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Organisational Readiness Component to Develop Readiness Model towards Smooth IPv6 Migration

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ABSTRACT

Background: The internet is migrating from IPv4 to IPv6 to overcome the addressed limitations of IPv4. Most countries in the world are in the midst of this migration. Based on previous research however, there are still a number of organisations that have not prepared for IPv6 migration even though they are aware of the urgent need to apply IPv6 in their network. Understanding the factors that influence organisation readiness of IPv6 can be an interesting topic for researchers since it could help to facilitate the migration process. The purpose of this study is to explore the components that can define an organisation's readiness for migration by referring to previous research. The findings show that IPv6 deployment (planning), hardware, cost, knowledge and motivation can be used to define readiness. The components can be used to propose the readiness model for an organisation.

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INTRODUCTION

IPv6 is the next generation of internet protocols designed by the Internet Engineering Task Force (IETF) to overcome the lack of addresses in IPv4 (Dai, 2011). Besides providing larger space, IPv6 development also facilitates other features that did not exist in IPv4 (Van Der Pal, 2013) such as different types of address configuration: global addresses; global unicast addresses; multicast addresses; and, link-local addresses (Dai, 2011). In order to migrate from IPv4 to IPv6, there are generally three techniques for transition before full deployment of IPv6 is complete: dual stack (Nguyen Phu Minh Nguyen, Rantapuska, Utriainen, & Matilainen, 2012); tunneling (Bahaman, Hamid, & Prabuwo, 2012); and, translation (Zhai, Bao, & Li, 2011).

Full implementation of IPv6 into networks and replacing previous protocols is impossible while the IPv4 still exists. IPv4 and IPv6 would coexist until full migration to IPv6 is complete. This migration is seen as a lengthy, difficult process for an organisation because it comprises many aspects such as stakeholder engagement, infrastructure design (George, Donley, Howard, & Liljenstolpe, 2012), procedure and methodology (Arkko & Baker, 2011), cost (Dai, 2011) as well as proper planning (Che & Lewis, 2010). Therefore, it is important for IT technical staff to plan the management of both protocols in their job schedule, and understand how they would complete the transition rather than solely plan for the implementation of IPv6. In fact, the organisation needs to be aware of the significance of quick response by starting their transition planning early (Gold, 2011). It would be useful to ensure that there is a standard method for making plans and checking readiness within an organisation. It would outline both the technical infrastructure and business activity of the organisation to facilitate any action that needs to be taken for commencement of transition to IPv6. Great organisational readiness with appropriate preparation, procedure, and implementation tools can control the cost and uncertainties involved within the project (SV Limkar & Jha, 2010).

Based on previous research, low levels of readiness in an organisation can be a factor to slowing down the migration process (Spelman, 2008) because the transition from IPv4 to IPv6 cannot easily be achieved in a short period of time. It involves a great amount of ground work and careful preparation (Nguyen, Anh, Rantapuska, Utriainen, & Matilainen, 2012). The state of readiness the world faces is even more of a consideration for developing countries (Kapetanovic & Ribic, 2012). In addition, according to Gold (2011), any organisation that starts planning towards IPv6 must at first, take steps to assess their level of readiness because organisations that are not quite ready for IPv6 and have a low level of readiness could contribute to significant problems within the ICT industry (Dell, 2012).

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There are some research and surveys in the world that present valuable data on IPv6 migration readiness from various perspectives such as Taiwan, Australia, Croatia, Bosnia Herzegovina and Vietnam. The studies were conducted from different viewpoints with different characteristics. Examples include a study on readiness for public organisations in terms of infrastructures, applications, end-user devices (Svedek, Dobrijevic, Matijasevic, Golub, & Stivojenic, 2011) core network, and software (Tseng, Lu, Ku, Chu, & Tsai, 2012). There also exists a study to investigate the readiness for IT users in Australia, carried out by Dell (2012) assessing their training, planning and policies. Additionally, other studies/research examined private enterprises and categorized the readiness into two (2) groups. They were the business side, which covered profit return and cost estimation, and the technical side, which covered infrastructure, project plans, personnel training and IPv6 architecture (Nguyen *et al.*, 2012). The rest of the studies provide information on an organisation's experiences (SV Limkar & Jha, 2010), implementation and challenges towards IPv6 migration (Kapetanovic & Ribic, 2012). Authors classify the IPv6 readiness aspect into two categories, the human and physical factors.

There are previous studies that report the different aspects, views and factors related to IPv6 migration readiness in organisations. In this literature, it is not clear which of these factors are important in relation to the success of an IPv6 migration project. In fact, there have been no official instruments on IPv6 migration readiness used to measure the readiness level of the organisation. There is also still no model that can evaluate the company's efforts towards internet infrastructure (Nguyen *et al.*, 2012), especially for the IPv6 migration in Malaysia.

