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Semantic, Technical, E-Government Information Systems Interoperability and the Moderating Effect of IT Capability among Ministries in Jordan

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Abstract: In the past two decades the interoperability of Information Systems counted from the main key feature of successful e-Government projects. While information systems and technologies are being developed and enhanced, many discussions on their success have been accomplished by scholars and researchers. Moreover, they found that achieving of IS interoperability between different institutions is a complex task and influenced by different aspects. As a part of these aspects the semantic and technical factors considered from the main issues related to interoperability. This study investigates the semantic and technical factors that affect the level of interoperability with focusing on interoperability of IS as a key concept to achieve the successful implementation of interoperability in the public sector. In order to explore the variables of the study and its relations, a variety of published literatures on the scope of the study was critically reviewed. Furthermore, data was collected using the survey by distributing 355 questionnaires to IT staff in 25 Jordanian ministries. 231 usable forms were returned. The data was analyzed using the Partial least squares-structural equation modeling technique. The findings showed that the semantic factor and technical factor positively affect the e-GISI. On the contrary, there was no moderate effect of IT capability in the relationship between both semantic and technical factors and the e-GISI. The semantic and technical factors are good for promoting e-GISI, which means that government entities must promote STD as a semantic factor and SAP as technical factor. On contrary, there was no moderating effect of IT capability between semantic and technical factors and the e-GISI among the Jordanian ministries.

Keywords: Jordan, Interoperability, IT Capability, Semantic Factors, Technical Factors.

INTRODUCTION

Electronic government (e-Government) defined as the use of information and communication technology such as internet and mobile technology to provide the government services to citizen, business and public sector itself (Pardo & Tayi, 2007; Sulehat & Taib, 2016). According to Alshehri and Drew (2013), many countries implemented e-Government as the most essential infrastructure for delivering public sector services. Moreover, Staden and Mbale (2012) stated that connecting public sector to its different stakeholder's citizen, business, and government both internally and externally is built on interoperability.

Interoperability defined as the ability of different kinds of information systems to work with each other to exchange information in a meaningful way (Lallana, 2008). It is vastly agreed that building of interoperability among organizations' information systems (IS) can promote and enhance business value. Furthermore, based on Pardo and Burke (2008) interoperability of information systems counted as the key concept of public sector delivering services. Moreover, as a part of e-Government information systems interoperability semantic and technical factors considered as sustainable success key in e-Government delivering services projects (Kubicek & Cimander, 2009).

Information systems interoperability can be influenced by many barriers in both public and private sectors, these obstacles classified as semantic, technical, and organizational issues which could prevent reaching the implementation of successful e-service projects (Solli-Saether, 2011; Sulehat & Taib, 2016). Based on Pudjianto and Hangjung (2009), about 60% of the implemented e-Government projects partially or totally fail. Moreover, Heeks (2003) stated that in developing countries, just 15% of e-Government projects implemented successfully, while 50% has partially failed, and about 35% cases of implemented e-Government projects were totally failed.

Based on a study included 193 country held by United Nations Department of Economic and Social Affairs (UNDESA) showed that the rank of the Hashemite Kingdome of Jordan in e-Government development index (EGDI) retract from rank 50 in 2008 to 91 in 2016 (United Nations, 2016; United Nations, 2008).

In the context of Jordan, the researchers focus on the ministries that counted as the backbone of the government sector. The government enhances the contribution in the Jordanian socio – economic development and despite of this the interoperability of information systems still faces many forces and challenges. The aim of this paper is to analyze the e-Government interoperability of the information systems and explore the most critical issues that are linked to the semantic and technical interoperability through field study of ministries' ICT in Jordan.

LITERATURE REVIEW

The objective of this section is to explore the dimensions of the research model e-Government information systems interoperability, semantic factors, technical factors, and the moderating effect of the IT capability.

e-Government Information Systems Interoperability(e-GISI)

eGISI is the ability of ICT information systems to communicate, interpret and exchange data in a meaningful way (Hellman, 2010; Knight, Widergren, Mater, & Montgomery, 2013). According to Knight et al. (2013), it

is about the features of both hardware and software to communicate, link, and work together in a way that enhances the resulting integration. Moreover, Othman and Razali (2013) assured that to establish feasible e-Government interoperability; the related stakeholders' systems should be connected in a way that information systems are interoperable in the early stages of the system development. Consequently, interoperability is counted as the primary success key of data exchange and information sharing among diversified systems. Furthermore Sulehat and Taib (2016) mentioned that before starting inclusive e-Government initiatives, there is a need to understand the government interoperability current level, desired level, and the gap among them.

