Survey on Available Methods to Evaluate IT Investment

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Abstract: Making decisions for Information Technology (IT) investments have become a critical decision in businesses today. IT investments are being seen as a strategic investment for many organizations. However, organizations are also concerned about how IT investment can be translated into dollar returns. In response, earlier literatures had attempted to propose evaluation methods and measurements to justify such investments. Unfortunately, none of these proposed solutions were considered appropriate for IT investment, hence to date, there are still no formal evaluation methods on the measurement of such investments. In view of this, this paper attempts to perform a survey across different evaluation solutions to justify IT investment and seek to further understand the different reasons that may prevent the IT industry from defining a standard evaluation method.

Keyword: IT Investment, Evaluation Method, Return on Investment, ROI, Net Present Value, NPV, Payback, PBK, Internal Rate of Return, IRR

1. Introduction

Making decisions on Information Technology (IT) investments have become critical for businesses today. According to Gartner, worldwide IT spending was USD $3.8 trillion in 2014 and this is forecast to grow 3.8% in 2015 (Rivera & Meulen, 2014). IT investments are being seen as a strategic move for many organizations to gain a competitive advantage and improve productivity, as well as boost the performance of their businesses (Powell, 1992). As spending on IT increases, awareness of the returns from IT investment is becoming more significant. Organizations are concerned about how IT investment can be translated into dollar returns. Two-thirds of Fortune 100 companies' chief executive officers believe that they are not getting the most out of their IT investments (Anandarajan & Wen, 2006). Organizations have found the increase in demand to justify the raising of IT expenditures and they are seeking to find a possible solution to measure the return on IT investment and its contribution to business benefits. Nevertheless, there is also a consensus among IT professionals that IT investment should be carefully justified and measured. In response, various literatures attempted to propose more reliable and more accurate evaluation methods and measurements. Despite the various attempts, none of these proposed solutions were considered to be appropriate for IT investment. Moreover, many of these evaluation methods measurements are still in the conceptual stage so cannot be used in practice. In fact, the current evaluation methods used by many organizations to measure the return on IT investment are the traditional financial measurements such as return on investment, payback period and net present value (Mills, Snoeck and Haesen, 2009).

Evaluating IT investment is a problematic topic. Although many organizations claimed to use financial measurements as an evaluation method, various literatures that highlighted its limitations claimed that the financial measurements are inadequate for measuring IT investment (Lefley, 2013). Hence, there is no formal evaluation method or measurement that is standardized across the IT industry. Neither traditional evaluation methods nor newly proposed methods are considered by both academics and practitioners to be the standard evaluation method and measurement for IT investment. Therefore, in this paper we are attempting to seek a greater understanding on the different reasons that prevent the IT industry from defining a standard evaluation method. This paper will consolidate and review existing evaluation methods used by numerous organizations. It will also focus on the traditional financial measurements as they are considered to be the only appropriate measurements used by various organizations. Finally, the paper concludes by analyzing the key reasons and attempts to address the fundamental question of why the IT industry is still unable to define a standard evaluation method and measurement for IT investment.

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2. IT Evolutions and the Impact upon Organizational Investment

For the past few decades, IT has been seen as a strategic investment by many organizations. As such, organizations are forced continuously to explore and invest in new technologies in order to stay competitive in today's market. Various studies have shown the different impacts, from technology development to organization operation and performance, and especially that organizations which extensively invest in IT will generally have a stronger strategic position in the market (Cron and Sobol, 1983; Dos Santos, 1991; Ho, Wu, Xu, 2011). In practice, organizations' expenditure on new technologies has been growing at a rapid pace. Technology development has shifted from technologies that replace manual human tasks to technologies that support decision-oriented and business innovation tasks (Powell, 1992; Anadarajan & Wen, 1999; Silvius, 2006). The various studies have demonstrated the close relationships between new technologies and organizational investment, which needed to be reviewed and understood prior to re-looking at the IT investment evaluation methods and measurements.

A Silvius (2006) study showed a clear relationship between technology development and organization investment where the IT investment evolves from the cost saving focus to a productivity and business value focus.

