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Value Characteristics of Cloud Computing and Big Data Attributes

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Abstract
This study attempted to investigate and explore the nature of relations between cloud computing value characteristics and big data attributes. The telecommunication industry was chosen as the research population and the study sample covered the main leading telecommunication companies in Jordan. The study investigated number of the proposed value characteristics of cloud computing and the 3Vs attributes of big data as described by the main stream of IT literature on the subject matter, and the possible impact relationship. The study adopted structural equation modeling and PLS bootstrapping techniques to test and validated the hypothesised model of the study. The results showed and strong significant causal effect between the two measurement models; cloud computing and big data. The results also revels interesting insights on the possible structure of the study factors.
Keywords: Cloud computing characteristics, big data attributes, confirmatory factor analysis, PLS Methods

1.0 Introduction
The presence of techniques and tools are becoming very imperative to cope and adapt to the everlasting changes and technological developments in various fields, and more precisely in the field of information technology as rapid continues changes occur. This demands a readiness of a capable and effective tools to adapt to these changes. Cloud Computing (CC) has emerged as one of the most important tools and services in response to these changes. CC received considerable attention by scientists and institutions, it had become a revolution in the world of technology, CC is a trend reveals a new generation used to achieve the requirements and needs of individuals and organizations. CC is a term refers to set of integrated services, techniques, applications and systems that serve the customer remotely without a necessarily need of local resources, with attractive characteristics which make it desirable and acceptable such as resource pooling, Broad network access, Virtualization, security, Rapid elasticity, scalability, and on-demand service. Cloud computing is non-separate concept, as it is applicable with several technologies, this research will attempt to investigate the nature of relationship between CC and big data concept.

2.0 Cloud Computing
Cloud Computing (CC) as indicated by Qusay (2011) as an approach by which we can access to a public and joined group of configurable and settable computing resources in a clear and on-demand way. CC is considered as one of the most important technologies initiatives in business computing today (Hurwitz et. al., 2010). CC refers to both the applications delivered as services over the Internet and the hardware and systems software in the data centers that provide those services. The services as mentioned by Armbrust, et al., (2010) are: Software, Infrastructure and Platform as a Service (SaaS IaaS, PaaS,). Jones (2009) also indicated that CC is simply the reallocation of storage and computing activities outside the organisation into the cloud, where the user define the needs of the computing resources, then cloud computing service provider compile these requests and submit them to the customer. Chihoub (2013) indicated that cloud computing customers can identify their requirements in terms of assets, performance, availability, etc., and pay only for the service provided. Reflecting on the previously mentioned contributions and based on the researchers' observation and analysis of the essence of cloud computing, CC can be seen as a set of integrated services, practices, techniques, systems, and applications that serve the customer remotely without the needs of local resources, with attractive characteristics that makes it desirable and acceptable such as shared resource pooling, broad network access, virtualization, security, elasticity, scalability, and on-demand service.

2.1 Architecture of Cloud Computing:
Jones (2009) aserted that CC it consists of more than one service, where the possible services provided by the cloud computing are as follows:
2.1.1 Software-as-a-Service (SaaS):
The SaaS can be referred to as a procedure with the Application Service Provider (ASP) give distinctive applications on the Internet. This empowers the clients drop establishment and utilizations the application on a

PC and furthermore evacuates an enormous weight for the upkeep of programming; further utilize, assurance and help (Nazir, 2012). Jones (2009) defines Software-as-a-Service (SaaS) as a model of conveying programming from an incorporated framework to keep running on a neighborhood PC or on the cloud. Software as a service enables you to rent an application and pay just for the time utilized. SaaS is the capacity to get to programming over the Internet as an administration. SaaS is the highest elevated amount in the negotiation of administration layers. The product administrations are facilitated on the framework of the cloud supplier, and are conveyed over a system. The advancement of the computing tools and the high transfer rate, it is feasible for customers to run applications and programming over the Internet as they feel appropriate in term of time and space.

