

**TOWARDS NEW METHODOLOGIES OF MEASURING COST
EFFICIENCY AND COST EFFECTIVENESS OF GEOSPATIAL DATA
INFRASTRUCTURES - paper for GSDI7 – Bangalore - conference**

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ABSTRACT

The difficulty in assessing the cost output and outcome for Geospatial Data Infrastructures (GDI's) can be traced back to the differences between the various models and techniques that are applied interchangeably. These include economic models, statistical techniques, responsibility accounting and value approaches. Various publications have described either estimates of the total cost, possible benefits or alternative funding mechanisms needed for a GDI's. Furthermore, a number of studies have been carried out to make an assessment of the cost of implementation in relation to the potential capitalized benefits. Most of these publications acknowledge that it is difficult to make a proper assessment of its cost, and even more difficult to assess its benefits, simply because most are very intangible. In one cannot properly assess the cost and benefits, than how can one even discuss mechanisms for funding, cost recovery free access? Are in fact the right questions posed for the right purpose? Perhaps the difficulty in estimating the benefits is not in the evaluation of benefits in relation to the cost, but already the proper assessment of the cost itself. Furthermore, the reason to address the cost and benefit question is in fact whether processes, structures and institutions are effective and efficient. Therefore, a different sort of cost measurement assessment may need to be made, focusing more on relative efficiency and effectiveness rather than absolute cost and benefits measurements. This article aims at addressing this issue of cost assessment from various perspectives.

It is observed that, although obviously completely different in nature and results, the approaches in the research for health care, technical capital assets or environmental costs and impacts are useful for the question how to approach the GDI cost, cost efficiency and cost effectiveness questions. Similar to these other sectors the GDI concept doesn't seem to fit either micro-, macro- or other economic theories, which makes that – in addition to the various definitions which are around for GDI, resulting in semantic differences- the system boundaries are not clear. The activities and the actors are operational in a network of national, organizational, inter-organizational and individual related parameters. The behavior and the benefits of GDI are therefore not conform either one or the other economic theory, but will have to rely on individual kinds of approaches. As a result, one can typically observe a difference in approach between a variety of micro-analyses within organizational or business boundaries, cost spending comparisons from a user perspective, sector or activity based cost impacts or national statistics showing public versus private spending, amongst very many others.

The conclusion is that the cost of GDI problem needs to be decomposed into various approaches. These include microanalyses, activity-based analyses, cross-sector analyses and trans-organizational analyses such as virtual enterprises. Each of these approaches could contribute in its own way to the GDI and cost related questions. In particular the paradigms of value options approaches and that of virtual enterprises may provide the mechanisms to evaluate cost efficiency and effectiveness at a general level, whereas a practical way to control output performance norms could be to relate it to results obligations. A combination of these would relate the objectives of GDI to its actors, its activities, its market and its performance.

Introduction

Various publications have described estimates of the total cost (Rhind, 2000), possible benefits (OXERA, 1999; Pricewaterhouse, 1995) and alternative funding mechanisms (Giff, 2002a; Giff, 2002b) needed for a Geospatial Data Infrastructure (GDI), of which Domain based Data Infrastructures would be part. Furthermore, a number of studies have been carried out to make an assessment of the cost of implementation in relation to the potential capitalized benefits (Bernhardsen, 2001; ECORYS-NEI, 2002; KPMG, 2001). Most of these publications acknowledge that it is difficult to make a proper assessment of its cost, and even more difficult to assess its benefits, simply because most are very intangible. In we cannot properly assess the cost and benefits, than how can we even discuss mechanisms for funding, cost recovery free access? Are we in fact posing the right questions for the right purpose? Perhaps the difficulty in estimating the benefits is not in the evaluation of benefits in relation to the cost, but already the proper assessment of the cost itself. Furthermore, the reason to address the cost and benefit question is in fact whether processes, structures and institutions are effective and efficient. Therefore, a different sort of cost assessment may need to be made, focusing more on relative efficiency and effectiveness rather than absolute cost and benefits measurements. This article aims at addressing this issue of cost assessment from various perspectives with the objective to come to a comprehensive cost appraisal for GDI.