Starting from the 1970s, organizations were focused on investing in new technologies to improve efficiency in administrative processes. The impact of IT investments during this period had been examined and highlighted in various literatures. Bender's (1986) study concluded a positive impact of IT investment in the insurance industry where new technologies helped to reduce overall operation cost. Northrop, Kraemer, Dunkle, and King (1990) also examined the similar influence of IT investment upon government organizations after computer systems were introduced in the area of availability of information, efficiency of operational performance and interaction with the public. Automated Teller Machines (ATMs) are a perfect example of modern technology that still exists today. The financial industry made a huge investment in the technology, which helps them to reduce manual bank processes and improve accessibility for bank's customers to date (Brynjolfsson, 1993)

During the 1980s and 1990s, the global market workforce had shifted from mainly production workers to information workers ("white-collar" workers), especially in the U.S market. Organizations were concentrated on investing in technologies that empowered the end-user and tailoring technologies to render appropriate processes in the organization, rather then on cost reduction (Roach, 1991; Wulf & Jarke, 2004). Benjamin & Blunt (1992) indicated client/server computing and back-office operation were the collective investments during this period. It allowed the organization to decentralize and distribute database processes across the organization. For example, call center applications became able to access customer data independently. Rai & Patnayakuni (1997) further added that the technologies empowered end-user and improved organizational effectiveness as the technologies allowed openness and a seamless computing environment.

The technology development during the 1980s and 1990s set up a foundation for rapid growth during the late-1990s and 2000s. The global market focused on the latest technologies was no longer about hardware and software. Various literatures indicated rapid growth in both network computing and the Internet during this period. Brodersen's (1997) study indicated the growth was due to the transition from computing to information access and manipulation. The Internet traffic alone is estimated to be over 400TB with an average growth of 20% per month. Quelch & Klein (1996) estimated the global transaction volume to reach more than USD $1 billion. Sweeny (1998) suggested that 64% of all IT spending during this period is related to network computing, specifically to transform businesses into e-businesses. Huge demand for any-to-any communications and interoperability forced the organization to focus their IT investment to provide ubiquitous access, location transparency, compelling usability, modularity and scalability. As IBM Chairman Lou Gerstener claimed, "The networked era promises to create the richest, most dynamic marketplace that the world has ever known."

The current period is considered to be another technology revolution in the organization. The development of technologies like the Internet allows organizations to explore new markets, new products and provides a new means of developing customer loyalty and innovating new businesses. Gartner.com (2014) explained it as "The Internet of Things", where it is a combination of data streams and services created by digitizing everything to create basic usage of manage, monetize, operate and extend. Silvius (2006) explained that the focus of the IT

investment during this period was to gain four (4) sources of values: more efficient, more effective, more flexible and more innovative. The amount of empirical evidence supported the explanation and indicates the alignment of IT investments and business strategy in order to take full advantage for business value. (Kim, Jang, Lee, Cho, 2000; Tallon & Kraemer, 2003). David Cearley, vice president and Garnet fellow supported the statement and identified that the top technology trends that organizations could not afford to ignore in today's strategic investment are: The merging of the real and virtual worlds, the advent of intelligence everywhere, and the technology impact of the digital business shift (Gartner.com, 2014)

Technology advances for the past few decades have allowed technology to break away from the traditional low-level back office and data processing tasks. Many organizations are now using technology to improve customer service and product delivery, increase flexibility, facilitate innovation and create new businesses (Serafeimidis & Smithson, 1999). Gartner technology trends continue to indicate the rapid pace in the development of new technologies. The continuity in IT development trends also mean that organizations are required to increase their spending on new technologies.

3. The Needs of formal IT Investment Evaluation

Increasing marketing competition is the main reason why organizations seek an alternative to be competitive in the market. IT is regarded as the alternative for organizations to continue investing in IT in the past few decades. Despite the continuity of IT investment, the question still remains as to what are the impacts, if any, from IT investment. Business executives are now more skeptical about IT investment. They doubt if the contribution of IT has any impact on the overall organizational objective and financial performance. Organizations are concerned about how IT investment can be translated into dollar returns. Therefore, they must reconsider their IT investment strategy in order to justify the actual returns from the investment (Teo, Wong and Chia, 2000; Morgan, 2005; Stewart, Coulson and Wilson, 2009).