Semantic Factors

Semantic interoperability is defined as the extent to which the information systems that are using various terminologies are able to communicate and connect in a meaningful way (Gottschalk & Solli-Sæther, 2009). In order to enhance the information systems interoperability within government institutions the semantic factors that affect e-GISI could be summarized as follows:

Information Quality (IFQ): Considered as one of the leading forces that affect eGISI, the common data definitions, maintaining, and information management are mostly impact data consistency (Ali & Sunitha, 2007). Moreover, the challenges linked with information quality are data accuracy, inconsistency, currency, objectivity, reliability, and authority (Al Haderi, 2012; Jiang & Ji, 2014).

Standards (STD): counted from the main key factors that influence eGISI. Standards are the means by which e-government enables interoperability between different departments to improve service delivery and ensure access to key data over time; it could be accessible through common standards, common frameworks and guidelines (Davies, Harris, Crichton, Shukla, & Gibbons, 2008).

Technical Factors

Technical interoperability defined as the communication protocols, which exist for exchanging data between different participating computer systems, and the required infrastructure for those protocols to operate (Saekow & Boonmee, 2010; Veer & Wiles, 2008).

- **IT Infrastructure (ITI):** classified as one of the main barriers that affect internetworking and lead to prevent e-GISI, this driving force is required for information sharing to open new channels for e-service delivery. According to Sulehat and Taib (2016), electronic readiness and communication among stakeholders considered as the most components related to ICT infrastructure that affect interoperability.
- **Security and Privacy (SAP):** security considered as one of the main significant technological challenges for e-GISI stability and considered as avery important factor for availability of e-service. Moreover, privacy is a significant challenge for the implementation of e-GISI projects, it concerns information sharing among government stakeholders and exposing private information (Majdalawi, Almarabeh, Mohammad, & Quteshate, 2015).

Semantic Factors and e-GISI

Many researchers in the field of interoperability figured that semantic factors have significant impact on the e-GIS, these factors such as IFQ and STD affect in a positive way e-GISI (De Angelis, 2009; Klischewski

& Scholl, 2006; Petter, DeLone, & McLean, 2008; Saekow & Boonmee, 2010). Based on the above explanations, it is hypothesized that:

H1: There is positive relationship between semantic factors and e-Government IS interoperability.

H1a:There is positive relationship between information quality and e-Government IS interoperability.

H1b:There is positive relationship between standards and e-Government IS interoperability.

Technical Factors and e-GISI

Another issues based on the literature in the field of interoperability are the technical factors, these factors such as ITI and SAP affect in a positive way e-GISI (Bhatt, Grover, & Grover, 2005; Guedria, 2012; Staden & Mbale, 2012). Based on the above clarification, it is hypothesized that:

H2: There is positive relationship between Technical factors and e-Government IS interoperability.

H2a:There is positive relationship between IT infrastructure and e-Government IS interoperability.

H2b:There is positive relationship between security, privacy and e-Government IS interoperability.

IT Capability as a Moderator

IT capability through IT knowledge sharing and IT operations has a great influence in public sector. IT capability can play a great role as a moderator between both semantic and technical factors on one hand and organization performance on the other hand (Ringim, Razalli, & Hasnan, 2012; Wunnava & Ellis, 2009). In this study IT capability moderators the relationship between semantic and technical factors and the e-GISI through its two attributes IT Knowledge and IT operations which are explained as follows:

IT Knowledge

The first attribute of IT capability is IT knowledge, which is defined as a combination or group of principles and techniques that are helpful to concentrate the organization's resources towards the required objectives (Ringim *et al.,* 2012). Moreover, based on Sanchez (2004), knowledge is categorized into two kinds the tacit and explicit knowledge, which are used for problems solving to achieve the required goals of the organization.

IT Operation

The second part of IT capability is IT operation which is defined as utilizing the IT to enhance the smooth functioning of the IT infrastructure through the management of capacity and availability of the information systems environment in order to enhance the e-service delivery (Zahari, 2015).

Subsequently, the following hypotheses are stated below:

H3: IT capability moderates the relationship between semantic factors and e-Government IS interoperability.

H3a:IT capability moderates the relationship between information quality and e-Government IS interoperability.

H3b:IT capability moderates the relationship between standards and e-Government IS interoperability.

H4: IT capability moderates the relationship between technical factors and e-Government IS interoperability.