This study is therefore important to explore the factors that can be used to identify the organisational readiness for migration to IPv6 which could develop a readiness model for an organisation. Meng, Elliott, and Hall (2010) concluded that by knowing the factors that influence readiness, the organisation is able to develop activities such as training and education that are needed before the implementation of any IT project. Failure to assess the readiness of the organisation before the implementation stage could cause project managers to spend more time managing the problem or at worst, lead to failure.

1. *Methodology:*

In order to achieve the objective, a qualitative research method (i.e. a document review) was implemented by referring to several previous studies (as a literature review). This method was used because it is a systematic process to review and evaluate printed documents and electronic materials (Sallabaş, 2013). It provides for exploration and analysis of factors or criteria from previous researchers to measure the organisation's readiness towards IPv6 migration. Five literature reviews from conferences, proceedings and journals, which summarized organisation readiness, were analysed. By referencing existing literature reviews, it appears that the relevant methods have been identified (Haug & Pedersen, 2011).

Table 1 lists the factors that are identified as being used to measure the readiness of the organisation towards migration based on five existing pieces of literature. Therefore, what is presented in this study is a combination of five reviews of the existing literature based on related factors. Given the credibility of the journal and the proceeding in which they were published, it appears reasonable to deduce that the most relevant findings were discussed. The factors identified are analysed and discussed using the frequency matrix table as shown in Table 3.

2. *Results:*

A. *Organisation Readiness:*

There are numerous definitions related to readiness that are available from previous literature on the subject. The Oxford Dictionary defines readiness as the state of being totally prepared for something or willingness to do something. Readiness is also defined as "the capability of a country to participate in the digital economy era" (Budhiraja & Sachdeva, 2002). Dada (2006) defines readiness as the measurement or degree to which a nation, society or economy is willing or ready to obtain the benefits arising from information and communication technology (ICT).

In the case of IPv6, Nguyen Phu Minh Nguyen *et al.* (2012) concludes that readiness is a form of preparedness of personnel, systems, and organisations to meet the situation and carry out any actions based on what has been compiled for the IPv6 migration. It is based on the completeness of planning, adequate training of personnel, and supplies for support services. Besides, according to Dell, (2012) readiness intended as how organisations should prepare for the migration as well as fully adoption of IPv6. In this situation, the organisation must be prepared for the implementation of IPv6 into the network when the need arises (Nguyen Phu Minh Nguyen *et al.*, 2012). Therefore, it can be concluded that readiness is the state of preparedness and capability (Aziz & Salleh, 2011) of an organisation to run IPv6 migration through personnel support, the organisation's environment, and infrastructure.

B. Organisation Readiness Components from Literature:

The factors used to measure the readiness are based on research done in five different countries. To give a better idea of the factors identified in relation to the migration of IPv6, the factors are classified into two categories, human factors (Nguyen Phu Minh Nguyen *et al.*, 2012) and physical factors known as organisation factors (Haug & Pedersen, 2011). The factors for assessing IPv6 migration readiness of an organisation are summarized and presented in the table below. Table 1 displays the physical factors and Table 2 shows the human factors that can be measured for readiness towards IPv6.

Table 1: Physical Factors for IPv6 Migration.

NO	SOURCE	PHYSICAL FACTORS FROM LITERATURE REVIEWS
1	(Dell, 2012) Australia	i. Planning ii. Assessment iii. Policy framework iv. IPv6 Deployment
2	(Tseng <i>et al.</i> , 2012) Taiwan	i. Service ii. Software iii. Core network
3	(Dobrijevic, Svedek, & Matijasevic, 2012) Croatia	i. Technology (equipment) ii. Cost iii. Motivation iv. Security concerns v. Transition strategy
	(Svedek <i>et al.</i> , 2011) Croatia	i. Technology (equipment) ii. Cost iii. Motivation iv. Security concerns v. Transition strategy
4	(Nguyen Phu Minh Nguyen <i>et al.</i> , 2012) Vietnam	i. Motivation ii. Cost planning iii. Assessment iv. IPv6 architecture v. Resources vi. IPv6 development
5	(Kapetanovic & Ribi, 2012) Bosnia Herzegovina	i. IPv6 Development ii. Transition strategy iii. Challenge (technical, cost) iv. Cost v. Planning vi. Policy

Studies show that the introduction to new information technology systems may impact the process, work environment, structure and strategy of an organisation (Salleh, Alshawi, Mohamed Sabli, Zolkafli, & Judi, 2011). This is because the new system relies on changing the way humans think and act. This human factor is an important issue that can affect the organisation's readiness to any new technology (or changes to them) that can impact the organisation's workforce (Aziz & Salleh, 2011). The table shows the human factors that can be measured with regards to readiness for IPv6.

