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Economic analyses for ICT in elderly healthcare: questions and challenges

Vivian Vimarlund and Nils-Göran Olve

Elderly healthcare is a likely arena for extensive change in years to come, and information and communication technology (ICT) will be an important enabler of such change. Before investing in new systems and practices, there will be a call for evaluations. To date, economic evaluations of ICT applications in healthcare have been rare, and a literature review did not turn up any examples of such evaluations of elderly care. The options for elderly care will often have to transcend organization boundaries, as the point of many ICT initiatives now being discussed is to make healthcare institutions, home care, and self-administered care interact in new ways. Analysts performing evaluations of such complex changes will have to be very specific about such classic issues in economic analysis as defining alternatives, the basis for comparison, and combining different indicators into an overall evaluation.

Keywords

economic evaluations, elderly healthcare, information and communication technology, Sweden

Introduction

Elderly people are becoming an increasing percentage of the population of industrialized countries. Some require special attention and vigilance due to their progressively reduced degree of autonomy. The traditional approach for taking care of the elderly has been to move them to elderly care centres. However, many would prefer to stay in their homes, for several reasons. One of the most important is to continue their life as usual, but to have the flexibility to belong to a healthcare service network [1].

Sweden, like other countries, faces major challenges in meeting increasing demands for healthcare services with limited resources. Proposals for developing the elderly care of the future have therefore focused on empowering care recipients and their relatives, and using ICT to provide personalized proactive and prospective health services through the implementation and use of home telemedicine, telemonitoring, teleassistance, and telehealthcare [2, 3]. Also, the use of non-invasive sensors to transmit test results from home to healthcare centers has been proposed in order to monitor individuals' wellbeing [4], and e-commerce has been promoted to support daily activities such as shopping.

However, while pilot studies indicate the good efficacy of ICT in healthcare for elderly at the intraorganizational level [5, 6], less is known about the cost-effectiveness and efficiency of the developed applications at the *interorganizational* level. Studies performed in this area are often limited to discussions of the technical aspects and/or the direct cost of the technology in use [7]. The potential effects of the use and implementation of ICT are identified, but are not analyzed from an interorganizational and economic perspective. Examples are the formation of networks and possibilities to develop online services, switching from payment per visit (PPS principle) to payment per episode of care [8], and the use of telehealth as a homecare business solution [9].

Technical difficulties no longer seem valid as explanations for this delay in the full-scale implementation of ICT-enabled new care models. Storing and transmitting large volumes of information have become feasible, and hardware such as fiber optics, cables, satellites, ISDN, and safe and secure technologies are available. Residential broadband networks are becoming available to interconnect households in local communities world-wide, providing one common gateway for information exchange. However, the diffusion of ICT applications in elderly healthcare is still much more limited than one could expect from the generally hopeful tone in current studies in the area. Recent studies indicate that a major impediment for investments in ICT applications, especially for the elderly, may be a lack of evidence of their impact. This refers both to the patient–provider relationship and (in particular) to the impact of ICT for healthcare on the total system of users, organizations, stakeholders and society as a whole [10]. Economic evaluations in this area are often partial evaluations, limited to how much the ICT will cost and how much reimbursement for production of home telemedicine services can be expected.

The *aim* of this paper is to describe the challenges that economic evaluations have to overcome, especially in elderly care, and the necessity to develop models and methods to identify the changes enabled by ICT. A secondary goal is to increase knowledge about the role and aim of economic evaluations and develop realistic expectations about which questions can be judged from an economic point of view.

Method

The base material for the present study consists of a review of existing scientific publications in the area 'ICT for elderly homecare'. A search for literature was conducted using the Internet and the Linköping University Library service, and the MEDLINE database. We reviewed also the proceedings of AMIA (1995–2003) and MEDINFO (1998–2004) conferences, journals such as *Telemedicine*, *International Journal of Medical Informatics*, *Health Informatics Journal*, *Journal of Methods in Medicine* and *Journal of the American Medical Informatics Association,* and the *Yearbook of Medical Informatics* (1998–2003),

as well as websites such as the Telemedicine Information Exchange (http://tie.telemed-org/homehealth), the Telemedicine Research Center (http://trc.telemed.org) funded by the National Library of Health, and the National Institute of Health (http://www.nlm.nih.gov). These have extensive materials including non-peer-reviewed magazines, newspapers, newsletters, books and summaries of book chapters, as well as references to a number of researchers that perform projects in the area of telemedicine, telehomecare, telehealth or home telehealth. We searched using terms and combinations of terms such as: economic evaluations, management and IT, telemedicine and evaluations, economic assessment and cost-effectiveness and ICT. Through the HIS-EVAL network, we also had up-to-date contacts with other researchers from the area of evaluations and medical informatics.