H4a:IT capability moderates the relationship between IT infrastructure and e-Government IS interoperability.

H4b:IT capability moderates the relationship between security, privacy and e-Government IS interoperability.

Conceptual Framework

Semantic, technical factors and IT capability appear to be prime interests that enhance e-GISI in any organization. Thus, from the previous discussion the conceptual framework is proposed in figure 1.

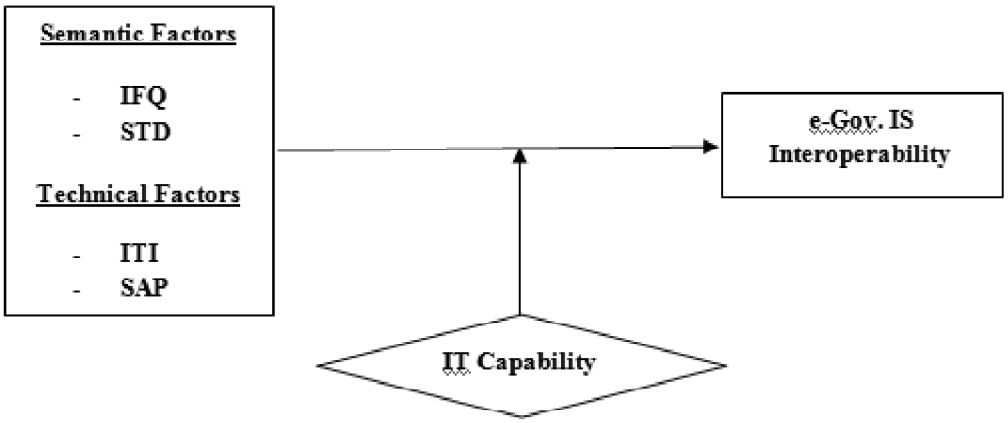

Figure 1: Conceptual Framework

METHODOLOGY AND ANALYSIS

This section covers the methodology and the data analysis that was used to reach the paper objective. Firstly, a brief about the study respondents were presented; secondly, the measurement tools that were used for examining the conceptual framework and the tools that were used for data analysis also introduced; finally, an evaluation of the study model for both measurements model and structural model were explained.

Respondents of the Study

The data was collected from IT directorates which are located in 25 ministries during the period from the beginning of Dec. 2016 till the end of Feb. 2017, which covers all ministries in the Jordanian capital. A total of 335 questionnaires were distributed; and the returned questionnaires were just 244. Thus, the response rate for the returned questionnaires was 73%. However, out of the 244 responses obtained, only 231 were used for further analysis, making a valid response rate of 69% (Yehuda, 1999). Based on Babbie (1990), in social sciences studies, 50% is considered an acceptable response rate, while at least 60% is classified as good response rate and a response rate of 70% or more is classified as very good.

The analysis showed that there were a large number of employees with a bachelor's degree of 76.2%, followed by masters 14.3%, diploma 7.8%, while just 1.7% represented employees with a high school diploma, in contrast, none of the respondents hold a doctorate degree. The other results of this study showed that most of the respondents were working without any supervisory positions at 68.8%, while 22.1% and 7.8% only for the head of department and director of the directorate, respectively; moreover, only 1.3% represent temporary contracts or work within specific project. Furthermore, the results revealed an almost equal proportion of 24.2 and 26 respondents with experience between 6-10 and 11-15, respectively. The highest proportion of respondents with 33.8 has experience of more than 15 years while only 16% employees work up to 5 years. The results also expose that the middle-aged respondents were 58% and 26% among 41 and 50, while the lowest percentage was very close 7.4% and 8.7% for employees under the

age of 30 and over 50 respectively. The last demographic finding revealed a low percentage of females representing 39.4% and 60.6% of male employees in IT directorates in ministries, although there was an equal ratio between females and males in Jordan.

Measurements

Likert's scale five-point was used in all measures, therefore 1 represents 'strongly disagree', 2 represents 'disagree', 3 represents 'neutral', 4 represents 'agree', and 5 represents 'strongly agree' (Likert, 1932). Firstly, the semantic factor was measured by two dimensions: IFQ and STD. The IFQ factor was measured by six questions, while STD was measured by three questions; meanwhile, technical factor was also measured by two factors ITI and SAP four questions for each factor was placed to measure the technical factor. Secondly, the moderator IT capability was measured by four questions. Finally, e-GISI was measured by nine questions.

