

Putting Technology Management Principles Into The Future Context: What's New? Where Next?

Syaiful Rizal Hamid

ABSTRACT

This research is about to predict the social movement and business trends in the future, as well as outlining on how current Technology Management principles will affect this trends. In order to achieve this, the research focuses on, an overview of how today's global issues and social trends will continue into the future and a discussion of how current Technology Management principles will be affected by these trends. In addition, the researcher has expanded the view of business trends to include the predicted future business trends, which the researcher has categorised as 'future context'. Consequently, sixteen drivers are established as future context review. Further, the potential impact of the corresponding future context on the corresponding current Technology Management principles are being map in the matrix. In which four Technology Management principles are tested in this study. Additionally, this research reveals the transition dynamic of future context, which reflects the predicted movement of future changes that may impact on the current Technology Management principles as they are today.

Keywords: Future context, future business trends, Web 2.0, open source movement.

1.0 INTRODUCTION

It is becoming clear that distance is no longer an obstacle to the accession of information. The business environment becomes fuzzy with unclear interrelations and an overlap between the player and the roles, as the world is changing so fast with new trends emerging (Boudreau & Lakhani, 2009; Grant, 2008; Greaves & Mika, 2008; Hamel, 2007; Hamid, 2008, 2009; Mason & Rennie, 2007; Ribiere & Tuggle, 2010). In addition, changes in the business environment and new technologies will drive far-reaching changes in structures, systems and leadership styles (Hamel, 2007). So, it obvious that 21st century management will be based upon distributed innovation, participative decision making and market-based mechanisms (Greaves & Mika, 2008; Hamel, 2007).

This idea is in line with Hamel (2007, p. 147) where in his book *The Future of Management*, he insists that embracing new principles is essential for future management. This also aligns with Malone (2004) who claims that the practice of future work (i.e. networked organisations) must be built from principles. In fact, future management is more likely to involve the extension of existing management principles to embrace

higher levels of complexity with particularly multidimensional integration, which accompanied by greater reliance upon informal structures and systems, including self-organisation (Grant, 2008). Concepts and principles are most likely to impact management thinking and practice over the next few years (Grant, 2008).

As a result, this paper is focused on the principles of Technology Management on how it may develop and continue into the future. Technology principles has been selected due to the fact that Technology Management field can be regard as interdisciplinary filed which lies in the high degree of interaction with other discipline (i.e. social science, business theory, engineering and natural science) (Phaal ,2004). In fact, most of technology management literature is focused on the direction of incorporating technological issues into business thinking, decisions and processes (Gregory, 1995; Robert Phaal, Farrukh, & Probert, 2004; R. Phaal, Paterson, & Probert, 1998), which truly shows the important of technology in giving impact to the big scale of societies (i.e. economics, business and applied sciences).

In so doing, this paper specifically aims to examine the importance of the present and predicted future social and global trends. In order to achieve this, the researcher will focus on two issues:

1. An overview of how today's, global issues and social trends will continue into the future.
2. A discussion of how current Technology Management principles will be affected by these trends.

Further, this paper answers the potential of social innovation, Web 2.0 and Open Source movement and its affect in the future. As such, this paper aim is to analyse, organise and structure knowledge from an academic standpoint and offer potential prediction for future research. The structure of this paper is as follows. Section Two briefly explains the method of this study. Section Three discusses a view of relevant literature on social innovation and business environmental over time. Then, Section Four focuses on the potential impact of the corresponding 'future context' on the corresponding current Technology Management principles. Consequently, sixteen drivers are established as future context review. In which four Technology Management principles are adopted in the context of this study. Finally, Section Five concludes with a description of an agenda for future research in the future.

2.0 METHOD OF STUDY

Specifically, in this study the researcher has adopted Matrix Table/Outcome Matrix in order to make prediction in identifying the potential impact of the corresponding future context on the corresponding principles of Technology Management. The author believes that it is much easier for the reader to understand and follow the Outcome Matrix, as it is very straight forward method, yet it fit the purpose (i.e. useful and dynamic for illustrating the future event). As such, the purpose and the usefulness of

the Matrix Table is that by means of simplification it provides clear and reasonably stable points of orientation onto which those who are exploring something else in the field can hold, not spending too much effort on understanding all the underlying complexities but rather focusing on their area of primary interest. Therefore, it is appropriate to study each prediction of these principles by looking at the mapping, as each principle is then discussed in more detail in terms of future characteristics (see Table 3 in page 8).

Thus, from the literature, eight Technology Management principles are identified in this study (Hamid, 2009) as they are:

1. Technology Development
2. Technology Improvement
3. Technology Leadership
4. Technology Partnerships/Supplier Participation
5. Technology Pioneering
6. Technological Integration
7. Technological Value
8. Technology Standard

Thus, this study followed (Chanaron & Grange, 2007; Donohoe & Needham, 2009) who claim that, if there is uncertainty in an area (i.e. technology principles) where knowledge is imperfect, where there are no correct answers or hard facts – as the principles of technology management are rarely discussed in the literature, so the assumption can be made. Hence, if the researcher comes up with an explanation that provides the opinions with a consistent framework, i.e. the contradictions disappear, the explanation can be considered good - and also quite strong. Therefore, it is generally accepted. So, in this study the researcher assumes that there are eight key principles of Technology Management, as of today. Table 1 as follows briefly describes the Technology Management principles.

