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Development of Data Center Management Evaluation Guideline: Case Study of BPS-Statistics Indonesia

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Abstract: Data Center (DC) has important role due to its main function to support various IT services. To ensure that the DC operates properly, it is important to have a proper management of DC and therefore need to be evaluated. Since, there was no specific guideline in evaluating DC management, the goal of this research is to develop guideline for DC management evaluation by deriving from from the existing DC standards. This research is a qualitative research using two approaches: case study and action research. It begins with selecting management aspects from DC standards (ANSI/TIA-942 and ANSI/BICSI-002) which then classified by DC components. BPS-Statistics Indonesia is selected as the case study for this research. Current condition of the DC at BPS-Statistics Indonesia is observed and evaluated based on the developed guidelines which then followed by a set of recommendations. The result of this research is the evaluation guideline that can be used as a basis for evaluating DC management.

Key words: Evaluation, guidelines, data center management, ANSI/TIA-942, ANSI/BICSI-002

INTRODUCTION

Data Center (DC) is a space that contains server, storage, network and other equipment including facilities that support it such as electrical, mechanical and others. All of those components exist to support Information Technology (IT) services such as website, email, file transfer and other systems. Various IT services help organization doing their works.

Nowadays, more organizations are depending on IT services. A lot of work cannot be done effectively and efficiently without it. If the DC as an IT infrastructure fails to gives those services, it could disrupt the entire operation. Therefore, it is important to manage a DC properly to ensure its availability in supporting organization.

To know whether DC management works properly, it needs to be evaluated. Evaluation can be done by comparing to best practices or standards. Unfortunately, there was no particular standard on DC management as a guideline for evaluation. However, the guideline for evaluating DC management can be derived from the general DC standards such as ANSI/TIA-942 and ANSI/BICSI-002.

The study on evaluating DC management is performed at BPS-Statistics Indonesia (BPS). BPS is a government agency that has a duty on statistical activities in the form of censuses and surveys. In BPS, DC has an important role to support BPS' activities ranging from monitoring system for census and survey, processing system, dissemination system, integrated service system, to communication system. Moreover, DC also provides IT services such as: email, web hosting, file transfer, file sharing, internet, VPN, video conference, database, colocation server and VoIP. If there is any problem with the DC that cause malfunction of IS/IT services then it can be considered as a disaster and therefore, DC management in BPS need to be evaluated whether it has been managed properly. The goal if this research is to develop a guideline to evaluate the DC management.

Literature review

Management and IT infrastructure management: Management is designing, providing and maintaining internal environment conducive in tune with the opportunities and challenges of the external environment through planning, organizing, directing and controlling all resources and operations in order to achieve effective organizational strategies efficiently (Rao and Kumar, 2010). Management is the art of getting things done by a group of people with the effective utilization of available resources to achieve the objectives of an organization (Ramasamy, 2010). IT dependency makes management on IT infrastructure becomes important. Big challenges of IT infrastructure management are bridging the gap between

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the business and technology unit so that IT could become the business enabler (Applegate *et al*., 2009). From those theories, the DC management is a series of activities that cover planning/defining, organizing (coordination and operation), directing, controlling all resources and operating effectively and efficiently to achieve BPS's goals. In the management of a DC, facility management becomes important because it must be available 24/7 h. These theories become a basis to derive management aspects from DC standards.

Data Center (DC): The US environment protection agency defines DC as electronic equipment used for data processing (servers), data storage (storage equipment) and communications (network equipment) (Hwaiyu, 2015). DC is also a building where multiple servers and communication tools are colocated because of their common environmental requirements and physical security needs (Barroso *et al*., 2013).

Modern DC provides high availability that is managed by infrastructure manager (Applegate *et al*., 2007). DC physically provides area for web, application, database, server, storage, mainframe and network tools in a strong environment which allow all devices work properly (Applegate *et al*., 2007). DC also supplies electricity, internet connectivity and support various services (Applegate *et al*., 2007).

In BPS, DC is the building which has primary equipment such as server, storage, network and also support equipment such as power supply, cooling, security system to support various IT services. DC components are used as a basis to classify the management aspects derived from DC standards which then can be used as the evaluation guideline.

