

# Coping with the Rapidity of Information Technology Changes – A Comparison Review on Current Practices

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**Abstract**—Information technology managers nowadays are facing with tremendous pressure to plan, implement, and adopt new technology solution due to the rapidity of technology changes. Resulted from a lack of study that have been done in this topic, the aim of this paper is to provide a comparison review on current tools that are currently being used in order to respond to technological changes. The study is based on extensive literature review of published works with majority of them are ranging from 2000 to the first part of 2011. The works were gathered from journals, books, and other information sources available on the Web. Findings show that, each tools has different focus and none of the tools are providing a framework in holistic view, which should include technical, people, process, and business environment aspect. Hence, this result provides potential information about current available tools that IT managers could use to manage changes in technology. Further, the result reveals a research gap in the area where the industries a short of such framework.

**Keywords**—Information technology, IT adaption, IT revolution, IT trends

## I. INTRODUCTION

OVER the last 50 years, people were doing business by ‘dealing on a handshake’. Today, it has been replaced with the cellular, the Internet, and now the wireless technology. Drake [1] describes information technology (IT) as one of the primary drivers of change in the ways that people work, seek information, communicate, and entertain themselves. IT continues to change in a rapid pace with no sign of slowing down. Every corporation, manager, and individual must now cope to an ever more complex set of economic realities. However, this situation is raising some fundamental question how to successfully manage technological change [2]. Technology change adaptable involves a careful balance between changing the technology to fit the organization, and changing the organization to fit the technology [3]. This idea shows that, to cope with the rapidity of technology changes, blended aspects should be managed, which include the IT infrastructure, people, process, and

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business environment. Within this research paper, we collect and investigate the current tools or practices that have been used in industry or developed by researchers. The tools then are discussed by comparison analysis. The purpose of this study is to understand how the industries nowadays are doing in managing the rapid pace of IT change. Is there any tools or practices available to support their decision making in developing IT system? While no studies currently exist comparing different management techniques to specific outcome, this paper will benefit the industries from studying current tools appearing in the literature. The reminder of this paper is as follows. In the first part, the trend of IT change is explained, looking at the trends of new technology inventions and IT investment. Sources of IT funding and technology drivers are presented, too. The second part presents an evaluation and a comparison of each model. Afterwards, the results are discussed and the contributions and future research are highlighted at the end of the paper.

## II. METHODOLOGY

The data and findings presented in this paper are mostly taken from secondary sources. The information was gathered from journals and literature books with a focus on the IT technology changes research from 1996 to the first part of 2011. The source materials of the data were obtained from libraries’ databases of universities, which covers 225 technology and social science journals. The Google Scholar, Google Web, and specialized databases and other information sources available on the Internet have been explored. To find articles related to IT adaption, the authors searched the following keywords: (technology adaption), (adapt \*information-technology\* change), (facing “information-technology” change), and (technology revolution). The selected references were selected based on the well-described methodology, and the research results are available and complete.

## III. UNDERSTANDING IT CHANGE

In a broader scope, ‘technology’ is defined as a manner of accomplishing a task using technical processes, methods, and knowledge [4]. ‘Information technology’ (IT) is a term that describes technology used to communicate, process, and store data for supporting the business and its processes through the combination applications of desktops, servers, networks, databases, and software. Today, IT is recognized as the enabling tool to increase the efficiency, productivity and

competitiveness of the economy [5-10]. It is no longer a fancy tool to attract prospective clients, but it already becomes an essential part of a business that cannot be forgone.

Technology is developing so quickly. The rapid change of technology turns out to be a challenge for many business and industries. The words of 'technology change' portray the process of technological invention, innovation, and diffusion of technology [11]. This original model was proposed by Rogers [12] where he explained that technological process is started with the creation of something new, and it continues by the spread of a technology through a society or industry (please refer Fig. 1). He found that the diffusion of a technology generally follows an S-shaped curve as early versions of a technology are rather unsuccessful, followed by a period of high levels of adoption, and finally a dropping off when it will be forgone due to another new technology is created. This theory is applicable in IT, too. The Gartner's Hype Cycle put forward five categories of durations that IT will take to be adopted; some technologies will take less than 2 years whilst many will take 2 to 5 years and 5 to 10 years, not many IT will take longer than 10 years, and few will obsolete before plateau [13].