Table 1: Description of Technology Management Principles

TM Principles	Descriptions	References
Technology Development	Involves the replacement of existing technology by one that is more advanced by establishing new functionality and understanding underlying phenomena related to new technologies.	Herps, et al., (2003); Hoecht (2004); Magnusson and Johansson (2008); Mahmood and Rufin (2005); Ofori (1994) and Manaikkamakl (2007);
Technology Improvement	Enhancing the performance of the particular technology by continuously improving technology capability and reliability (i.e. process improvement and result of improvement – the end result).	Gehani (1998) and Thomas, et al., (2008)

Technology Leadership	The technological direction specifically in providing leadership in technology areas (i.e. how leadership drives the technology).	Babcock and Morse (2002); Rogers (2003); Jong and Hartog (2007)
Technology Partnerships/Supplier Participation	The interaction and involvement of suppliers in forming the alliances and collaborations in order to handle technology activities/issues amongst themselves (i.e. partners, suppliers and producers).	Babcock and Morse (2002); Carr, et al., (2008); Karandikar and Nidamarthi (2006); Li and Vanhaverbeke (2009); Machado and Manaus (2007); Giannakis (2007); Kayis and Kara (2005)
Technology Pioneering	Pioneer that takes the risks to develop and commercialise a new technology to the market, and this allows pioneers to gain market share advantages, thereby developing the potential to earn profits.	Ali (1994); Benedetto and Song (2008); Garrett, et al., (2009); Gehani (1998); Li and Vanhaverbeke (2009) and Voss (1989)
Technological Integration	Emphasises the need to integrate different disciplines and perspectives, and also implies its diversification and integration (i.e. incorporating technology, enterprise business and strategy).	Drejer (1997); Drejer (2000); Capuano, et al., (2008) and Christensen, et al., (2004)
Technological Value	Focuses on providing value creation of technology with regard to different contexts (e.g. economy, society). This enables the possibility to confirm whether a technology is 'bad or good' or even 'better or worse' than other technologies. Thus, value creation under rapidly evolving markets underlines the need for innovation, flexibility, and speed, pressure for new applications, unique solutions.	Drejer (1997) based on Maack; Laitinen (2004); Pralahad and Krishnan (2008)
Technology Standards	Associated with reducing uncertainty by controlling variety; enhancing competition by clearly defining what is required to serve a market (information); and defining the relevant aspects of products, which are accepted and shared within a community.	Tirole (1988); Baldwin and Woodard (2008); Chituc and Azevedo (2007); Cragil (1989); David (1995); Eisenmann, et al., (2008); Iansiti (2009); Iversen, et al., (2004) and Wonglimpiyarat (2004)

However, for the purpose of this paper, only four quality principles are tested - the outcomes of the analysis process. The reason why the author only tested four main principles of Technology Management not less or more because the researcher believes that THREE or less is far too few. FIVE and more, tends to be too much and may create an uneasy feeling to the reader as well as considering the limitation for the publication itself. So, FOUR is the ideal. Hence, the researcher also believes that these principles will have the greatest impact on the future of Technology Management principles. Similarly, Hamel noted that *“embracing new principles are essential for future*

management” (Hamel, 2007, p. 147), and future work (i.e. networked organisation) is building *from principle to practise* (Malone, 2004).

3.0 FUTURE CONTEXT

The renew of literature on future trends identified sixteen (16) drivers which were established as future context. From the analysis of literature, Table 2 briefly describes the transition dynamics of future context, which reflects the predicted movement of future changes. The focus is on the transition (e.g. the effect of the transition) of the evolving trends from present to the future. Further, the following Table 3 illustrates how the predicted future changes shown in Table 2 may impact on the current Technology Management principles as they are today.

Table 2: Predicted Changes in Business and Social Environment

Dynamic Transition	Descriptions	References
Web 1.0 to Web 2.0	This transition is from a passive web based technology to a participative social networking web. Web 2.0 provides the platform for participation, collaboration and creativity allowing more people to share their ideas and in more ways.	Gray, Thompson, Clerahan, Sheard, & Hamilton, (2008), Hamel, (2007), Hendler & Golbeck, (2008), Mason & Rennie, (2007), Needleman, (2007)
Ideas and actions originating from the network rather than internally	The transition is where the ideas and actions are not solely built up within the organisation but across the network as well.	Bard & Soderqvist, (2002), Hamel, (2007)
Central Regulation to Self Regulation	This transition is from a wide span of control to self managed, self controlled, self organised processes and decision making where the individual is given more freedom in performing his/her task.	Bititci, Garengo, Dorfler, & Nudurupati, (2008), Prahalad & Krishnan, (2008)
Contract to Trust	This transition is from formal or legal procedures to relationships based on trust. Trust becomes the main driver for every player to contribute and share their thoughts for relational improvement.	Acaccia, Kopacsi, Kovacs, Michelini, & Razzoli, (2007), Crosno, Nygaard, & Dahlstrom, (2007), Hamel, (2007) Jahansoozi, (2006), Malone, (2004)
Legal Regulation to Moral	The transition is where the relationship is no longer bound solely by procedures and regulation and	Bititci, et al., (2008), Hamel,