The bibliographic findings were read to decide if they belonged to the scope of the research field. Studies considered of relevance for the present article were those with an explicit focus on economic effects or economic evaluations of the use of ICT for elderly care at home, including evaluation of hardware and software used for patient care or education at home. Qualitative evaluation models, or approaches aiming to evaluate technical and organizational effects, were not considered in this study. Some studies discuss the importance of ICT and of adjusting it to work routines, but they do not evaluate or quantify economic consequences.

Ideas on economic evaluations in other fields were derived from more general literature in the area and from both authors' previous published research in the area of strategic management, medical informatics and economic evaluations of ICT in healthcare [11–14].

The context

Investments in ICT systems are based in part on expectations of improving interorganizational networks, reducing costs, controlling resource allocation, and achieving higher quality [15, 16]. That is to say, the introduction of ICT is assumed to enable rationalization in the sense of improvement of different observable processes. However, it is also expected that ICT applications will contribute to individual empowerment and stimulate learning, and thus increase the possibility of independent living at home.

Healthcare services for the elderly are usually provided in collaboration between hospitals, elderly care centers and primary healthcare.[2] Introducing ICT support to allow elderly people to live longer at home will thus have to be linked to changes in work processes and organizational practices for all of these. To achieve the benefits of new technology, extensive change ('reengineering') is often required, and sometimes redesign of organizations. A conceptual illustration of this is provided in Figure 1. Obviously, the redesigned practices need to safeguard that basic health problems are dealt with, and that specialists will be consulted when needed.

Apart from healthcare institutions, there will be obvious effects for relatives, municipal services, and housing providers whose roles may change. This in turn will affect human and social, cultural and organizational dimensions for these actors. Any economic evaluation will need to recognize that the system we are dealing with is not just an 'information system', but an entire grid of interlocking actors and work processes whose boundaries need to be determined. Such 'integrated care' has received increasing attention in recent years, and ICT may become an important driver in this development.

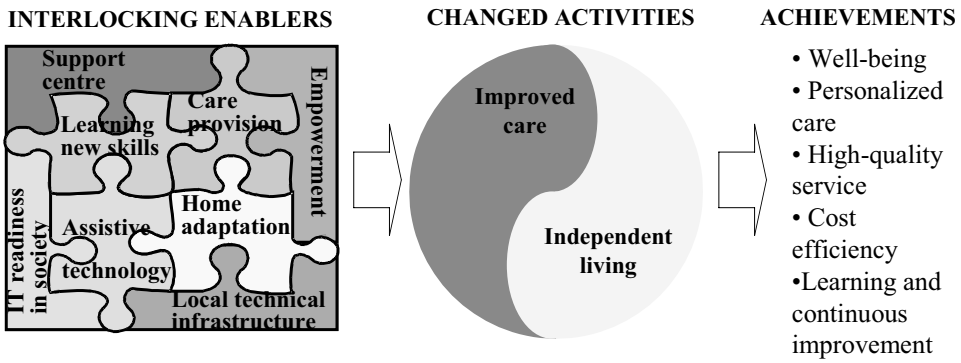

Figure 1 Effects of the introduction of ICT and expected achievements as a consequence of independent living in the area of elderly care

Some of the contributors to a recent anthology on integrated health initiatives in Western European countries [17] use terms such as 'virtual organization' and stress the need to share information about patients, but they do not give any example of an integration project that was triggered by new technology.

