

# GIZACHain: e-Government Interoperability Zone Alignment, based on blockchain technology

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E-government provides access to services anytime anywhere. There are many e-Government frameworks already exist to integrate e-government services, but efficient full interoperability still a challenge.

Interoperability per se can be modeled via four maturity stages, in which the interoperability zone is the holy grail of full interoperability to be reached ultimately with strategy alignment. As e-government services shift in the same way as e-commerce with value chain, this implicitly implies the possibility of benefiting from blockchain with e-government. Blockchain is a nascent promising architecture, whose transactions are permanent, verifiable, and recorded in a distributed ledger.

This research article suggests applying blockchain in achieving e- government interoperability. Forms are juxtaposed on the outer borders of the system. These forms adopt those used by UK government, because they are standard as well as they are available for Python developers. Once a form has been completed, PySOA calls the requested service, before storing the data in Ontology Blockchain. After the service is performed, the policies are analyzed in batch processing using quantgov. A report is submitted to the central government periodically. Ontology Blockchain has a dual effect. On the one hand, it works as a secure data storage. On the other hand, it cooperates with PySOA in supporting both technology and semantic interoperability . The most important feature of the proposed method is the presence of (Government Interoperability Zone Alignment; GIZA), which acts as a backbone that coherently connects the internal subcomponents. This linkage is possible, because each form has an title, that corresponds to the appropriate service name. Each service in turn has a counterpart in the wallets stored in Ontology blockchain.

To measure interoperability empirically, there is a need for metrics. This study adopts and quantizes a standard interoperability matrix along three dimensions of interoperability of Conceptual (Syntax& Semantics), Organizational (Responsibilities& Organization per se), and Technology (Platform& Communication). While concerns are : data, business, service, and process. Any deviation from the standard could contributes to the interoperability score (counting mismatches) or interoperability grade (counting absolute differences). An estimation is performed, for 1000 total random cases. It is estimated that the probability of getting a conceptual/technical interoperability score as large as the standard strategy score is  $(713 / 1000 = 0.713$  (2 in 3). It is estimated too that the probability of getting a organizational interoperability score as large as the standard strategy score is  $(712 / 1000 = 0.712$  (2 in 3). Then, Markov model is proposed to provide an accurate representation of the evolution of the strategies over time.

# GIZACHain: e-Government Interoperability Zone Alignment, based on blockchain technology

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## Abstract

E-government provides access to services anytime anywhere. There are many e-Government frameworks already exist to integrate e-government services, but efficient full interoperability still a challenge.

**Background.** Interoperability per se can be modeled via four maturity stages, in which the interoperability zone is the holy grail of full interoperability to be reached ultimately with strategy alignment. As e-government services shift in the same way as e-commerce with value chain, this implicitly implies the possibility of benefiting from blockchain with e-government. Blockchain is a nascent promising architecture, whose transactions are permanent, verifiable, and recorded in a distributed ledger.

**Methods.** This research article suggests applying blockchain in achieving e- government interoperability. Forms are juxtaposed on the outer borders of the system. These forms adopt those used by UK government, because they are standard as well as they are available for Python developers. Once a form has been completed, PySOA calls the requested service, before storing the data in Ontology Blockchain. After the service is performed, the policies are analyzed in batch processing using quantgov. A report is submitted to the central government periodically. Ontology Blockchain has a dual effect. On the one hand, it works as a secure data storage. On the other hand, it cooperates with PySOA in supporting both technology and semantic interoperability. The most important feature of the proposed method is the presence of (Government Interoperability Zone Alignment; GIZA), which acts as a backbone that coherently connects the internal subcomponents. This linkage is possible, because each form has an title, that corresponds to the appropriate service name. Each service in turn has a counterpart in the wallets stored in Ontology blockchain.

**Results.** To measure interoperability empirically, there is a need for metrics. This study adopts and quantizes a standard interoperability matrix along three dimensions of interoperability of

Conceptual (Syntax& Semantics), Organizational (Responsibilities& Organization per se), and Technology (Platform& Communication). While concerns are : data, business, service, and process. Any deviation from the standard could contribute to the interoperability score (counting mismatches) or interoperability grade (counting absolute differences). An estimation is performed, for 1000 total random cases. It is estimated that the probability of getting a conceptual/technical interoperability score as large as the standard strategy score is  $(713 / 1000 = 0.713$  (2 in 3). It is estimated too that the probability of getting a organizational interoperability score as large as the standard strategy score is  $(712 / 1000 = 0.712$  (2 in 3). Then, Markov model is proposed to provide an accurate representation of the evolution of the strategies over time.

## Introduction

E-government provides access to services anytime anywhere thanks to the evolution in Information and Communication Technology (ICT) (Hany, 2008).

There are many e-Government frameworks(Riad et al, 2011) already exist to integrate e-government services, but efficient full **interoperability** still a challenge (Charalabidis, 2010).