According to Symons (2006), the key consideration of IT investment strategy is for organizations to consider the actual returns on their investment in dollar value, in which the appropriate measurement of costs and benefits has to be identified. However, the costs and benefits of IT investment have been the topic of many debates among both academics and practitioners. The topic highlights the difficulties for organizations appropriately to define and evaluate IT investment (Silvius, 2006). Farbey, Land and Targett (1992) discovered that only half of 98 organizations surveyed subjected their IT projects to formal costs and benefits of evaluation. Lin, Graham and McDermind (2005) also found that 59% of large organizations in Australia did not even evaluate costs and benefits of IT investment due to inadequate and inappropriate evaluation methods. A survey conducted by Ross & Beath (2002) in e-business investment suggested that 25 out of 30 companies relied on business cases to justify the investment. There was no mechanism to justify the actual costs and benefits from the investment, instead of the business case being used to justify, the investments were based on a lump sum from the marketing department. Furthermore, a recent survey conducted with organizations in the UK suggested that more than 66% of 71 respondents have established formal IT evaluation procedures within the organization. Of these, only 34% of them used the evaluation formally (Lefley, 2013). Various literatures highlighted that there was a lack of solid procedure for evaluating, prioritizing, monitoring and controlling IT investment (Gunasekaran, Love, Rahimi and Miele, 2001). There was neither uniform conceptualization nor appropriate measurements for IT investment (Rai, Patnayakuni, Patnayakuni, 1997). The difficulties of measuring IT investment were stated by Powell (1992), who said that "The computer is a difficult investment to evaluate because the income from the computer is not as clearly defined as it is with other investment."

Nevertheless, various authors attempted to define an evaluation method for IT investment. Based on Powell's (1992) research, IT investment evaluation methods can be classified into two (2) main categories: Objective methods and Subjective methods. The former refers to traditional methods, which aim to quantify system inputs and outputs in order to attach values to the items. On the other hand, subjective methods evaluate the IT investment value from the attitudes and opinions of users and system builders.

In a similar aspect, Bannister and Remenyi (2000) provided a classification on IT investment evaluation method based on how value translates to an investment decision. They classified the methods into three basic groups: Fundamental, Composite and Meta methods. The fundamental method is a set of measurements which attempt to classify a set of characteristics of investment down to a single measurement; for example, capital

budgeting techniques such as return on investment and internal rate of return. The composite method is a combination of Fundamental measurements to obtain an overall picture of value of the investment; for example, balanced scorecard of Kaplan and Norton (1993); the investment portfolio approach (Ward, 1994), and Simple Multi-Attribute Rating Techniques (Goodwin and Wright, 1998). Lastly, the Meta method attempts to select the optimum set of measures for a context or set of circumstances; for instance, the comparison between different projects or IT investment overtimes.

In contrast, Gomez & Partner's (2012) research suggested that previous literatures on IT investment evaluation methods were focused too much on the concern of the effective use of technologies, and explained the effectiveness in a variety of ways, ranging from relatively simple accounting measures to complex multi-dimensional balanced score-card. They argued that the IT investment evaluation has dependency with the transformation of technologies in which today, the focus is more on the intangible aspects of business benefits including loyalty and brand improvement. Gomez & Partner's suggested model by Wiggers, Kok, and De Boer-De Wit (2004) on IT Value Perception Model shows where the IT evaluation should be based on the maturity of IT in the organization. As the maturity of demand and supply would have an impact of the value of the technology invested, the evaluation should lean towards dimensions and metrics related to enablement of the investment e.g. the value of IT infrastructure investment should increase with higher demand and supply required from the infrastructure (Gomez & Partner, 2012). Taylor & Zhang (2007) supports the argument and states, "When a technology is regarded as the prime initiator of change in society, measuring the changing technology might seem to be enough" and that "measuring computers, cables, and connections tells us very little about the actual state of society". Gunasekaran, Love, Rahimi and Miele (2001) provided an example of IT intangible benefits from IT infrastructure investment where organizations are slowly realizing the benefits to help transform their business processes.

