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Keywords: ICT evaluation; Intangible Benefits; Mobile Computing; Construction Sites

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ICT Investment Evaluation and Mobile Computing Business Support for Construction Site Operations

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Abstract

The intangible qualitative innovation benefits of Information and Communication Technology (ICT) are essential for improving quality of production, enhancing business activities and creating new competitive opportunities. Still, these benefits are not accounted for in traditional financial investment evaluation methods like Return On Investment (ROI) and Net Present Value (NPV). The strict quantitative financial methods for evaluating ICT investments leave out most of the strategic long-term performance benefits that ICT provide. There is a need for a multidimensional evaluation method that includes the long-term performance perspective, generation of system usefulness and future business value of ICT investments.

This paper starts from a general perspective of ICT investment evaluation. It describes the complexity of ICT benefits, some of the common pitfalls when estimating the business value of ICT and two general approaches for evaluating ICT investments. The paper then reflects upon the benefits of mobile computing for the construction site production environment and the evaluation of such a technology investment in that business context.

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1. Introduction

"You can see the computer age everywhere but in the productivity statistics" (Solow, 1987).

The so-called productivity paradox of Information and Communication Technology (ICT) has been debated and analyzed for over twenty years. The particular issue in focus has been whether the often huge investments in ICT have resulted in significant productivity gains or not. Brynjolfsson (1993) presents four explanations why ICT have not shown measurably improved productivity and therefore caused speculation of a seeming ICT productivity paradox:

1. Measurement errors – Outputs, inputs and benefits are not being properly measured by conventional evaluation approaches. The core of the ICT productivity paradox.
2. Lags – Time lags due to learning and adjustments of the new technology make analysis of current costs versus current benefits misleading. Benefits from ICT can take several years to show in significant financial terms.
3. Redistribution – ICT may be privately beneficial to individual firms but do not contribute to the total output of an industry or the economy as a whole.
4. Mismanagement – Decision makers may not be acting in the interests of the firm. Political interests and/or poor evaluation practice may contribute to failure to realize observable gains from ICT investments.

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Mismanagement in combination with mismeasurement is a viable explanation for the productivity paradox, resulting in failure to recognize new technological potential, needed changes and organizational effects in the implementation process, and lack of knowledge and methods to estimate and evaluate innovation benefits of ICT. These weaknesses have resulted in a static status of "what gets measured gets managed" (Willcocks and Lester, 1996).

The purpose of this paper is to draw attention to the complexity facing organizations when they are about to evaluate in-house ICT investments. A mobile computing case in the Swedish construction industry is used to further illustrate the unique requirements of evaluating a mobile ICT investment in an existing business environment.

2. Technological shortsightedness

ICT implementation and evaluation is an interdependent long-term process. An ICT investment plan and its following implementation should be supported by an ongoing evaluation of the benefits for the individual users as well as the organization. But it is unrealistic to expect immediate organizational benefits from the technology implementation. The effects of ICT have to be optimized and accomplished over a period of several years, rather than at a single point in time close to the implementation stage (Byrd et al., 2006). An evaluation method that takes into account a longer time period of the ICT investment provides more insight and better information for evaluating the impact of the technology in the organization.

The long-term performance perspective is often neglected in technological investment decisions. Some investments that are considered unprofitable may actually be beneficial because they enhance a firm's competencies and enable it to introduce and produce more profitable products in the future. The 'technological shortsightedness' (Milgrom and Roberts, 1992) in investment decisions focus too much on the costs and benefits of developing the current production, instead of how to create future business potential. New ICT solutions are often designed and used to improve efficiency of what is currently done, rather than thinking about these applications as opportunities to redesign and redefine the organization and its business activities (Dos Santos and Sussman, 2000).

Corporate government that is trained in financial analysis but lack integrated technological-organizational knowledge will encounter problems. These managing teams often defend their investment estimates based on a narrow set of 'hard' benefits, and ignore long-term innovation benefits that are difficult to quantify. They may also fail to distinguish technologies that offer these important benefits from ones that do not. Realizing and understanding the complementary nature of organizational and technological innovation benefits are of great importance to enable long-term strategic positioning and improve future business performance (Milgrom and Roberts, 1992).

For strategic technology investment decisions, a financial investment calculation based solely on direct cash flows often lead to the wrong answer because a large part of the value of the project may come from its indirect effects on other business units or projects in the organization (Milgrom and Roberts, 1992).