A quick literature review is presented in the rest of this section, focusing on success stories and learned lessons, before presenting e- government interoperability zone alignment based on blockchain in next section, in which blockchain acts as the core distributed repository. This allows citizens to gain access to the e-services quickly and with transparency and high privacy.

**E-government** is "the use of ICT by governments that have the ability to transform relations among citizens, business and other arms of government" (WorldBank Website, 2015). It can be viewed as an interaction tool between government and citizens (Drucker, 2001).

It aims for :

- enhance quality of service (Siddiquee & Mohamed, 2007),
- cost-effective service (Bhuiyan, 2011),
- reduce time(Alshehri & Drew 2011),
- saving resources (Seifert & Bonham, 2003),
- efficient administration (Rajon&Zaman, 2008),
- enhance bureaucracy (West, 2004),
- sustainability (Bwalya 2009),
- corruption control (Schuppan, 2009), and
- fighting poverty (Pathak et al. 2007).

Development of e-government, usually through stages (Layne & Lee, 2001), encounters many barriers to reach full interoperability (Hellman, 2010). Interoperability per se can be modeled via four maturity stages (Gottschalk& Solli-Sæther, 2009), in which the **interoperability zone** is the holy grail of full interoperability to be reached ultimately with **strategy alignment**<sup>1</sup>.

Based on e-government ranking, **Estonia** is a **success story** (X-Road). Its X-Road system *connects all government databases over Internet, thus generating a common e-data resource*

<sup>1</sup> Refer to figure 1, (Hellman, 2010).

(Waseda University, 2013). A key learned lesson is that the realization of e-government services usually necessitates a network organization of services (Goldsmith & Eggers, 2004) (Osborne, 2010). Yet, the standard model of e-government, focusing on the exchange of information on 24hours/7days basis (Basu 2004), incorporates a triade of communication styles (Sharma & Patni, 2012):

- Citizen-to-Government,
- Business-to-Government, and
- Government-to-Government

A second learned lesson is that e-government services shift in the same way as e-commerce with value chain (Osborne & Gaebler, 1992), (Kamarck, 2007).

Based on that learned lesson, blockchains may be a perfect match to be employed in e-government, as proposed in the subsequent section.

## Methods

This research article suggests applying blockchain in achieving e-government interoperability, as shown in Figure 1.

Figure 1 near here

Forms are juxtaposed on the outer borders of the system. These forms adopt those used by UK government, because they are standard as well as they are available for Python developers. Once a form has been completed, PySOA calls the requested service, before storing the data in Ontology Blockchain. After the service is performed, the policies are analyzed in batch processing using quantgov. A report is submitted to the central government periodically.

The most important feature of the proposed method is the presence of (Government Interoperability Zone Alignment; GIZA), which acts as a backbone that coherently connects the internal subcomponents. This linkage is possible, because each form has an title, that corresponds to the appropriate service name. Each service in turn has a counterpart in the wallets stored in Ontology blockchain.

## Results

To measure interoperability empirically, there is a need for metrics. This study adopts interoperability matrix from (Ducq & Chen, 2008), as shown in Table 1.

Table 1 near here

Barriers along the three dimensions of interoperability (Ducq & Chen, 2008):

- Conceptual (Syntax& Semantics),

- Organizational (Responsibilities& Organization per se), and
- Technology (Platform& Communication).

While concerns are : data, business, service, and process.

Originally each dimension is decomposed into a dichotomy with binary values. For a matter of mathematical convince, each dimension is quantized. For instance, the intersection of Conceptual and Data was originally (0,0). This binary value has a corresponding 0 quantization value, as 00→0, 01→1, 10→2, and 11→3.

The standard has "3,3,3,3" quantization. Any deviation from the standard could contributes to the interoperability score (counting mismatches) or interoperability grade (counting absolute differences), as shown in Table 2, and Table 3 respectively.

Table 2 near here

Table 3 near here

Each of technical and conceptual interoperability has "0,2,3,3" possible quantization values, but for different concerns. Organizational interoperability has "0,1,1,3" quantization values. An estimation is performed <sup>2</sup>, for 1000 total random cases. Conceptual/technical interoperability scores and grades are shown in Figure 2 and Figure 3 respectively.

Figure 2 near here

Figure 3 near here

For conceptual /technical interoperability, it is estimated that 713 of the 1000 strategy alignments of random conceptual /technical interoperability has "0,3,2,3"/"3,0,2,3" possible quantization had strategy alignment scores that were equal to or greater than 2. Hence, it is estimated that the probability of getting a conceptual/technical interoperability score as large as the standard strategy score by chance is (713 /1000 =) 0.713 (2 in 3). This P-value is sufficiently high, to conclude that it is probable to gain a conceptual/technical interoperability with score as high as 2 by a mere chance.