Data center standard: The DC standards used as the basis to derive management aspects for the evaluation guideline are TIA (2005) and ANSI/BICSI-002. ANSI/TIA 942 is a DC standard approved by Telecommunication Industry Association (TIA) which refers to American National Standards Institute (ANSI). The purpose of this standard is to provide requirement and guideline for the design and installation of DC or computer room. Even though this standard mostly explains about DC design, this study took some aspects that can be used to manage DC which are capability management, environmental control (temperature and humidity), cabling management (include administration) and others.

BICSI (2011) is a standard for DC design and implementation. This standard provides a reference of common terminology and design practice. This standard

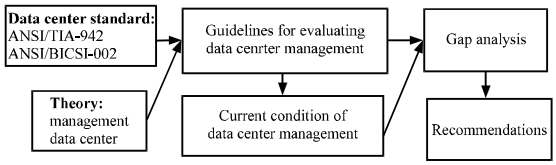

Fig. 1: Theoretical framework

is intended to be used by architects and engineers to determine design requirements with the DC owner, occupant or consultant. It is intended primarily for DC owners, DC operators, telecommunications consultants, IT consultants, project manager, telecommunication installers and IT installers. It is primarily design standard with installation requirements and guidelines related to implementing a design. It also includes other installation requirements and guidelines for DCs where appropriate.

Theoretical framework: From theories described above, the theoretical framework for this research can be seen in Fig. 1. Based on theories, DC standards that are related to DC management are selected and then classified based on DC components. The guideline will then be used to evaluate the current condition of DC management in BPS. Gap analysis is used to compare the current condition of DC in BPS to the guidelines. Finally, recommendations can be given to improve DC management in BPS.

MATERIALS AND METHODS

This research is qualitative research using combination of case study research and action research. The data about current condition is obtained from interviews and observation. Interviews are conducted to DC team including DC manager. Observation is done directly against DC and documents that are related to DC management. The steps to develop the guideline for evaluating DC management can be seen in Fig. 2.

First step is developing aspects of DC management that derived from DC standards by selecting the management aspects. Second step is grouping the management aspects that have similarity and then classify them based on DC components. Third step is validating the aspects of DC management. The validation is done by interviewing BPS's DC Team on each aspect by using questionnaire. Fourth step is evaluating current condition of DC management using the evaluation guideline from previous steps. The outputs of this step are current condition, obstacles encountered and recommendations.