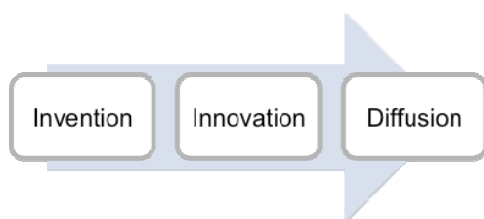


Fig. 1 Phases of technological change [12]

#### A. New IT Application Initiation Trends

Today, the world can see the number of computers in the world has increased rapidly at a dramatic rate. The advancement of technology built in computers is unbelievable. Computers are not limited only in desktop and laptop, but in this information age, computers can be seen everywhere – in the form of embedded microprocessors such as cell phones, mp3 players, car engines, appliances and in countless other applications. Up to date, the IDC calculated that the numbers of computers users are reaching 68 million in 55 countries [14]. Virki [15] estimated that there are now over a billion personal computers in use around the world, and clearly the numbers does not stop there.

With a great demand of computers from consumers, new IT has been initiated in a hastily pace. The rate of current technology-driven innovation is so much faster than it was seven years ago [16]. Some scholars believe that the new technologies are developed and produced everyday [17, 18]. The Moore's Law stated that the capacity of new technologies doubles every 18 months to 2 years [19]. In addition, since the Patent and Utility Innovation Grants<sup>1</sup> has been introduced

<sup>1</sup> A patent is an exclusive right granted for an invention, which is a product or a process that provides a new way of doing something, or offers a new

in 1988 [21], the number of granted patents shows the new inventions has been increasing year by year as shown in Fig. 2. Up until year 2010, the inventions of new technologies are 1,861 yearly in average, and it marks 5 new technology inventions per day. Thus, the issue of how to manage the rapidity of technology change becomes a crucial part in most of the organizations that embrace technology.

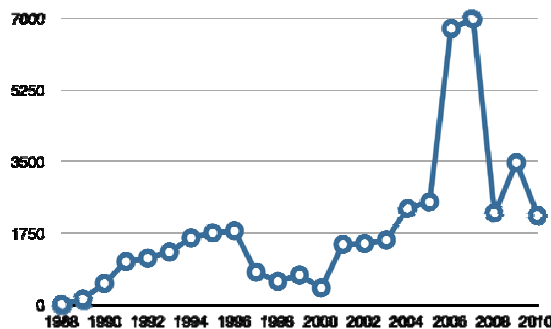


Fig. 2 Patents granted from 1988-2010 [21]

#### B. IT Investment Trends

In a context of IT investment trends, Salleh [22] found 6 stages of maturity (please refer Fig. 3). At the beginning stage, an organization start with ad-hoc investment where IT system are developed or purchased based on what the management sees taking place within other external organizations. In the next level, the organization increases number of IT applications in its IT development plans. Then, short-term development of IT starts to appear with management welcoming user involvement to define needs and requirements, followed by long-term development of IT with an attempt to align business strategy and IT strategy. When the organization become more mature in IT, the organization will use IT for adding value of products or services, for supporting supply chain activities, and for supporting strategic and innovative business objectives



Fig. 3 IT investment maturity model [22]

Currier [23] studied a patent of IT investment trends by surveying 468 of IT budgeters. He found that, IT investment trends on applications vary by size of companies. Big size companies with more than 500 employees, were more likely to avoid capital investment such as buying hardware due to the risk that the new equipment will not be needed and comparatively high maintenance. On the other hand, for medium size companies with 50 to 499 employees, they were likely to buy new hardware, as they believe that it will reduce

technical solution to a problem. A patent provides protection for the invention to the owner of the patent for a limited period, generally 20 years. WIPO. *World Intellectual Property Organisation*. Intellectual Property - some basic definitions 2011 [cited 2011 1 March]; Available from: [http://www.wipo.int/about-ip/en/studies/publications/ip\\_definitions.htm](http://www.wipo.int/about-ip/en/studies/publications/ip_definitions.htm).

their operational costs. The Table I shows the kinds of IT that companies invested for.

