mean values for each investigated pillar, the eGovernments were most advanced in terms of the *integration* (mean 77.21 out of 100 points) and *information* (mean 68.43 points). The biggest potential for improvement lies in the *communication* (mean 45.32 points). The most coherent results were given for the *information* pillar with a standard deviation of 11.77 points. The biggest divergence between the eGovernments was given for the *transaction* pillar with a standard deviation of 23.65 points. The overall *maturity* of investigated eGovernments was rather sub-optimal, reaching the mean 289.57 (out of 500), with a standard deviation of 56.59 points.

Considering the usability of investigated websites, the span between the most and least usable eGovernments was mediocre, reaching from 504 to 927 (out of 1000 points). The mean usability of 720.65 (around 72%) is rather suboptimal.

We have applied Spearman's rank correlation coefficient to measure the nonparametric statistical dependencies between the results for investigated pillars and usability of governmental websites. There is a positive correlation at 1%-level between the different pillars and overall maturity. This correlation was expected since the maturity level displays the sum of the respective pillars' results. However, there is a correlation at 5%-level between the pillars *information* and *communication*, *communication* and *transaction*, as well as *communication* and *participation*, meaning that eGovernments with advanced *information* pillar also lead in terms of the *communication* pillar, whereas advanced *communication* pillar indicates more progressed *transaction* and *participation* pillars. Only *integration* remains with no correlation, indicating that this pillar is being developed separately from other aspects and there is no connection between more or less progressed integration and the development of investigated aspects. We, therefore, conclude that the consideration of different eGovernment aspects as separate pillars instead of consecutive steps is justified, especially regarding more advanced domains like integration.

In order to analyze our outcomes from a more holistic view, we conducted a comparison with the results of eGovernment maturity and usability investigation undertook by Holzer et al. (2014) (Table 2). Since only a fraction of the investigated cities overlapped (16 out of 31), and because of the differences in the distribution of indicators and their quantifiers, only an approximate comparison of the results was possible. Partially comparable aspects are the outcomes for information (or, according to Holzer et al., *content*), transaction (or *services*), usability, and the overall maturity (or *digital governance*) since they encompass similar domains. Interestingly, the overall results for digital governance and maturity correlate positively at a 1%-level, meaning that even though two different models were applied, the resulting rankings are displaying significant similarities. There are some further positive correlations between these two models on a 5%-level, namely our transaction pillar with the outcomes for digital governance, usability, and content

Table 1
Statistical Analysis.

VARIABLES	Descriptives				Correlations (Spearman)						
	Mean	S.D.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Information	68.43	11.77	39.41	91.85	1.00						
(2) Communication	45.32	13.92	18.58	67.14	0.42*	1.00					
(3) Transaction	62.80	23.65	16.60	94.06	0.24	0.39*	1.00				
(4) Integration	77.21	20.70	25.00	100.00	0.29	−0.02	0.33	1.00			
(5) Participation	35.81	16.74	0.00	50.00	0.17	0.43*	0.20	0.20	1.00		
(6) Maturity (sum)	289.57	56.59	144.03	372.07	0.59**	0.64**	0.74**	0.59**	0.53**	1.00	
(7) Usability	720.65	93.03	504.00	927.00	0.35	0.21	−0.08	0.21	0.27	0.21	1.00

The symbols * and ** denote statistical significance at the 5% and 1% levels.

domain by Holzer et al., as well as our maturity outcome with Holzer's *content* domain. Hence, there—at the first sight—are no correlations between similar domains or pillars, but instead between (supposedly) different aspects. The possible explanation could be the different allocation of indicators between the investigated dimensions, which makes the dimensions themselves rather not comparable, but eventually, the overall outcomes are similar.

Interestingly, when considering only a fraction of investigated cities, our outcomes for maturity and usability also correlate significantly on a 5%-level. Apparently, some of the very mature websites (not included in the comparison) unfortunately showed poor levels of usability or vice versa. Here, the necessity to provide a usable website comes to light—no matter how mature the contents and applications offered on a website are, they also have to be accessible and retrievable.

4.4. Boundary documents

Having analyzed all government websites of the defined cities, only Tokyo's government website provides an instruction sheet. All other websites provide exclusively remarks on accessibility or general information but contain no page which explains how different user groups can interact with the website.

On the other hand, the flagging of different user-specific information areas seems to be typical for eGovernment. In total 84% of our analyzed websites (i.e., 26 out of 31) apply links to user-specific information on their entry pages. Most home pages address residents, businesses, and visitors. A good example for targeting different user groups is found on the website of the City of Chicago.

Even though boundary documents are supposed to improve the navigation on a website, when considering our usability results, there is no direct link between boundary documents, or at least classification of user-specific information areas, and the resulting usability score. The only website with an instruction sheet as a boundary document (Tokyo) did not perform well in our task-based usability evaluation (rank 30 out of 31). When considering the flagging of user-specific information sections, the five cities without any separated sections have performed much differentiated (Vienna had the most usable website, Munich took 4th rank, Vancouver was 11th, Milan 23rd, and Sao Paulo 28th). Apparently, the test persons evaluating the municipal websites did not need the boundary documents. The boundary documents solutions were either not necessary due to well-structured websites (Vienna, Munich, Vancouver), or they were insufficient to help to navigate on less structured ones (Milan, Sao Paulo, Tokyo). The investigation of boundary documents, the task-based usability evaluation, and maturity investigation had to be conducted separately, in order to not distort the results.

