

Balancing of Benefits and Disadvantages using IT-integration to support the health care value-added chain

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Abstract: The implementation of national eHealth interoperability platforms is one answer to the problematic financial situation of health care systems in many places. Using IT-supported integration between IT systems and processes of health care institutions should make the health care value-added chain more effective and more transparent. This article will present the capabilities for interoperability in the integration of added-value in connection with the benefits and disadvantages, which arise from the various players (with diverse characteristics in some circumstances). A better consideration of the balancing of disadvantages or benefits of the IT-supported integration in health care value-added chain can lead to increased preparedness on behalf of the health care institutions to the development and financing of interoperability platforms.

1 Introduction

The health care systems of the industrial nations exhibit an increasing frequency of usage with cumulative limiting of the available financial means, also due to the demographical developments. In addition to the political reorganization through changes to the financing and distribution models, an increased premium as problem solution is adjudicated above all to the adoption of information technology within the framework of an integrated national eHealth-platform. The goal is the networking of the information systems of the individual parties or institutions in the healthcare value-added chain [Po06] using among others IT- and communication-systems integration.

This striven-for integration of IT-supported business processes via systems integration entails considerable initial investment for the individual participants and running costs or other disadvantages with it, which are in many cases not adequately seen in the context of a corresponding benefit. It should thereby be considered that health care systems are characterized by complex added-value chains involving many participants and networks, which are often modified by the adoption of IT-supported processes or are moved to a higher level of development.

New business and value-added models can also arise. Examples of this are the emergency records or the cross-establishment electronic patient file (Ha06a). The benefits of such applications, desired from the point of view of politics and society, do not primarily arise where the necessary investment and disadvantage attacks are. The consequence of this is that mechanisms of compensation between the participating cooperative partners are necessary. Their absence today leads to problems in the acceptance of IT-supported integration and cooperation. This background poses the questions: “What makes the interoperability in health care successful from the economic point of view?”, and “Which compensatory mechanisms are necessary for benefits and disadvantages based on IT-supported process integration?”.

2 Levels and Processes of Added-Value in Health Care

2.1 Combinatorial Complexity Problems of Interoperability between the Players

For improved understanding of the dependencies between the various service providers, the examination of the processes in health care from the point of view of added-value is necessary, whereby three dimensions of added-value can be determined: Added-value through medical process integration, administrative process integration, and patient relationship process integration (Wa05). The added-value chains and networks have been created within and between these levels. Complexity, quality and scope of interoperation in the health care added-value chain [Po06] depend essentially upon the following determinants:

- Number of private/state-run players: Hospitals, laboratories in practices, all types of suppliers, apothecaries, insurance businesses, state-run positions for controlling and monitoring health care, etc.
- Number of lobbies for doctors, infirmaries, insurers, patients, pharmacological businesses, equipment business, etc.
- Number of the transactions to be concluded between the business partners
- Number of business partners participating in an actual business process
- Number of various information systems, which are employed with individual categories of institutions or businesses.
- Number of patients or customers from various patient/customer segments and number of contacts by the various segments with the service providers and insurers.
- (Number of) Legal, safety-specific, and technical specifications for the (partial) formal transaction of business.
- Degree of liberalization for the offers, performance of services and their effects on the pricing.

Starting from the complexity arising in such manner, the question poses itself: how the participants should be adequately integrated into the health care added-value chain? Thereby the internal and the bi- or multi-lateral inter-operational integrations are significantly affected by the complexity. Different interoperability topologies, which bring various cost-benefit relationships for the participants with them, can be solidified according to the size of the arising networks.

2.2 Classes of Processes to be integrated

Many complex processes occur in health care from the point of view of adding value. The following main process categories can be identified:

- *Administrative Processes:* for example, the completion of administrative processes between health care providers and health insurers or billing centers, between patients/the insured and health insurers.
- *Customer or patient relationship management processes:* by which health care providing institutions enter into a relationship with patients using appointment booking portals or consulting and triage services, telephone support, or for the coordination of health care providers vis-à-vis to patients, etc.
- *Medical Processes:* such as examination processes, diagnostic processes, (emergency) treatment processes, healing or recovery processes, medical support and monitoring processes.
- *Support processes:* (logistical processes, information technology processes, data integration processes, analysis processes, of blood in laboratories, etc.)