2.1.2 Platform-as-a-Service (PaaS)

Is portrayed as a whole virtualized platform that incorporates at least one server (virtualized over the arrangement of physical servers), working frameworks, and particular. Sometimes, these stages can be predefined and chosen; in others, you can give a VM picture that contains all the fundamental client particular applications (Jones, 2009). Nazir (2012) said that the platform as a service (PaaS) offers a comprehensive infrastructure for the usage of the testing of system applications. Platform as a Service (PaaS) is sort of services incorporates giving a processing stage, notwithstanding the verifiable foundation that has the stage assets. Clients depend on the stage to make as well as run their applications. PaaS has been picking up popularity as of late (Chihoub, 2013).

2.1.3 Infrastructure as a Service (IaaS)

Generally, the use of parts of the Infrastructure Cloud information but controlled by the operating systems and storage applications. The service provider is the organs responsible for the apartment, management and maintenance. If Customer granting the administration after use (Nazir, 2012). Chihoub (2013) stated that IaaS customer's contract out the foundation and the hardware that are vital for their stage and application measures. Customers can simply lease on-request the virtual machines, and the capability assets they need. The CC supplier has, oversees, and keeps up pools of foundation gear including capacity, registering servers, organizing, and other equipment segments.

2.2 Cloud Computing Characteristics

There are several characteristics of cloud computing which make it attractive to be adopted, as following:

2.2.1. Shared resource pooling and Multi-tenancy

The infrastructure provider recommend a set of processing resources that can be gradually doled out to many asset purchasers. Such distinctive asset task capability gives much flexibility to basis suppliers for dealing with their own accurate asset application and working expenses (Zhang, et al., 2010). It is also Sharing of "resources and costs" among large group of users allows efficient utilization of the infrastructure (Jadeja & Modi, 2012). Cloud organization providers pool their assets that are then conferred by various customers. This is implied as multi-residency where, for example, a physical server may have a couple of virtual machines having a place with unmistakable customers (Puthal, et al., 2015). Resource pooling allows combining resources of computing (e.g. hardware, software, processing, network bandwidth) to provide various consumers (Mahmood, 2011). It is also the provider's computing resources are pooled to serve various clients using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to demand of consumer (Mell & Grance, 2011). Durkee (2010) indicated that resource pooling as to CC services permit customers layers infrastructure participation, in order to save the consumption of the size of the network. In a cloud setting, services claimed by several providers are co-exist in a solitary server farm.

2.2.2 Broad network access

Clouds are generally accessible through the Internet and use the Internet as a service delivery network. Hence any device with Internet connectivity, be it a mobile phone, a PDA or a laptop, is able to access cloud services (Zhang, et al., 2010). Broad network access identifies the aptitudes that are offered over the network and retrieved over a typical tools that stimulate use by diverse thick and/or thin client platforms such as Cell phones, PDAs, tablets, and laptops (Mell & Grance, 2011). The framework which is by and large given by an outsider is gotten to with the assistance of web (Jadeja & Modi, 2012). Broad network access indicates that resources could be gotten by using many devices that have access to internet for example, laptops or mobiles telephones (Puthal, et al, 2015). It means that users can always access cloud computing services whenever they have an access on internet (Bhardwaj, et al., 2010)

2.2.3 Virtualization

Cloud assets are frequently virtualized as a service over the Internet. Up to the present, many distributed computing frameworks comprise of server farms. Server farm utilizes virtualization advances which theoretical the ordinariness of foundation in various levels (Gong, et al., 2010). Virtualization is to utilize equipment or programming to make the perception of things. Server has their own specific CPU that is appropriate for running particular a particular working framework (Puthal, et al., 2015). Virtualization is a critical empowering innovation that digests framework and assets to be made accessible to customers as segregated VMs (Takabi &

Joshi, 2010).

2.2.4 Security

Security is one of the most critical characteristics of cloud computing that make clients adopt this technique to perform their transactions (Zhang, et al., 2010). High security of cloud computing is accomplished for the most part through three ways. Firstly; the free coupling makes cloud computing framework run well when some portion of it is demolished. Second, the deliberation, virtualization and privation of cloud supplier abstain from uncovering the points of interest of relating usage. Third, innovation participating with law is the watch of distributed computing (Gong, et al., 2010).