This may be counter-interoperability hypothesis, but bear in mind that the 3,3,3,3" standard is not a realistic assumption. As quantizations "0,3,2,3" and "3,3,3,3" are initially 50% zone-

<sup>2</sup> R code is publicly available [https://github.com/dr-dos-ok/GIZACHain/blob/master/r\\_zone\\_alignment\\_estimation.ipynb](https://github.com/dr-dos-ok/GIZACHain/blob/master/r_zone_alignment_estimation.ipynb) . It only requires installing seqinr package to use c2s function to facilitate conversion of a string to a character vector.

alignable, hence they are interoperable. It is expected that it can be raised up to at least 75% interoperability when lowering the standard only one.

Similarly, organizational interoperability scores and grades are shown in Figure 4 and Figure 5 respectively.

Figure 4 near here

Figure 5 near here

Similarly, for organizational interoperability, it is estimated that 712 of the 1000 strategy alignments of random organizational interoperability has "1,1,0,3" possible quantization had strategy alignment scores that were equal to or greater than 3. Hence, it is estimated that the probability of getting an organizational interoperability score as large as the standard strategy score by chance is  $(712 / 1000 =) 0.712$  (2 in 3). This P-value is sufficiently high, to conclude that it is probable to gain an organizational interoperability with score as high as 3 by a mere chance.

The simplest model of strategy evolution assumes that the quantization follows the multinomial distribution. In other words, randomly chose any of the four quantization(0,1,2,3) has a predetermined probability. That is  $(1/4, 0/4, 1/4, 2/4)$  for conceptual/technical dimension as shown in Figure 6, and  $(1/4, 2/4, 0/4, 1/4)$  ) for organizational dimension as shown in Figure 7.

Figure 6 near here

Figure 7 near here

However, for some actual scenarios, it is not true, because the probability of finding a particular strategy by any government at a particular time does depend on adjacent strategies. In this case, Markov model is a more accurate representation of the evolution of the strategies over time. A Markov model chose any of the four quantization values, where the probability of choosing any one of the four quantizations at a particular time depends on the quantization chosen for the previous time, as shown in Figure 8.

Figure 8 near here

## Discussion

This study extends the standard model of e-government (Sharma & Patni, 2012), in which blockchain is placed at the heart of the proposed model. This is based on the shift of e-government services that resembles the shift in e-commerce with value chain (Osborne & Gaebler, 1992), (Kamarck, 2007).

The most important feature of the proposed model is the presence of (Government Interoperability Zone Alignment; GIZA), which acts as a backbone that coherently connects the internal subcomponents. This linkage is possible, because each form has an title, that corresponds to the appropriate service name. Each service in turn has a counterpart in the wallets stored in Ontology blockchain.

Ontology Blockchain has a dual effect. On the one hand, it works as a secure data storage. On the other hand, it cooperates with PySOA in supporting both technology and semantic interoperability. Blockchain is responsible for primitive operations known as CRUD (creation, reading, updating, deleting). The blockchain, by nature, does not allow the last two types of operations. This may be considered a double-edged sword.

To measure interoperability empirically, there is a need for metrics. This study adopts and quantizes interoperability matrix from (Ducq & Chen, 2008). An estimation is performed, for 1000 total random cases. It is estimated that the probability of getting a conceptual/technical interoperability score as high as the standard strategy score is about 71%. Make no mistake, the 3,3,3,3" standard is not a realistic assumption. As quantizations "0,3,2,3" and "3,3,3,3" are initially 50% zone-alignable, hence they are interoperable. It is expected that it can be raised up to at least 75% interoperability when lowering the standard only one. Moreover, for some actual scenarios, Markov model is proposed to provide a more accurate representation of the evolution of the strategies over time.

## Conclusions

Based on the shift of e-government services that resembles the shift in e-commerce with value chain (Osborne & Gaebler, 1992), (Kamarck, 2007), blockchain is proposed to be placed at the heart of the standard model of e-government (Sharma & Patni, 2012).

Based on a rough estimation, the probability of reaching an a interoperability zone alignment is estimated. One possible future direction is to produce accurate estimations based on Markov model of strategy evolution.

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290 [3~menuPK:702592~pagePK:148956~piPK:216618~theSitePK:702586,00.html](http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/EXTGOVERNMENT/0,,contentMDK:20507153~menuPK:702592~pagePK:148956~piPK:216618~theSitePK:702586,00.html)> [15  
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293 <https://www.ria.ee/x-road/>

# **Table 1**(on next page)

## Interoperability Matrix

There are three dimensions of interoperability : Conceptual (Syntax& Semantics), Organizational (Responsibilities& Organization per se), and Technology (Platform& Communication). While concerns are : data, business, service, and process.

BARRIER CONCERN	CONCEPTUAL (SYNTAX& SEMANTICS)	ORGANIZATIONAL (RESPONSIBILITIES& ORGANIZATION PER SE)	TECHNOLOGY (PLATFORM& COMMUNICATION)
Data	0	1	3
Business	3	1	0
Service	2	0	2
Process	3	3	3

1

## Table 2 (on next page)

Interoperability score for two arbitrary subsystems

A score is calculated by counting mismatches.