The systematic completion of processes in the health care added-value chain embraces various participants, which are also combined through process integration into larger health care networks. The conclusion of the processes can be supported in many ways through electronic data transmission and the integration of the information systems of the participating establishments. In the simplest cases, selective data between two information systems, such as a hospital and a practice, are exchanged. However, more complicated processes, in the sense of cross-establishment workflow management (Ja06, He06, Di06), could also be controlled and supported electronically, as it is the case for example in an order-result process.

2.3 Interoperability within and between Levels of Added-Value

The cooperation within, and between, levels of added-value can be categorized analogous to the known eBusiness arrangements, such as B2B, B2C, B2A, etc. Taxonomy of the conceivable applications for this is found at Haas (Ha06b). The essential classes of players are suppliers, service providers, insurers and patients or the insured/customers. This results in the following interoperability potentials through IT-supported integration

Relationship	Interoperability Characterization	Interoperability benefits and strategic view
Supplier to Supplier	Integration between the information systems of various suppliers with the goal of enabling coordination between the suppliers, for example regarding products or systems, including logistical integration.	Increased efficiency regarding production or goods and services through the optimization of production or service networks, modularization due to optimization of acquisition and customer relation management (CRM through interoperable solutions increased efficiency).
Supplier to Healthcare Provider	Integration between suppliers' information systems and the service providers, coordination, bundling and control of the products, service provision and cash flows between service providers and suppliers (Supply Chain Management (SCM). Various levels conceivable. Wholesale and retail businesses, distribution and dispersion of the goods, etc., Integration of eCRM and eProcurement processes or markets.	Optimization from the point of view of SCM and CRM processes through intelligent organization of logistical networks (whole sale and retail businesses), Optimization of distribution to the service providers.
Healthcare Provider to Healthcare Provider	Integration between information systems used by the institutions for health care provision, substantiated between the same diversified treatments and care giving pathways.	Increased efficiency due to optimization of the logistical networks (wholesale and retail business and logistics).
Healthcare Provider to Patient	Integration of the communication processes between patient or customer (CRM and patient relations management (PRM) (Ba04, We05, Pu01)) and health care provider, which lead to and follow up on treatment. For illness-related patients as pre-triage to be understood in the sense of feeding to the service provider, for example using telemedicine or call centers, communications processes as trigger for medical and administrative processes.	Various service provider networks are conceivable in the strategic view (for example, between private practice doctors and regional or private infirmaries), thereby conceivably targeted orientation towards customer or patient connections. Obstruction by Data Privacy Act possible, for example regarding distributed usage of data such as patient dossiers, conceivably similar between general practitioners and specialists in the sense of networks of doctors.
Healthcare Provider to Insurance Company	Goal: integrated conclusion of uni-, bi-, and multi-directional administrative processes, for example settlement and billing or also data forwarding regarding patient treatment, including corresponding cash flow, etc.	Problematic relationship, since the service providers and insurers traditionally confront each other skeptically, unlike distributed primary advantages at the administrative level. Service providers profit less than insurers from the optimization capabilities of integrated billing processes, etc. From the point of view of insurers, transparency enables them to target and to optimize patient risk portfolios and their selection, in order to increase profit ratios (Data Privacy Act could obstruct). However the control of the medical activities will be possible only according to the degree of transparency based on the data supplied.
Patient to Patient	Electronic "Integration" of communities for individual (or general) categorization of illnesses. Example: From Morbus Crohn, to MS, to cancer types, etc., however including communities of patient associations for the exercise of patient rights, for example in confrontation with insurers or service providers (Da07).	Patient empowerment, danger of duplicated treatments when patients allow themselves by agreement with each other to be redundantly examined (and treated), etc. Optimization potentials exist also through the exchange of knowledge between patients regarding treatment pathways and the selection of the most successful treatment methods.
Patient to Insurance Company	Enabling of new Types of CRM processes of and between, insurers and health care providers towards patients (customers): Through these processes insurers attempt to improve their risk portfolio (active recruiting of better risks or disposal of poorer risks, marketing platforms for basic and rider insurance policies),etc.	Customer involvement in the insurance processes (allowing customer integration, through which scrawnier and more efficient administration processes are achieved). Improvement of risk selection through improved customer knowledge, as well as optimization of the level of insurance and coverage through integrated insurance products, etc.

Table 1: Characterization of strategic interoperation relationships and benefits.