2.2.5 Scalability and elasticity

As indicated by Alkhaldi and Qararah (2016) asserted that cloud computing will support and offer a high range of scalability and elasticity for end users and organizations where scalability means that performance can be monitor and thus it is scalable (Jadeja & Modi, 2012). Rapid elasticity and scalability allows functionalities and resources to be rapidly and automatically provisioned and scaled (Mahmood, 2011). Users swiftly can increase resources from cloud by reducing out and roll back by discharging those resources once they are no more needed (Puthal, et al., 2015). Rapid elasticity and scalability allows functionalities and resources to be rapidly and automatically provisioned and scaled (Mahmood, 2011). Rapid elasticity is cloud computing capability to increase and decrease the capacity according to customer demand (Bhardwaj et. Al., 2010). Elasticity indicates that Computing is provided in the amount required and disposed of when no longer needed (Durkee, 2010).

2.2.6 On-demand Service oriented

On-demand self-service (ODSS) enables users to consume computing capabilities (e.g. applications, server time, and network storage) as and when required (Mahmood, 2011). On-demand access: Cloud computing offers fast accomplishment of demand for computing and has the continuing ability to accomplish that demand as required (Durkee, 2010). ODSS shows that buyer can independently run and govern the selected computing capabilities, such as network storage and server time, as autonomously as needed without calling for any human interaction with every single service supplier (Mell & Grance, 2011). The service oriented concept is like but more practical than SOA (Service-Oriented Architecture) in grid computing. Abstraction and accessibility are main keys to achieve the service oriented conception. Through virtualization and other technologies, the underlying architecture is abstracted without exposing much to user (Gong, et al., 2010).

In order to assess the most important characteristics of cloud computing, the researchers reviewed previous relevant studies to this area and selected the most important characteristics as mentioned in these studies, and accordingly, the following table shows the most mentioned characteristics; Shared Resource pooling, Broad network access, On-demand service oriented, Virtualization, Security, Scalability and elasticity.

Table 1. Cloud computing characteristics as reported by related studies.

Characteristics	**References**
Shared Resource pooling	Zhang , et al., (2010); Jadeja & Modi (2012); Puthal, et al. (2015); Mahmood (2011); Mell & Grance (2011); (Bhardwaj, Jain, & Jain, 2010); (Durkee, 2010) Takabi & Joshi 2010; (Bezemer & Zaidman, 2010).”
Network access	Zhang , et al., (2010); Jadeja & Modi (2012); Puthal, et al. (2015); Bhardwaj, et al. (2010); Mell & Grance (2011)
On demand service oriented	Zhang , et al., (2010); Gong & et al., (2010); Puthal, et al. (2015); Mahmood (2011); Bhardwaj, et al. (2010); Mell & Grance (2011); (Durkee, 2010); Takabi & Joshi (2010);
Virtualization	Gong & et al., (2010); Puthal, et al. (2015); Takabi & Joshi (2010);
Security	Zhang , et al., (2010); Gong & et al., (2010); (Jadeja & Modi, 2012).
Scalability and elasticity	Jadeja & Modi (2012); Puthal, et al. (2015); Mahmood (2011);

3.0 Big Data

The notion of big data (BD) is used to point to the growth of data in the volume that poses a challenge to store, prepare, and segmented via traditional database technologies. The term "enormous information" is moderately new in information management (Abaker, et al., 2014). Big data is more than the developing hesitance of gatherings, yet that development creates regarding different parts of information handling. The model of "3v's" is included in the idea of huge information. The information propose that extensive gatherings of size, or fast presentation substantial determination (Chihoub, 2013). Abaker, et al. (2014) indicated that BD is a principles of techniques and technologies that necessitate a new practices of integration to reveal the enormous anticipated value from huge data sets that are diverse, complex, and of a massive scale. Data is not only becoming more available but also more understandable to computers. Katal, et al., (2013) asserted that BD is seen as a huge sum of data that demands a new form of architectures as well as technologies, so that it possible to extract values from it. BD phenomenon refers to the practice of collection and processing of very large data sets and associated systems and algorithms used to analyze these massive datasets (Begoli & Horey, 2012).