3. Intangible benefit

In the corporate world today, a company's official book value accounts for less than half of its market value (Kristensen and Westlund, 2003). This gap between book value and market value comprise the intangible assets and benefits of a company, and has made the relevance of a firm's balance sheet questionable. There is a need for improved methods for evaluating intangible assets and benefits and include these in the financial reporting to better correspond to the actual business value creation of a company (Eskildsen et al., 2003).

The benefit effects of ICT in organizations and its business activities are problematic to categorize and measure. A major reason for this is that traditional evaluation techniques focus on the observable aspects of output, like price and quantity, while neglecting the intangible benefits of improved quality, new products, customer service and speed (Brynjolfsson and Hitt, 2000). Also, the accumulation of intangible capital assets, such as new business processes, new production systems and new skills are treated as expenses rather than as investments. This leads to a lower level of measured output (Brynjolfsson and Hitt, 2000). The complementary changes and the quantity of intangible factors associated with ICT are very large. Even though they are difficult to estimate, they cannot be ignored when evaluating the economic contribution of ICT. Hinton and Kaye (1996) use the analogy of the investment 'iceberg' when organizations fail to comprehend the hidden intangible costs and benefits 'below the waterline' of ICT investments and its socio-technical and long-term strategic characteristics.

There is also a difference between 'benefit' and the broader concept of 'value'. The benefit of an ICT-based application is connected to the improvements of specific operational business activities. The collective set of business activity benefits can in turn generate various types of improved operational, tactical and strategic business value (Martinsons et al., 1999). Byrd et al. (2006) argue that the intangible benefits to the end-users are critical to the success of an ICT system investment that will lead to improved performance of the organization over time. Therefore, improvement efforts and evaluation methods that address the intangible user oriented needs in addition to financial impact are likely to result in long-term benefit to the organization (Byrd et al., 2006).

4. Financial evaluation

The traditional investment evaluation approaches are structured financial calculation methods that traditionally are used for accounting purposes. These techniques are based on the assignment of cash values to tangible costs and benefits, and do not include intangible factors. Investment risks can be included in some of these methods through discount rates. Short descriptions of four of the most common traditional financial investment calculation methods are presented here below.

4.1 Payback period

The payback period is the period between the moment when an investment is made and the moment when the total sum of the investment is recovered through the incoming cash flows. A time period is decided within which the investment capital must be recovered. If that time period is less than the calculated payback period then the investment calculation generate a positive return.

The payback period method should be considered the least suitable evaluation technique for ICT investments. Short-lived projects with fast payback are favored with this method and many long-term projects are rejected. This is especially harmful for ICT investments because of their strategic future oriented perspective (Milis and Mercken, 2004). Also, the payback period technique does not include risk assessment and ignores the time value of money in the evaluation. The time value of money means that if the moment of an incoming cash flow is located further into the future, the value of this cash flow will be less.

4.2 Return on investment

The Return On Investment (ROI) technique is based on the same principles as the payback period, but is a more appropriate evaluation method than payback period because it takes into account the total lifecycle of the investment. ROI still has a problem with including risk and does not consider the time value of money (Milis and Mercken, 2004).

4.3 Internal rate of return

Internal Rate of Return (IRR) takes the time value of money into consideration by introducing a discount factor. The IRR is the resulting net value threshold after discounting the incoming and outgoing cash flows. If this threshold exceeds the cost of investment capital, the calculation yields a positive return.

Nevertheless, IRR can be criticized for the following reasons (Milis and Mercken, 2004):

- The result of IRR is a percentage which makes it difficult to compare and rank different potential ICT investment alternatives of various shapes and sizes.
- IRRs that differ greatly from the cost of capital make projects with different time plans difficult to compare.
- There may exist more than one IRR for an investment.
- When the IRR method is used for deciding between different investment alternatives, risks are not accounted for. Risk levels can not be included into the selection process.

4.4 Net present value

The Net Present Value (NPV) method calculates the present value of an investment’s money flows, using a discount rate. Unlike IRR, different rates can be used to reflect the risk levels when evaluating different investment alternatives. NPV is the most complete of the traditional strictly financial methods for investment calculation because it includes the total lifecycle of the investment, considers the time value of money and incorporates multi-choice risk levels.