Further cooperation scenarios implicate the public management, illness registry, insured, etc., for example between health providers and registries of illness within the registration must be able to be communicated electronically and partially automated.

2.4 Various Forms and Necessities of Interoperability

Due to the occasionally large number of players, the complex interaction of the same, and the sometimes high number of transactions to be concluded between the same, a combinationally complex number of relationships arises.

It doesn't appear reasonable, that the institutions select point-to-point (IT-)integration as a profitable alternative to integration at any one time from the technical or semantical view for the electronic conclusion of common transactions.

As in the history of the IT-integration of information systems in (and between) hospitals, where the employment of communications servers as connecting component based on the communication standard HL7 has been quickly implemented after bilateral attempts, a central communicating platform can also be of great interest for eHealth business processes. Because of this, communicative institutions or intermediaries between the various target groups arose in the recent past in many countries. Moreover, various national or international standardization initiatives have been intensified. The construction of a national eHealth platform essentially serves the purpose of making various intermediary services available to the participants in a safe network environment with various impressions of disadvantage and benefits.

Intermediaries as a third party thereby absorb the functions of a broker between the cooperating parties at various operational, medical and technical levels, which can be characterized as follows. "The progression, in the digital society, therefore has been towards a shift in the creation and utilisation of *middlemen* (i.e. intermediation type brokers) that add value by offering advice and possibly by reducing the content of the catalogue. The Internet has already come full circle, from enabling anarchic commercial activity through disintermediation, back to providing intermediation between many suppliers and many customers. This has occurred as the size of the Internet has increased and customers require value-added services to find what they are looking for. The role of the broker is to mediate and support the initiation and completion of transactions between one of many suppliers and one of many clients or customers." (Pu01)

However, mediation requires investment and causes expense. The primary benefits do not normally accrue to the intermediary, but rather only at the business partners who use the intermediary platform, who also without intermediaries cannot implement these benefits or can, but only with limitations. Thereby, it becomes interesting for those to adequately participate, in whichever direction, in the benefits resulting from the intermediary.

3. Foundations for a Discussion of Balancing Benefits and Disadvantages

3.1 Basic Model for Explaining the Balancing of Disadvantages and Benefits

In a simple bilateral relationship, the following situation displayed in the Figure 1 results in the usage of intermediaries. Partnerships with or without intermediation are imaginable according to Table 1. It can be assumed that both K1 and K2 can represent other categories of partners, meaning the service providers and insurers or the insured. Innumerable point-to-point relationships can be maintained and integrated without the intercessions through an intermediary. This has corresponding (transactional) expense effects.

This can arise in another relationship to the benefits, as if an intermediary is appointed.

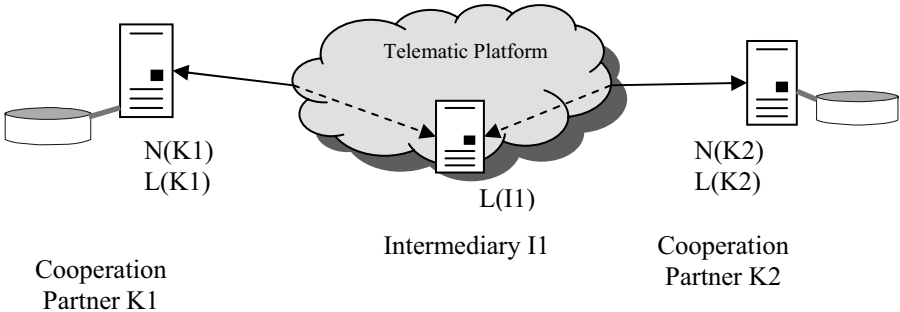


Figure 1: Simplified Model of Benefits and Disadvantages

Both of the partners or partner categories K1 and K2 consequently have benefits and carry disadvantages at the same or different levels. However, one potential mass escalation can also represent a benefit. The total advantage $N_G = N(K1) + N(K2)$ of the IT-supported cooperation is distributed to the cooperation partners, and not necessarily to the same measure. Thereby, a benefit can also arise for the intermediary, which does not appear in the foreground here. The total disadvantage $L_G = L(K1) + L(K2) + L(I1)$ is distributed to all participants, likewise not necessarily in the same measure. Only then does this result in a reasonable business model for the intermediary, when the number of partners, and/or the number cooperating institutions, and the sum of the benefits generated thereby, are sufficient, in order for it to realize a profit.