Economic modeling versus statistical accounting

Construction of analogies is a frequently used method to gain insight in an academic problem. A similar question as determining the appropriate cost for GDI would be that of determining the desirable spending for health care (infrastructure). Economists would say that there is no clear answer to this without considering which model to use, whereas statisticians would argue that one could measure any financial transaction without modeling as such. This statistical accounting approach would imply that the cost at national level could be summarized by the cost needed for all individual components and resources involved in health care. However, this does not answer the normative question of how much it should be. There is a tremendously influencing factor of political decisions, which make the question impossible to answer in an objective way. Secondly, there is the problem of the boundaries of the system. Are patients –those who pay for health services – or insurance companies – those who recover part of the health costs - part of the health cost system or not. In other words, can one objectively distinct one cost driver from the other, and determine the actual costs for whom by whom, at which particular point in time? The only way to do this is to make use of a model and something which economists refer to as the *ceteris paribus* condition, all else being equal. Costs can be modeled in a certain way, and costs will behave in a certain way depending on this model. As a result typically one can observe a difference in approach between a variety of micro-analyses at the hospital level (within organizational or business boundaries), such as (Harrell, 2001), cost spending comparisons from a user perspective (Sager & Socolar, 2000), sector or activity based cost impacts(Choi, 1997), or national statistics showing public versus private spending (example (CIHI, 2003)), amongst very many others.

Although obviously completely different in nature and results, the approaches in the researches for health care costs and impacts are useful for the question how to approach the GDI cost, cost efficiency and cost effectiveness questions. The problem with GDI is similar to that of health care in the way that the GDI concept doesn't seem to fit either micro-, macro- or other economic theories, which makes that – in addition to the various definitions which are around for GDI, resulting in semantic differences- the system boundaries are not clear. Both the activities and the actors are operational in a network of national, organizational, inter-organizational and individual related parameters. The behavior and the effects / benefits of

GDI are therefore not conform either one or the other economic theory, but will have to rely on individual kinds of approaches, similar to that of the health care sector.

Economic production modeling for GDI

So, under which conditions do the economic questions of GDI make sense? The answer lies in the conditions of the economic model in use and the statistical transaction one would like to measure. In other words, the question of the cost of GDI will have to be translated in either a micro- or macro-economic model question, or, more pragmatically, a business economic or management accounting question. In GI literature one often sees the term low-cost GIS or – more sector related - low-cost cadastre (Kaufman, 1998) or low-cost EIS (Tveitdal, 1999). The low-cost reference is however misleading, because the sum of the individual components is not the same as the system as a whole. Often it is only used to describe the micro-economic situation, i.e. an approach to whether it costs the organization less to produce the same item. In other words, there has been a mixture of the context and research paradigms. This production cost efficiency paradox can be illustrated by a simple example.

Imagine that the GI market, or the GDI at large, would behave according to “normal” micro-economic theory as the previous examples suggested. One would then measure either the collective cost pressure or the individual / micro cost pressure. The advantage of measuring the micro cost pressure is that one can immediately review the impact of a certain (national) policy on transactions by individuals or individual organizations. An example of that is the following: Suppose that the total production cost would be 200, and the number of consumers 5. In case of full cost recovery, the consumers would have to contribute an amount of 40 each. Suppose now that the production would increase in efficiency and would now cost only 180. The low-cost advocates would argue that this would always lead to lower cost per consumer, since consumers would now only have to pay 36 each in order to achieve full cost recovery. However, the model assumes here a stable market. It may be such that with the number of consumers for that particular product is not stable at all. A decrease to 4 instead of 5 would obviously lead to a contribution of 45 each, in other words a higher contribution even though the production efficiency was increased. If one operates in isolation, or if the organization is a true monopolist and equally remaining number of consumers, then cost reduction in production would directly lead to lower cost for a consumer.

However, in an economy where the producer is often also consumer itself of a number of products and services, it is not always evident which economic actor spends which amount of money on which particular product or service. To address this uncertainty activity based costing (ABC) was developed amongst others. Documents such as (Cooper & Kaplan, 1991; Hicks, 1999; Turney, 1996) prove that in certain economic production models ABC provides a more transparent picture of the actual relationship between activities and cost. (Vries & Pholbud, 2002) apply this for National Mapping Agencies. It can be shown that the model provides additional information on the cost accounting.

Part of the question is thus also a clarification of which financial transactions really take place between which actors based on which relation, and how does the relation between actors in these transactions behave. Here again, there is no uniform answer to all GI transactions. The transactions models vary from direct payments for identifiable products, to indirect or chain payments for chained value-adding products (see for example, (Krek, 2000)). Who pay whom for what is related to the system boundaries under consideration. In an open system one cannot really determine the absolute costs, because many cost transactions may “escape” the system. But even in a closed system, one could wonder whether the total costs are indeed the sum of all components, subsystems, and /or sub organizations. The examples show that the cost itself is perhaps not the issue but rather the cost behavior of different arrangements of GDI. In other words, asking the question of whether things get more or less expensive if one opts for one or the other solution. At the end of the day, this is also the type of question that a

decision maker is faced with, namely should we invest more or less, given certain assumptions and conditions. Therefore, perhaps a closer look is needed towards the kinds of cost under consideration.