TABLE I  
IT INVESTMENT TRENDS ON APPLICATIONS [23]

Med-size Companies	Large-size Companies
Data loss prevention	Desktop/notebooks
Access control	Data center
Authentication management	Storage hardware
ERP application	Application and Web platforms
Security	
Virtualization	
Backup hardware	
Servers	
Storage area networks	

### C. Sources of Funding for IT Investment

In general, new IT inventions are funded by two different sources: the public sector, which includes universities, and the private sector. As found by Barton [24], the allocation of funds varies from industry to industry, time to time, and nation to nation. In developing countries, he discovered that public sector's funds far outweigh the private sector. The government normally subsidizes the early development of new technology, and it is then supported by the private sector for contemporary research and engineering.

### D. Factors of IT Innovation

Green [25] suggested that the main factor that motivates a development of new IT inventions and sustains it, is social. It is divided into four categories, namely intellectual agenda, economics push, politics, and upgrading existing infrastructure. Mika [26] suggested finding and fostering talent as a technology driver. Bossink [27] found four other factors of IT innovation, which include environmental pressure, technological capability, knowledge exchange, boundary spanning. All these factors are consistent that can be concluded in four categories as follow:

- Intellectual agenda – initiatives of an individual or leaders to be better;
- Business competition – influences that force and stimulate organizations to innovate;
- Political agenda – initiatives to co-innovate across the boundaries of departments, organizations, and partnerships, as well as providing financial support at the early stage of new innovation;
- Technological push – technical factors enabling organizations to upgrade and enhance existing technology or develop new innovation products or processes.

## IV. CURRENT PRACTICES IN COPING WITH IT CHANGE

The introduction of new IT benefits the world in the way of upgrading people's lifestyle and their mode of doing work. Technological changes increases people interest in knowledge discovery and developing new ideas and this creates healthy environment for future generation. However, the IT change must be properly managed. The ability of most industries to manage change has been the subject of controversy and debate for many years [28]. The recent KMPG's survey [29] shows that organizations are now moving towards having IT infrastructure that is able to react to changes. Several attempts have been made to deal with such situation. The following strategies are current tools that are been practiced, and they are explained in a sequence of year the tools were developed.

### A. Conventional Approach

Conventional approach has been applied in many organizations from various industries. It has been practiced since people started to realize the importance of managing the technological change. Koehn & Adler [30] illustrated the conventional approach of managing the IT change is by looking the challenges in three dimensions namely business (structure, outputs, and technologies), process, and people (please refer Fig. 4). Using this approach, an organization specifies methods in each track for taking action and assessing performance, and the methods vary from company to company.

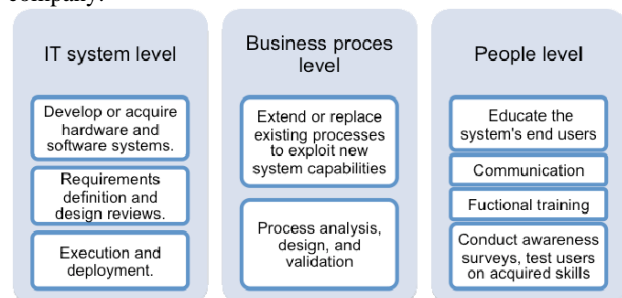


Fig. 4 Conventional approach in managing IT change [30]

### B. Outsourcing

IT outsourcing becomes an emerging trends nowadays [31]. It is not a tool or model, but it becomes a practice that many organizations are convenient with. It occurs when an organization contracts a service provider to perform and an IT function instead of performing the function itself. The service provider could be a third party or another division or a subsidiary of a single corporate entity. In facing the rapidity of IT change, outsourcing method is believed to deliver cost reductions for both operations and applications maintenance, as well as improving productivity, the speed of delivery, and the value of IT investment [31].