Analysis of Data

IBM SPSS 22 statistics tools were used for nominal data analysis; meanwhile for ordinal data analysis smart PLS 3.0 software package was applied (Sarstedt, Ringle, Smith, Reams, & Hair, 2014). Based on Hair and Hult (2016), analyze of the measurement model and structural model was performed to test all the model's hypotheses.

Measurement Model

According to Hair *et al.* (2013), evaluation of the measurement model is counted as the main phase in PLS-SEM analysis because it asserts the constructs' reliability and validity. Based on Henseler, Ringle, and Sinkovics (2009), the measurement model can be examined by the values of composite reliability (CR), discriminant validity, and convergent validity. Moreover, cross loadings and outer loadings were used to examine the reliability of the indicators. Therefore, internal consistency reliability has been evaluated by testing CR.

Cronbach's alpha values located among 0.6 and 0.7 were considered as accepted values; meanwhile values located within 0.7 and 0.9 were treated as more rational, on the other hand CR does not require an equal indicator loading of construct (Henseler *et al.,* 2009). In this study, the Cronbach's alpha values located between 0.75 to 0.93 and CR values range within 0.86 to 0.95 for all the model's constructs as shown in Table 1 and figure 2, these results are in consistent with the recommendations of Hair et al. (2013) and Henseler *et al. (*2009).

In this study, checking the values of AVE was used to examine the convergent validity. Based on Sarstedt et al. (2014), convergent validity is defined as the degree of agreement that occurred among various constructs which are used to measure particular concept. Moreover, the values of AVE are acceptable if its results counted over 0.50 (Henseler et al., 2009). As seen in Table 1 all constructs' AVE exceeds the required value of 0.50, from this table it is shown that the convergent validity is established because the AVE values located within 0.53 and 0.76.

The last measurement in evaluation the model reliability and validity was done by examining the discriminant validity. According to Hair and Hult (2016), the discriminant validity is examined by comparing the relationship among correlations between each construct and their square root of AVEs. For the purpose of this study, discriminant validity was tested using the criterion of Fornell and Larcker's (1981) as seen in Table 2.

Table 1
Results of Constructs Measurement

Construct	*Cronbach's Alpha*	*Composite Reliability*	*Average Variance Extracted (AVE)*
IFQ	.93	.95	.74
STD	.75	.86	.66
ITI	.81	.88	.64
SAP	.89	.93	.76
ITC	.81	.88	.64
e-GISI	.89	.91	.53

Note: IFQ=Information Quality, STD= Standards, ITI=Information Technology Infrastructure, SAP= Security and Privacy, ITC= Information Technology Capability, e-GISI= Electronic Government Information Systems Interoperability.