3.2 Simplified Consideration for a Networked Relationship and Implementation of an Intermediary

Effects of disadvantages and benefits, with or without interoperability, with or without the implementation of an intermediary, can have quantitative or qualitative characteristics. Thus are for example the treatment expenses saved through a positive healing process due to integrated IT-support only calculable if a an implementation of technology with non-monetary effects has already occurred and thereby can be compared with an ex-ante state (without technological support).

The question is raised with an intermediary implementation, whether economic survival is possible from its own point of view and due to the realizable fees dependend on the realizable benefits of the partners. This correlates with the price model of the intermediary and their performance portfolio for the attention of the partners in relation to the disadvantages and benefits on the part of the partners. Finally does the intermediary live from the difference in the transaction expenses (P_{i01} , W_{i75} , W_{i90}), which result for the partner with or without the implementation of an intermediary. Since the transaction expenses are not accounted for as such in the balance or earnings statements, a broad quantification or qualification as well as an adequate deviation of the disadvantages and benefits appears very difficult. Aside from this, it hampers the funded decision for interoperability with or without an intermediary. A corresponding decision can occur thereby only with the observance of partial criteria for disadvantages and benefits.

The Table 2 shows possible combinations and aspects of the implementation of the intermediation. This can be assumed by the following formula for explanation of the effects of transaction expenses from the view of the total system. The number of connections without intermediaries results from the formula number $K*(K-1)$. With intermediaries exist so many connections to the intermediary as there are partners, which are connected to the intermediary, therefore implying $K*N$ (Wa06).

Number of partners category K1	Number of partners category K2	Implementation of an intermediary	Suppositions and considerations of effects of disadvantages and benefits for the participants
1'000	1	No	All K1's have contact with a K2. K2's have contact to all K1. The case can occur when a state-run insurer exists and no multiple-competition system among the insurers has been implemented. From the point of view of transaction expenses, 1,000 connections arise. An intermediary can be advantageous, when system landscapes and data formats for the category K1 partners are very different.
1'000	1'000	Yes	All K1's have contact with all K2. The case can occur in a competitive insurance market with multiple competitors or insurers (e.g. Switzerland). Without intermediary, the following numbers result in roughly $1,000 \times 1,000 = 1,000,000$ connections. With intermediaries, the numbers result in $1,000 + 1,000$ connections to the intermediary = 2,000 connections.
2	3	Rather not	All K1's have contact with all K2. Five connections result with intermediaries; without intermediaries, 6 connections. Benefit and disadvantage relationships cannot be strongly modified by the implementation of intermediaries. It should certainly be observed that if point-to-point connections are implemented that dependencies can arise, which can lead to complex side-effects on the other information systems given modification to one information system.

Table 2: Networked Relationships and Implementation of Intermediaries.

If several intermediaries are available, then they can arrange roaming contracts between themselves and new partners such as financial service providers can be integrated into the network (Wa06, Wa07). Roaming contracts can entail modification to the transaction expenses or distribution of disadvantages and benefits between participants can be changed.

Direct integration for K1 multiplied by 1,000 K2 = 1,000 * marketing, sales, and after sales service expenses as well as logistics expense shares for support and conclusion of business with other parties. All IT expenses, which can arise, should be added on, that arise from different integration requirements due to the 1,000 times opposition and interfaces. As a counteraction to this, shares of the expenses invoked by the integration through intermediaries are cancelled according to the service provider's portfolio (CRM intermediaries, data intermediaries, delivery intermediaries, medical intermediaries, etc.) in a certain relationship. To a certain extent, the IT expenses are also absorbed on the part of the K1 partner, because they have initially carried IT adaptation expenses (each according to the transformational, standard and routing functionality and cannot be forcibly required for example to participate in data standardization on the part of the K1 or K2, which reduces the attractiveness according to the level of standardization of the affected system) for specific process areas, which are completed through the intermediary. Certainly, the amount depends upon the level of integration. The adaptation expenses can also represent a barrier to withdrawal from the intermediary relationship. A proportionally high savings premium for integration expenses can accumulate among all K1 category members.

Perspective of the individual market participants: Integration for K1 at 1,000 K2 through intermediaries. Somewhere, regarding the expense saving capabilities each according to the number K1 members or K2 members represented above, there are optimization points from which the integration becomes unattractive due to the lacking number of participants from the view of K1, intermediaries or K2. However, optimization capabilities due to the attractiveness of the service providers portfolio are provided on the part of the intermediary.