Regulation		where there is a greater emphasis on morality. People prefer to make morally correct choices and actions (i.e. doing the 'right thing').	(2007), Malone, (2004), Ulhøi, (2004)
Increasing Transparency		This transition is from closed to open intellectual properties. The concept of transparency is linked to openness and is described as a required condition for rebuilding trust and commitment in relationships. The higher the level of openness and sharing, the greater the transparency achieved.	Acaccia, et al., (2007), Bessire, (2005), Jahansoozi, (2006), Malone, (2004), Prahalad & Krishnan, (2008), Ulhøi, (2004)
Proprietary to Open Source	to	This transition is from the principle of closed source based on a profit motive to the principle of open source based on a non profit motive. The transition line is where the rights of ownership are waived and the public are allowed to share and given access.	Hamel, (2007), Krogh, (2003), Muir, (2005), Ulhøi, (2004), von Hippel & von Krogh, (2003)
Copyright to Copyleft	to	This transition is from legal rights protection to the waiving of certain public rights. A particular example of Copyleft is the General Public Licence.	de Laat, (2005), Ulhøi, (2004)
Increasing Emphasis on Innovation	on	The transition line is on the emphasis of innovation in networking where innovation comes in the form of open source innovation as the result of across the network participation and collaboration.	Boudreau & Lakhani, (2009), Machado & Manus, (2007), Malone, (2004), Prahalad & Krishnan, (2008), Ulhøi, (2004)
Bureaucracy to Netocracy	to	This transition is from hierarchical, procedural and rigid structures to flat, loose and flexible structures. Netocracy in the context of social governing reflects the idea of moving from an industrial society where social values are money driven to a humanitarian society which is knowledge driven.	Bard & Soderqvist, (2002), Malone, (2004)
Clear Organisational Boundaries to Fuzzy Organisational Boundaries	to	This transition line is from formal and clear organisational boundaries to loose and fuzzy organisational boundaries. This will allow businesses to become more responsive and enhance their ability to change.	Bititci, et al., (2008), Malone, (2004)
Increasing Emphasis on Community Opinion	on	The transition line reflects the idea of increasing the emphasis on community opinion with the objective of gaining peer recognition, reputation and community prestige.	Ulhøi, (2004)
Increasing Emphasis on Continuous Learning	on	The transition line reflects the idea of increasing the emphasis on learning opportunities and enhancing knowledge literacy mainly through the network. The fastest way for learning is through conversation, blogs and web.	Ulhøi, (2004)

<p>Increasing Emphasis on Corporate Social and Environmental Responsibility</p>	<p>The transition line suggests that businesses go beyond money making via commercial activities and make a commitment to the well-being of the community. e.g. ISO 26000 (Social Responsibility).</p>	<p>Baron, (2008), Castka & Balzarova, (2008), Falck & Hebllich, (2007), Husted & Allen, (2007), O'Connor & Meister, (2008), Robins, (2005), Yoon, Gürhan- Canli, & Schwarz, (2006)</p>
<p>Loyal Customers to Picky/Curious Customers</p>	<p>The transition line is where customers have become more educated especially the younger generation and so have become highly selective and curious in choosing products or services.</p>	<p>Bititci, et al., (2008), Chang, Hung, & Ho, (2007), Demouline & Ziddab, (2007)</p>
<p>Increasing Pace of Change</p>	<p>The transition line reflects the pull of ideas for improving and rectifying problems more quickly, as the result of breeding ideas and solutions mainly through the network.</p>	<p>Bititci, et al., (2008), Hamel, (2007), Prahalad & Krishnan, (2008)</p>

Table 3: Matrix of Drivers of Future Context and Technology Management Principles

Future Context																
Principles	(1) Web 1.0 To 2.0	(2) Ideas & Actions Originating from the network rather than Internally	(3) Central Regulation to Self Regulation	(4) Contract to Trust	(5) Legal Regulation to Moral Regulation	(6) Increasing Transparency	(7) Proprietary to Open Source	(8) Copyright to Copyleft	(9) Increasing Emphasis On Innovation	(10) Bureaucracy To Netocracy	(11) Clear Organization To Blurry Organization Boundaries	(12) Increasing Emphasis On Community Opinion	(13) Increasing Emphasis On Continuous Learning	(14) Increasing Corporate Social & Environmental Responsibility	(15) Loyal Customer To Picky/ Curious Customers	(16) Increasing Pace of Change
Technology Improvement	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Technology Partnerships /Supplier Participation	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	X
Technological Integration	X	X	-	X	-	X	X	X	X	-	X	X	X	X	-	X
Technological Value	X	X	-	-	X	X	X	X	X	X	-	X	-	-	X	-

(x) Identifies the potential impact of the corresponding future context on the corresponding current Technology Management principles

4.0 THE POTENTIAL IMPACT OF THE CORRESPONDING FUTURE CONTEXT ON THE CORRESPONDING PRINCIPLES OF TECHNOLOGY MANAGEMENT

Table 3 presents the matrix and each principle is discussed thereafter with regards to the drivers. It needs to be clear that the Table 3 is an author's opinion, which is informed by the literature (categorised into the boxes). However, the reality is not as clear cut as it is. Therefore, they should not be taken as definitive. What is more important is that the reader sees the big picture and gains an understanding of how - the outcome of placing Technology Management in the future context is to highlight the principles of Technology Management that need to be revised and where necessary, revised, incrementally or radically as appropriate. Rather than worrying about the allocations. As different authors/researchers may look from different perspective and may likely placing/crossing differently, the table is indicative.

4.1 Principle 1: Technology Improvement

It could be anticipated that the next technology improvement will rely heavily on the future context. (Refer Table 3)

The principle of technology improvement in the future could involve networking wide technology improvement, which has the following characteristics:

- Web 2.0
- Self managed
- Trust
- Moral regulation
- Transparency
- Open source and Copyleft
- Participative
- Collaborative
- Innovation
- Originated across network
- Community Opinion
- Knowledge Sharing
- Corporate Social and Environmental

The transition from Web 1.0 to Web 2.0 impacts on technology improvement in terms of process improvement. For instance, technology can be improved mainly via the network from ideas to actions. This can be justified as people are willing to comment and put honest reviews in order to improve existing technology, and therefore the ideas and actions are originating from the network rather than internally (Ribiere & Tuggle, 2010; Vujovic & Ulhøi, 2008). With Web 2.0 as the platform behind this movement, more global players throughout the networks can share and respond, leading to the transformation of ideas into actions. Nevertheless, Web 2.0 promotes the element of self-recognition, which makes people become more independent and self-managed in performing their job. Ideally, people become more responsive and willing to think and react in innovative ways and become more creative (i.e. self-regulation). This leads to improvements in technology, which is persistent and resilient, and afford more ways of performing tasks, as the options continuously evolve (i.e. through the participation and

collaboration amongst the communities of practice) (Greaves & Mika, 2008; Shin, 2008; Weaver, Pifer, & Colbeck, 2009).