### C. Model of Change Management

Orlikowski & Hofman [32] have developed a model for managing technology-based changes for open-ended, customizable technologies or for complex and unprecedented change. This model is an improvised version from the

traditional Lewin [33]’s three-stage change model of “unfreezing, change, and refreezing”. The model distinguishes between *anticipated changes* – changes that are planned ahead of time and occur as intended, *emergent changes* – changes that arise spontaneously which are not predicted, and *opportunity-based changes* – changes that are not anticipated ahead of time but are introduced purposefully and intentionally during the change process in response to an unexpected event. The model spells three interdependent dimensions; the technology, the organizational context, and change model used to manage technological change. This model pre-defines each step to be taken and then controlling events to fit the plan, thus it creates an environment that facilitates improvisation.

**D. Three-E Strategy**

Haymes [34] introduces the Three-E Strategy for gaining acceptance of any new technology for education industry. He focuses on shaping the users’ behaviors rather than the technology itself. He defines the user behaviors as a soft problem that has more to do with psychological and social barriers to technology adoption. The three ‘E’s on his strategy are as following Table II. This model, however, is not empirically studied and it plays a promoting role rather than a strategic method.

TABLE II  
THE THREE-E STRATEGY [34]

Three-E Strategy	
Evident	<i>A technology must be evident to the user as potentially useful in making his or her life easier.</i>
Easy-to-use	<i>A technology must be easy to use to avoid rousing feelings of inadequacy.</i>
Essential	<i>A technology must become essential to the user in going about his or her business.</i>

**E. The Gartner Hype Cycle’s Priority Matrix**

The Gartner’s Hype Cycles comes with a ‘Priority Matrix’ (please refer to Fig. 5). This tool helps organizations in prioritizing emerging technologies by looking beyond the hype and assesses technology opportunities in terms of their relative impact on the enterprise and the timing of that impact. The vast majority of technology innovations do make it through the hype cycle [35]. In the Priority Matrix, the vertical “benefits” shows which technologies to invest in. The top left hand corner contains “high priority” technologies. These are low-risk high-benefit technologies that are likely to become mainstream within the next 5 years. On the other side, in the top right hand corner, the matrix shows technologies with a potentially very high return – but also a higher risk. Therefore, these technologies cannot be expected to emerge anytime soon.

Benefits	Years to mainstream adoption			
	< 2 years	2 – 5 years	5 – 10 years	> 10 years
Transformational	Invest aggressively if not already adopted	Conservative investment profile	Moderate investment profile	Aggressive investment profile
High	Conservative investment profile	Moderate investment profile	Aggressive investment profile	Invest with caution
Moderate	Moderate investment profile	Aggressive investment profile	Invest with caution	Invest extreme caution
Low	Aggressive investment profile	Invest with caution	Invest with extreme caution	Invest extreme caution

Fig. 5 The Gartner's Hype Cycle's Priority Matrix [13]

**F. Change, Adapting, Learning Model (CALM)**

Koehn & Adler [30] has developed a CALM that focuses on measuring and addressing organizational readiness to accept and respond to technological changes. It provides a checklist for formulating, validating, and executing strategies to enable transformational change. The development of CALM was facilitated by Delphi techniques to estimate values for CALM metrics on a scale 1 to 100. The respondents were from teams of leaders and senior workers drawn from all organizational levels. The CALM posits three dimensions of change. The first dimension is to assess readiness to change at the project and enterprise levels and aggregate them together into a dimension called “Infrastructure”. The other two dimensions are called “Organizational Mindset” and “Personal Mindset”. These dimensions are composed of metrics designed to measure critical socio-politic and workforce readiness factors (please refer to Table III). The CALM focuses on the intangible factors that tend to drive success or failure in carrying out transformational change; namely social, political, cultural, and psychological factors. Anticipated benefits of using CALM include reducing risk of workforce resistance and productivity drops, and improved confidence, consistency and alignment in change enablement strategies.