4.5 Financial methods and ICT investments

When the purpose of an ICT investment is to improve operational efficiency, many of the strictly financial techniques may be considered appropriate because they consider the generation of tangible financial benefits related to the direct financial costs. ICT systems aimed to improve and enhance more complex organizational information and communication processes require a richer and more descriptive evaluation framework that considers the generation of benefit and value over the complete life-cycle of the technology. Such a framework have to identify and measure tangible/financial and intangible/non-financial costs and benefits, as well as recognize the differences of benefit value of the ICT investment on operational, tactical and strategic business levels within the organization (Irani, 2002). The strict financial evaluation methods tend to favor and approve ICT investments that lead to cost savings, but miss out on future oriented strategic ICT projects (Fitzgerald, 1998). They also do not include the important intangible costs and benefits of ICT investments.

More importantly, the traditional financial methods merely consider the ‘appraisal’ of an ICT investment concerning the feasibility on an investment before it is carried out. ‘Evaluation’ is a much wider consideration of an ICT investment and is carried out during the whole life-cycle of the technology; throughout the feasibility stage, the implementation and follow-up stages (Ballantine and Stray, 1998). Stewart and Mohamed (2002) divide this ICT investment management and evaluation process into three main components:

- Project appraisal and selection – estimating benefits, risks and costs.
- Implementation and monitoring – applications, deficiencies and reviews.
- Performance evaluation – measurements, corrective actions and lessons learned.

These phases should not be viewed as separate steps, but as a continual interdependent management effort (Stewart and Mohamed, 2002). The technology that is appraised, selected and implemented needs to be evaluated with the same methods throughout all stages of the investment project. Otherwise there is a risk of mismatch of objectives over time and important benefits of the investment will be overlooked or lost. A well composed management approach for planning, implementing and evaluating ICT investments allows for high accuracy in the appraisal process, improved data on financial benefits, reduces strategic project risks and monitors both tangible and intangible benefits of the technology investment over the entire life-cycle. Such an ICT investment management process tries to find a suitable balance between combined business value and project risks (Stewart and Mohamed, 2002).

5. Integrated evaluation

The purpose of the integrated evaluation approaches is to combine and complement the quantitative financial dimension of investment evaluation with qualitative and descriptive measures relating to strategic issues such as innovation, business development and customer orientation. Two often advocated integrated evaluation methods for ICT investments, Information Economics and Balanced Scorecard, are briefly described here below.

5.1 Information economics

The staring point of the Information Economics (IE) evaluation method is a financial measure called Enhanced Return On Investment (EROI). The EROI includes cash flows arising from cost reduction and cost avoidance as well as estimation of incoming cash flows. The EROI is then supplemented with a strategic qualitative evaluation of the 'business domain' and the 'technology domain' to generate a total combined value of an ICT investment (Renkema and Berghout, 1997). IE uses a process of assigning point-rating scores to estimate the benefits and strategic relevance of ICT investments, and is generally done through an appointed group of leading persons affected by the investment decision within the organization. The point-rating process includes obtaining consensus on intangibles, quantifying the importance weight of benefits and risks on a relative scale, estimating the probabilities of benefits and risks and multiplying each estimate by the weight and probabilities (Milis and Mercken, 2004). These figures are then summed up, and the best investment alternative has the largest total sum.

IE seeks to account for a wider scope of information system benefits by including less tangible factors such as improved customer service or a higher degree of competitiveness. The benefits and risks of an ICT investment is separated into the respective domains, the business domain and the technological domain, with each domain evaluated separately. The IE approach can be criticized for relying heavily on agreement of subjective opinions (Milis and Mercken, 2004). The result of an IE evaluation is also hard to interpret because the result of the analysis is expressed in an abstract number instead of monetary terms.

5.2 Balanced scorecard

The balanced scorecard is designed to complement financial measures of past performance with measures of the drivers of future performance. The purpose is to balance short- and long-term objectives, financial and non-financial measures, lagging and leading indicators and internal and external performance perspectives (Kaplan and Norton, 1992). The balanced scorecard approach can be modified specifically for different kinds of performance evaluation purposes. A balanced scorecard for ICT investments could for example include four measurement perspectives, or scorecards (based on Grembergen, 2000):

- Operational excellence – improving existing internal processes, reducing time and cost (efficiency perspective).
- User orientation – delivering utility, usability and value to end users (effectiveness perspective).
- Business contribution – increasing the financial value of business activities and management (effectiveness perspective).
- Future orientation – technological innovation and learning, enabling development of business and organization (performance perspective).