The transition from relational contract to relational trust allows trust to become the unconditional element for technology improvement, specifically in the network. Most of the business, project and improvement in the network needs to be build upon trust, as people do not even see each other or have any contact beforehand (e.g. face-to-face interaction). This reflects the principle that the greater the transparency, the deeper the trust will be. As such, the improvement is not based on the primary basis of legal regulation, but is more prone to moral regulations, where people are willing to refine existing technology. This would potentially increase transparency, as people are more open to share new ideas, explore, develop and materialise them.

Open source and copyleft movements can possibly affect technology improvement. Technological improvement, especially in terms of intellectual property, to a certain extent would bring the potential of more new ideas and invention, which can be shared in greater amounts. This includes the participation of people (actively giving ideas and comments) and reviewing current ideas, products and services, which ideally will enhance breakthroughs in new technology (i.e. increasing leap of innovation) in the market. Another element is collaboration, where firms in the industry can get together to produce new technology improvements, either in the sense of the technology improvement process or end-to-end product improvement. As a result of these, copyleft movement can inspire more young companies and small budget companies to be more innovative and competitive in order to improve existing technology in the market. Of course, this is a relatively cheaper strategy than producing masterpieces from typical research and development.

Further, it could be argued that netocracy could play an important role for technological improvements in the future. Eliminating red tape and introducing a meritocracy will be supporting elements for driving forward such innovations. Indeed, in building new products and services, firms will also need to take into account their corporate social and environmental responsibility. This includes placing an emphasis on community opinion (communities of practice), as the brain of the networks which lead to peer recognition and reputation building in the industry. The idea is not based solely on finance, but will also focus on showing responsibility for the greater good of society. Customers have been well fed with information and knowledge about the latest trends in technology around the world. Information about products or services can be easily accessed from websites, so, as a consequence, customers are likely to become more choosy and demanding. However, on a positive note, the customer becomes willing to share their thoughts about product improvement, and demand what is right for themselves. As the result, this also contributes to new improvements in technology.

In terms of organisational structure, in the future, the transition from clear organisation to fuzzy organisation boundaries, gives more opportunities for people to be integrated into project based teams (i.e. cross-functional) and not be static to their job descriptive/function. Each function can be more flexible and work together. Job

enrichment will be the idea with the greater use of Web 2.0 and the open source innovation concept, so technology could be improved in a faster time, as people within the organisation of each department and function can share their opinions, suggestions and take action for the improvement of product or services that they offer. As the network becomes the platform, everyone can enjoy and take benefit from self-improvement and self-learning. This becomes good practice and a learning curve for everyone to participate, collaborate, review and revise each other's ideas and put the ideas into practice. As a result, this leads to an increasing pace of change and response in the improvement of technology. Consequently, this also creates an environment of continuous learning within and outwith the organisation.

Similarly, Boudreau and Lakhani (2009) suggest that future technology improvement will be via external innovation, with multiple parallel paths to solve an innovation problem. In both markets and communities, external innovators will explore innovation landscapes that are often unknown and unexpected by the organisation. A high-performing solution often comes by this type of exploration. External innovation also appears to be more cost-effective, because the cost of failure is typically not borne by the host organisation. If an external innovator fails in its attempt to solve an innovation problem, then it alone bears the costs (and benefits of learning) from that attempt (Boudreau & Lakhani, 2009). Also, external innovation appears to achieve fast solutions that arrive quite quickly and can often exceed the capacity of the seeker (Boudreau & Lakhani, 2009).

As a result of all the above mentioned, it is suggested that, the future principle of technology improvement in the future will be based on network-based/networking wide technology improvement. For instance, the improvement in terms of ideas and innovation come from the networks and not solely from inside the organisation (i.e. innovation as the heart of technology). As a result, managing external innovation will be the key issue with the tools of creativity widely distributed. As such, there will be more focus on self-management, establishing trust, transparency, open innovation (e.g. external innovation) and also participation and collaboration, as well as knowledge sharing and community opinion across the network.

4.2 Principle 2: Technology Partnerships/Supplier Participation

It could be anticipated that the future technology partnerships/supplier participation will rely heavily on the future context. (see Table 3)

The principle of partnerships/supplier participation in the future could be based on:

- Suppliers and partnerships having a much closer relationship because of social integration and tightly integrated online supply chains.
- Relationships built upon trust, openness and transparency.

The relationship is becoming much closer as a result of social integration, with trust, openness and transparency at the core (Berger, 2007; Jahansoozi, 2006; M'aloivics,

Csig'én'e, & Kraus, 2007). Having said that, suppliers and partnerships are likely to have a much closer relationship because of social integration and tightly integrated online supply chains (Chen, 2008; Karandikar & Nidamarthi, 2006; LaRoche, 2009).

This may happen as Web 2.0 provides the platform that allows suppliers to communicate, review and evaluate their partnerships. As a result, relationships are built upon trust, openness and transparency (openness in information). Therefore, communication becomes much clearer and misinterpretation is avoided, as mass information is made available for both parties to retrieve and access. Ideas and actions can come from the partnership immediately. For example, product specification, customer specification, reviews, comments and supplier partnership meetings can be uploaded onto the web. Indeed, supplier relationships tend to be built on the basis of trust, which brings greater flexibility in terms of decision-making and executing tasks.