The following theses regarding the distribution of disadvantages and benefits can be substantiated:

- As the number of K1 and K2 members increases: intercession becomes more attractive for intermediation to occur, according to process area; the attractiveness of the intermediation advantages increases relative to the savings in transaction expenses; and the preparation of the intermediary services can become more attractive from the point of view of the intermediary.
- The younger the market for intermediation services, the more attractive is the construction of an intermediary with connections to K1 and K2 partner categories (or at best to the state), since the attractiveness of the transaction expense savings and the preparedness to pay for a service in the sense of an intermediary is lower. It may also occur during this phase that the (inhouse-)IT-integration at the K1 and K2 partners is imperfect, whereby an offer for intermediation has lower attraction.

- As the number of direct transactions between a K1 and a K2 increases (somewhat in relation to the other relationships and their transaction count), the attractiveness of maintaining direct relationships parallel to the intermediary (or at best under waiver of the intermediary advantage) increases.

3.3 Action Model for achieving a Balance of Disadvantages and Benefits

Obviously, a procedure in the sense of a checklist should be defined for the problem described through which the balancing of the benefits and disadvantages can be performed using the following process steps.

1. Specification of the process chain (between operations) to be considered.
2. Analysis and modeling of the beneficial and disadvantageous issues to be integrated in the current state through conventional means without IT- and communication technology support.
3. Modeling of the process chain with integrated IT-support and conclusion and determination of the benefits and disadvantages. For many partners (see Figure 1), even intermediaries should be considered and observation should be made with or without intermediaries.
4. Investigation of the required hardware, software, and organizational modifications and the expense per partner.
5. Totaling and appraisal as well as comparison of the totals from disadvantages per participating partner according to conventional operation without IT-Support.
6. Totaling and appraisal as well as comparison of the totals from benefits per participating partner using the support of IT and IT-integration platforms.
7. Appraisal and totaling of the disadvantages of intermediaries.
8. Investigation of the cash flow per participating partner as well as of the cash flow after disadvantages on the part of intermediaries.
9. Balance statement and determination of the resulting monetary flows and their direction with dissimilarly distributed cash flows.

The method of cost-benefit analysis can be used for evaluating various solution options from the point of view of the interacting health care providers or of the intermediary [St05].

3.4 A Simple Example: eReport

Discharge summaries and medical reports from specialists are one of the today's most communicated information objects in health care. They are used in the „HealthCareProvider2HealthCareProvider“-cooperation supporting the administrative/medical process of order-entry/result reporting. Despite of the huge importance the communication of medical reports, still conventional communication via letters take place, because many medical practitioners have no readiness to invest in electronic

communication due to cloudy benefits. The following example deals with the communication between a radiological institute (K_{Rad}) and a medical practice (K_{Pr}) whereas both institutions still running an institutional application system for internal purposes i.e. for internal documentation, organisation and report writing. Per anno 400 reports are send from radiological institute to the medical practice.

Looking to conventional paper based communication, the following expenditures can be outlined on base of 50 Cent/man minute (without expenditures for report creation/writing) :

- Radiological Institut: Organisational expenditures (printing report, internal transportation and signature processes, enveloping and franking, transportation to postoffice) overall 160 seconds -> 1,33 €, material costs (paper, envelop, ink cartridges) of 3 cent and cost of postage 50 cents resulting in 1,86 € per report.
- Medical practice: Organisational expenditures (Receiving and opening paper report, manage paper workflow, archive paper report in patient record, sometimes scanning of paper record and integrating scanned file into electronic patient record) of 2 minutes -> 1 € and costs for conventional archieving (not considered here).

Looking now to the implementation of a telematic-based report-communication every partner has initially to invest into hardware/software add-ons and education and education time and communication fees to intermediation, so implementing IT-based report communication results in:

- Radiological Institut: Organisational expenditures are reduced to the electronic signature time (5 seconds = 4 cent), all other expenditures drop out for the application system can do this automatically. But new hardware and a additional software module and signature cards and signature equipment are necessary (-> capital costs of 4.000 €, 1000 € hardware/3.000 € software licence), for the transmission a monthly flatrate from a special health telematics mediator is necessary (-> 60 € per month), software and hardware maintenance fees of 500 €/anno.
- Medical practice: Organisational expenditures fall down to 10 seconds/report (=0,08 Cent), because the eReport can be received automatically and also is automatically integrated into the Electronic Patient record, only a short visual check must be done before storing in the patient record. All other costs are similar to the radiological institute.