One of the distinctions, also used by (Benitez et al., 2002) is that between economic and accounting costs. Economic cost is usually referred to by *opportunity cost*, i.e. the reward the factors of production involved in the provision of the service would obtain in their best alternative use. As stated in (Atkinson et al., 1997) firms make decisions based on prices and economic costs. In particular, in dynamic, competitive markets like telecommunications, and its spatial information component location-based services¹, firms base their decisions on the relationship between prices and *forward-looking economic costs*. Forward-looking economic costs are the costs, which would be incurred if a new service were to be provided (with the least-cost, most efficient technology currently available), or avoided if an existing service's provision were to be terminated, assuming that *all* inputs of the firm can vary freely (thus the term 'forward-looking' or 'long-run'). Considering the long-run economic cost ensures that the firm recovers all of its costs, not only operating and maintenance costs (which vary in the short run), but also fixed investments costs, necessary inputs in the provision of the service (which are not variable in the short run).

If market (or regulated) prices in a competitive framework exceed long-run economic costs, new providers will be attracted to the market, and this entrance would be efficient. Predictions of the market are that much is expected from the introduction of new data-oriented, value-added services, such as the Internet and location-based services, facilitated by Wireless Application Protocol (WAP) and General Packet Radio Services (GPRS) interfaces. It is estimated that 71% will offer location-based services². If market (or regulated) prices fall short of economic costs, no new competitor would have an incentive to enter the market, and some incumbent firms may decide to leave. These voluntary actions of the firms in a competitive market achieve an efficient resource allocation by adjusting price or output until the value to consumers of additional output is equal to the additional costs incurred in its production (*incremental costs*).

In contrast to economic opportunity costs, accounting costs are usually historically based costs (*embedded costs*) as registered by an internal booking system in organizations. As such accounting costs are thus often considered not dynamic with regards to the market and pricing. Allocation of resources can therefore be inefficient, if the costs aren't constantly measured and monitored. In other words, for very dynamic markets, such as location based services, only forward-looking economic costs can give operators in the market the right signals for entry, investment and innovation. At the same time, one could also argue that many future decisions can only be based on past accounting, as a result of which accounting information is also partly forward looking. Activity-based accounting is for example typically geared towards predicting forward looking economic costs.

For the telecommunication industry there is some consensus on which type of costs to use, namely the economic concept of *long-run incremental costs*.³ Part of this definition is related to the availability of universal services:

- Calculating the costs of universal service (based in principle on a long run average incremental cost methodology);

¹ <http://www.telecomweb.com/reports/cotm/lcommerce7.htm>

² <http://www3.amsinc.com/CMC/newsroom.nsf/pr/BWAD-4MUL3A>

³ See, for example, http://europa.eu.int/ISPO/infosoc/telecompolicy/review99/tcstatus_k9.htm, Commission Recommendation 98/322/EC (European Commission, 1998); or FCC Order 96-325 (CC Docket 96-98 and 95-185), 'In the Matter of Implementation of Local Competition Provisions in the Telecommunications Act of 1996', United States Federal Communications Commission, 1996.

- The practical operation of universal service funds or other financing mechanisms, and
- Determining who contributes and in what proportion to any burden associated with universal service

Is there, however a universal service in the GI industry? The answer is partly confirmative, namely with regards to so-called foundation data. (Groot and MacLaughlin, 2000) and other publications such as (Onsrud, 2001) identify some communality in the type of GI that is produced worldwide. These include the so-called fundamental datasets. The production and provision of so-called fundamental spatial datasets has traditionally been under the authority of National Mapping Agencies and other types of National Surveys. (Groot., 2001) even argues that simply because of the national interest of such fundamental datasets, its production should remain under the public administration authority. In many countries this responsibility –under public authority – has not changed, and therefore the question on its efficiency can be translated in the question of which institutional arrangement has been proven the most efficient. In analogy to what (Adamson, 2002) mention on the water resources, land and its information are both economic and social goods, where unregulated market forces can never completely and equitably satisfy social objectives. As a result, transparency and strong public regulatory oversights are fundamental requirements in any efforts to share public responsibility for providing appropriate services and information. Part of this requires a notion that fundamental information is an infrastructural asset, which needs to be managed effectively and efficiently.