Inevitably, in terms of moral regulation, such partnerships are not bound by rules and regulations; rather, the situation seems to be shifting to a symbiotic relationship. In such a scenario, people are willing to do good things without being instructed, with a greater emphasis on collective altruism (e.g. knowledge sharing among suppliers and partnerships). This leads to increasing transparency with a spirit of openness and sharing information.

As a consequence, new developments in technology are shared, and become the public standard (copyleft). This provides more opportunities for other parties, including suppliers, to create and enhance existing technology (from the open source concept). This leads to greater innovation. Innovation can happen in a faster manner throughout the network. In other words, suppliers become more innovative and create an environment where communication, the exchange of ideas and solutions takes place amongst suppliers and partnerships as a result of open source innovation, which, in turn, leads to more rapid decision-making and the avoidance of misinterpretation. The partners thereafter work closely with a greater emphasis on sharing knowledge in order to build greater collective intelligence amongst themselves (Karandikar & Nidamarthi, 2006; LaRoche, 2009; Mason & Rennie, 2007).

Moreover, the concept of netocracy involves eliminating unnecessary bureaucracy in making decisions and establishing corrective action in relation to supplier relationships; whereas the increasing emphasis on community opinion could help build a good profile and positive image of the business within the community. Further, all of these strengthen the view that there will be more third parties - individuals and organisations - participating and collaborating in each other's business models.

In turn, the increasing emphasis on continuous learning in partnership/supplier relations makes it possible for them to learn from and update each other. In addition, the increasing pace of change also makes it possible for partnerships and supplier relationships to become more responsive.

This suggests that based on the analysis, the principle of technology partnerships/supplier participation would be based on collaboration in supplier relationship with greater emphasis on suppliers partnering into the business models. Further, this relationship will be more complex with competing and complementary activities happening at the same time. The establishment of trust, transparency and open source innovation will also occur.

4.3 Principle 3: Technological Integration

The future contexts that may affect the principle of technological integration can be seen at Table 3.

The future principle of technological integration within organisations would be based on technology becoming the driving force in leading innovation and integrating business as a new mode for communicating, collaborating, socialising and working together (Hamel, 2007; Nousala, Ifandoudas, Terziovski, & Chapman, 2008; Shin, 2008).

In addition, technological integration would also be based on the integration of internal and external systems with business models (i.e. a networking model) through ‘inter-enterprise applications’, made possible by the advancement of Web Services and ERP (Hoving, 2007). For example, ERP has made cross-functional systems a necessity with the corresponding need to integrate common processes and technologies across the departments and, to a certain extent, across company borders as well.

The wave of 2.0 movements advances the view that Web 2.0 takes the principle of integration to the next level. Integration happens in the form of Intranet 2.0, which makes it possible to provide comments, reviews, and discussions about problems and solutions across the organisation. Moreover, trust may play a large part in integrating business, strategy and technology, which leads to the promotion of unconditional trust. In turn, this suggests that, the more transparency there is, the higher degree of integration there could be. Thus, open source and copyleft movement may possibly act as the medium that combines and integrates business, strategy and technology (i.e. open source innovation).

As a consequence, this leads to an increased emphasis on innovation that would inspire a greater development of new technology and integration within the organisation. Further, the increasing emphasis on continuous learning may result in interactive integration from one department to another within the organisation. In principle, technological integration is linked to business, and the refinement of strategy is concerned with corporate social and environmental responsibility, which also needs to be emphasised as a major business strategy. It is believed that the increasing pace of change may speed up and provide a platform for individuals to respond, in order to make it possible for greater integration within the organisation.

Accordingly, authors such as (Prahalad & Krishnan, 2008, p. 126), suggest that technological integration is about developing the capacity to rapidly integrate new technologies and legacy assets via networks – Information Communication Telecommunication (ICT) platform and as the systems that can be integrated for independent enterprise (Wei, Tan, & Feng, 2009). Hence, this may lead to globally integrated and locally responsive systems (Prahalad & Krishnan, 2008, p. 125).

Further, this shift results in the ability to use technology to integrate companies and ensure that all parties can properly react to supply chain disruptions, and implement a strategy to overcome problems and expand improvements. Leveraging integrated technologies, data is collected faster, allowing for a proactive analysis of the data to ensure more efficient and streamlined operations (Rabren, 2010).

This suggests that based on the analysis, the future principle of technological integration would be based on internal and external systems integration with business models (i.e. networking model) through ‘inter-enterprise applications’, made possible by the advancement of Web Services and ERP.

4.4 Principle 4: Technological Value

The future contexts that may affect the principle of technological value can be seen at Table 3.

In the future, technological value would be delivered on the basis of technology as an ICT platform that provides engagement with customers. There will be more value placed on network collaboration for innovation, as well as providing access to free resources to allow more opportunities.

It is becoming clear that technology is likely to act as a platform that creates opportunities, to be expanded to host networking type functionality and collaboration tools (Gordon, 2010; Gosain, 2007). This happens in the transition from Web 1.0 to Web 2.0, which provides the value for technology in terms of speed (fast action and quick response), and access to people across the networks with interesting ideas and knowledge. Indeed, this creates wider coverage and unique improvement and development of technological value. Aside from that, it could be said that moral-based practices will provide greater value for technology, as new developments in technology will not only be based on legal matters, but also moral aspects. This reflects the view that the issue is not solely concerned with advancing good technology, but technology that is also morally right. In turn, the movement of increasing transparency and open source may create more opportunities and synergies for technology to be optimised in the networks. Thus, the copyleft movement may also create more value for technology as copyleft allows more innovative ideas to be implemented for replacing and improving existing technology in the market.

Accordingly, technology value requires greater emphasis on innovation, which can be seen throughout the network, as this, potentially, gives further added value to existing

technology. Technological values, in the context of community opinion, means that communities of practice value the technology and give feedback, and this may involve an element of recognition and reputation. Occasionally, selective customers will reflect social changes, which may impact and shape the direction of technology in terms of providing value.