This means that various challenges have to be overcome before ICT can achieve its potential in elderly healthcare. One of these is to design systems that truly support the workflow in the complex environment that healthcare constitutes [18]. Another is to develop ICT systems that support both the internal and the external stakeholders' demands [19], i.e. adaptation to home environment, patient-driven ICT applications, and networks for interchange of knowledge. In addition to this, it is important to construct user-friendly ICT and to maintain the focus on patient data, but at the same time to provide useful and satisfactory systems at a reasonable cost and at a reasonable time [20]. To maintain and enhance the quality of life for older citizens, ICT for the care of the elderly further involves facilitating independent living, promoting social integration, enhancing opportunities for learning to control chronic diseases at a distance, and training and increasing the availability and quality of care and technical assistance. In addition to this it is expected that ICT applications contribute in reducing the increase of cost of care, supporting occupational activities, and increasing the exchange of knowledge between healthcare personnel. Worries about cost and who should pay what among the several actors involved probably also put a brake on progress.

The complexity of the expectations, comprising technical and human and organizational aspects, the absence of clarity of the core questions, and the absence of long-run strategies to be evaluated, have all made economic evaluations difficult to develop and perform [21].

Previous economic evaluations

In the reviewed literature, we find no economic evaluation focusing specifically on elderly care, and high-quality economic evaluations in the area of medical informatics are rare [7–10]. There are, however, partial economic studies in the areas of telemedicine, health information systems, and computer-based patient records. In these, direct medical costs

are the main indicators of effects, with some estimates of transportation costs. From these a breakeven analysis can be performed, where investments are compared with direct savings over time [22]. When measuring the cost-effectiveness of health information systems in general, indicators of effects concentrate on human factors, organizational constraints, and the costs and benefits caused by the system as such, without addressing the complex total package of changed organization and work practices. Intangible benefits, also important in convincing decision-makers, have not been quantified, and usually studies simply enumerate the various intangible benefits rather than quantifying them.

In general, evaluations performed in the area of medical informatics have covered the strategic implementation and performance of ICT, or use approaches that consider social and technical aspects as inextricably intertwined, and as equally important in information systems design, implementation and evaluation [23]. Issues such as the importance of job satisfaction, workers' needs, work practices and skill enhancement when ICT is designed and implemented are discussed and analyzed, but there is a lack of combined economic analyses based on post-implementation performance, i.e. ICT's benefits to business processes [24]. Evaluations then provide no accurate answer as to how to combine efficiency, effectiveness and business process benefits derived from ICT implementation and use, and more importantly, they fail to recognize differences in perceptions between various participants estimating benefits and those measuring them. Evaluations, which have been performed as partial studies, have therefore been accused of being unusable or even confusing for decision-makers and stakeholders [25]. Given the diversity of the studies in terms of design, topics, covered populations and healthcare settings, more general conclusions about the economic consequences and effects of ICT are not feasible.

This is particularly the case at the *interorganizational level*. There the most common approach to analyzing the effects of ICT on organizational structures has been transaction cost theory [26, 27]. More recent attempts with a focus on the *intraorganizational* level have tried to evaluate savings due to improved quality of project information, savings due to productivity improvement and cost reductions, and transformational[3] benefits of ICT [28] using frameworks such as return of investment (ROI), internal rate of return, and payback period, or using such approaches to describe users' requirements and organizational effects. However, most of the ICT applications in the area of elderly homecare are developed and applied in non-profit organizations. For these, although purely financial evaluations obviously matter, they need to be complemented with more broad-based economic evaluations. Also for this reason, existing evaluations must be considered too partial to convince practitioners. They fail to consider both ICT-induced benefits apart from direct savings, and the efforts needed to enable the change: overcoming user resistance, training and technical support, and achieving management support.

Studies in the area of medical informatics show that people and work processes usually undergo unexpected changes when ICT is introduced, and that changes associated with its introduction are often drastic and cause intraorganizational tension [12, 29]. For this reason it has been argued that in order to avoid unexpected costs associated with ICT implementation it is necessary to identify risk-bearing factors and minimize inefficiencies.

Information systems are being marketed to healthcare organizations to provide management information, to control costs, and to facilitate total quality management (TQM) and continuous quality improvement (CQI) programmes. However, in the literature reviewed, we do not find any instances of more specific economic studies addressing the

large-scale redesign of organizations and work practices that we regard as likely for this specific area.

Stakeholders and managers must understand the multiple roles of technology and consistently develop a business case when making technology investment decisions. Organizations driven by such an understanding will have a robust infrastructure of enabling technology designed to integrate people and process elements with technology to achieve the goals and initiatives of the organization.