Funding relations as measure of efficiency

(Mol & Kruijf, 2002) use the analogy of efficiency and effectiveness appraisal of government with those of private businesses. From a business economic point of view it can be found in the so-called “continuity conditions”, i.e. to which extent is the current financial situation of the business convincing that the business will do well enough in the future. “Steering” government organizations towards more efficiency and effectiveness, and defining incentives for these organizations to achieve this, is in principle related to the implicit demand by the human resources and other production capacity to assure continuity of their income. Both internal as external incentives for those working within the organizations are a reflection of the results on which the organization is assessed. The objective of more effectiveness needs therefore a system of “accountability” with regards to results. In business economics this is done through responsibility accounting. A general assessment of mission objectives and economic performance is often difficult to produce, and often does not lead to an unambiguous statement on the organization’s efficiency. Control and steering on the basis of financial information often only relates to the cost of human resources and materials, not so much to the actual activities. Steering in such cases can thus only be input (=staff and materials) related. Any research on which instruments / tools (conditions and incentives) to ensure an effective and efficient “conduct of business” of a government organization from a financial information perspective will therefore need to include:

- 1) The funding mechanisms
- 2) The nature and implication of this with regards to the responsibility for results
- 3) The arrangements of planning and control of this results responsibility

This assumes that not the activities of government organizations themselves determine the results responsibility, but the funding mechanisms do this.

Government organizations obtaining yearly budgets can only be assessed based on production related financial results information. How to control the conduct of business in these cost allocation centra based on the benefits will therefore have to rely on non-financial criteria. To define results responsibility requires therefore a definition which assessment criteria can be used efficiency and effectiveness. In a typical output budget assessment this is done through cost norms (relating to efficiency) and output norms (relating to effectiveness):

output budget = number of outputs X cost price per output

In practice the output and cost norms are not always sufficient and appropriate to assess the output budgets, because output needs to be assessed both on number as well as on quality. The alternatives for assessment and control based on output budgets are therefore (Table 1):

Table 1. Assessment forms of effectiveness and efficiency

Assessment forms of effectiveness and efficiency	Control and steering based on output performance norms	
	Yes	no
Control and steering based on cost norms		
yes	output budget	process budget
no	task budget	input budget

Examples of these different performance and financial assessment methods are listed in Table 2:

Table 2. Examples of responsibility budget accounting

Process budgets	Education; funding and/or FTE allocation often based on number of contact hours, while quality often based on additional steering / appraisal methods (such as visitations, peer review, etc.)
Task budgets	Research budgets; quality steered based on terms of reference, while cost control based on general resources budget
Input budgets	In case no performance or cost norms are available; only the available resources – staff and materials – are evaluated, without anything clear in return; the evaluations such as (ECORYS-NEI, 2002; OXERA, 1999; Pricewaterhouse, 1995) are in fact examples of such input budgets control mechanisms, since there are no particular indications of steering and control criteria.

The fact that most GDI's are not controlled or steered financially can be explained based on the 4 phases of governance, namely planning, authorization, management and evaluation. (Mol, 1997) argues that the activity of control is actually only starting at the moment of the authorization phase, where results responsibilities – in terms of budgets and financial results – are being authorized. In practice, such an authorization can only take place if one can realistically know how to manage and control the costs and the benefits. Since the latter is not yet clearly the case with GDIs, most plans can still be considered in the planning phase, i.e. will still require decisions on the needed resources and the aimed performance norms. Some of these performance norms could therefore perhaps only be based on value appraisals.

GDI as virtual enterprise

An approach that could potentially deal with this problem of assessing and appraising the value of GDI, is that of “virtual” enterprises. Various recent conferences have addressed this issue of virtual enterprise environments.⁴ The academic e-journal of commuter-mediated communication⁵ jointly with the journal of Organization Science⁶ dedicated a special issue to virtual organizations. (Meissonier & Feraud, 1999) even propose a whole new typology of virtual enterprises. Although most of these publications deal with the more technical aspects, similar to a “normal” enterprise, one could assess this GDI virtual enterprise by its market, its assets, its (increase in) share/ stock value, and its capacity to deal with economic risks. (Ahuja & Carley, 1998) write that:

For virtual organizations, performance metrics must cross-organizational boundaries and take collaboration into account. Therefore, measures of collective effectiveness are needed. In situations where several separate organizations collaborate, it is conceivable that each individual organization is effective on its own, yet the collaborative effort among them is not effective). As information technology enables collaborative work across organizations, there is a clear need for further research employing network level outcomes.

Performance, including cost efficiency and effectiveness must thus be evaluated across organizational boundaries. Where individual enterprises would be evaluated and valued based on their annual accounting reports, in analogy such financial accounting reports would need to be generated for such virtual enterprises. Only with such (perhaps virtual) account can be appropriately assess the sharevalue of the enterprise. One important question and research issue is therefore how shareholders –being virtual - would react to changes in such a sharevalue, and how this would effect the performance of the enterprise.