5. Discussion

All 31 analyzed Informational World Cities provide online services for governmental purposes. In this article, we investigated the maturity of eGovernment in the sense of a five-pillars model as well as the usability of the government websites' information architecture and checked whether these websites cater for different user groups.

The maturity of the 31 analyzed eGovernments is more or less suboptimal. Even the class-best website, of the city of Barcelona, fulfilled only 74% of all scrutinized aspects. The average of all maturity values were 289 points (out of 500). This means that nearly half of the described aspects are lacking. Many of the evaluated municipal governments still focus on information dissemination. Our assumption that there are rather independent pillars of eGovernment than interdependent stages has been validated. The top cities succeeding (nearly) 100% in the fourth or third pillar did not necessarily perform as well regarding pillars one or two.

The usability of eGovernments' information architecture is varying between 504 and 927 (out of 1000) points. The top-ranked Informational World City, Vienna, scored 927 points, which means that almost all information can be retrieved without any problems. When considering all investigated cities, there is no correlation significant on a 1%- or 5%-level between the maturity and usability of eGovernments. Even though some governmental websites offer mature contents and utilities, without appropriate accessibility and retrievable information, they cannot satisfy the needs of their citizens. When planning the advancement of their websites, the governments should focus on both aspects—mature

Table 2
Comparison of eGovernment and usability outcomes with results by Holzer et al. (2014).

VARIABLES	Correlations (Spearman)						
	(1)	(1a)	(2)	(2a)	(3)	(3a)	(4)
(1) Information	1						
(1a) Content by Holzer et al.	0.0971	1					
(2) Transaction pillar	0.2575	0.5504*	1				
(2a) Services by Holzer et al.	0.1558	0.4907*	0.2773	1			
(3) Usability	0.3808	0.2345	0.1225	0.2755	1		
(3a) Usability by Holzer et al.	−0.1757	0.3461	0.5294*	0.5013*	0.1085	1	
(4) eGovernment maturity	0.6512**	0.4855*	0.7892**	0.3953	0.5026*	0.3535	1
(4a) Digital Governance	0.2528	0.6405**	0.5379*	0.87**	0.2466	0.6884**	0.5996**

The symbols * and ** denote statistical significance at the 5% and 1% levels.

content fulfilling the expectations of the users and usable navigation system enabling citizens to actually access these contents.

Governmental websites are boundary documents and address different user groups. Nearly all websites apply tabs to support navigation to user-specific content, however, only one eGovernment included a more detailed support in the form of an instruction sheet. Nevertheless, when applying task-based evaluation of the superficial navigation system, the supporting boundary documents do not seem to play a significant role.

In conclusion, there is a great potential for improvement regarding the maturity levels of governmental websites. For some municipalities, the usability standards of their eGovernments should be improved. However, in this context, the sole implementation of boundary documents does not seem to necessarily improve the usability of the (at least superficial) navigation system of the websites.

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Appendix A. Criteria model for quantifying the maturity of eGovernment.

Pillar	Question	Points	Total points
INFORMATION			100
	Are press releases available?	8,3	
	Is basic information available?	8,3	
	Is information on healthcare available?	8,3	
	Is information on politics available?	8,3	
	Is information on services available?	8,3	
	Are forms for services available?	8,3	
	Is information for various user-groups available?	8,3	
	Is the website accessible via smartphones?	8,3	
	Are applications for smartphones available?	8,3	
	Are push services available?	8,3	
	Is the website available in English?	8,3	
	Is the website available in the languages of the three most important immigrant groups?	8,3	
COMMUNICATION			100
	Are social media services used?	20	
	Is it possible to make appointments with an authority via the web?	20	
	Do I get answers to email requests?	20	
	Is emailing possible instead of written (snail) mail?	20	
	Is it possible to leave feedback or complaints?	20	
TRANSACTION			100
	Is it possible to fill out forms online?	16,6	
	Is it possible to pay taxes online?	16,6	
	Is it possible to pay penalties online?	16,6	
	Is it possible to pay fees online?	16,6	
	Are services for libraries available?	16,6	
	Is a personalized portal available?	16,6	
INTEGRATION			100
	Is an entry homepage available?	50	
	Email: Cooperation with authorities? Software/safety measure/intranet/database?	50	
PARTICIPATION			100
	Are online questionnaires available?	25	
	Do forums and platforms for asking questions exist?	25	
	Is it possible to participate in a community meeting via the WWW?	25	
	Is it possible to vote online?	25	

Appendix B. Usability scores of Informational World Cities' government websites.

Rank	Informational World City	Points
1.	Vienna	927
2.	Seoul	876
3.	Shanghai	860
4.	Stockholm	822
5.	Munich	811
6.	Berlin	809
7.	Boston	783
8.	Helsinki	781
9.	Frankfurt	779
10.	San Francisco	775
11.	Vancouver	762
12.	Los Angeles	759
13.	Toronto	745
14.	Chicago	726
15.	Montreal	723
16.	New York	715
17.	Melbourne	706
18.	Amsterdam	700
19.	Paris	696
20.	Shenzhen	687.5
21.	Barcelona	687
22.	Beijing	680
23.	Milan	669
24.	Sydney	668
25.	Hong Kong	662.5
26.	Dubai	631
27.	London	629
28.	Sao Paulo	600
29.	Singapore	587
30.	Tokyo (English version)	580
31.	Kuala Lumpur	504

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