3.1 Big Data Attributes

3.1.1 Volume

Volume focuses on the quantity of data (Brauna, et al., 2016). it refers to a broad range of ever expanding data created from a numerous sources. Volume is related to the creation and augmenting of masses of data, where data scale becomes progressively huge (Chen, et al., 2014). Many example on the how about of the expansion of data and inforamtion masses can be seen in as in interpersonal communication creating information all together of terabytes as this measure of information is conclusively challenging to be dealt with via the current orthodox frameworks (Katal, et al., 2013).

3.1.2 Velocity

Velocity denotes to the speed of data exchange, for many systems, the speed of data creation is significantly more imperative than the volume. Continues stream of data in and out of leads to a more flexible organization than its rivals (McAfee & Brynjolfsson, 2012). Velocity denotes to the convenience of huge data, particularly; data gathering and investigation must be swiftly and convenient performed, so that to excellently use the business estimation of enormous data (Chen, et al., 2014). As far as BD is in concerrn, velocity oversees the speed of the data which has been initiated from different sources, but is view only limited velocity to the speediness of imminent data at which it streams (Katal, et al., 2013).

3.1.3 Variety

A significant number of the most critical wellsprings of enormous data are generally new, where data appears as messages, updates, and pictures presented on interpersonal organizations; readings from sensors; GPS signals from PDAs, and that's only the tip of the iceberg. The massive measures of data from informal organizations (McAfee & Brynjolfsson, 2012). Many resrachers such as (Chen, et al., 2014; Abaker, et al., 2014 and Katal, et al., 2013; and Brauna, et al., 2016) all indicated that variety demonstrates the different sorts of data, which incorporate various forms of data structures, it refers to the distinct categories of data grouped by means of various technological tools such as cell phones, sensor, etc..,. Such data incorporates vaious structure like picture, content, sound, and video, in any structured or unstructured format. The following table summarizes several reference studies of 3Vs attributes and consensus as the most mentioned attributes.

Table 2. Big data attributes reported by previous studies.

Attribute	Reference
Volume	(Abaker, et al., 2014); (Brauna, et al., 2016); (Chen, et al., 2014); (Katal,et al., 2013); (McAfee & Brynjolfsson, 2012).
Velocity	(Abaker, et al., 2014); (Brauna, et al., 2016); (Chen, et al., 2014); (Katal, et al., 2013); (McAfee & Brynjolfsson, 2012).
Varity	(Abaker, et al., 2014); (Brauna, et al., 2016); (Chen, et al., 2014); (Katal, et al., 2013); (McAfee & Brynjolfsson, 2012).

4.0 Research Model

Based on the above discussion a conceptual model was developed, to investigate the possible relation between the cloud computing value characteristics and big data attributes the variables of the proposed research model are listed in table 1 and 2. It is hypothesised that all cloud computing value characteristics variables and big data attributes variables should have an explanatory power and each load significantly on it latent factor. As an explanatory study it was decided that no hypotheses should be claimed in this study as to the nature and the strength of impact from cloud computing value characteristics on big data attributes, as it was left to be revealed as results of the investigative part of this research.

To accomplish the objectives of this study, a quantitative approach was adopted. Attributes representing the cloud computing value characteristics were developed from a wide review of literature as described in pervious sections. All items were analyzed based on a score of the extent of agreement and it was assessed on a 5 point Likert-t scale. Prior to the distributions of the final version of the questionnaire, pre-testing stages and a pilot work for validating the survey instrument were performed. The questionnaire was administrated largely to various level of managers. Validity measures was established via extensive subject matter expert review, and the use of various indexes see table 4.