Thus, in principle, the realisation of technological value, not only through technology-to-market linking (where the technology is embodied in a product to be meaningfully employed and can create benefits for its users (Gruber, MacMillan, & Thompson, 2008), but also by providing the capacity to engage customers in a wide variety of activities, such as product development, pricing and logistics (Prahalad & Krishnan, 2008). As such, the co-creation nature of this engagement can enable firms to learn about customers as part of a technological value creation process (Prahalad & Krishnan, 2008, p. 157).

Also, the shift provides the value for technology in terms of speed (fast action and quick response) and access to people across the networks with interesting ideas and knowledge. Indeed, this creates wider coverage and unique improvement, and the development of technological value as a whole.

This suggests that based on the analysis, the future principle of technological value would be delivered on the basis of technology as an ICT platform that provides engagement with customers. There will be more value placed on collaboration networks for innovation as well as providing access to free resources to follow more opportunities.

5.0 CONCLUSIONS

In conclusion, it is clear that the future would be based on netocracy, network, open source and innovation. The impact of this future context may have on Technology Management principles have been discussed. Having undertaken the analyses, it is also becoming clear that in the future, Technology Management principles may commonly be done in network wide, engaging more people for improvement across the network.

Thus, these technology principles (i.e. technology improvement; technology partnerships/supplier participation; technological integration and technological value) inform that the future characteristics may consist of self-management, trust, transparent, open source, participative, collaborative, originating across network, and corporate social and environmental responsibility would be the driving factors in supporting the improvement.

All of these mentioned above, suggest that the changes in the future is truly depend upon the principles of today. Consequently, current principles are also would be affected by future business and social environment. Ironically, it is fair to say that some of today principles might be not working for tomorrow, which mean these principles

need to be reviewed and where necessary revised, incrementally or radically as appropriate. Therefore, next agenda of research lies on the breakthrough of new principles by least the changes of the content of the respective principles would be the key for the future.

REFERENCES

- Acaccia, G. M., Kopacsi, S., Kovacs, G. L., Michelini, R. C., & Razzoli, R. P. (2007). Service Engineering and Extended Artefact Delivery. In G. D. Putnik & M. M. Cunha (Eds.), *Knowledge and Technology Management in Virtual Organizations: Issues, Trends, Opportunities and Solutions*. London: Idea Group Publishing.
- Ali, A. (1994). Pioneering Versus Incremental Innovation: Review and Research Propositions. *Journal Production Innovation Management*, 11, 46-61.
- Babcock, D. L., & Morse, L. C. (2002). *Managing Engineering and Technology*. Harlow: Pearson International Edition.
- Baldwin, C. Y., & Woodard, C. J. (2008). Competition in Modular Clusters. *Harvard Business School Working Papers*, 1-49.
- Bard, A., & Soderqvist, J. (2002). *Netocracy: The New Power Elite and Life after Capitalism*. London: Reuters.
- Baron, D. P. (2008). Managerial contracting and corporate social responsibility. *Journal of Public Economics*, 92, 268-288.
- Benedetto, C. A. D., & Song, M. (2008). Managerial perceptions of global pioneering advantage: Theoretical framework and empirical evidence in the U.S. and Korea. *Industrial Marketing Management*, 37, 863-872.
- Berger, H. (2007). Agile development in a bureaucratic arena—A case study experience. *International Journal of Information Management* 27, 386-396.
- Bessire, D. (2005). Transparency: a two-way mirror? *International Journal of Social Economics*, 32(5), 424-438.
- Bititci, U., Garengo, P., Dorfler, V., & Nudurupati, S. (2008). Performance Measurement; Question for Tomorrow. *SIOM Working Paper Series, No. 0001*, www.strath.ac.uk/siom. University of Strathclyde, Glasgow, UK. University of Padava, Padova, Italy.
- Boudreau, K. J., & Lakhani, K. R. (2009). How to Manage Outside Innovation. *MIT Sloan Management Review*, 50(4), 69-78.

- Capuano, N., Gaeta, M., Ritrovato, P., & Salerno, S. (2008). How to integrate technology-enhanced learning with business process management. *Journal Of Knowledge Management*, 12(6), 56-71.
- Carr, A. S., Kaynak, H., Hartley, J. L., & Ross, A. (2008). Supplier dependence: impact on supplier's participation and performance. *International Journal of Operations & Production Management*, 28(9), 899-916.
- Castka, P., & Balzarova, M. A. (2008). The impact of ISO 9000 and ISO 14000 on standardisation of social responsibility—an inside perspective. *International Journal of Production Economics* 113, 74-87.
- Chanaron, J. J., & Grange, T. (2007). Towards a Re-Engineering of Technology Management *Technology Management, Concepts and Applications*, 3-29. Hyderabad: ICFAI University Press.
- Chang, H.-J., Hung, L.-P., & Ho, C.-L. (2007). An anticipation model of potential customers' purchasing behavior based on clustering analysis and association rules analysis. *Expert Systems with Applications* 32, 753-764.
- Chen, M.-J. (2008). Reconceptualizing the Competition–Cooperation Relationship: A Transparadox Perspective. *Journal of Management Inquiry*, 17(4).
- Chituc, C.-M., & Azevedo, A. L. (2007). Business Networking: The Technological Infrastructure Support. In G. D. Putnik & M. M. Cunha (Eds.), *Knowledge and Technology Management in Virtual Organizations: Issues, Trends, Opportunities and Solutions*. London: Idea Group Publishing.
- Christensen, C. M., Anthony, S. D., & Roth, E. A. (2004). *Seeing what's next: using the theories of innovation to predict industry change* Boston: Harvard Business School Press.
- Cragil, C. F. (1989). *Information technology standardization: Theory, process, and organization*. Bedford: Digital Press.
- Crosno, J. L., Nygaard, A., & Dahlstrom, R. (2007). Trust in the development of new channels in the music industry. *Journal of Retailing and Consumer Services* 14, 216-223.
- David, P. A. (1995). Standardisation policies for network technologies: the flux between freedom and order revisited. In R. M. Hawkins, R. Skea, (Ed.), *Standards, innovation and competitiveness*. Aldershot, UK: Edward Elgar
- de Laat, P. B. (2005). Copyright or copyleft? An analysis of property regimes for software development. *Research Policy* 34, 1511-1532.