TABLE III  
CHANGE, ADAPTING, LEARNING MODEL [30]

CALM
Organizational Mindset <ul style="list-style-type: none"> <li>Cultural coherence</li> <li>Organizational alignment</li> <li>Teaming</li> <li>Leadership change capacity</li> </ul>
Personal Mindset <ul style="list-style-type: none"> <li>Mental scheme development</li> <li>Work preferences</li> <li>Learning capability</li> <li>Competency development</li> <li>Personal competencies</li> <li>Social competencies</li> </ul>
Infrastructure <ul style="list-style-type: none"> <li>Business process re-engineering &amp; continuous process improvement</li> <li>Technology upgradeability</li> <li>Operational agility</li> <li>Organizational adaptiveness</li> </ul>

**G. Cultural Theory**

Using Cultural Theory derived from Anthropology as a theoretical lens, Jackson & Philip [36] investigated the role of culture in the management of technological change. They examined the relative effectiveness of the three approaches in

the management of technological change, namely, technological determinism, cultural determinism, and techno-cultural emergence. Through case studies and multiple methods such as in-depth interviews, documentary analysis, and observations, they found that a techno-cultural emergence perspective would be successful in the management of technological change in the enabling forms of individualism or market, hierarchism, and egalitarianism, as shown in the following Figure. Meaning that, an organization needs to give ongoing attention to unanticipated cultural and technological issues arising over time and space. From this perspective, both cultural and technology are refined and improved upon on a continuous basis.

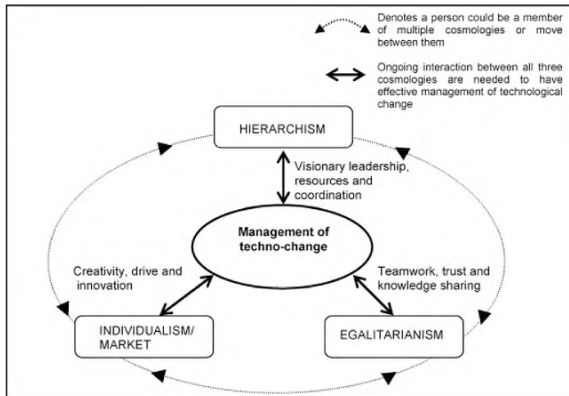


Fig. 6 Cultural theory [36]

#### H. Unified Model of Technology Resistance

This model is developed by Laumer & Eckhardt [37] through a single case study and scientific analysis. The purpose of the Unified Model of Technology Resistance is to identify factors of why people are rejecting new technologies. The model shows that people's affective, behavioral, cognitive resistance to change, and individual personality trait resistance could explain the resistance behavioral intention in the pre-implementation stage.

#### V. DISCUSSION

This paper managed to gather eight current tools or practices that have been used for managing technological change (please refer Table IV in Appendix). The most commonly practice is the conventional method [30], however, this approach has limitations where it is not comprehensive enough, for example, it ignores critical issues relating to organizational readiness to respond effectively to the changes. In particular, the people level strategy does not appear to educate the workforce regarding how the overall business processes will work. It also does not address how the new system, processes, and work roles and responsibilities relate to the existing organizational culture. As the procedures vary from project to project, and company to company, conventional approach does not promote continuation in decision-making. Outsourcing is one of the practical methods in facing technological change. By practicing this method, the outsourcer needs to support all new and existing critical IT

functions, thereby enabling an organization to focus more clearly on its core business activities and its strategy for significant change. On top of this, the organization bear lower risks of changing technology, as well as, changing requirements and legislation during the implementation of IT system. During the post-implementation, outsourcer continues to service the organization in term of maintenance and updating at a certain period of time, and this reduces risks of failure hold by the organization. Even though it is believed to save costs in a long run, outsourcing demands high investment upfront. Furthermore, it opens the organization's privacy of information to the third party.