Nonetheless, the costs and benefits from IT investment are still difficult to assess and quantify. Even though a number of different literatures offered different methods and measurements with different focuses to resolve IT investment evaluation problems, none of these techniques is considered as being a formal evaluation method for the IT investment. Anandarajan and Wen (1999) stated, "Researchers have attempted to develop evaluation measures for examining the effectiveness of IT. Some of these measurements, however, though having academic value, have the problems of being esoteric and difficult to operationalize". Thus, formal evaluation methods considered by most industries and organizations are still based on financial measurements such as Return on Investment (ROI), Payback (PBK), Net Present Value (NPV) and Internal Rate of Return (IRR). According to O'Leary (2002), "Any business leader who does not understand an ROI analysis is in trouble". A survey by Fortune magazine of management executives indicated that the financial measurements provided a comprehensive analysis of performance encompassing both the present and the future (Papp, 1999). Financial measurements may not provide qualitative measurements, but it does provide a good indicator for the organization. Bacon (1992) indicated 75% of 80 organizations surveyed used financial measurement as the criteria for IT investment decision, and 40% applied the measurements for the investment evaluation, particularly for large projects. Paul and Tate (2002) indicated over 86% of the 288 CFOs that responded to their survey on the use of financial measurements as formal evaluation techniques on IT investment did so. Mills, Sneock and Haesen et al (2009) highlighted various CIOs claim pressure to calculate the return on IT investment, and their research showed the consistency of use in financial measurements over time from 1990 until 2008. Furthermore, Botchkarev, Care and Andru (2011) stated, "ROI is the most popular metric to use when comparing the attractiveness of one IT to another. ROI is a key metric used by CIOs to help quantify the potential success of an IT or business project. "More and more managers are being asked to justify their spending using ROIs", says Linda Matthews, assistant professor of management at the University of Texas-Pan American (O'Leary, 2002). In the following section, we will explore the various financial measurements used by organizations to evaluate IT investments.

4. Financial Measurements for Investment

In general, investment is defined as the expectation of future benefits, which is created from time, energy or matter spent in a specified date or time frame. In economics, it is defined as a purchase of goods to create wealth in the future (Investopedia.com, 2014). In finance, it means putting money into an asset with the expectation of capital appreciation, dividends, and/or interest earnings (Wikipedia.org, 2014). An investment is an exposure of cash with an objective to produce cash inflows in the future in which the return on investment would be measured by how much cash the investment is expected to generate (Fields, 2011).

Return on investment (ROI), therefore, is implied by its name. It is the measurement of magnitude on benefits and costs with a simple calculation of the benefit (return) of an investment divided by the cost of the investment (Investopedia.com, 2013). ROI can also be understood as "ROI method", "ROI approach" or "ROI analysis" which consists of a number of financial measurements such as Internal Rate of Return, Net Present Value or Payback Period (Fields, 2011; Schmidt, 2014). These measurements provide different comparisons on the investment and they provide a different type of indication on the investment. The common indication of these measurements is the expected cash flow from the investment. The cash flow projection provides an estimate of the net financial impact of a decision over costs, benefits and time periods (O'Leary, 2002).

ROI measurements can be classified into two (2) common categories: Discounted cash flow (DCF) and Non-discounted cash flow (Non-DCF) (Mathur, 2011). The DCF comprises ROI measurements that consider the concept of the time value of money. All future cash flows are estimated and discounted to make the present value (Wikipedia.org, 2014). The known financial measurements in this category are Net Present Value (NPV), Internal Rate of Return (IRR), and Real Option Value (ROV). On the other hand, the Non-DCF does not take into consideration the time value of money and discounted future cash flow. It ignores the size of the investment and any cash flow that takes place after the investment has been recovered (Rushinck, 1983; Collier, 2003). These measurements include Accounting Rate of Return (ARR) or Return on Investment (ROI) and Payback period (PBK).

The following examples describes individual ROI measurements:

Account Rate of Return (ARR) is the profit generated as a percentage of the investment. It is seen as the equivalent to the ROI. It expresses the average return on the investment as a percentage of the investment where the investment value for ARR is its depreciated value each year. It assumes that the cost of the project will reduce to zero over the life of the project. It usually assumes a life of five (5) years with no residual value at the end of the lifetime. In general, the higher ARR indicates a good return on investment (Leftley & Sarkis, 1997; Collier, 2003).

Payback (PBK) is the calculation of how long it will take in terms of cash to recover the initial investment, on the assumption that the shorter the payback period, the better the investment (Kee & Bublitz, 1988; Collier, 2003). The measurement is different from other calcualtions as the measurement intends to measure the risks associated with the investment. Consideration of PBK is especially important for companies with limited cash flow (Fields, 2014).

Net Present Value (NPV) is the comparison of the present of value of future cash flows to the initial capital investment. It is a time series of incoming and outgoing cash flows in which it also can be described as the difference in amount between the sum of discounted cash inflow and cash outflows. It compares the present value of money today to the present value of money in the future. A positive calculation of NPV means the actual return on investment is more than the target rate (Collier, 2003; Fields, 2014; Wikipedia.org, 2014).