An agenda for economic evaluation of ICT in elderly healthcare

To match expectations about the varied benefits to be derived from ICT in elderly healthcare, several issues need to be considered when using economic evaluation methods and models. These are not specific to elderly healthcare, or indeed to ICT applications. But the combination of elderly healthcare and ICT presents more difficult evaluation problems than most other fields because of the complexity of expectations and the variety of end-users.

In this section, we provide an overview of some issues that need to be addressed in designing economic evaluations. By this term we mean a process of observation and analysis that aims to support decision-making by providing information on available courses of action. We believe that the issues we raise are uncontroversial and long established in policy evaluation and business studies. What is of interest to us here is rather the questions arising about how they should be handled in connection with proposals concerning ICT in elderly healthcare. Could it be that uncertainty concerning how to deal with these issues explains the lack of evaluations in practice?

Issue 1: specifying what is being evaluated

Two features characterize economic analysis.

First, economic analysis deals with the inputs and outputs, sometimes called costs and consequences, of activities. Linking cost (resource use) and consequences allows decision-makers and stakeholders to reach the final decision and trust that ICT will be effective.

Second, economic analysis is about choices. Resource scarcity and our consequent inability to produce all desired outputs necessitate that choice must and will be made in almost all areas. These choices are made on the basis of many criteria, sometimes explicit but often implicit. Economic analysis seeks to identify and to make explicit such criteria [30]. Choices, and thus evaluation, may concern future alternatives. But past performance may also need to be evaluated, in order to support choices to continue current practices or not.

Good economic evaluations of ICT, especially for elderly healthcare, have to be performed as a comparative analysis of alternative courses of actions in terms of both their costs and their consequences. The basic task of evaluations is to identify, measure, value and compare the costs and consequences of the alternatives being considered. Economic evaluations therefore presuppose comparison of alternatives through the identification and description of the programmes to be evaluated, the description and measures of the outcomes, and the relation of these to efficacy and efficiency issues. Measurement problems usually mean that the range of benefits valued directly in

monetary terms is fairly limited, making it necessary also to analyze and value other, less tangible effects [30].

Evaluation is always relative to some alternative: a presently existing system, or how this is expected to perform in the future, or between different future options. As precise identification of alternatives as possible, including a status quo do-nothing option, is of course a necessary first step in evaluation. It is our experience, however, that when proposing ICT solutions for elderly healthcare, little or no effort has been made to identify alternatives clearly. Without measurement and comparison of outputs and inputs we have little upon which to base any judgment about value for money. The real cost of any programme is not the number of dollars appearing on the programme budget, but rather the outcomes achievable in some other programme which has been forgone by spending instead on the first programme. It is this opportunity cost which economic evaluations seek to estimate and to compare with programme benefits.

For ICT in elderly care this may be problematic for two reasons. First, it is uncertain what level of traditional service our societies will be able to afford in the future. The ICT-enabled option should of course be compared to a realistic alternative. Second, the introduction of an information system must often be combined with other changes (cf. Figure 1). This entire package, rather than the information system as such, needs to be defined, and its costs and other consequences compared to those of relevant alternatives.

Issue 2: evaluations as input in decision processes

The normal reason to perform an evaluation is as input in some decision process. Sometimes a decision has already in effect been taken, but an evaluation is needed to justify it or prove the decision-maker's conviction. Sometimes evaluations will be used in designing new proposals, to fine-tune their features, or decide if a proposal needs more work or is acceptable.

When we analyze the consequences of a system, we may be concerned primarily about its consequences for some specific actor who is going to use our analysis. Even if we want to include broader societal consequences, it will often make a difference who is going to act on the information. This also has an impact on whose values should be applied in summarizing the evaluation. Proposals to use ICT to enable elderly persons to live longer in their own homes are likely to increase the burden for social care, which in many countries is a municipal service. A consequent reduction in the demand for old-age homes will in some countries constitute savings for municipalities, while in others these are paid for privately. Depending on which is the case, there will be different incentives for the municipal actors. To what extent the consequences for each constituent part of the system need to be identified will be a matter of how evaluations are intended to be used.

Issue 3: analyzing the system

The main problem in evaluating ICT usually is tracing and delimiting the consequences of an ICT application. Benefits may occur only after a time lag which is needed in order to make necessary changes in organization and work practices, and sometimes they may crop up in other parts of the system than those expected [31]. Difficulties in tracing consequences have led to talk of 'hidden costs of computing'. Hopefully there are hidden benefits as well.