Besides these common practices, many researchers have developed tools to handle technological change. Most of the tools focus on people issue, but the only tool that is tackling infrastructure subject is the Gartner's Hype Cycle. It is the most popular tools among all, and has been used widely by many industries [35]. This tool, however, focuses only at IT application issue, and does not provide information for administering human infrastructure and the business environment managing technological change.

After all, none of this tools address the issue of managing technological change problem specifically. The tools are more concern about assisting the right technology and managing people resistance to cope with new technology. Besides that, very few tools were developed through empirical study. Many of them were using personal or organization experience, and this marks as one of the weaknesses in the current available tools. In collecting information about these tools or practices, the process clearly gives an idea that the industries are lacking of tools or models dedicatedly for managing the rapidity of IT change.

#### VI. CONCLUSION

The world is facing development of many technological advances in a rapid pace. It hence becomes a challenge to an organization to develop or choose the best IT system for their project or company. Finding the best tool to face this challenge is not easy as the industries are actually lacking with available tools that suit them. Based on the literature reviewed, some of the tools are widely used in assisting them choosing the right technology, but none of the tools are providing them a framework in holistic view, such as the adaptability of infrastructure, people, and business environment to face the hasty technological changes.

##### A. Research Contributions

The rapid evolution of IT is transforming the world. Therefore, the findings of this study are important for a better understanding of IT change trends in construction. By understanding this, it creates awareness of importance to be adaptable with the technological changes. Hence, a collection of current available tools provides to managers which approach may suit their companies. It then could assist managers in developing their company's IT policy and strategy. In term of knowledge contribution, this paper reveals that the industries need a practical tool or model to face the

challenge of technological change. For this reason, it opens up opportunities in research and development that the industry could take-up and cooperation could be done internationally.

#### B. Future Work

In this paper, we addressed the discussion of trends of IT application and investment. The same study could be done to measure these trends in particular industry, for examples, in construction industry, banking industry, or education industry. The trends may vary from industry to industry, as some industries have been seen as a slower uptaker in technology inventions. Such study is very useful to predict the future and helps IT managers to plan their IT investment. Then again, to understand the trends of technological change, a tool or model need to be developed so that it can be measured easily for any industry.

Further, the Authors' goal for future research is to develop a model as a tool for an organization to deal with the rapid changes of IT that could aid the organization developing, implementing, or choosing IT infrastructure, which is flexible to changes. The model will be a blended process from an extensive literature reviews and expert opinion and will further enhance through pilot study, case studies and large survey. It will focus at cost-effectiveness, fast and efficient process. The tool also is expected in evaluating the construction organization's strategies and opportunities resulting business value through increased IT effectiveness.

#### APPENDIX

Table IV – Meta-analysis of current practices used to cope with IT change.

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TABLE IV  
META-ANALYSIS OF CURRENT PRACTICES USED TO COPE WITH IT CHANGE