Looking to the unidirectional example with 400 reports per year from radiological institute to general practice and calculating a 3 year usage period for hardware and 5 years for software, we'll get the following balance of benefits and costs: The Radiological Institut will have total cost per month 179 €, per transmitted report 5,38 €, resulting benefit of -3,70 € per report or -1481 € per anno. The Medical Practice will have a benefit of -4,38 € per report or -1753 € per anno. This show, that implementing only communication to one business partner is not worth for both. The break even for the radiological institute is 1282 (= a minimum of 3 partners), for the medical practice 2154 (= a minimum of 5-6 partners). On the other hand for the radiological institute the

benefit by communicating all reports per year (estimated 80 reports per day / 19.200 reports per year) electronically to the partners adds up to 30.102 €. The example shows: In a given process benefits for the partners often differ extremely, so also the readiness to invest. Benefit only results by realizing larger networks with partners, that have a lot of monthly communication traffic. In complex networks intermediation is essential and the example shows the limit for transaction fees a mediator will realize when no balancing of benefits between the partners are feasible.

3.5 Characterization of Disadvantages, Benefits, as well as Manners of Balancing Disadvantages and Benefits.

Initial investment expenses and running costs (operational expenses) must be differentiated with regards to the disadvantages. Initially, these investment expenses are for hardware and software, training expenses and leave for employees for training. Running expenses arise through software maintenance costs, transmission costs and, if necessary additional organizational expenses in comparison with conventional procedures such as for digital signatures. The benefit is multifaceted and quantitatively or qualitatively subsumable. Benefits arise, for example, through increased quality of service and processes, of patient or customer condition, time savings related to services and processes and with the patient or customer, cost savings due to qualitative factors in processes and service provision as well as cost savings due to qualitative customer (or patient) factors, or other directly affected stake holders (Lo05, Sc95). However, if one benefit can represent a strategically better placement of the company or the institution, this is conceivably thanks to the intermediation of new cooperation capabilities, and new business models.

The following instruments for balancing benefits and costs can be differentiated (Wa06). Financial benefit balances are transmitter payments, recipient payments, license fees for adapters, etc. Furthermore, balancing of expenses and benefits related to hardware and software interfaces and software expenses can be differentiated. Last but not least, bulk discounts and possible pricing levels, flat fees (for example, through differentiated prices for provider, hardware and software usage) or differentiated payments for various the services of intermediaries through adapters are conceivable, as well as prices for conveyance by means of roaming or support costs and expenditures.

The problem exists for all of the aspects described that the benefit balance is mostly seen from the perspective of a network participant. Network specific considerations or entire economic effects of intermediation or integration are seldom considered and are not of interest for the individual participants. In the end, players look out for themselves as financial benefit maximizer. In addition, relative to the entire system, quantitative and qualitative benefits cannot always be determined simply.

4 Conclusion

IT-supported business process integration in health care modifies existing and creates new added-value chains and networks (e.g. through network roaming). The motivation of the individual players to invest and participate in the IT-integration with or without intermediaries depends essentially upon a positive balance of disadvantages and benefits for them. An appropriate balancing of the disadvantages and benefits across all of the players in the affected business processes is essential; also effective balancing mechanisms have to be implemented. Actually, this is often not the case today. Therefore disadvantages for the health care players arise through large scale changes of their process, the necessary investments and running costs for the interoperability and mediation. The last is inevitable in a complex interaction network, such as represented by the health care system.

The preparation of standardized interoperability solutions and platforms in health care (such as those, which have been implemented for a long period of time in the financial services area) are under initial construction and in an evolutionary state in the form of (privately owned or state owned) regionalized or nationalized health care interoperability platforms due to the complexity and specificity of health care in many countries.

Given this background, collective expense benefit observations, whose results are the input for the cross-process balancing of disadvantages and benefits, are necessary to improve the acceptance of integrated health care IT-applications based upon the analysis of the current and desired processes. Given this background, future research must, on the one hand, include the discussion of formal solutions for the investigation and calculation of the distribution of disadvantages and benefits, and on the other hand, include the existing practical problems for standardized compensatory mechanisms for benefits and disadvantages.

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