CONCERN	SUB-SYSTEM1 STRATEGY	SUB-SYSTEM2 STRATEGY	SCORE
Data	0	3	1
Business	1	2	1
Service	2	2	0
Process	3	3	0
Total score			2

# **Table 3**(on next page)

Interoperability grades for two arbitrary subsystems

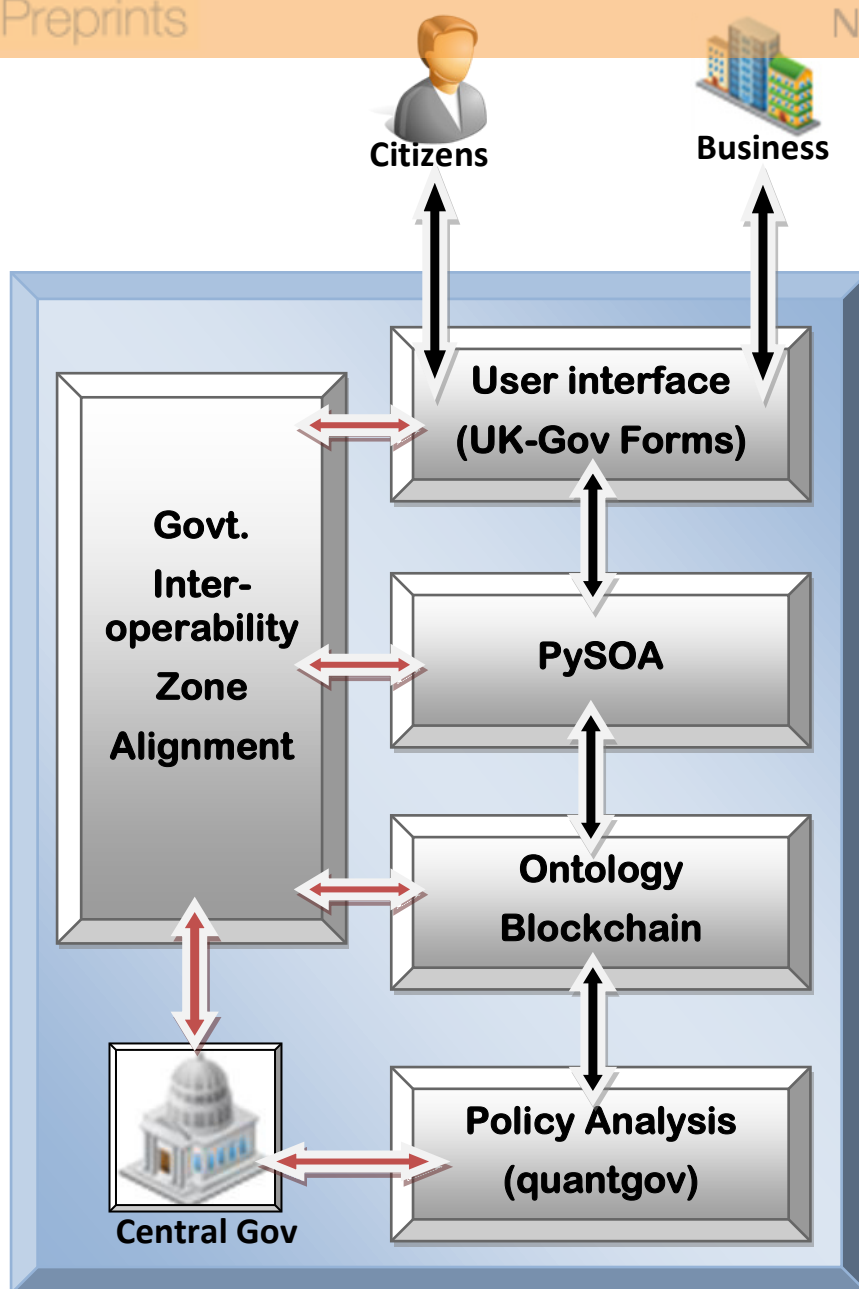
A grade is calculated by the absolute differences between values.

CONCERN	SUB-SYSTEM1 STRATEGY	SUB-SYSTEM2 STRATEGY	GRADE
Data	0	3	3
Business	1	2	1
Service	2	2	0
Process	3	3	0
Total grade			4