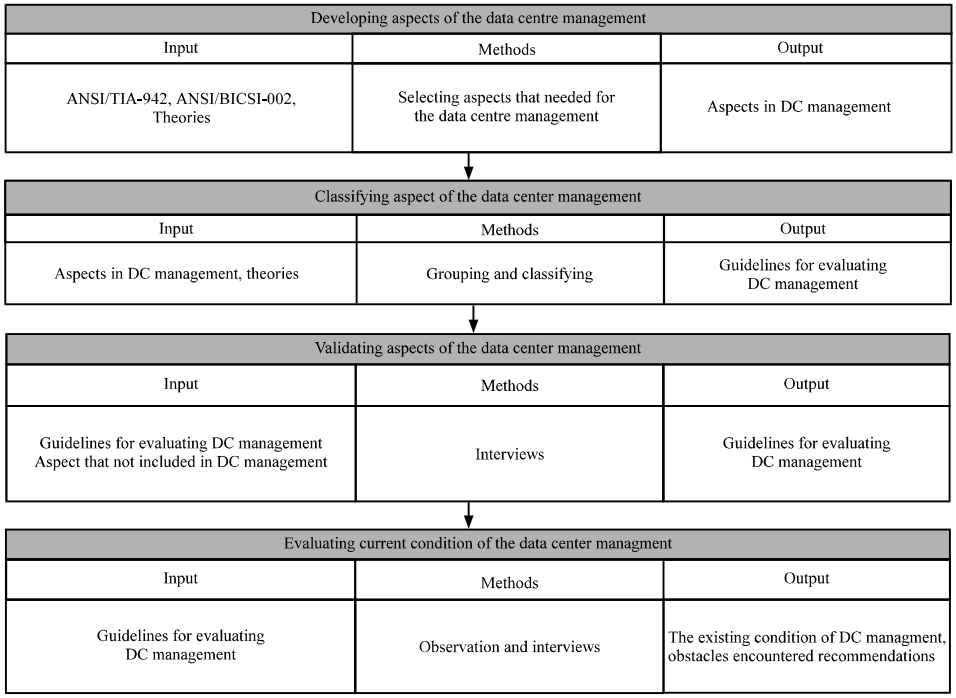

Fig. 2: Research methodology

RESULTS AND DISCUSSION

Developing aspects of the DC management: Aspects for DC management are selected from ANSI-TIA 942 and ANSI/BICSI-002. Management of DC means how to manage resources and operation of DC effectively and efficiently to achieve organization's needs and goals. In the standards, examples of management aspects are system availability, monitoring, maintenance and disaster recovery. There are also design related aspects that can be used for management aspects such as cable management, environment control (temperature and humidity), labelling and others. Table 1 shows examples of the management aspects as well as design aspects that also used for management. Table 2 and 3 show the examples of management aspects taken from ANSI/TIA-942 standard and ANSI/BICSI-002 standard, respectively. Complete management aspect from these standards are viewable on Hadiyanti (2016).

Classifying aspects of the DC management: The management aspects from both standards are then combined based on aspects. Furthermore, classification is made on each aspect to facilitate evaluation of the current condition. The classification is done based on the components of DC and management theory. Phases in DC management and DC components that need to be evaluated is shown in Fig. 3. Components of DC management in Fig. 3 cover:

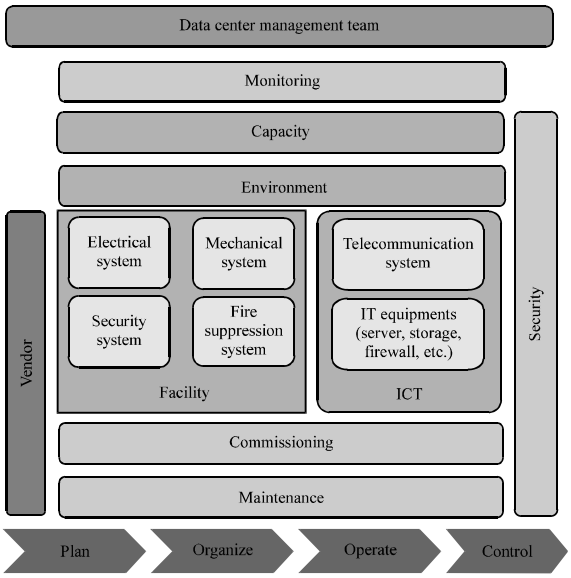

Fig. 3: Phases and components of DC management

- Facilities that support DC such as electrical system, mechanical (cooling) system, security (access) system and fire suppression system
- ICT (information and communication technology) infrastructure on DC include telecommunication system (switch, router, cabling, etc.) and IT equipment (server, storage, firewall, etc.)

Table 1: Example of selecting management aspects from data center standards

Standards	Content	Aspects
ANSI/TIA-9423. data center design overview	It is essential for either case that the design of the telecommunications cabling system, equipment floor plan, electrical plans,architectural plan, HVAC, security and lighting systems be coordinated	Can not be used as management aspect because it is related to the design of the DC
ANSI/TIA-9425.3 computer room requirements	Computer rooms should provide access to authorized personnel only	Management
ANSI/BICSI-0029.7 Automation and control	Without monitoring, operators are not able to respond to failures or to determine the loading or operation of their systems. Monitoring is mandatory for all classes with increasing levels of observation scope and granularity with increasing class	Management
ANSI/TIA-9425.3 computer room requirements	The temperature and humidity shall be controlled to provide continous operating ranges for temperature and humidity	Management (related to the design but it is needed to manage DC)

Table 2: Management Aspects from ANSI/TIA-942 (Partially) (Hadiyanti, 2016)

Standards	Content
5.3.3 access	Computer rooms should provide access to authorized personnel only
5.3.4.1 size	Sizing should include projected future as well as present requirements
5.3.4.8 signage	Signage, if used, should be developed with the security plan of the building
5.3.5.1 containments	The room shall be protected from containments in accordance with ANSI/TIA-569-B
5.3.5.2.1 continuous operation	
5.4.8.10.1 continous operation	HVAC shall be provided on a 24 h/day, 365 days/year basis
5.3.5.3 operational parameters	
5.4.8.11 operational parameters	The temperature and humidity shall be controlled to provide continous operating ranges for temperature and humidity; dry Bulb Temperature: 20°C (68°F) to 25°C (77°F); relative Humidity: 40-55%; max Dew Point: 21°C (69,8°F); max Rate of change: 5°C (9°F) per hour a positive pressure differential with respect to surrounding areas should be provided
5.3.6.2 standby power	
5.4.8.13 standby power	Any generators used should be rated for electronic loads
5.4.4 access	Access to the entrance room shall be controlled by the data center owner or their agent
5.4.8.2 size	Meet with all access provider to determine their initial and future space requirements
5.7 zone distribution area	There shall be no active equipment in the zone distribution area with the exception of DC powering equipment
7.2 security for data center cabling	Any maintenance holes on building property or under control of the data center owner should be locked and monitored by the data center security system using a camera, remote alarm or both.Entrance to utility tunnels used for telecommunications entrance rooms and other data center cabling should be locked