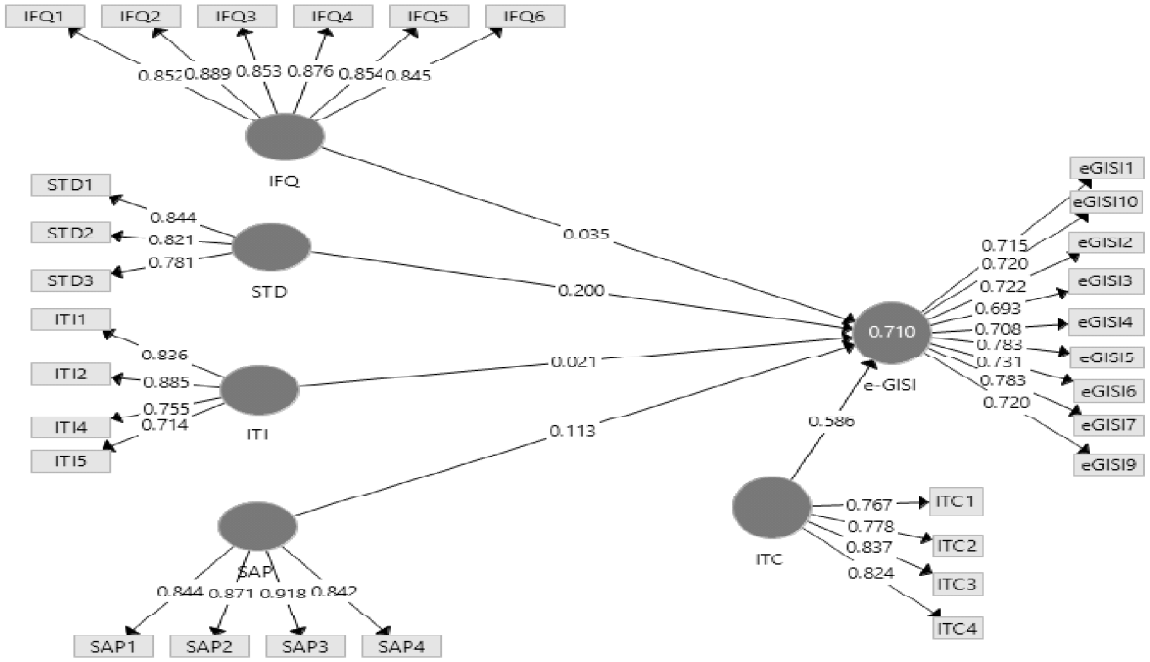

Figure 2: Measurement Model

Table 2
Discriminant Validity

Construct	*IFQ*	*ITC*	*ITI*	*SAP*	*STD*	*e-GISI*
IFQ	.86					
ITC	.66	**.81**				
ITI	.63	.62	**.80**			
SAP	.53	.63	.72	**.87**		
STD	.59	.61	.62	.54	**.82**	
e-GISI	.61	.80	.61	.62	.65	**.73**

Structural Model

After the measurement model evaluation the second step was to assess the structural model. Based on the recommendations of Hair and Hult (2016), an assessment of the structural model direct relationship among both constructs the exogenous and endogenous was done through the value of path coefficient, standard error, t-values, and p-values. According to Ringle *et al.* (2014), the bootstrapping procedure that is used in Smart PLS 3.0 software was carried out to test the direct and moderating effect models.

Direct Relationships

Based on the results of the PLS testing, table 3 presents the outcomes of the hypotheses' direct relationship for both the semantic and technical factors as the proposed hypotheses below:

H1: There is positive relationship between semantic factors and e-Government IS interoperability.

H2: There is positive relationship between technical factors and e-Government IS interoperability.

The result reveals that two of the exogenous constructs have a positive influence with the endogenous construct, at the same time two exogenous variables do not have positive influence with the endogenous variable. Based on H1a hypothesis, there is no positive influence of IFQ on e-GISI (β.035; t=.485; p>.1); consequently, H1a is not supported. Meanwhile, H1b is supported as the result shows there is a positive impact of STD on e-GISI (β.200; t=3.190; p<.01). Yet H2a, does not show any positive influence of ITI on e-GISI (β.021; t=.362; p>.1); thus H2a is not supported. On the opposite H2b, shows positive influence of SAP on e-GISI (β.113; t=2.011; p<.05); consequently, H2b is supported. Thus, H1 and H2 are partially supported.

Table 3
Results of Hypotheses Testing for Semantic and Technical Factors (Direct Relationships)

Hypotheses/Path		*Path Coefficient*	*Standard Deviation*	*T Statistics*	*P Values*	*Decision*
H1a	IFQ -> e-GISI	.035	.071	.485	.628	Not supported
H1b	STD -> e-GISI	.200***	.063	3.190	.002	Supported
H2a	ITI -> e-GISI	.021	.058	.362	.718	Not Supported
H2b	SAP -> e-GISI	.113**	.056	2.011	.045	Supported

*:p<0.l; **:p<0.05; ***:p<0.0l

Moderation test

The moderating effects of IT capability on the relationship between semantic factors: IFQ and STD, technical factors: ITI and SAP, and the endogenous construct e-GISI were examined and reported. Table 4 shows the results of indirect relationship between semantic, technical factors and e-GISI via the interaction of the moderator IT capability as the main hypotheses proposed below:

H3: IT capability moderates the relationship between semantic factors and e-Government IS interoperability.

H4: IT capability moderates the relationship between technical factors and e-Government IS interoperability.

Table 4
Results of Hypotheses Testing for Semantic and Technical Factors (Indirect Relationships)

Hypotheses/Path		*Path Coefficient*	*St. Deviation*	*T Statistics*	*P Values*	*Decision*
H3a	IFQ * ITC -> e-GISI	.107	.125	.857	.392	Not supported
H3b	STD * ITC -> e-GISI	.072	.124	.578	.563	Not supported
H4a	ITI * ITC -> e-GISI	.057	.088	.653	.514	Not supported
H4b	SAP * ITC -> e-GISI	.003	.073	.048	.962	Not supported

*:p<0.l; **:p<0.05; ***:p<0.0l

From the table above, the hypothesis H3a is not supported; consequently IFQ*IT capability is not significant (β.107; t=.857; p>.1). Similarly, there is no positive effect of the STD*IT capability (β.072; t=.578; p>.1); thus, H3b is not supported. Moreover, H4a is not supported; as there is no positive influence of the ITI*IT capability interaction (â.057; t=.653; p>.1). Further, the result reveals no positive impact of the SAP*IT capability (â.003; t=.048; p>.1); so, H4b is not supported. Consequently, both H3 and H4 are not supported.