- Demoulina, N. T. M., & Ziddab, P. (2007). On the impact of loyalty cards on store loyalty: Does the customers' satisfaction with the reward scheme matter? *Journal of Retailing and Consumer Services*.
- Donohoe, H. M., & Needham, R. D. (2009). Moving best practice forward: Delphi characteristics, advantages, potential problems, and solutions. *International Journal Tourism Research*, 11(5), 415-437.
- Drejer, A. (1997). The discipline of management of technology, based on considerations related to technology. *Journal of Technovation*, 17(5), 253-265.
- Drejer, A. (2000). Integrating product and technology development. *European Journal of Innovation Management*, 3(3), 125-136.
- Eisenmann, T. R., Parker, G., & Alstyne, M. V. (2008). Opening Platforms: How, When and Why? *Harvard Business School, Working Paper*, 09-030.
- Falck, O., & Heblich, S. (2007). Corporate social responsibility: Doing well by doing good. *Business Horizons* 50, 247-254.
- Garrett, R. P., Covin, J. G., & Slevin, D. P. (2009). Market responsiveness, top management risk taking, and the role of strategic learning as determinants of market pioneering. *Journal of Business Research*, 62, 782-788.
- Gehani, R. R. (1998). *Management of Technology and Operations*. United States of America: John Wiley and Sons.
- Giannakis, M. (2007). Performance measurement of supplier relationships. *Supply Chain Management: An International Journal*, 12(6), 400-411.
- Gordon, C. (2010). Making sense of collaboration, Web 2.0, and virtual worlds in the enterprise. In H. Bidgoli (Ed.), *The Handbook of Technology Management: Supply Chain Management, Marketing and Advertising, and Global Management* (Vol. 2). New Jersey, United State of America: John Wiley & Sons, Inc.
- Gosain, S. (2007). Realizing the vision for web services: Strategies for dealing with imperfect standards. *Inf Syst Front* 9, 53-67.
- Grant, R. M. (2008). The Future of Management: Where is Gary Hamel Leading Us? *Long Range Planning* 41, 469-482.
- Gray, K., Thompson, C., Cleahan, R., Sheard, J., & Hamilton, M. (2008). Web 2.0 authorship: Issues of referencing and citation for academic integrity. *The Internet and Higher Education*, 3(1).

- Greaves, M., & Mika, P. (2008). Semantic Web and Web 2.0. *Journal of Web Semantic* (Editorial), 1-3.
- Gregory, M. J. (1995). *Technology management: a process approach*. Paper presented at the Proceedings of the Institution of Mechanical Engineers.
- Gruber, M., MacMillan, I. C., & Thompson, J. D. (2008). Look Before You Leap: Market Opportunity Identification in Emerging Technology Firms. *Management Science*, 54(9), 1652-1665.
- Hamel, G. (2007). *The future of management*. Boston: Harvard Business School Press.
- Hamid, S. R. (2008). *Social Innovation and Business Trends in the Future*, Paper presented at the 5th International Conference on Innovation Management (ICIM).
- Hamid, S. R. (2009). *Putting Technology Management principles in the future context*. Paper presented at the 4th European Conference on Management of Technology (EUROMOT 2009).
- Hendler, J., & Golbeck, J. (2008). Metcalfe's law, Web 2.0, and the Semantic Web. *Journal of Web Semantics*, 6, 14-20.
- Herps, J. M. J., Mal, H. H. V., & Halman, J. I. M. (2003). The Process of Selecting Technology Development Projects: A Practical Framework. *Management Research News*, 26(8), 1-15.
- Hoecht, A. (2004). Control in collaborative research and technology development: A case study in the chemical industry. *Journal of Managerial Psychology*, 19(3), 218-234.
- Hoving, R. (2007). Information Technology Leadership Challenges - Past, Present, and Future. *Information Systems Management*, 24(2), 147-153.
- Husted, B. W., & Allen, D. B. (2007). Strategic Corporate Social Responsibility and Value Creation among Large Firms Lessons from the Spanish Experience. *Long Range Planning*, 40, 594-610.
- Iansiti, M. (2009). Principles that Matter: Sustaining Software Innovation from the Client to the Web. *Harvard Business School, Working Paper*, 09-142.
- Iversen, E. J., Oversjoen, E., & Lie, H. T. (2004). Standardisation, Innovation and IPR. *Telektronikk*, 2, 65-79.
- Jahansoozi, J. (2006). Organization-stakeholder relationships: exploring trust and transparency. *Journal of Management Development*, 25(10), 942-955.