Tool/Model	Developer	Focus	Adoption Level	Purpose	Assessment Criteria	Tool/Model Methodology	Strengths	Weakness
Conventional approach	-	Technical, people, and management.	Organization	Case-by-case solution.	<ul style="list-style-type: none"> <li>• Technical</li> <li>• People</li> <li>• Business</li> </ul>	Ad-hoc approach.	<ul style="list-style-type: none"> <li>• A general tool than can be used by anybody</li> <li>• Flexible</li> </ul>	<ul style="list-style-type: none"> <li>• No continuation of decision-making.</li> <li>• Increase people resistance to change.</li> <li>• Not comprehensive</li> <li>• Ignores critical issues such as organizational readiness</li> </ul>
Outsourcing	-	-	Project	Transfer risks of unsuccessfulness due to technological changes to a third party.	-	-	<ul style="list-style-type: none"> <li>• Save long term cost as a result or risk bearing by the third party.</li> <li>• The organization can focus on their core business.</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of control on the desired IT system.</li> <li>• Information security will be at risk.</li> <li>• Expensive on the first phase on investment</li> </ul>
Model of Change Management	Orlikowski & Hofman (1997)	Technical	Project	Predicting changes that will occur during system implementation.	<ul style="list-style-type: none"> <li>• Anticipated changes</li> <li>• Emergent changes</li> <li>• Opportunity-based changes</li> </ul>	<ul style="list-style-type: none"> <li>• Literature review</li> <li>• A case study</li> </ul>	<ul style="list-style-type: none"> <li>• Empirically studied.</li> <li>• Help in controlling the project plan.</li> </ul>	<ul style="list-style-type: none"> <li>• Does not discuss about any unforeseen changes during the IT implementation.</li> </ul>
Three-E Strategy	Haymes (2008)	People	Organization	Awareness in changing mindset to accept new technologies.	<ul style="list-style-type: none"> <li>• Evident</li> <li>• Easy-to-use</li> <li>• Essential</li> </ul>	Personal experience.	<ul style="list-style-type: none"> <li>• Increase awareness among people.</li> </ul>	<ul style="list-style-type: none"> <li>• Not empirically study.</li> <li>• Not comprehensive</li> <li>• Neglect infrastructure issues.</li> </ul>
The Gartner's Hype Cycle's Priority Matrix	Gartner (2010)	Management	Organization	As a guideline in choosing right technology to be adopted in an organization.	Duration of adoption	Not stated.	<ul style="list-style-type: none"> <li>• Useful to assess any new technologies.</li> <li>• Clearly stated how many years the technology could be adopted.</li> </ul>	<ul style="list-style-type: none"> <li>• Neglect people and management issues.</li> </ul>
CALM	Koehn & Adler (2010)	People and management	Organization	Measuring and addressing organizational readiness.	<ul style="list-style-type: none"> <li>• Organizational mindset</li> <li>• People mindset</li> <li>• Infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>• Delphi technique.</li> <li>• Metric values 1 to 100.</li> <li>• Respondents were leaders and seniors workers.</li> </ul>	<ul style="list-style-type: none"> <li>• Empirically studied</li> <li>• Focuses on tangible factors</li> <li>• Reduce risks of people resistance</li> </ul>	<ul style="list-style-type: none"> <li>• Neglect intangible factors especially on infrastructure</li> </ul>
Cultural Theory	Jackson & Philip (2010)	Technical and work environment	Organization	Continuation in upgrading the infrastructure and setting mindset.	<ul style="list-style-type: none"> <li>• Techno-cultural emergence</li> </ul>	<ul style="list-style-type: none"> <li>• Interviews</li> <li>• Documentary analysis</li> <li>• Observations</li> </ul>	<ul style="list-style-type: none"> <li>• Investigate the role of culture in managing technological change</li> </ul>	<ul style="list-style-type: none"> <li>• Does not provide a framework or guideline derived from this theory.</li> </ul>
A Unified Model of Technology Resistance	Laumer & Eckhardt (2010)	People	Organization	Provide understanding of why people reject technology.	<ul style="list-style-type: none"> <li>• Resistance as personality trait</li> <li>• Resistance to change</li> <li>• Resistance behavioral intention</li> </ul>	<ul style="list-style-type: none"> <li>• Case study</li> <li>• Statistical analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Help in identifying which people issues to accept new technology.</li> <li>• Focuses on IT pre-implementation stage.</li> </ul>	<ul style="list-style-type: none"> <li>• Represents only one single case study.</li> <li>• No focusing on technology change.</li> </ul>