RESULTS AND DISCUSSION

e-GISI is one of the key core issues facing heterogeneous information systems because of the need to obtain information from various institutions and departments that are connected to the provision of electronic services. Thus, in order to enhance interoperability, different organizations should focus on semantic and technical factors, which are from the main key issues leading to e-GISI success. The results of this study reinforce previous studies, with the exception of the findings related to IFQ and ITI. The results are not hypothesized with respect to IFQ and ITI. Thus, there is no significant relationship of IFQ and ITI on e-GISI. Unexpectedly, the current results found that the IFQ is not a factor that can affect e-GISI; this result is not consistent with previous studies that found relationship between IFQ and e-GISI (Al-Mamary *et al.,* 2014; Bajwa & Rai, 1994; Kamal, Themistocleous, & Morabito, 2009; Khanh, Trong, & Gim, 2014; Sohimi & Abbas, 2011). This is due to the perception among IT staff that the government has the right information in its databases. Other results of this study showed that there was no statistically significant relationship between ITI and e-GISI. This result is a bit inconsistent with previous studies that found relationship between the ITI and the e-GISI (Goldkuhl, 2008; Guedria, 2012; Kubicek, 2008; Kubicek & Cimander, 2009; Tarabanis, 2006; Ndou, 2004). However, the interpretation of this inconsistent result may be reasonable because of the prevailing perception among IT staff that government institutions have the infrastructure, which may be limited to technical equipment such as servers and the secure government network that was built among these institutions.

On the contrary, the result from this study revealed that STD and SAP were positively influence e-GISI. This finding supports prior related studies conducted by Paul and Paul (2012), Hellman (2010), Kamal *et al.* (2009), and De Angelis (2009). STD is the important factor to facilitate business to improve e-GISI. Moreover, SAP also considered from the important factors that has effect on e-GISI.

Unexpectedly, the results showed that H3 and H4 were completely rejected. IT capability has not significantly mitigated the relationship between semantic, technical factors and e-GISI. However, this inconsistency is reasonable due to Jordanian ministries still suffering in the culture of IT capability in both IT knowledge sharing and IT operations enhancing. In theory, a review of literature showed that there is a lack of studies that have tested the IT capability as a moderator to e-GISI. Therefore, if there are studies that examine the IT capability as a moderator, they relate only to the performance of the organization (Liu, Lu, & Hu, 2008; Mazidi, Amini, & Latifi, 2014; Ringim *et al.,* 2012; Wunnava & Ellis, 2009). A further result of this study showed that out of 25 ministry that was surveyed it was found that 8 ministries have an average level of e-GISI, 15 of the ministries are at the lowest level of e-GISI, while just two ministries are at the top level of e-GISI.

CONCLUSION

In conclusion, semantic and technical factors should be managed well for reinforcing e-GISI, which reveals that Jordanian ministries must work together to enhance the semantic and technical dimensions. This study, examines empirically the role of IT capability as its moderating relationship between semantic and technical factors from one side and the e-GISI on the other side within Jordanian ministries. From the findings it concluded that STD as a semantic factor was found significantly impact e-GISI in a positive way. Unexpectedly, the findings revealed that IFQ is not a semantic factor that could significantly influence e-GISI. Further, the SAP as a technical factor was found significantly influence e-GISI in a positive way. In contrary ITI did not influence e-GISI in a positive way. Furthermore, the current study did not support the moderating role of IT capability between both constructs semantic and technical factors and the construct e-GISI. Subsequently, the interaction between public sector institutions requires more emphasis on interoperability of their information systems to strengthen their e-GISI among them and this can be done by transferring the semantic and technical factors discussed earlier from barriers to success factors. In addition, Jordan has the infrastructure to enhance interoperability between ministries, but there are still many forces that prevent information systems from fully interoperating within government entities, and these forces should be eliminated through convergence of vision among government institutions.

Limitations of this study can open further studies in this area. In subsequent studies, other technical and semantic factors can be investigated to measure their impact on the interoperability of e-government. This study can make a real contribution to the real direction in planning interoperability between public organizations. In addition, the present study will benefit both practitioners and researchers in ways to enhance interoperability in the public sector. The literature research reveals limited empirical studies on interoperability issues among Jordanian public sector.

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