Some of these issues are dependent on its current product prices and production costs, but others have more to do with the trust in the management and maintenance capacity of the enterprise, and the trust towards changes in the (stock) market. In particular the latter issues are seldom addressed in most GI related literature. A number of publications speak of the value of GI as a product, but do not address the share value of GDI as an enterprise. Even if all production and institutional arrangements are completely the same in two different GDIs, each of their share value could still be different from the other. As a result, there cannot be a cookbook for GDI applicable for all countries, simply because the share value increase depends on different factors from country to country, or even from organization to organization. This is largely determined by the potential capacity to increase the share value of any enterprise, including that of a GDI.

The Gartner consulting group⁷ provides publications and methods to formulate the business value of IT. (Magrassi, 2002) writes that:

Even when they are truthful, enterprises' balance sheets do not reveal some important aspects of interest to every stakeholder. Ask yourself whether the following factors are important when evaluating the future profits of an enterprise:

- *Corporate reputation*
- *Brand awareness and brand loyalty*
- *Customer intimacy (for example, satisfaction or loyalty)*
- *Supplier intimacy*
- *Organizational or process excellence*
- *Quality of "human capital"*

⁴ <http://cnr.kaist.ac.kr/gc2002/>

⁵ <http://www.ascusc.org/jcmc/vol3/issue4/>

⁶ <http://web.gsm.uci.edu/orgsci/>

⁷ <http://www4.gartner.com/pages/story.php.id.2284.s.8.jsp>

It is argued that none of such factors will appear — at least in quantitative terms — in financial reports, because such reports are mostly about past spending. Yet, there are additional factors to forecast a company's financial performance. These are the "intangible assets," often referred to as "intellectual assets" or "knowledge assets." Such assets are typically also part of a CDI. In analogy to what (Applegate, 1999) note with regards to traditional approaches to valuing IT investments, CDI can therefore not be valued in the traditional sense. It can no longer be considered an expense, instead, one must think of IT as a string of value-creating investments that deliver value today and in the future. The value of these "future" uses can be thought of as the "options value" of the technology. This value-based approach could separate CDI into two broad categories:

- 1) the reusable, value-enabling technology that comprise the information and telecommunication infrastructure of the enterprise (Category 1,2 hereunder)
- 2) the CDI-enabled value-creating business solutions developed and deployed upon that platform (category 3,4,5 hereunder table)

Within each of these categories, specific types of benefits can be identified, and specific types of sample metrics could measure these. In other words, each type of benefit needs a specific type of metric to measure its performance. In table form (adapted from (Applegate, 1999)), the benefits can be described as in Table 3:

Table 3. Benefits and performance measures

Category i of benefit	Enterprise benefit	Market/industry benefit
1) Platform improvements	Improve ability to share information, communicate, and control activities inside the enterprise	Improve ability to share information, communicate, coordinate, and control activities with customers, suppliers, and business partners
2) Options value	Increase the functionality, flexibility and "useful life" of the internal IT infrastructure	Increase the functionality, flexibility, and "useful life" of the industry IT infrastructure
3) Commerce	Improve core operating activities inside the firm (e.g. procurement, sales, customer service)	Improve existing supply/distribution channels that link the firm to customers, suppliers, and business partners or create new ones
4) Content	Improve decision making and enhance organisational learning	Exploit the economic value of information by adding value to existing products and services and creating new ones
5) Community	Enhance collaboration and coordination of work and commitment and loyalty of individuals and teams	Establish a position at the center of an electronic market and maintain that position by ensuring loyalty of all members

Such benefits can be measured by performance measures such as listed in Table 4:

Table 4. Sample metrics and performance measures per category

Sample metrics per category i	Performance measures resulting in a value change $\Delta V(i)$
ICT technology	<ul style="list-style-type: none"> - Lower operating and maintenance costs - Improve application development process increase the useful life of the platform

	<ul style="list-style-type: none"> - Increase range of options for new business solutions
Process performance improvements	<ul style="list-style-type: none"> - Savings in paper, communication, supplies, transactions, inventory, etc. - Speed increase by reduction of process steps, cycle times, etc. - Quality improvement by decreases in service failure rate, process errors, etc.
Increase shareholder loyalty	<ul style="list-style-type: none"> - Increased satisfaction and retention: <ul style="list-style-type: none"> o Customers o Suppliers o Partners o Employees
Increase revenues, profits, and value-added	<ul style="list-style-type: none"> - Increase sales in existing markets - Increase revenue from sales in new markets - Decrease prices yet sustain margins - Increase profitability - Improve productivity: <ul style="list-style-type: none"> o Revenues per employee o Profits per employee o Operating margins - Increase cash flow - Improve competitive position - Increase market share - Increase stock price