## Figure 1(on next page)

### Proposed Model

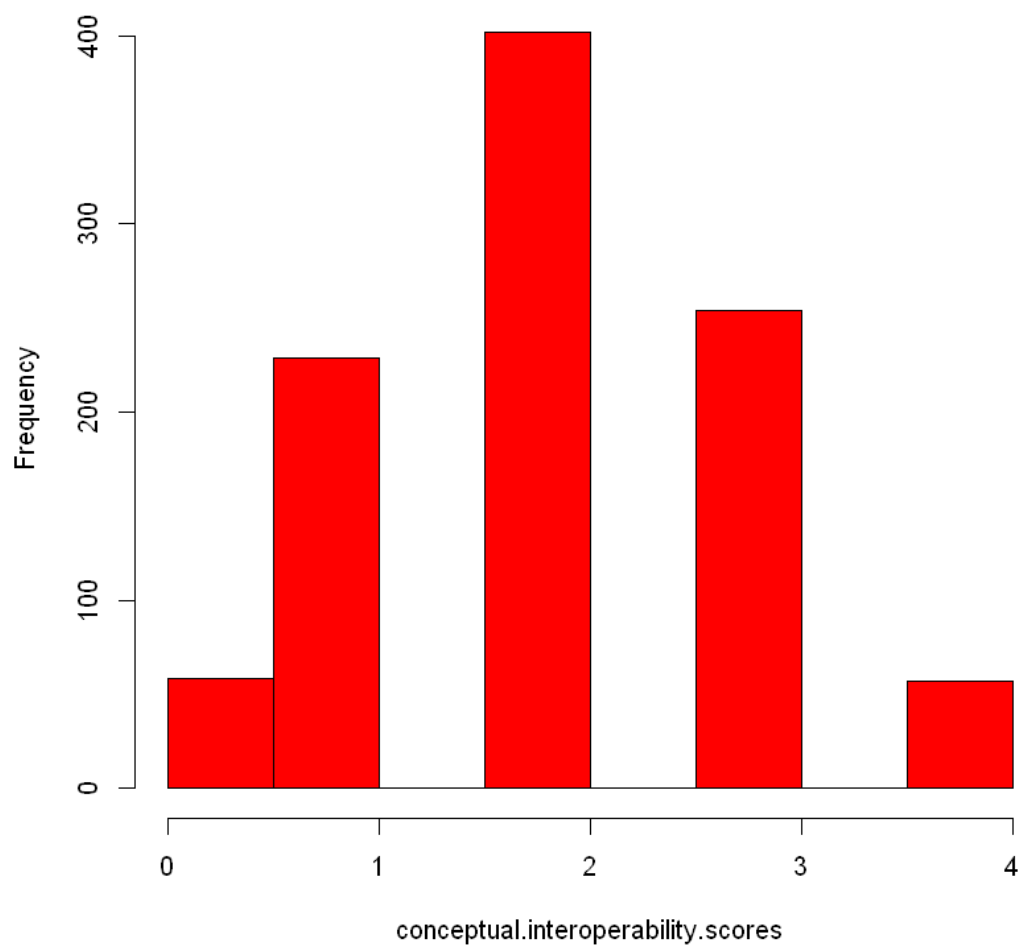
Forms are juxtaposed on the outer borders of the system. These forms adopt those used by UK government, because they are standard as well as they are available for Python developers. Once a form has been completed, PySOA calls the requested service, before storing the data in Ontology Blockchain. After the service is performed, the policies are analyzed in batch processing using quantgov. A report is submitted to the central government periodically. Ontology Blockchain has a dual effect. On the one hand, it works as a secure data storage. On the other hand, it cooperates with PySOA in supporting both technology and semantic interoperability . The most important feature of the proposed method is the presence of (Government Interoperability Zone Alignment; GIZA), which acts as a backbone that coherently connects the internal subcomponents



# Figure 2(on next page)

Conceptual interoperability scores

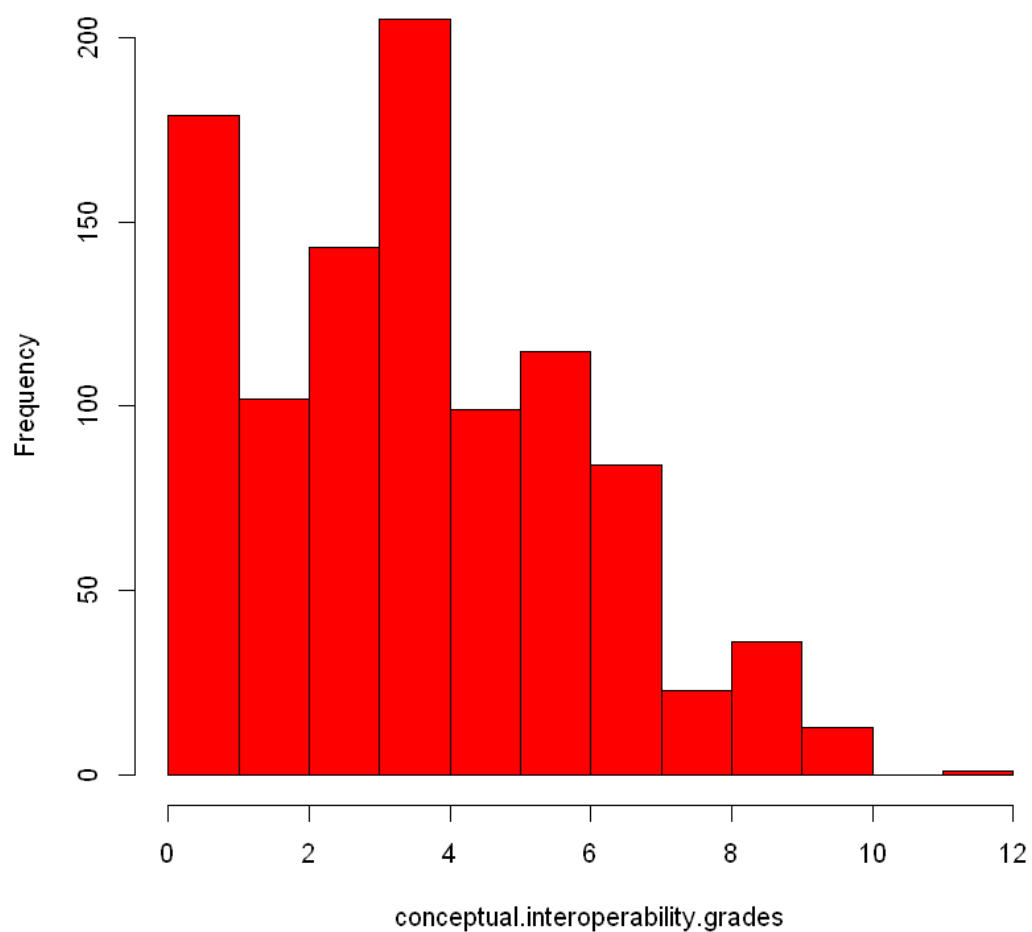
Histogram of conceptual.interoperability.scores