Table 3: Management aspects from ANSI/BICSI-002 (Partially) (Hadiyanti, 2016)

Standards	Content
5.2.3 generator power	The minimum amount of generator fuel storage required should be between 8 and 96 h running at full load depending on the data center availability requirements. Depending on specific owner needs, the amount of fuel storage required may be far >4 days
5.2.3.2 onsite fuel storage (recommendations)	
5.4.11 waste/recycle	Recycle and/or compliance with local environmental initiatives
5.6.2 racks, frames and equipment rack unit capacity	The amount of IT Equipment (ITE) that should be placed within a cabinet will depend on many factors that vary for each hardware platform, data center and organization. The availability of power and cooling, rather than space, may limit the amount of ITE per cabinet or rack. To ensure that the initial and ultimate power and cooling system capacity will meet the anticipated demands, validate power consumption either by performing measurements or by obtaining actual power consumption data from manufacturers. Any unused rack space should be filed with blanking devices to reduce any nonfunctional airflow migration through the equipment rack
5.6.2.3 end equipment cabinets and racks	When equipment cabinets or racks are installed adjacent to each other thus forming continous aisle, the number of cabinets or racks within one row should not exceed twenty. Where one end of aisle is closed off or has n personnel exit, the number of cabinets and racks within one row should not exceed ten racks/cabinets
5.6.2.3.2 recommendations	
7.5.12 circulation	
7.5.12.2 recommendation	

- Environment covers overall condition of DC such as temperature and humidity, protection against contaminants and others
- Capacity means capacity management for facilities (electrical, mechanical, etc.,) and ICT like rack capacity, telecommunication capacity and others
- Security covers security management inside and around DC, risk management and recovery plan
- Commissioning covers management for testing ICT equipment and facilities
- Maintenance covers maintenance for ICT equipment and facilities
- Monitoring includes monitoring for ICT equipment, facilities, environment and capacity
- Vendor that are related to DC management
- DC Management Team that manages DC

DC management consists of four phases as follows:

- Plan: in DC management, planning is needed such as maintenance planning, security planning and others
- Organize: to organize all components in DC include coordination with other parties, resource allocation and others
- Operate: to ensure all components in DC working properly as needed
- Control: to control all process in DC management work as planned

Table 4: Details on each components of the data center management

Components	Details on DC management
Capacity	General capacity (availability, future need, device change, etc), rack capacity, eficiency and change management
Environmental	Temperature and humidity, contaminant and waste/recycle
Information Technology Equipment (ITE)	General (manage ITE), ITE placement and ITE recovery
Electrical	General (availability, alternative on electricity, control), power cables and other components, IT interconnection, bonding and grounding and manage UPS
Mechanical	General (temperature control, availability, rebalancing) and air pressure
Telecommunication	Labelling, documentation and active devices
Security	Physical security, security plan, security policy, access to DC, recovery, device and media security, human safety, security on working area/building and security training
Fire supression	Flammables material, training, labelling
Monitoring	Monitoring in all components and operator response
Commissioning	Commissioning in all components, commissioning types, testing procedure and documentation
Maintenance	Activity, planning, strategy, covers all components and documentation
Vendor	Coordination and availability
DC team	Role and responsibility

Table 5: Current condition of capacity management in general compared to standards