Internal Rate of Return (IRR) is similar to NPV; it evaluates the value by trial and error. It involves repeated calculation of NPV where different discounted rates are applied until NPV is equal to 0. It is the calculation of the rate until the investment break-even (Collier, 2003; Wikipedia.org, 2014)

Real Option Value (ROV) is founded on the theoretical framework that investment decisions should be made from the point of view of the stakeholders. It is emerging as a new standard for valuing, selecting, and managing strategic investments. ROV recognizes that the business environment is dynamic and uncertain, and that identifying and exercising managerial flexibility or "real options" can create the greatest value. The calculation is an updated version of NPV where it is a sum of passive NPV and strategic option value. The strategic option value is calculated from benefits and costs with the probabilities of occurrence for each variable used (Dos Santos, 1991; Mun, 2002; Dawson & Considine, 2005; Herath & Bremser, 2005).

These measurements were generally used by large organizations to evaluate new investment (Drury & Tayles, 1997). By comparing ARR/ROI, PBK, NPV, IRR and ROV, these measurements provided different aspects of new investment and were required to be calculated prior to any investment. According to O'Leary (2002), an organization needs to build a business case, which includes a financial story based on facts, reasonable assumption, and logic. In order to create such a business case, an organization must document not only the

costs and benefits of the decision but also the time period required. Therefore, organizations required the calculation of these measurements to provide coverage in various aspects prior to an investment decision.

5. Issue with Financial measurements: Financial Aspect

Although financial measurements had been highlighted as a mandatory calculation to justify new investment, various accounting literatures were still debating over the appropriate financial measurements for justifying new investment. Do we require having all measurements or selective measurements calculated? The answer is no. These measurements are only used by large organizations. Most organizations rely on simple or single measurements such as ARR/ROI. The only instance when an organization would consider using multiple and sophisticated measurements is when dealing with the risks associate with the investment (Klammer, 1972; Sundem, 1974; Robichek, 1975). None of these common financial measurements are able to consider all the risks associated with the investment. Therefore, the following section attempts to analyze and identify the key issues associated with the individual measurements.

ARR/ROI is considered to be the most popular ROI measurement of the 1970s. According to Lefley and Sarkis (1997), the reason for ARR/ROI usage is because of its simplicity, ease of calculation, ease of understanding, and the use in accrual accounting measurements. Schmidt (2014) further highlighted the main reason for its popularity is because the measurements reflect the reality of the investment. ARR/ROI used relevant and actual variables to calculate the return on investment whereas other measurements used ideal theoretical variables. Compared to other financial measurements, Whittington (1969) also claimed that "ARR may be superior to IRR or other measures merely because, in a world of uncertainty and imperfect information, it is the rule of thumb to which decision-makers cling". It is trying to explain the actual situation normatively rather than trying to define the optimal calculation. However, some literatures argued that the measurement does not take fully into account the fact that cash flow may vary over time (Carmichael, 2011). ARR/ROI measurement assumes a state of certainty, which does not exist in the real world. As Leftley and Sarkis (1997) stated "ARR/ROI attempts to evaluate the profitability of a project, but in a very simplistic and, in many cases, unrealistic manner". Furthermore, Fisher and McGowan (1983) and Salamon (1985) argued that there is an error in ARR/ROI calculation caused by systematic error that makes the calculation inaccurate. They demonstrated the level of desperation on the variables impacts the inaccurate result of ARR/ROI.

Unlike ARR/ROI, PBK maintains its adoption rate as a secondary evaluation measurements PBK is different from ARR/ROI because of its objectivity. PBK attempts to evaluate the investment in terms of risk instead of profitability. It stresses that cost recovery is important in a time where interest rates are increasing and liquidity is decreasing (Rushinck, 1983; Collier 2014). However, the issue with PBK is the time itself. The question is how to fix the required payback period, which can create another debate by itself. Traditionally, organizations used a standard of 3 or 5 years to define the payback period (Mumford, 1972). Rushinck (1983) supported the argument where the length of PBK should not be set as a guideline for a specific investment opportunity. The timing also limited evaluation of other information since the measurement focuses only on the timing for break-even. PBK ignores the time value of money beyond the cut-off date, which is often impacted by economic uncertainty and fluctuation (Rushinck, 1983; Graham & Harvey, 2002). With PBK limitation, the recent study suggested that PBK is found to be co-existing in use with NPV or IRR as secondary evaluations. According to Dean (1989), many organizations use PBK to support DCF measurements for risk assessment, where the various discount rates applied would reflect the risk identified from PBK; both measurements are commonly used as consecutives stages in the appraisal of investment, and both have to be satisfied, whereas in the past only the PBK would have been critical (Mumford, 1972; Kee & Bublitz, 1988).