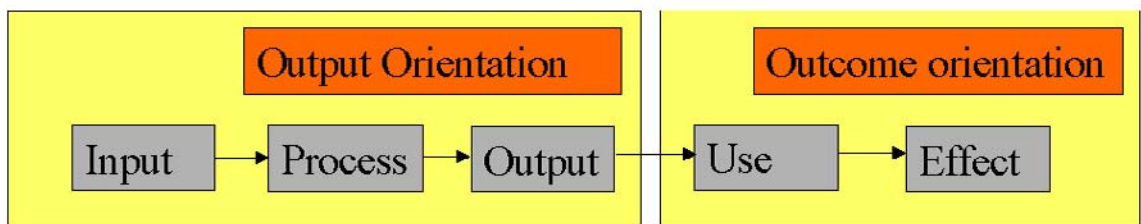
Towards a process-based appraisal

As shown above, there are different perspectives to the cost question. On the one hand one could model the production-based outputs and the efficiency by which this output is organised (accompanied by statistical or management accounting tools), on the other hand there are a number of tools available to measure the overall performance and outcomes. In the discussion of how to (re-) shape public information providers, the unresolved questions seem to be both economical (efficiency question as well as the costing and cost recovery issues) and institutional (how to shape or reshape the organisational agreements such that they (re-) fulfil a certain need in society). If the objective would be to come up with comprehensive cost appraisals one would need to combine these various approaches. This combination must be structurally based on the combination of Neo-Institutional Economics (NEI) and New Public Management (NPM).

NIE theories compare the cost effect trade off between formal institutions and informal institutions. This trade-off is often calculated in the form of transaction costs, whereby the degree or amount of transaction cost is a measure for the effectiveness of the institution under consideration. In other words, the degree of transaction cost by the institutions of GDI provides a measure for the effectiveness of GDIs. An approach of NEI and transaction cost one also finds in evaluating efficiency of physical infrastructures. One key ingredient for enhancing efficiency of infrastructure is through an increased focus on reliability of services. Where the first aim of infrastructure deals with access to information services, one can say that access alone is not enough. For users, reliability means that a service has a high probability of being available in the quantity, quality, and at the time required. This concept can be directly linked to a specific use. Substantial changes in reliability will induce changes in users' behaviour.

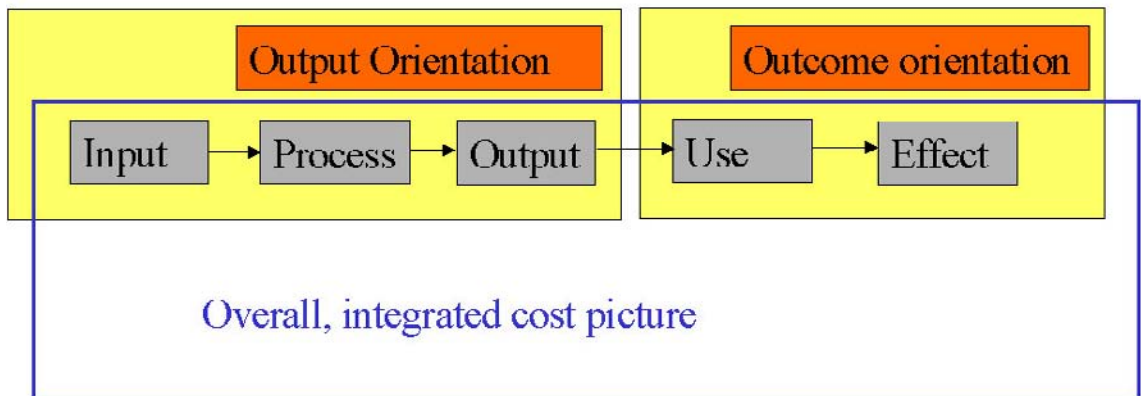
NPM in turn is new in the sense that public sector management is including issues of business strategies, cost performance and a critical review of how public financing is used. Some researchers and politicians speak amongst others of “modernization” of government and governance through public administration. Although not a formal theoretical concept, there are a variety of publications, which often originate from the more theoretical NEI but take a more practical, retrospective and/ or normative approach. NPM publications look very much at how the public sector is producing its products and services. Such insights can be relevant for the questions of how efficient GDIs are producing its cadastral products and services. Questions of institutional reform, possible privatization and/or cost recovery should thus be seen in the light of both theories.