Lucas [32] and Hodgbin and Thomas [33] structure these consequences in a number of categories. Those most relevant here are:

- direct return from ICT – e.g. savings when old practices are discontinued
- indirect returns – e.g. benefits caused by improved access to information
- strategic application – e.g. when new customers are attracted by the improved services made possible through the new information system, changing the future of an organization
- transformational ICT – e.g. when ICT enables entirely new modes of operating; an example is new patterns of collaboration among formerly unrelated organizations.

However, among the different types of categories that need to be included in most ICT evaluations in elderly care it is necessary also to take into consideration indicators that, in fact, are spread over various rather distinct disciplines (economics, psychology, usability studies, management, human–machine interaction, system development methods), covering a range of dimensions of the options being evaluated:

- operational (improvement of processes, time saving for data processing, reduction in multiple handling of documents, clinical decision support, coordination of services)
- administrative (contracting, coordination and communication, less rework, reduced traveling, improved cost control and rationalization)
- technology system (reliability, appropriateness for application and functions, security, human–machine interaction issues)
- user orientation (user acceptance of ICT, training provided, frequency of support provided, ICT utilization, ICT functions adopted by the organization)
- strategic competitiveness (enhance organizational competitiveness, enhance organizational image, project alliances through electronic means, increase of customers/users, increased competence, increased productivity)
- intangible benefits (increased quality of services due to the use of ICT, user satisfaction, effects of independent life).

What makes this an *economic* evaluation is the focus on providing input to a specified decision process. We thus need to delimit the system in which we will look for impacts from the proposed changes, deal with uncertainties and contingencies on other factors, and decide for what parts of the system we will record impacts. As an example of the last point: a proposal may benefit some people, but leave others worse off; or it may save money for society and taxpayers, but increase mortality risks for some few cases. We will return to questions about equity below; but the 'granularity' of our analysis will determine if we are in a position to note such disadvantages.

Issue 4: combining metrics

As an outcome from performing the systems analysis just described, we will have a set of separate metrics, often expressed with different scales: investments required; increased life and work quality; cost reductions; increased happiness scores [34]. Sometimes these all point in the same direction: a system like this is indeed a good one. But we may need

to compare several good systems, which is why most evaluations aim for a single measure of advantage for each system being evaluated. Only if one is better in all respects can we avoid somehow combining metrics into one index number.

We already discussed (issue 2) the need to be precise about what comparisons to make. Change proposals can always be compared with the alternative of doing nothing, but even then the future may not be the same as today. Choosing one system in society often means saying no to another, and for a considerable time. Often it is the difference between alternatives that is evaluated, rather than just one system.

Combining several metrics into one index of advantage often follows one of two methods. The first is to transform all metrics into similar scales with, say, a range from 0 to 10. Then they are assigned weights and summarized. The alternative is to find money equivalents for all metrics, which can then be added. Both methods neglect non-linearities and contingencies between metrics. They usually also fail to recognize uncertainties. All methods such as cost–benefit analysis (CBA) and cost–effect analysis (CEA) are really variations on these. An alternative would be to simulate future developments, recognizing the dynamic properties of the systems under study. But in a situation where any evaluation is rare, we have to be grateful also for less sophisticated approaches such as weighted scores of attractiveness.

Even these may be hard to arrive at. It is questionable if all stakeholders involved in an ICT system in healthcare can really agree on one set of values, including the attitude to risk. We are often forced to deal with issues of equity that are essentially political. Maybe the most honest evaluation is to avoid presenting a single measure as its result, and retain a number of dimensions or present a few different scenarios.

Issue 5: the analyst's role

One reason for using simplistic methods for combining metrics (such as additive weights) is to be able to describe to everyone involved how the evaluation has been performed, and, perhaps, through this guide modifications of the design of some alternative so that criteria with high weights are improved. Often, however, analysts are the only ones who really understand how an evaluation has been performed, its uncertainties and other limitations, and how the issues above have been dealt with.

Churchman [35] discussed the systems analyst's need for a 'guarantor': some higher authority to invoke when deciding on issues like those we have discussed here. In this spirit we call for openness concerning the choices involved in any evaluation. Proponents of critical social theory would require us to 'enlighten' those affected by the change that is being discussed and involve them in the process, which often will have political dimensions [36].