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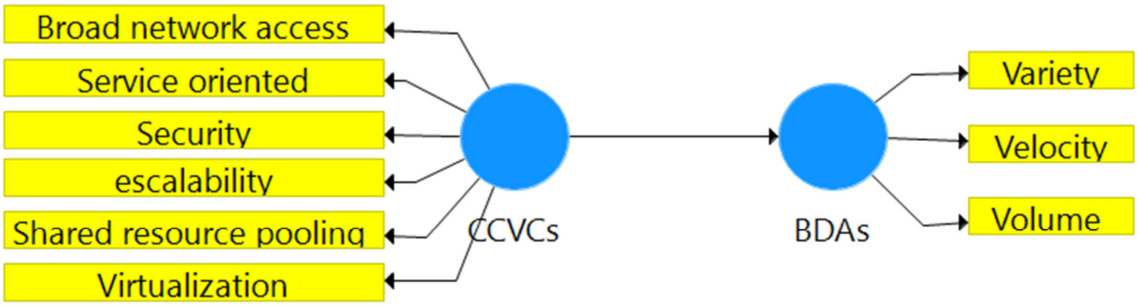

Figure 1. The Hypothesised Model of Cloud Computing and Big Data

5.0 Research Methods

Data were collected from the three major Jordanian telecommunication companies were distributed to a total of 100 respondents, of which 88 was deemed valid and thus were utilized. Internal consistency was established using two leading indicators; Cronbach's alpha and rho_A, where the results showed an accepted level on consistency as measures did meet the acceptable benchmark. As for validity, the average value extracted (AVE) and the composite reliability was adopted, and the results showed in table 4 reflects an acceptable level of validity. Along with the needed sample size, two basic assumptions was analysed to be met for factor analysis requirement: normality and correlation among variables. Skewness and kurtosis indicators were used to test the normality assumption, and it verified that all variables tested in this study were all normally distributed as all measures are within the acceptable range of less than 1, see table 3. The measure of sampling appropriateness "Kaiser–Meyer–Olkin" showed sufficient inter-item correlations within the data and thus deeded appropriate for performing factor analysis, see table 6.

Table 3. Descriptive statistics-normality test

	Mean	**Std. Deviation**	**Skewness**	**Kurtosis**
CCBNA	4.4716	.49918	-.593	-.703
CCSRP	4.2311	.51381	-.489	-.919
CCVIR	4.3371	.48343	-.252	-.585
CCESC	4.3636	.51264	-.735	.451
CCSO	4.3712	.46164	-.686	-.182
CCSEC	4.2803	.33481	.119	-.794
DBVOLOW	4.1250	.60291	-.096	-.855
DBVOLOP	4.3523	.55791	-.607	-.073
DBVAR	4.2841	.51427	-.977	.497
BDVEL	4.3438	.51040	-.707	.361

Table 4. Validity and reliability tests

	BDAs	CCVcs
Validity test measures		
AVE	0.42	0.41
Composite Reliability	0.71	0.72
Reliability test measures		
rho_A	0.62	0.52
Cronbach alfa	0.59	0.49

6.0 Data Analysis

6.1 Sample Characteristics

The average respondents' age fall between 36 and 35, with 48.6% ranges between 26 and 30, and 85% ranges between 26 and 35. For the respondent's level of education; the most frequent number of level of education is Bachelor's degree with 52% and the next frequent number is postgraduate degree with 43%. For gender 53% of sample was female.

6.2 Explanatory factory analysis

The proposed model was analyzed using explanatory factor analysis using SPSS. The results as displayed in table 3 showed an acceptable level of factor appropriateness as KMO in most case exceeded 0.50, while factor loading in both dimensions was above the acceptance criteria of 0.50 (see Hair et. al., 2010). The total variance explained (TVE) show a strong explanation power for all items ranging from 33% to 73%.

Table 6. Explanatory factor analysis results

Dimensions	Factors	KMO*	Loading Range	TVE**
CCVCs	CCBNA	0.500	0.836-0.972	70.41%
	CCSRP	0.564	0.505-0.786	47.83%
	CCVIR	0.432	0.616-0.907	56.47%
	CCESC	0.500	0,662-0.790	0.62.44%
	CCSO	0.500	0.853-.0856	73.87%
	CCSEC	0.500	0.712-0.712	51.98%
BDAs	DBVOL_OW	0.516	0.816-0.915	38.79% (71.89%)
	DBVOL_OP	0.516	0.713-0.973	33.09% (71.89%)
	DBVAR	0.638	0.740-0.821	59.41%
	BDVEL	0.620	0.600-0.825	55,26%