Since the 1980s, the popularity of ARR/ROI and PBK has started to decline. The adoption of NPV and IRR started in the 1980s and slowly became the primary evaluation method, used in many organizations to this very day. Various literatures commonly point out similar issues against ARR/ROI and PBK where the time value of money is what makes these measurements inaccurate (Schall, Sundem and Geijsbeek 1978; Freeman & Hobbes, 1991; Chen, 1995). The time value of money implies that a dollar received today is worth more than a dollar that will be received in the future. It can be referred to as "Present discounted value" (Rushinck, 1983; Collier, 2003; Fields, 2014; Investopedia, 2014). DCF measurements are taking into consideration the time value issue and the variation of the cash flow. Agnes Chang, Kite and Radtke (1994) indicates that the measurement meets the evaluation criteria in terms of wealth maximization, time value of money, systematic risk accommodation and generation of optimal rankings of mutually exclusive alternatives. NPV is expressed

explicitly as the effect of an investment on the organization's wealth position. On the other hand, IRR generates an interest rate that is useful in evaluating the project's profitability. Lefley & Sarkis (1997) further highlighted that both NPV and IRR are considered economic factors, unlike ARR/ROI that considered only accounting factors.

Furthermore, a number of literatures also highlighted different issues against NPV and IRR. Dos Santos (1991) highlighted the major problem using NPV and IRR is the estimation of the real benefit of the project. Real benefits such as user-oriented benefits are generated by the investment. For example, an IT project would create various benefits such as new investment opportunities, and reduction in future development cost. Levinsohn (2001) stated that NPV and IRR typically undervalue assets or potential projects from the investment. "When management has significant flexibility to respond to uncertainties, the discounted cash flow valuation will probably under value the asset, the company, or the project because it uses expected cash flows, and we know that things never turn out as expected". Liginlal, Khansa, and Chia (2010) highlighted NPV and IRR assumes pre-commitment to future plans and considers investment decisions as "now or never" propositions. It should incorporate the flexibility of investment decisions. In practice, management may wait until more information is gathered before committing more investment to the project. The limitation of NPV and IRR led to further evaluation in financial measurement to incorporate management flexibility. These new measurements have been suggested by a number of researchers. Real Options Valuation (ROA or ROV) is one of many measurements most discussed. Hearath & Bremser (2005) stated that ROV addresses the limitation of NPV and IRR, as the measurements ignore the time value of the deferral option, which undervalue the investment opportunities. Hence, ROV provides insight information to business opportunities and it allows decision makers to conceptualize and compare various investment options. The measurement, therefore, claims to provide a formal procedure to support decision makers to make sense of the complex and ill-defined nature of flexibility. It claimed to be able to capture the idea of being able to "keep our options open" i.e. investing in real assets like plant and machinery, property and IT (Busby & Pitts, 1997; Ghahremani, etc., 2012)

According to a recent research paper by Ghahremani, Aghaie and Abedzadeh (2012), financial measurements were evaluated using ten (10) evaluation criteria to compare individual financial measurements as follows:

Evaluation Criteria	ARR/ROI	PBK	NPV	IRR	ROV
1. Does it consider the entire lifetime of the investment?	Yes	No	Yes	Yes	Yes
2. Does it consider time value of money?	No	No	Yes	Yes	Yes
3. Can risk-level be entered into the feasibility evaluation?	Yes	No	Yes	Yes	Yes
4. Can risk-level be entered in the selection of mutually exclusive projects?	No	No	Yes	No	Yes
5. Does it consider other department's perspectives except investment department?	No	No	No	No	Yes
6. Does it consider non-financial benefits, intangible, or immeasurable factors	No	No	No	No	Yes
7. Can several sources of uncertainty be entered into the appraisal process	No	No	No	No	Yes
8. Does it consider managerial flexibility to alter the course of a project	No	No	No	No	Yes
9. Does it manage the project actively?	No	No	No	No	Yes
10. Does it take into account behavioral and organizational biases?	No	No	No	No	No