Based on the virtual enterprise model and the need to relate efficiency to effectiveness, the following approach to efficiency and effectiveness is taken. The economic activity of GDI is taken as a process, from input to effect. One can however make a difference between a more production, i.e. product or output process, and processes that support certain (desired or undesired) effects, or outcomes. The combination, however, entails the complete economic process. In figure form one could regard this as follows:



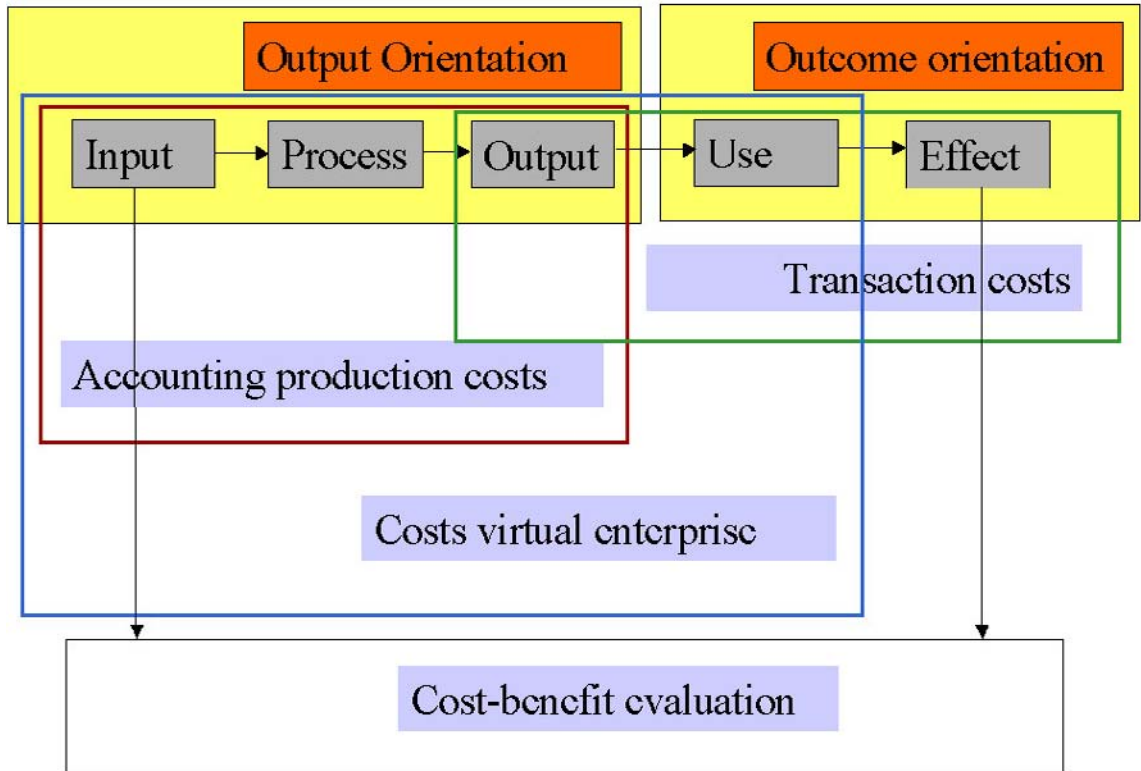
As the cost is incurred in all parts of this process an evaluation of the total costs could give insight to the overall efficiency and effectiveness questions:

Efficiency evaluation of economic processes

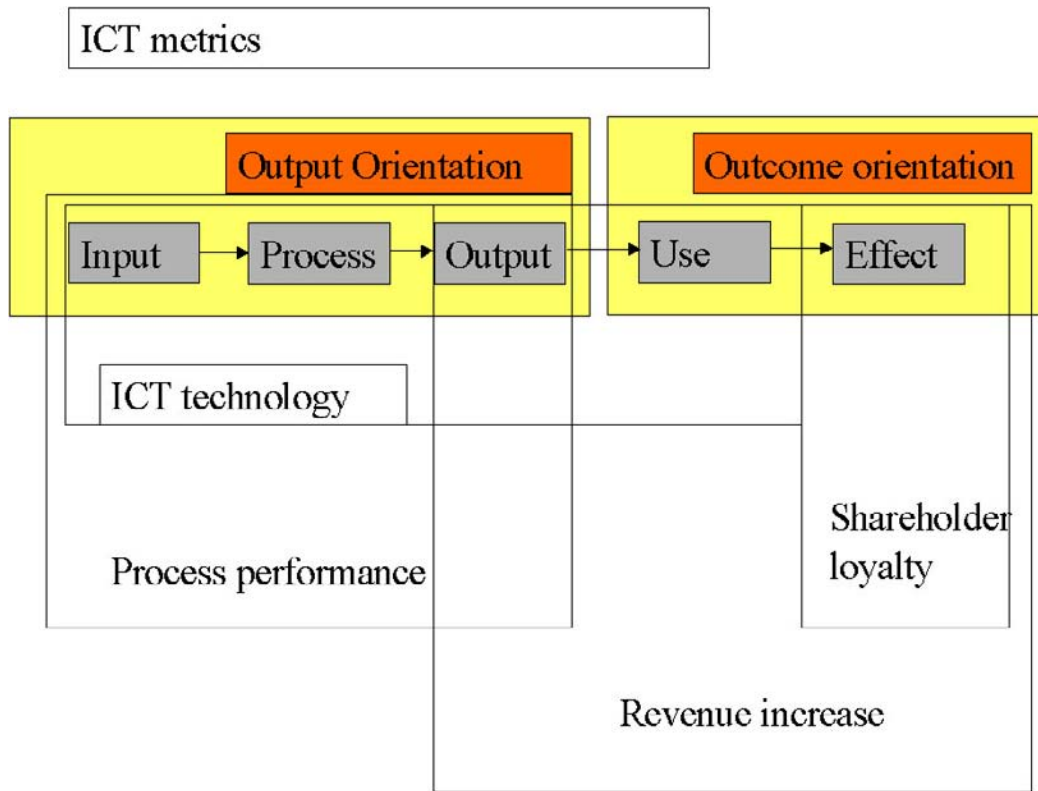


The types of costs, which are incurred in the process, are the following:

Efficiency evaluation of economic processes

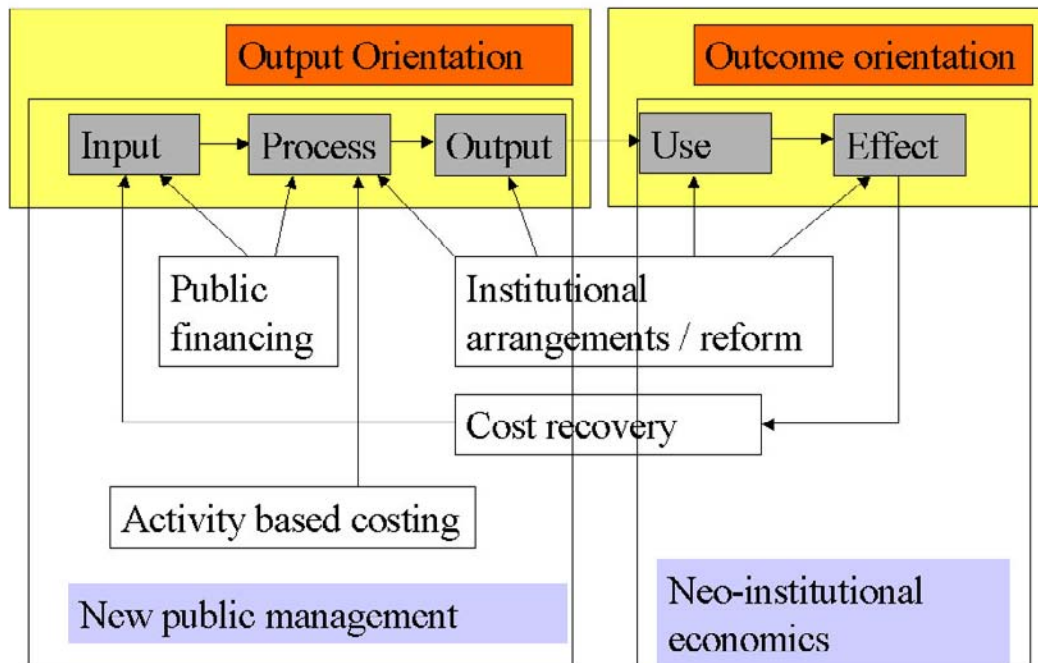


When relating the above metrics to the process picture than it would look like this:



The relation to the theoretical background would be as follows:

Choice of economic theory to evaluate



Conclusions

The cost of GDI issue needs to be decomposed into various approaches. These include microanalyses, activity-based analyses, cross-sectoral analyses and trans-organizational analyses such as virtual enterprises. Each of these approaches could contribute in its own way to the GDI and cost related questions. In particular the paradigms of value options approaches and that of virtual enterprises may provide the mechanisms to evaluate cost efficiency and effectiveness at a general level. A practical way to measure and control output performance norms is to relate these to outcome results obligations. This would relate the objectives of GDI to its actors, its activities, its market and its performance.

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