The design of the balanced scorecard approach is aimed towards enabling a complete strategic investment management tool, ranging from initial feasibility estimation, monitoring support of implementation and follow-up evaluation (Milis and Mercken, 2004). Also, different evaluation techniques can be integrated into the framework. The financial scorecard can contain for example ROI or NPV or any other traditional quantitative measure. The NPV technique can be used to calculate cash flows of the tangible benefits and costs, as an initial quantitative feasibility evaluation. The balanced scorecard method can then be used to obtain a multidimensional qualitative evaluation, identifying and assessing intangible benefits and linking these to the financial perspective with probabilities of achieving these values. This combined method can enable a technology life-cycle evaluation that considers both quantitative/tangible and qualitative/intangible factors and their performance effects (Milis and Mercken, 20004).

5.3 Integrated methods and ICT investments

Integrated evaluation methods as the ones presented above are very useful to map out and describe the benefit range of ICT investments. Still, the problem with these approaches is that it is difficult to carry out a complete analysis and translate these innovation benefits to financial measures. Also, there are no generic ICT measures that fit all organizations. Metrics must be specifically adjusted the goals, activities and user base of a firm. The performance measures within an organization should be designed so that they involve the personal development of employees. These measures have to be relevant to the work force in performing their everyday job activities and coinciding performance measures should be identified and linked together (Folan and Browne, 2005).

ICT projects whose purpose is to introduce new systems and applications always involve a strategic dimension and include intangible innovation benefits and indirect costs (Love et al., 2005). For these kinds of ICT investments a carefully designed integrated evaluation method is a more suitable approach compared to traditional financial evaluation techniques.

Still, the most crucial part is to adjust the ICT evaluation framework to fit the specific business operations at hand, the chosen technology solution and the implementation strategy. Investment decision and evaluation is a complex management process, largely due to the wide variety of interacting socio-technical factors within and surrounding an organization. This makes a design of a generic integrated ICT investment evaluation method impossible

(Irani, 2002). Measures must be adjusted to the specific organization and continually evolve to accurately evaluate the technology in the context of its particular business environment.

6. Mobile computing value in construction

This section puts the discussion so far into an existing real life production context. The complexity of ICT investment evaluation is exemplified by the insights from an ongoing case study of a pilot project concerning mobile ICT business support for construction site operations at the Swedish construction company Skanska AB.

6.1 Management and communication issues in construction projects

The construction industry today is struggling with issues concerning efficiency, productivity and quality in its building projects, especially during the production phase. These production issues have a strong relation to the communication and information exchange between the involved parties of a construction project.

Like all business processes of any industry of today, construction projects is dependent on reliable and updated information through a number of ICT based business systems, communication tools and shared storage servers. But this has also caused an increased work load and an almost untenable job situation for production management teams at construction site operations today. Production managers, construction supervisors and superintendents are needed on site to coordinate work, do inspections, conduct environment and safety rounds, document and follow up ongoing and completed construction activities, At the same time, they also need to be located inside the site office at their computers ordering equipment and building materials, exchanging digital CAD models and drawings between architects and design engineers, e-mail subcontractors about upcoming work, follow up budget figures and invoices as well as prepare deviation reports on finished construction work with unsatisfactory result. On top of this, there are daily production meetings that afterwards need to be transcribed in computer documents and e-mailed to all involved parties.

Unanticipated events occur all the time in construction projects. To solve arisen problems and critical situations, quick access to necessary information is needed. Production management personnel therefore have to run back and forth between the construction site and their computers inside the site office. With a large part of the management team stuck at their computers several hours per day, a lot of on-site production leadership, coordination and organization are lost, resulting in deficiencies of the construction process altogether. Also, there is a waste of productive work hours when construction management staff has to carry out administrative work of construction site activities and meeting notes twice; once with paper and pen during the actual event and then again writing it down in computer document templates for reports and protocols.

6.2 Mobile production management at construction sites

The narrative above implies that the ICT tools are not adjusted to the needs and demands of site production management personnel. Existing business information systems and project communication tools are not used properly and not to the level expected. This causes performance issues for construction projects altogether. Many of the major construction enterprises have begun to recognize these issues and started to realize the potential of new mobile ICT solutions to improve the information management and project communication at construction site operations.