** Kaiser-Meyer-Olkin Measure of Sampling Adequacy. **Total variance explained*

6.3 Structural model analysis

Smart PLS 3.2.6 statistical software was used to test the hypothesised model. Using bootstrapping PLS methods to analyse the structural model, where three indicators were utilised beta, *T statistics and adjusted* R^2. The results suggested the removal of two factors from the cloud computing value characteristics hypothesised model (scalability and service oriented) as they fail to have any significant loading nor reasonable explanation power to the main dimension of CC, see figure 2, thus the decision was made to remove these two factors (CCESC, CCSO) and to revised the model as suggested by the test results shown in figures 2. The revised structural model were adjusted to reflect the previous suggested amendments and tested again using the same above techniques. The results as shown in figure 3 reflects an acceptable significate power of explaining the behaviour of the Cloud computing value characteristics measurement model, where security was the most significant effect with a value of 0.733 flowed by broad network access with significant value of 0.658 and virtualisation was the least effect value in the model as loading was 0.552. As for the big data measurement model, volume was the main contributor where it is seen as data ownership and as a results from data operations with significant loading score of 0.782 and 0.726. Variety comes second with a significant loading of 0.550, and finally velocity comes as the least factor to contribute to the understanding of the big data attributes. All *beta* value and *TTest* values are reported in the figure 2, and 3, as *TTest* value are seen in parenthesis, where the significate relationship must exceed the value of 1.96

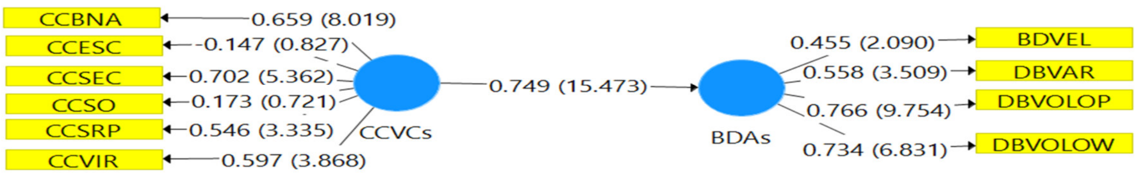

Figure 2. The Hypothesised Structural Model of Cloud Computing and Big Data

As for the total direct impact of could computing on big data, the structural relation as shown in the direct path of figure 3 a significate causal relationship as beta scores 0.740 with 0.588 coefficient of determination R^2. this means that any unit enhancement of the cloud computing value characteristics will increase the value attributes output of big data by 0.740 of a unit value, in simple term more enchased security will yield more volume, more velocity and more variety of data and this it also true for the remain cloud computing value characteristics.

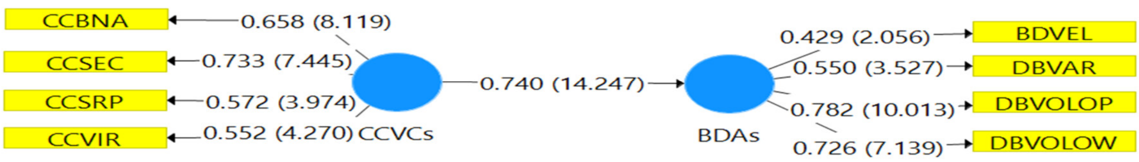

Figure 3. The Revised Structural Model of Cloud Computing and Big Data

7.0 Conclusion

This study attempted to investigate the nature of cloud computing value characteristics and big data attributes and the possible underlying effect and impact the study results relevels that only four out of six main characteristics can be accounted for in the possible structure of the cloud computing values; broad network access, security, shared resource pool, and virtually with security as the leading value. As to this finding telecommunication and similar filed companies and professionals should pay more attention to these value and investigate the activities that might add more value to and improve the robustness of the characteristics. As far as big data, this study validated the 3Vs attributes with the telecommunication industry, and highlighting volume as the main contributor to BD concepts. The study revels a significant impact of the proposed and validated cloud computing value characteristics on the big data attributes. This findings should draw more attention toward improving the outlook of such values as it can be employed to increase the yield and the production of data

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