# Figure 3(on next page)

Conceptual interoperability grades

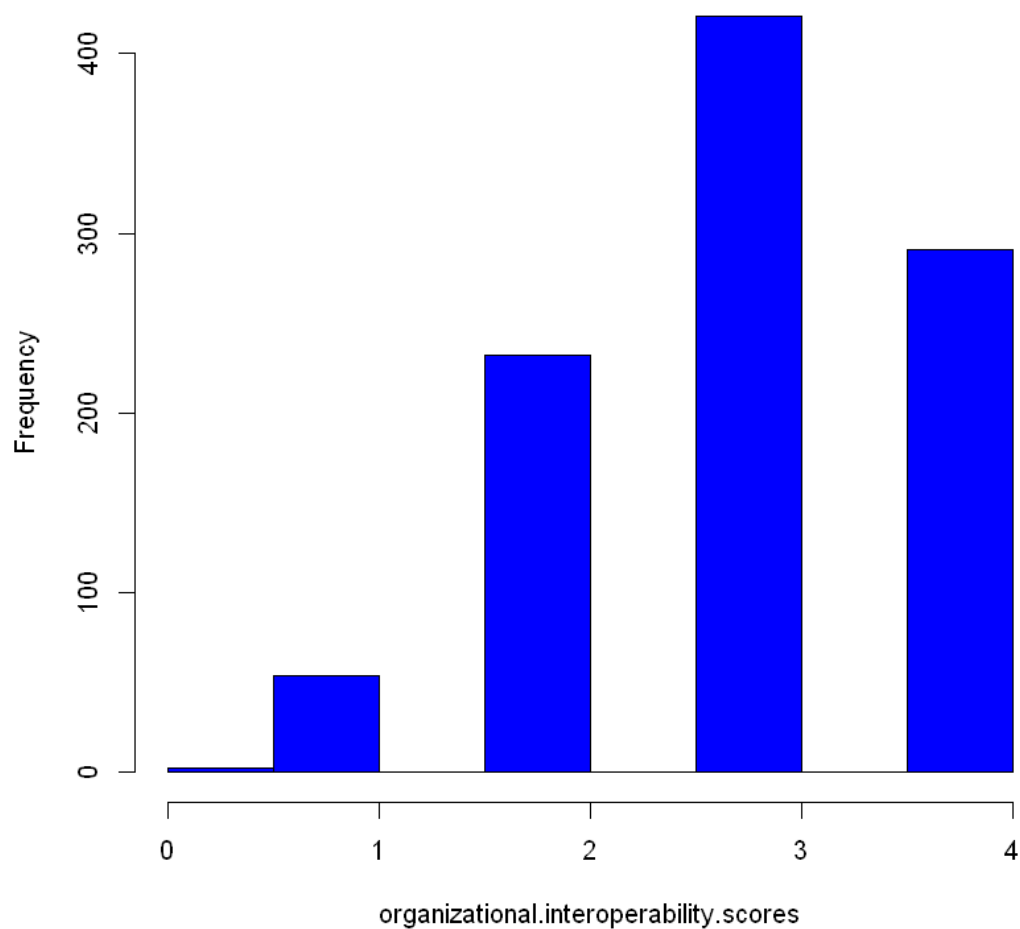
Histogram of conceptual.interoperability.grades