A mobile computing pilot project at Skanska has highlighted the potential of tablet computers with wireless network connections for construction purposes. The project has indicated that the tablet computer concept could enable an appropriate ICT platform for the production site environment.

A tablet computer looks like a laptop computer without a keyboard, and is therefore thinner and lighter than a regular portable computer. The main property of the tablet computer is that it consists of a screen with the size of an ordinary sheet of paper on which the user navigates with an electronic pen writing directly on the screen.

Pic. 1. Tablet computer test at a construction site

The pilot project at Skanska tries to identify a general ICT platform concept that delivers the mobility, flexibility as well as robustness that the construction site requires. The idea is that when production management personnel are on site they are wirelessly connected to the company network, extended from the site office via wireless access points. In the site office they can use the tablet computer as an ordinary computer using a docking station with keyboard, mouse and bigger screen at their own desks, as well as connect wirelessly elsewhere in the office, in meeting rooms etc.

The fundamental approach of this project is very simple. It is about extending existing information systems out on the site, making them mobile and flexible to access. The purpose is to adapt the access and utilization of existing ICT resources to the needs and demands of the targeted user group at the construction site. The tablet computer concept could facilitate new ways of administrating construction activities, exchanging project data and handling collaboration processes to enable construction site personnel to improve their jobs. Generating usefulness and user acceptance is of critical importance in this context, because that is what ultimately will influence much of the benefit and value creation of the technology. If the mobile ICT platform creates usefulness for the individual in his/her everyday construction activities, then it will be appreciated by construction site personnel as a helpful ICT tool and will therefore be utilized. Apart from the mobility features, another usefulness aspect of the tablet computer concept seems to relate to the procedure of working with a pen directly on the tablet computer screen. This is an intuitive user interface because production management staff is accustomed to using pen and paper on site doing inspections, documentation of activities, and taking notes on purchase orders and other on-site administrative work. With the tablet computer, the idea is that these administrative duties are supposed to be carried out once only, at the time of occurrence.

Pic. 2. Tablet computer screen with electronic pen

So, the staring point of the pilot project at Skanska is to achieve mobile on-demand access of project data and drawings on site through wirelessly connected tablet computers. With this technical setup the procurement system can be brought up on site and orders on additional equipment and material can be placed immediately as it is discovered. It can enable production management staff to be online with activity based project management budget tools on site when doing inspections and follow-ups of current and completed construction work. Environment and safety rounds, deviation reports and other inspections can be filled out on site directly on the tablet computer in digital forms and templates using the electronic pen and then upload them on shared project storage areas or e-mailed to the concerned project participants. Using a digital camera, observed construction problems can be photographed, immediately transmitted to the tablet computer via wireless bluetooth connection and attached to site inspection reports. In this way the information quality of production issues communicated to involved actors can be enhanced. In the site office, meeting notes can be taken directly with the electronic pen on the tablet computer. When the meeting is over a text recognition tool can translate the writing into an ordinary data text document which then directly can be distributed via e-mail to project participants.

The technical approach of this pilot project is rather mundane. It involves only simple and small changes in how construction data is accessed, information is administrated and how project communication is conducted. But these seemingly insignificant changes could enable a better match between information needs, communication behaviours and an appropriate on-site ICT. The key is to make production management staff at construction sites feel that the ICT tools is actually helping them performing their work, instead of being something that is obstructing them from doing an effective job in managing events and resources on site. So, much of the resulting benefit and value of the investment depends on whether the mobile ICT solution can deliver the appropriate usefulness and user acceptance or not.

6.3 Evaluating mobile computing in construction

The mobile computing concept at Skanska is going to be implemented and tested at several construction sites in Sweden. The company is hoping that the wireless tablet computer platform is going to deliver explicit benefits relating to three main areas of construction process improvements:

- *Enable more effective on-site administration of construction activities* through mobile on-demand wireless access to existing business information systems and construction project administration tools. The aim is to reduce inefficient paper work, make better use of human and material resources and create more flexible work planning, coordination and follow-up procedures of production activities.
- *Enhance real-time risk management and collaborative problem-solving in construction projects* through mobile multimedia conferencing and data exchange between construction site personnel, expert teams and project participants outside the production environment.
- *Facilitate improved on-site presence, involvement and leadership of production management* through making information management and project communication mobile. The construction management team does not have to be tied-up in front of their computers inside the site office if their ICT-based business support is made portable.