- Jong, J. P. J. d., & Hartog, D. N. D. (2007). How leaders influence employees' innovative behaviour. *European Journal of Innovation Management*, 10(1), 41-64.
- Karandikar, H., & Nidamarthi, S. (2006). A model for managing the transition to a global engineering network spanning industrialized and emerging economies. *Journal of Manufacturing Technology Management*, 17(8), 1042-1057.
- Kayis, B., & Kara, S. (2005). The supplier and customer contribution to manufacturing flexibility: Australian manufacturing industry's perspective. *Journal of Manufacturing Technology Management*, 16(7), 733-752.
- Krogh, G. v. (2003). Open-Source Software Development. *MIT Sloan Management Review*, 44(3), 14-19.
- Laitinen, E. K. (2004). Nonfinancial Factors as Predictors of Value Creation: Finnish Evidence. *Review of Accounting and Finance*, 3(3), 84-130.
- LaRoche, J. (2009). Future Collaboration and Partnerships. *Illinois Library Association Reporter* 27, 6-9.
- Li, Y., & Vanhaverbeke, W. (2009). The effects of inter-industry and country difference in supplier relationships on pioneering innovations. *Technovation*, 29, 843-858.
- M'aloovics, G. o., Csig'en'e, N. e. N. a., & Kraus, S. (2007). The role of corporate social responsibility in strong sustainability. *The Journal of Socio-Economics*.
- Machado, M. A., & Manaus, P. d. (2007). System Innovation Capability: The Case Study of Embraer, the Brazilian Aircraft Manufacturer. In G. D. Putnik & M. M. Cunha (Eds.), *Knowledge and Technology Management in Virtual Organizations: Issues, Trends, Opportunities and Solutions*. London: Idea Group Publishing.
- Magnusson, T., & Johansson, G. (2008). Managing internal technology transfer in complex product development. *European Journal of Innovation Management*, 11(3), 349-365.
- Mahmood, I. P., & Rufin, C. (2005). Government's Dilemma: The Role of Government in Imitation and Innovation. *Academy of Management Review*, 30 (2), 338-360.
- Malone, T. W. (2004). *The future of work: How the new order of business will shape your organization, your management style, and your life*. Boston: Harvard Business School Press.
- Manaikkamakl, P. (2007). Personal technology orientation in R&D: A tool to intensify organizational learning. *Development and Learning in Organizations*, 21(6), 18-20.

- Mason, R., & Rennie, F. (2007). Using Web 2.0 for learning in the community. *Internet and Higher Education, 10*, 196-203.
- Muir, S. P. (2005). An introduction to the open source software issue. *Library Hi Tech, 23*(4), 465-468.
- Needleman, M. (2007). Web 2.0/Lib 2.0—What Is It? . *Serials Review 2007*, 202-203.
- Nousala, S., Ifandoudas, P., Terziowski, M., & Chapman, R. (2008). Process improvement and ICTs in Australian SMEs: a selection and implementation framework. *Production Planning & Control, 19*(8), 735-753.
- O'Connor, A., & Meister, M. (2008). Corporate social responsibility attribute rankings. *Public Relations Review, 34*, 49-50.
- Ofori, G. (1994). Construction technology development: role of an appropriate policy. *Engineering, Construction and Architectural Management, 1*(2), 147-168.
- Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2004). A framework for supporting the management of technological knowledge. *International Journal Technology Management, 27*(1), 1-15.
- Phaal, R., Paterson, C. J., & Probert, D. R. (1998). Technology management in manufacturing business: process and practical assessment. *Technovation, 18*(8), 541-553.
- Prahalad, C. K., & Krishnan, M. S. (2008). *The new age of innovation : driving cocreated value through global networks*. New York: McGraw-Hill.
- Rabren, J. (2010). Technology, Integration and Data Drive Supply Chain Visibility. *Material Handling Management, 65*, 42.
- Ribiere, V. M., & Tuggle, F. D. (2010). Fostering innovation with KM 2.0. *The journal of information and knowledge management systems, 40*(1), 90-101.
- Robins, F. (2005). *Why corporate social responsibility should be popularised but not imposed*. Paper presented at the Proceedings of the European Academy of Management Conference.
- Rogers, E. M. (2003). *Diffusion of Innovations* (4 ed.). New York: Free Press.
- Shin, D. H. (2008). Understanding Purchasing Behaviors in a Virtual Economy: Consumer Behavior Involving Virtual Currency in Web 2.0 Communities. *Interacting with Computers*

- Thomas, A. J., Barton, R., & John, E. G. (2008). Advanced manufacturing technology implementation: A review of benefits and a model for change. *International Journal of Productivity and Performance Management*, 57(2), 156-176.
- Tirole, J. (1988). *The Theory of Industrial Organization*. Cambridge, MA: MIT Press.
- Ulhøi, J. P. (2004). Open source development: A hybrid in innovation and management theory. *Management Decision*, 42(9), 1095-1114.
- von Hippel, E., & von Krogh, G. (2003). Open source software and the 'private-collective' innovation model: issues for organization science. *Organization Science*, 14(2), 209-223.
- Voss, C. A. (1989). *The managerial challenges of integrated manufacturing*. Paper presented at the Operations Management Association Annual International Conference.
- Vujovic, S., & Ulhøi, J. P. (2008). Online innovation: the case of open source software development. *European Journal of Innovation Management*, 11(1), 142-156.
- Weaver, L. D., Pifer, M. J., & Colbeck, C. L. (2009). Janusian Leadership: Two Profiles of Power in a Community of Practice. *Innovation Higher Education*, 34, 307-320.
- Wei, Z., Tan, J., & Feng, Y. (2009). Integration technology of ERP and PDM based on business remote function call. *International Journal Advance Manufacturing Technology*, 40, 1044-1052.
- Wonglimpiyarat, J. (2004). The use of strategies in managing technological innovation. *European Journal of Innovation Management*, 7(3), 229-250.
- Yoon, Y., Giihrhan-Canli, Z., & Schwarz, N. (2006). The Effect Of Corporate Social Responsibility (Csr) Activities On Companies With Bad Reputations. *Journal Of Consumer Psychology*, 16(4), 377-390.