# Figure 4(on next page)

Organizational Interoperability scores

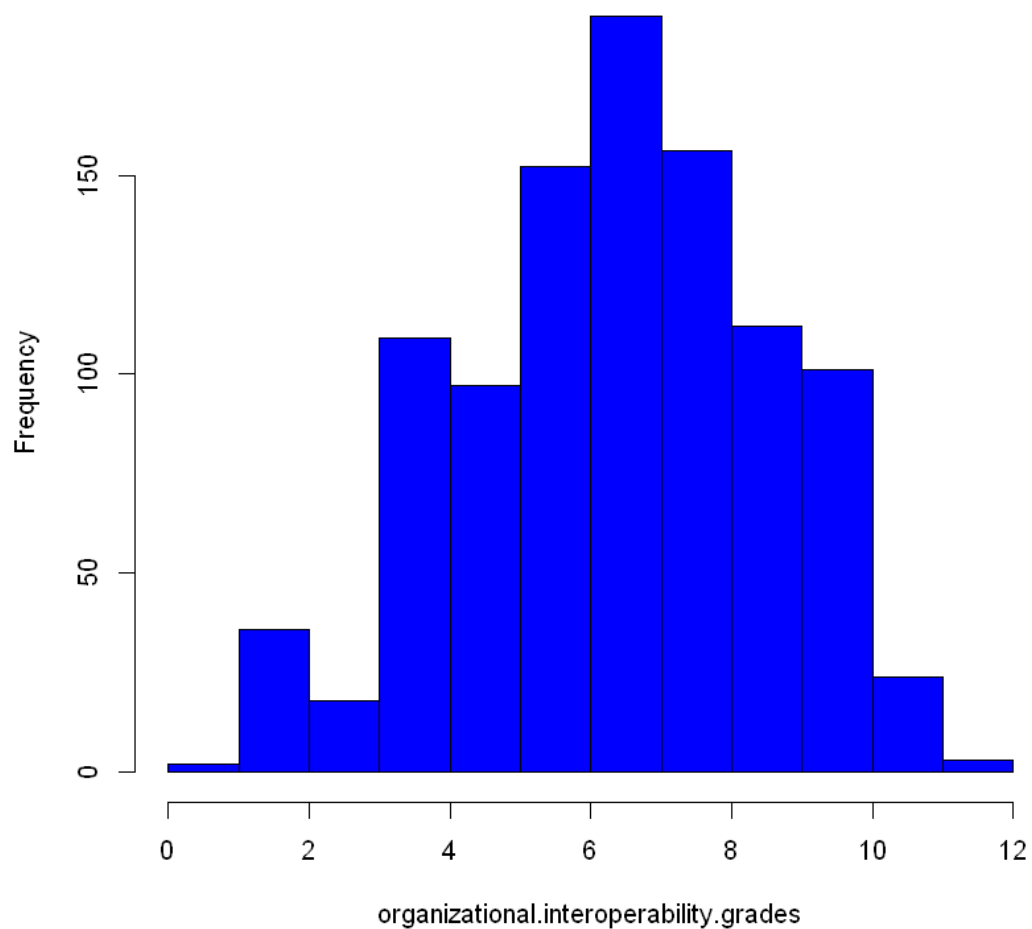
Histogram of organizational.interoperability.scores