When considering the distributed benefits over a long-term perspective, the overall benefit framework of mobile computing for construction site operations becomes rather complex. Below is a simplified mind map of the scope of such a framework without showing interdependencies between different benefit measures.

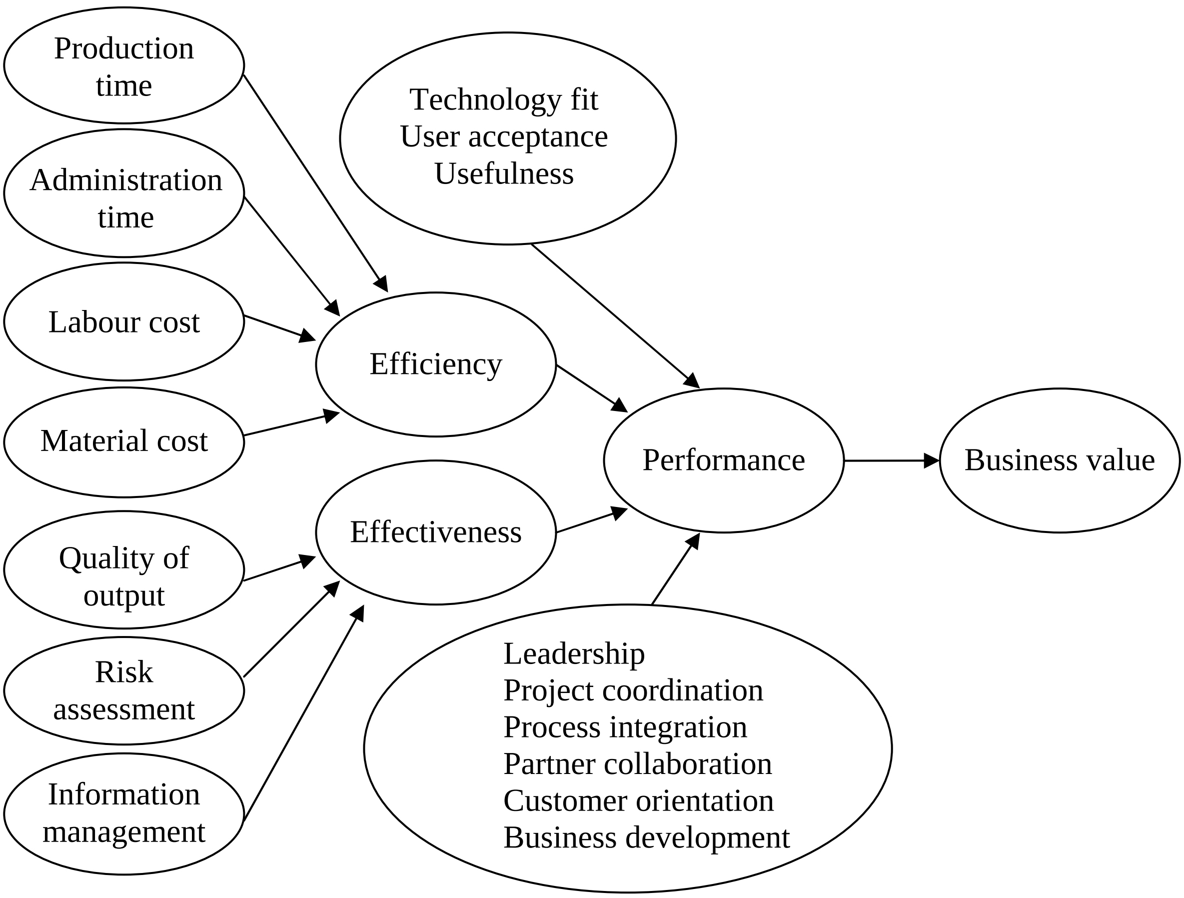

Fig. 1. Construction process innovation benefits of mobile computing at production site operations

Putting the brief case presentation into a more general discussion, mobile and wireless ICT may be an enabling technology to facilitate an improved and more flexible information and communication platform for construction site operations, which in turn can increase project business performance altogether. Considering fig. 1 above, evaluating mobile computing in a specific business context involves measuring benefits relating to three general improvement categories (based on Andersen et al., 2000):