ANSI/TIA-9426 and ANSI/BICSI-0027	Current conditions
Sizing should include projected future growth as well as present requirements	The DC is designed to meet Tier II- Redundant Component and to be able to accommodate future up to 10 year ahead
The average DC may significantly change its ITE inventory every 3-5 years	IT equipment is already changed every 3-5 years. Some equipment that has age >5 years is used for non critical functions
Critical DCs are often operational 24 h/day 7 days/week	The uptime percentage in BPS's DC is 99%. Tolerable time for downtime is 7 h 12 min each day, month
Documentation, labeling and administration of DC components are critical to proper operation and maintenance of a DC. Administration systems may be manually operated or utilize an automated system. However, physical labeling of all items should be undertaken irrespective of the system being implemented	Most devices are already using the label. Devices in the DC are recorded in asset system but not updated
Electronic documents of DC are: base building, DC, DC utilities, balanced twisted pair, coaxial and optical fiber cabling, power cabling, rack and cabinets elevations, active equipment inventory	Electronic documents are gained from vendor after each project

Table 6: Current condition of temperature and humidity management compared to standards

ANSI/TIA-9426 and ANSI/BICSI-0027	Current conditions
The temperature and humidity shall be controlled to provide continuous operating ranges for temperature and humidity: ANSI/TIA-942 Dry Bulb temperature: 20°C Relative humidity: 40-55% Max dew point: 21°C Max rate of change: 5°C/h ASHRAE Temperature: 18, 3-26, 7°C Max relative humidity: 60% Max dew point: 15°C Min dew point: 5, 5°C NEBS GR-3028-CORE Temperature: 18, 3-26, 7°C Max humidity: 55%	Temperature and humidity are controlled via LCP (temperature set: 20°C) and via PAC (temperature setting: 19-20°C and humidity). It also uses sensor to control temperature with range 18-35°C and humidity with range 30-70%. If temperature or humidity is outside the range, the sensor will give an alert

The details on each component can be seen on Table 4. Details on each aspects can be seen completely on.

Validating aspects of the data center management: The guidelines are validated by BPS's DC team through interview. The outputs from the validation are then inserted to the guideline. To ensure that all management aspects are included in the guidelines, the aspects that are not included are validated using questionnaire.

Current condition of the DC management in BPS: Current condition of DC management at BPS is evaluated according to identified components.

Capacity: There are three parts of capacity management; capacity management in general, rack capacity, DC efficiency and control change. Table 5 and 6 shows current condition of capacity management in general. Other parts can be seen completely on. There are two recommendations for the capacity management

(in general): first, label the devices and make it consistent. Second, update asset management if there is any addition, deletion or removal of the devices or if any documentation needed.

Environment: Management of environment in DC has three parts; temperature and humidity, contaminant and waste/recycle. Current condition of temperature and humidity management can be seen in Table 6. Management of contaminant and waste/recycle can be seen completely on. Recommendation for temperature and humidity management is to set the temperature and humidity in ideal range that conforms to standards. To determine ideal range, it should consider the devices and environment condition. The devices work optimally in 18, 3-26, 7°C while the resistance could reach 45°C but should be tolerated up to 35°C. Considering all of that the proposed temperature range is between 20-26, 7°C and the humidity is between 40-60% conform to ANSI/TIA-942 and ANSI/BICSI-002. The current condition and the recommendations of other components can be seen completely on.

CONCLUSION

Based on this research, conclusions that can be drawn are as follows; the aspects of DC management can be obtained from DC standards. The current condition of DC management can be evaluated using those guidelines. Both can be compared and if it is not conform to those guidelines, recommendation is given. Proposed recommendations can be used as an input for DC management to provide better IT services.

REFERENCES

Applegate, L.M., R.D. Austin and M.F.W. Farlan, 2007. Corporate Information Strategy and Management: Text and Cases. McGraw-Hill/Irwin, Boston, Massachusetts,.

BICSI, 2011. Data center design and implementation best practices. Building Industry Consulting Services International, USA.

Barroso, L.A., J. Clidaras and U. Holzle, 2013. The datacenter as a computer: An introduction to the design of warehouse-scale machines. Synth. Lectures Comput. Archit., 8: 1-154.

Hadiyanti, R.D., 2016. Design of policy and guideline for data center management: Case study of BPS-Statistics Indonesia. Master Thesis, Universitas Indonesia, Jakarta.

Hwaiyu, G., 2015. Data Center Handbook. John Wiley & Sons, New York, USA.,.

Ramasamy, T., 2010. Principles of Management. Himalaya Publishing House, Mumbai, India,.

Rao, P.S. and V.T. Kumar, 2010. Management Theory and Practice: Text and Cases. Himalaya Publishing House, Mumbai, India,.

TIA., 2005. Telecommunication infrastructure standard for data centers: TIA-942. Telecommunication Industry Association, USA.