# Figure 5(on next page)

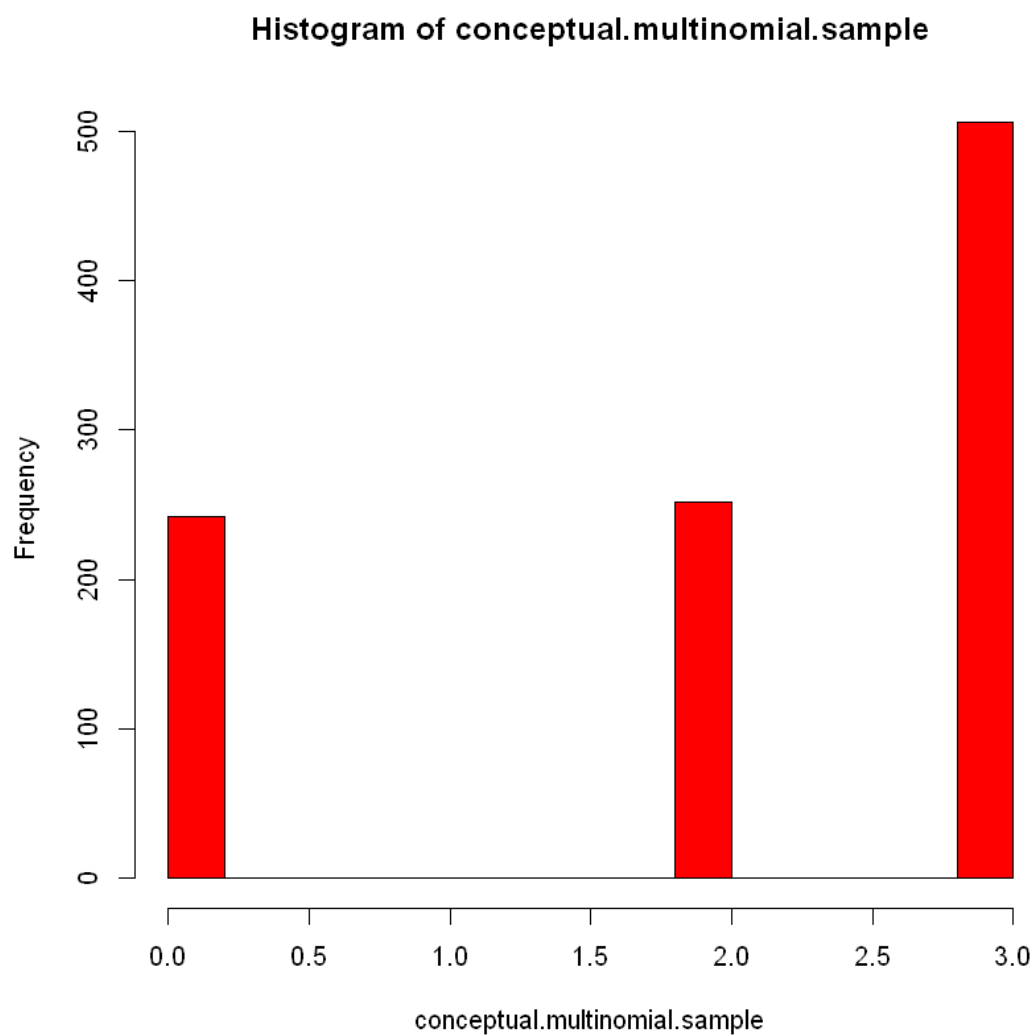
Organizational Interoperability grades

Histogram of organizational.interoperability.grades



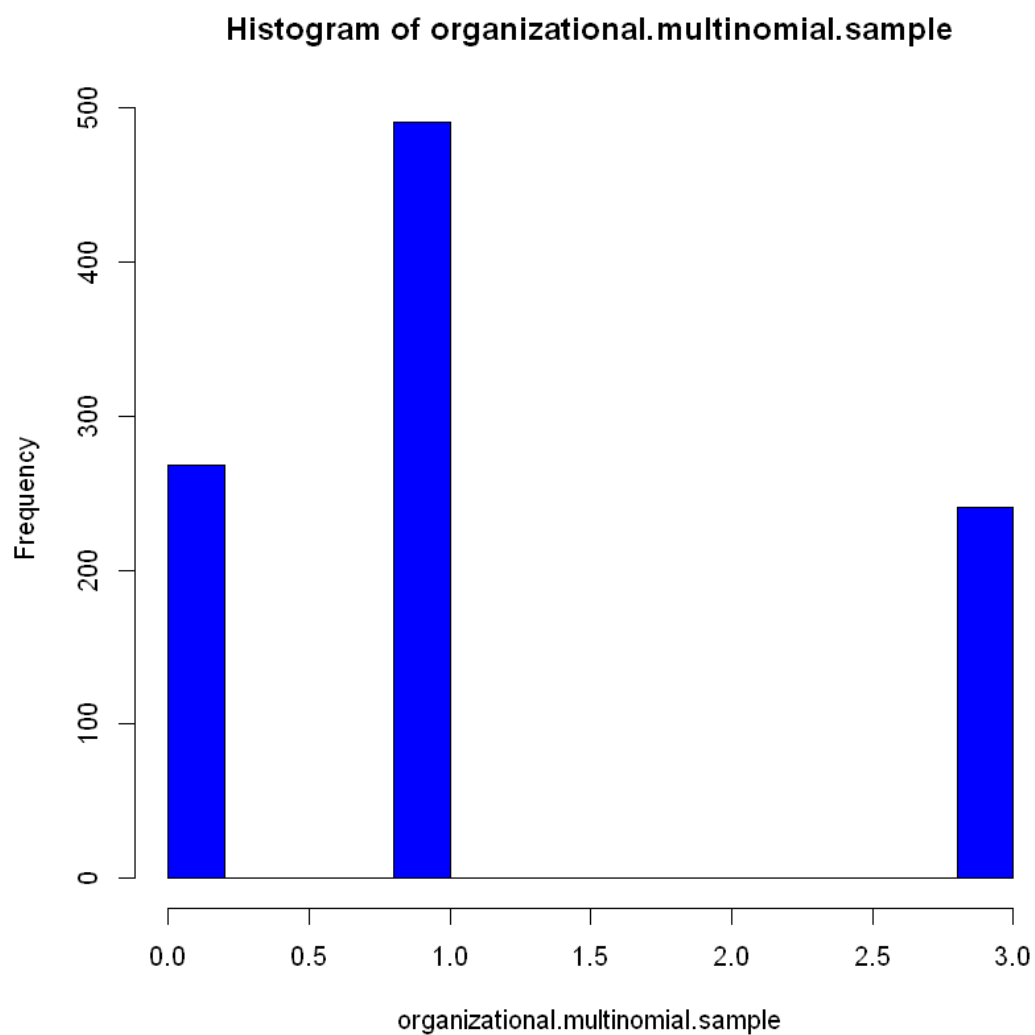
# **Figure 6**(on next page)

Conceptual Sample



# **Figure 7** (on next page)

Organizational Sample



# Figure 8(on next page)

Markov Sample

Histogram of markov.sample