As demonstrated, various literatures have highlighted different issues against each individual financial measurement. The key issues identified explain why a single measurement may not be able to provide appropriate evaluation for new investment. These key issues are still an ongoing discussion among professionals across different industries

6. Issue with Financial measurements: IT Aspect

In the previous section, we have seen the fundamental issues associated with financial measurements from a financial aspect. Measuring and justifying IT investment are considered to be a problematic issue without

considering financial measurements. As Powell (1992) stated, IT is difficult to quantify: "The computer is a difficult investment to evaluate because the income from the computer is not as clearly defined as it is with other investment". By applying financial measurements to evaluate IT investment, an ongoing debate was created among financial and IT professionals. As William Kelvie, CIO at the Federal National Mortgage Association, stated: "What we're doing with technology today is creating an entrepreneurial situation where you're unleashing potential for huge change. A classic ROI may not capture that" (Moad, 1995). There appears to be a general agreement among IT literatures that financial measurements ignore the true value of IT investment by such indirect and intangible benefits (Botchkarev, Care, Andru, 2011).

The key argument is that financial measurements may lead to inadequate or outdated IT systems (Ford, 1994; Gunasekaran, Love, Rahimi and Miele, 2001; Lin, Graham and McDermind, 2005). Al-Yaseen, Eldabi and Less (2006) also claim that there is no body of knowledge in the area to help improve the financial measurements used in evaluation, which encourages decision makers to refrain from employing it together. The term "productivity paradox" is typically used in various studies. It is the traditional economic measurement to measure an organization's investment. Therefore, many organizations expect to evaluate IT investment by measuring organizational productivity. However, many have argued that the simple cost and benefit evaluations are inappropriate and it requires new techniques to evaluate IT investment (Ford, 1994; Leftley & Sarkis, 1997; Brynjolfsson & Hitt, 1998). The International Federation of Accountants (IFAC) published a report demanding that IT investment should be evaluated differently and it should be based upon the impact to business transformation, business costs/benefit and business strategy. "We have trouble convincing ourselves of value in business terms. We cost justify new systems on the basis of lies and overstatement, we then do not measure the true business value" (Ford, 1994). Wulf & Jarke (2004) supported the argument and commented that today IT investment has a direct impact to empower the end-user to improve productivity.

As such, various literatures provided several reasons on why financial measurements are not appropriate to evaluate IT investment. Forrester research highlighted five key criteria to be addressed by financial measurement for IT investment, which can be summarized as follows (Symons, 2006):

Evaluation Criteria	ARR/ROI	PBK	NPV	IRR	ROV
1. Too Many Measurements	Yes	Yes	No	No	No
2. Precision does not exist	Yes	No	No	No	No
3. Capturing Intangible	No	No	No	No	Yes
4. Capturing Future Opportunities	No	No	No	No	No
5. Incorporate Risk of IT project	No	No	Yes	Yes	Yes

Too Many Financial Measurements: For IT professionals or technical persons, there are too many financial measurements out there. For those from a non-accounting background, these measurements provided various interpretations that may lead to inconsistency. Various literatures also stated different aspects of financial measurements, which can be confusing to someone with a non-accounting background. The complexity of the calculation would make IT professionals avoid using these financial measurements. Fung & Stapleton (1980) stated that given the range of tools and techniques available for evaluating the investment, financial managers are confronted with the problem of selecting an appropriate technique that adequately reflects the goal of the investment. In addition, there is no suitable mechanism to select one measurement over other measurements. Each financial measurement has its own purpose. Therefore, there won't be a single measurement to evaluate IT investment.

The measurements imply a precision that does not exist: None of the existing financial measurements would be able to address this issue because the measures are calculated by a formula and produce estimated numbers. These numbers produced are based on various assumptions, so the accuracy of the calculated measures is only as good as the underlying assumption (Symons, 2006). This would be a challenge since selected assumptions would be based on IT professional understanding of these financial measurements. ARR/ROI and PBK may have simple calculations but NPV, IRR and ROV would require a certain level of understanding to support the calculation e.g. discount rate. Hence, several literatures have already indicated that companies in the UK and US were under-investing because they misapplied or misinterpreted financial measurements (Drury and Tayles, 1997). The difficulties of producing the estimated numbers contributes to the uncertainty of the expected impact of IT investment such as project duration, number of people involved, and distinctive political agenda (Irani & Love, 2001).