Table 2: Human Factors for IPv6 Migration.

NO	SOURCE	HUMAN FACTORS FROM LITERATURE REVIEWS
1	(Dell, 2012) Australia	i. Training
2	(Spelman, 2008) Irish	i. Awareness
	(Dobrijevic <i>et al.</i> , 2012) Croatia	i. Technology (knowledge) ii. Motivation
3	(Svedek <i>et al.</i> , 2011) Croatia	i. Technology (knowledge) ii. Motivation
4	(Nguyen Phu Minh Nguyen <i>et al.</i> , 2012) Vietnam	i. Motivation ii. Development team iii. Communication iv. Training
5	(Kapetanovic & Ribi, 2012) Bosnia Herzegovina	i. Knowledge

With reference to the table, previous researchers discussed the readiness to IPv6 with different factors and views. This makes it difficult for organisations to give the same priority in all aspects (Haug & Pedersen, 2011) as it is not clear which of these factors are the most important in relation to the project's success. The organisations need to know which factors are most important, so they know where to put their main focus (Dada, 2006). Such knowledge would allow organisations to estimate their readiness towards IPv6 migration.

After analysing the theory and related factors using the frequency matrix table, we have identified a combination of factors that can be used to assess readiness. These factors are shown in Table 3.

Table 3: Factors to Define IPv6 Readiness for Organisations.

Physical Factors	Human Factors
IPv6 Deployment (Planning)	Knowledge
Hardware (Equipment)	Motivation
Cost	

Based on the analysis shown in Table 3, such factors as IPv6 deployment (planning), hardware, cost, knowledge and motivation can be used to gauge the readiness of the organisation to face the IPv6 migration.

3. Discussion:

To further investigate the five factors defined in Table 1, this section will explain each factor based on relevant literature.

i. IPv6 Deployment (Planning):

Planning is a way of predicting and preparing for the future (Coveney, 2013). Planning allows people to prepare something before taking action to prevent errors that may affect cost and possible embarrassment. Through planning, people can understand what needs to be done now and in the future to achieve goals.

IPv6 development is a long process which requires appropriate planning, effort, accurate resources, expertise, and must be well understood by the technical staff before the deployment is a success. Correct planning includes developing the motivation of staff, ensuring that all networking hardware is compatible with the new protocol and high technical skills among network administrators is in place. With the right planning, approach and implementation tools, the costs and risks involved with the project can be well managed (Suresh V. Limkar, Jha, Patil, & Maroti Kalbande, 2010).

ii. Hardware (Equipment):

It is important to check the inventory of applications and hardware of IPv4 and IPv6 devices to determine the readiness of IPv6 so that organisations can evaluate the stability of IPv6 in the network system, and review the technical impact of the IPv6 implementation (Spelman, 2008).

During the IPv6 transition, the network infrastructure and host should be compatible with IPv6, and network applications must be compatible to run within an IPv6 environment (Hanumanthappa, Manjaiah, & Kumar, 2009). Examples of infrastructure that should be noted are the gateways, routers, servers, switches, and clients (computers).

iii. Cost:

According to Arifin *et al.* (2006), migration from IPv4 to IPv6 is very expensive since current network applications run on IPv4. Moreover, appropriate cost estimations need to be considered in advance to include planning, design, testing, deployment, staff training, and operational overheads (Nguyen Phu Minh Nguyen *et al.*, 2012).

iv. Knowledge:

The basic knowledge of what IPv6 is, what the entities involve, and how it operates are critical for any organisation (Graveman & Rooks, 2010) before it intends to implement IPv6 in the network. Knowledge, skill, and experience are major aspects that can affect the successful adaptation of new technology. The correct programmes and training, established by the organisation will ensure that IPv6 is always kept at the forefront of everyone's mind and its complexity does not distress technical staff when IPv6 is in place (van der Pal, 2013).

v. Motivation:

Motivation is the reason behind what drives the organisation to deploy IPv6 in the network. As long as the IPv4 address continues to be allocated in the network environment, an organisation's motivation will remain low to adopt IPv6. They are more motivated to continue to use IPv4 in the network (Dell, 2010). The highest motivation behind the implementation of IPv6 is related to exhaustion of IPv4 addresses, and efforts of the network vendor that support IPv6 (Angelo, 2012).

4. Conclusion:

The factors and components defined in previous sections can be used to develop a readiness model for organisations heading towards the IPv6 migration. By referring to the components, it will help organisations plan and take any action before they decide to implement the IPv6 in their network.

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