Applying our agenda in practice

To summarize, we believe that any economic evaluation of ICT in elderly healthcare must be able to answer the following questions:

1. What is being evaluated, in particular what comparisons are intended?
2. What is the intended use of the evaluation?

3 As the object for study is a system with many contingent variables, how is this system modeled?

4 How is the dimensionality of costs and benefits reduced, most often to just a single index of attractiveness or a recommendation to choose one system in preference to a continued use of the present practice?

5 What is the role of the analyst in designing and performing the evaluation?

Careful answers to these questions will also clarify the position taken concerning questions such as:

- Are we satisfied that the healthcare resources required to make the service available should be spent on ICT rather than in some other way? This links to issue 1 – should 'some other way' be specified as one more decision alternative?
- Is the investment efficient enough? This points to another aspect of issues 1 and 2. Often evaluation is intimately related to design of alternatives. Is the use of our evaluation just to judge efficiency, or should it point to further improvements and lead to additional proposals?
- Does the use of ICT do more good than harm to people who fully comply with the associated recommendations? Is technology available to all users? Will it reach those who need it and make services accessible to all who could benefit from them? Tradeoffs (issue 4) need to recognize that the impact of a new system may be different for different groups. It is then necessary to model such effects (issue 3) in a way that makes tradeoffs transparent.
- Is there any risk for users, organizations and their personnel? Similar to the previous point, analysts must model effects on these groups and decide on a rationale (issue 5) for how much attention they should be given. Even though the final decision usually is not for the analysts to make, they need to recognize the impact they will have on it.

Conclusions and implications

The area of economic evaluations is receiving increased attention in health and medical informatics. Decision-makers see the potential of improved management through increased efficacy of decision. Economic evaluations aim to obtain knowledge about what can be gained if resources are invested, the costs involved (and their distribution), and how the changes that are produced will affect the actors involved. They should therefore be essential as tools for decision-making and design of new proposals, but also in preparing for change, and monitoring of change processes.

Investment in ICT applications almost inevitably involves simultaneous investment in organizational changes, innovative business strategies, and human capital [37]. To an unusual degree, evaluators are therefore faced with difficult questions concerning the delimitation of their studies, and the assumptions to be made about non-ICT issues. In addition to this, the introduction, implementation and use of ICT in service organizations such as elderly centers have relevance for the entire society. This is so because of both the ethical issues involved and the need in today's service organizations for decision-makers to concern themselves about effectively managing technical, economic and human resources.

As yet, we do not see this role for economic evaluations of ICT in the sector of elderly care. This may have to do with the complexity of investing in ICT that will have societal consequences.

The arguments for 'buying in' to the idea of telemedicine and using it and similar technologies may still not be altogether convincing. Planning for ICT-based services to better support an elderly patient and improve his or her life quality has to look beyond today's standard practice of relying on per-visit or per-service cost reimbursement. ICT for elderly care represents a new way of providing more home care services more frequently, and is a needed part of the newer goals of providing long-term, cost-effective home care. A proper understanding of when it is justified, and how it should be applied, requires systematic analysis.

In this paper, we have called for a more conscious design of such evaluations, in particular concerning classical systems analysis aspects: delimiting the system, choosing an appropriate granularity when modeling it, and combining indicators. Management often lacks a common view on prioritization criteria and a selection mechanism for aligning new and ongoing projects. Evaluations have to be grounded in a set of conscious choices concerning their delimitations and how the balance of interest between stakeholders is handled.

More research is needed to examine the factors that influence usage and external variables, which in turn affect ICT adoption and diffusion in different social contexts. We found that reported evaluations were few and rather hazy about these aspects. Lastly, organizations of all types want individuals to utilize the ICT they acquire. Identifying what influences use is important when developing ICT and will thus influence organizational performance. To make responsible economic decisions about the use of scarce resources it is necessary to discuss issues such as risk, cost and benefits but also the contractual stipulations and how they are consistent with efficient use of resources.

Acknowledgement

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Notes

1 Transmitting patient data and laboratory results to allow a physician at another location than the hospital to view and hear patient data.
2 These are usually separate organizations, often with different principals and owners.
3 Value added through innovation.

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