Capturing Intangible Benefits: Intangible benefits remain the issue for all financial measurements. Various literatures claimed that all financial measurements failed to capture intangible benefits generated by the investment (Antine, Eph, Stray, 1998). Oliver, Barrick and Janicki (2009) indicate several reasons for the challenges to indicate intangible benefits in evaluation measurements. These challenges include identifying the intangible benefits from the investment, developing standard measurement for these benefits, incorporating these benefits into financial measurements, buy-in with business units on the benefits claimed and post-project evaluation. Gomez, & Pather (2012) further summarized the issue of capturing the intangible benefit as difficult to quantify and difficult to put a financial value on the benefit. As a result, many organizations have a tendency to put intangible costs and benefits as a low priority for investment consideration (Lin, Graham, McDerind, 2005). Having said that, Ghahremani, Aghaie and Abedzadeh (2012) claimed ROV would be the alternative resolution for this issue. The measurement assumes that the benefits are subject to market risks, whereas investment costs depend on internal private risk. Therefore, the measurement is not only used as a single discount rate for all future cash flow events; it should be incorporated into the changing risk structure of cash flow over time.

Capturing Future Opportunities: No financial measurements are able to capture or estimate benefits from all future opportunities created by the investment. An example would be implementing an ERP system, which would provide future opportunities to layer on human resources, supply chain and analytics, etc (Symons, 2006). Botchkarev, Care and Andru (2011) stated that the future opportunities couldn't be easily measured. It is often impacted by time value of money, risk and uncertainty. An alternative consideration claimed by Dos Santos (1992) is to break down single projects into two separate projects (first-stage and second stage) as it would introduce probabilities of the second stage's outcome to consider and improve the evaluation.

Incorporate risk of IT project: Traditionally, IT project risks are not included into the calculation because organizations do not understand the technologies and risks associated with the technologies. The problem with measuring IT investment is because the definition of IT investment is too broad and therefore it does not distinguish among different types of IT, with respect to its effects (Teo, Wong, Chia, 2000). In fact, an IT organization track record of delivering IT projects is on average 20% over budget (Symons, 2006). Today, there are too many risks to consider and these measurements are not able to incorporate all of them into the calculation, although some of these risks have been considered a form of discounted cash flow in financial measurements such as NPV, IRR and ROV.

7. Conclusion

There is a need for appropriate evaluation measurement for IT investment. Various literatures demonstrated growth in using financial measurements to evaluate IT investment. However, these financial measurements have not been shown to be a standard evaluation for IT investment. ARR/ROI and PBK are basic measurements and claim to be the simplest evaluation, but the issue of time value of money still impacts the accuracy of the measurements. NPV and IRR seem to be the alternative for a specified period. However, when there is change in marketing and IT trends, the accuracy of NPV and IRR becomes much less. The declining use of NPV and IRR is due to the rapid change in markets and increasing demands of shareholder value. Boards of directors typically set quite high 'hurdle' rates for investing in different assets. These are commonly in terms of payback periods of two to four years or ROI rates of 25–50% in which the expectation had reduced the importance of discounted cash flow techniques (Collier, 2003).

The studies also demonstrated the needs of new financial measurement to evaluate emerging IT investment. Boer remarked, "the era of discounted cash flow came to an end". Ochoa (2004) further explained the DCF failed because it does not take account of values such as intellectual capital, market power, and real options, and empirical evidence shows that ROV would be a better option. Busby & Pitts (1997) supported the argument. They claimed traditional ROI such as NPV and IRR are likely to be an unreliable guide to value and the ROA provides a more formal procedure for value flexibility. (Busby & Pitts, 1997; Ochoa, 2004.

From our best knowledge, we highlighted five key reasons on why we still are unable to define a standard financial measurement to evaluate IT investment. The rapid growth in technology development continues to be a key influence on these reasons. As the technologies are shifting from replacing manual human tasks to supporting decision-oriented and innovation tasks, it created a challenge to identify the right factors to be used for individual financial measurement. The tangible factors, intangible factors and unknown risk associated

with new technologies created a fundamental challenge to estimate the right value for the calculation. Hence, the IT industry required new financial measurements, which consider these challenges to provide formal evaluation methods for IT investment. Various literatures and research indicate possible frameworks and methods for IT professionals to be able to measure IT investment. However, it would require time for the organization to prove the concept and accept these frameworks and methods.

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