- *Efficiency* – 'doing things right', is the rate in which inputs are converted to outputs. This could mean reduced production time, less paper work, increased labour productivity, reduced waste of material resources. Efficiency is financially measurable and is represented by money.
- *Effectiveness* – 'doing the right things', is the rate of actual outputs compared to the planned. Effectiveness is measurable but not in direct monetary terms. It is represented by improved precision of production operations such as improved building quality and accuracy in available business information.
- *Performance* – 'doing better things better', is the level of new outputs enabled, e.g. production flexibility, product and business development. Performance is not directly measurable in quantifiable terms but is evaluated qualitatively in terms of long-term business innovation capabilities, improved partner collaboration and market share.

Love et al. (2005) argue that the evaluation methods for ICT investments used in organizations in the construction industry neglect to address the complexity associated with the ICT introduction and adoption process. No single technique can cope with the wide range of perspectives and aspects of ICT investment issues. A traditional strictly financial evaluation method like NPV would only cover the efficiency perspective, and misses out on the even more valuable benefits of the mobile computing technology. The complexity shown in fig. 1 suggest that an integrated approach have to be considered to enable an improved investment analysis and evaluation that ranges from current cost savings to the creation of future business value. But this integrated evaluation method can not cover everything. Therefore it is important to have an initial idea about the scope of the current problem and what is sought to be improved. This includes identifying what the critical problem areas are, how the technology is supposed to improve these issues and an approach for assessing the improvements. The chosen integrated evaluation method should therefore include a clearly defined delimited set of goals and measures relating to efficiency, effectiveness and performance categories. The method for conducting the actual evaluation has to be carefully constructed, including how different metrics relate to each other as well as to financial and more intangible business values. The intangible benefits have to be described and their impacts on human resources, material assets, organization and business processes have to be clearly mapped out.

Four fundamental steps need to be recognized, understood and managed in the process of outlining an appropriate technology evaluation approach (based on Love et al., 2005):

1. *Determine business benefits* – Tangible and intangible benefit dimensions ranging from strategic, tactical and operational perspectives linking to specific business activities on different organizational and functional levels.
2. *Determine cost of technologies* – Tangible costs relating to hardware, software, networking and telecommunications, education and training, maintenance, consultancy and services etc. Intangible costs relating to re-design issues, delays, resistance, productivity losses, organizational changes, distraction, interference etc.
3. *Conduct financial evaluation* – Using one or a few of the more complete traditional financial evaluation methods, for example NPV.
4. *Risk analysis and risk assessment* – Identify the risks associated with the technology investment, their business impacts and probability of occurring.

A properly designed mobile computing evaluation framework for construction operations could for example contain five performance measurement perspectives; operational, user orientation, strategic competitiveness, benefits, and technology system (Stewart and Mohamed, 2001, 2003). A certain set of project-, tool- and process-specific ICT indicators could then reflect the particular aspects of how the technology affects information management and collaborative communication processes in the project organization. Such an integrated framework could enable a multidimensional evaluation of enhancements of specific construction process activities, improved efficiency, cultural change, improved user/staff training and support, tangible and intangible benefits, process coordination/integration, system usefulness and increased competitiveness (Stewart and Mohamed, 2001, 2003).

7. Conclusions

As the discussion in this paper has shown, there are a lot of complementarities between a wide range of different factors affecting the resulting benefits of implementing new ICT into an organization. There is a need for a shift of focus away from the strict financial efficiency factors to a strategic performance perspective when deciding and evaluating ICT investments. This includes a more comprehensive approach on how to manage and evaluate innovation benefits of the technology over its whole life-cycle considering both financial and intangible factors.

8. Implications

ICT evaluation has to be closely linked to the implementation and use of the specific technology within its organizational business context through an on-going integrated monitoring process. This continuous process and strategic long-term view on ICT investment evaluation include:

- Creating an implementation strategy that tries to establish cause and effect relationships, mapping desired benefits and value to achieve.
- Including sufficient generic outcome measures as well as firm specific performance drivers.
- Identifying the intangible costs, benefits and business value of the investment.
- Seeking to link the evaluation model to financial measures, striving to translate improved operational ICT benefit and value to increased financial performance.
- Understanding the specificity of each case. There are no generalized evaluation methods that suit all business organizations and all kinds of ICT investments.

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