INFORMATION SHARING ACROSS MULTIPLE HUMANITARIAN ORGANIZATIONS – A WEB-BASED INFORMATION EXCHANGE PLATFORM FOR PROJECT REPORTING

Dr. Stefan Huesemann

stefan@huesemann.org

Innovation Process Technology / University of Fribourg, Switzerland

+41 79 60 18 424

Fenetta 13, 1752 Villars-sur-Glâne, Switzerland

Abstract. This article analyzes information sharing problems in the humanitarian development sector and proposes the concept of a web-based exchange platform to face some of the technical challenges. The "Development Information Exchange System" is a mediator-wrapper-architecture that uses XML documents to loosely couple autonomous and heterogeneous information systems. Detailed project information of humanitarian organizations that resides on data provider systems can be formatted with XSL stylesheets according to the needs of the users and shared within or between organizations. The system can help to close the control loop by providing qualitative information about humanitarian projects. This makes project management more efficient. The proposed architecture solves an interface problem between the various partners and stakeholders of humanitarian projects. It is a first step towards a service-oriented architecture between humanitarian organizations. The next step could be the definition of cross-organizational business processes. These processes may be defined platform-independently with the Business Process Execution Language for Web Services. A prototype of the exchange platform is presented and evaluated in this article.

Keywords: loosely coupled information systems, XML-based project reporting, Development Information Exchange System, humanitarian organization

Introduction

"Sharing information on their activities is one way in which agencies can save money and time, by avoiding duplication of efforts achieved elsewhere, and helping them to find partners with whom they can pool funds and expertise." [1]

Information sharing and exchange problems that will be addressed in this article occur in various types of companies and organizations. Special attention will be given to organizations in the humanitarian development sector to illustrate the challenges and to propose solutions.

Many information sharing problems between and within institutions are organizational in nature. This is why we will first analyze challenges from a business perspective in section 1 Information Sharing between Humanitarian Organizations. Subject areas that are pertinent are knowledge management [2, 3] and organizational learning [4-6]. As these concepts are very general we focus on specific problems related to project management in non-profit organizations.

There are technical challenges to data exchange between systems. This vantage point will be taken in section 2 Information Exchange between Heterogeneous Information Systems. Theory about integration of heterogeneous and distributed systems will be considered.

The research question we would like to answer is: What technical architecture can enable project stakeholders to share information across organizations?

In section 3 Development Information Exchange System (DIES) we will present a concept, the resulting architecture and the prototype of a web-based information system for cross-organizational information exchange.

The concept of the "Development Information Exchange System (DIES)" shows how information and communication technology can not only solve technical problems, but also enable organizations to face some business problems.

From a research paradigm point of view, the work can be classified as design science. According to March and Smith [7] design science is concerned with devising artifacts to attain goals, while natural science is concerned with explaining how and why things are. Design science generates four types of output: Concepts, models, methods and implementations. The main research activities are development of artifacts and their evaluation.

The research project was carried out according to the Rational Unified Process [8]. This project management methodology is specialized on software development.

Strengths, weaknesses, opportunities and threats of the artifact are evaluated in section 4 Evaluation of the DIES. The last section will put the presented solution in a wider context and look into the future.

1 Information Sharing between Humanitarian Organizations

To have a better understanding of problems related to information exchange in development projects we first describe the context.

1.1 Humanitarian Development Organizations

Almost anywhere in the world there are people who need substantial help to survive and to live on a minimal standard [9-11]. That is the reason why humanitarian organizations (like the Red Cross) exist. Humanitarian organizations are often non-governmental organizations (NGOs) that organize programmes and projects in two major fields [12]:

- Relief activities, i.e. short term interventions such as refugee support in crises and
- development projects, i.e. medium or long term actions with sustainable impact such as education of farmers or the construction of infrastructure.

The term "development project" is also used in the information technology (IT) sector. If relating to IT projects we will use the expression "software development". The terms "humanitarian project / organization" and "development project / organization" will be used as synonyms in this article.

International funding agencies and private donors give financial support to humanitarian organizations. There is increasing competition for donations between organizations.

Although many NGOs have similar objectives, the fight for financial resources discourages them from cooperating. On the other hand, many partners can be involved in a project. In general, one or more funding agencies (e.g. ECHO for Europe [13], USAID for the USA) and many private donors give money or other resources to international humanitarian organizations. They set up programmes which can be composed of several projects (e.g. World Health Organization programme for the eradication of malaria). In cooperation with local partners specific projects are defined and resources are allocated. Local partners can be companies, governments or non-governmental organizations. Sometimes the local partners contract other partners to achieve their goals. The main objective of humanitarian projects is to help needy people [9, 11, 14].

1.2   The broken Control Loop

The analysis of the situation in the inception phase of the research project has led us to formulate the following hypothesis: Within the humanitarian development sector there is little allocation of resources by market mechanisms (supply and demand). It is also difficult to conceive an allocation based on financial results, because such measures are not applicable or not available (how should the construction of a well or the education of a child in Asia be evaluated?) [15, 16].

Profit-oriented companies have the generation of profits as their main objective. They can use profit-ratios as feedback for the work they have done (e.g. earnings per share (EPS), earnings before interests and taxes (EBIT) [17]). Based on the results of preceding periods in combination with strategic considerations, the resource allocation is determined for the following period. This cycle is called control or feedback loop [18].

Humanitarian organizations do not aim to earn profits, and there is almost no cash flow out of the projects back to the NGOs. Thus, the financial ratios which are normally used in profit-oriented companies cannot be applied fully to NGOs. The main objectives refer to issues such as the improvement of training conditions in countries in transition or the eradication of a specific disease [14, 19]. These kinds of objectives are very difficult to measure and correlation of the impacts with the invested funds is hard to prove (e.g. fighting against drug abuse, elimination of diseases, improvement of the overall economic situation of a country, providing humanitarian relief to refugees).

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There is almost no allocation of resources which could be guided by profit-ratios. The decision-making process can be influenced by the donors in a limited way, above all by institutional funding agencies. One precondition, however, is that the donors are well informed about the projects and their impacts. Contrary to private donors, governments and funding agencies want to be informed in great detail to know what has happened to their funds, and they have the power to enforce these requirements.
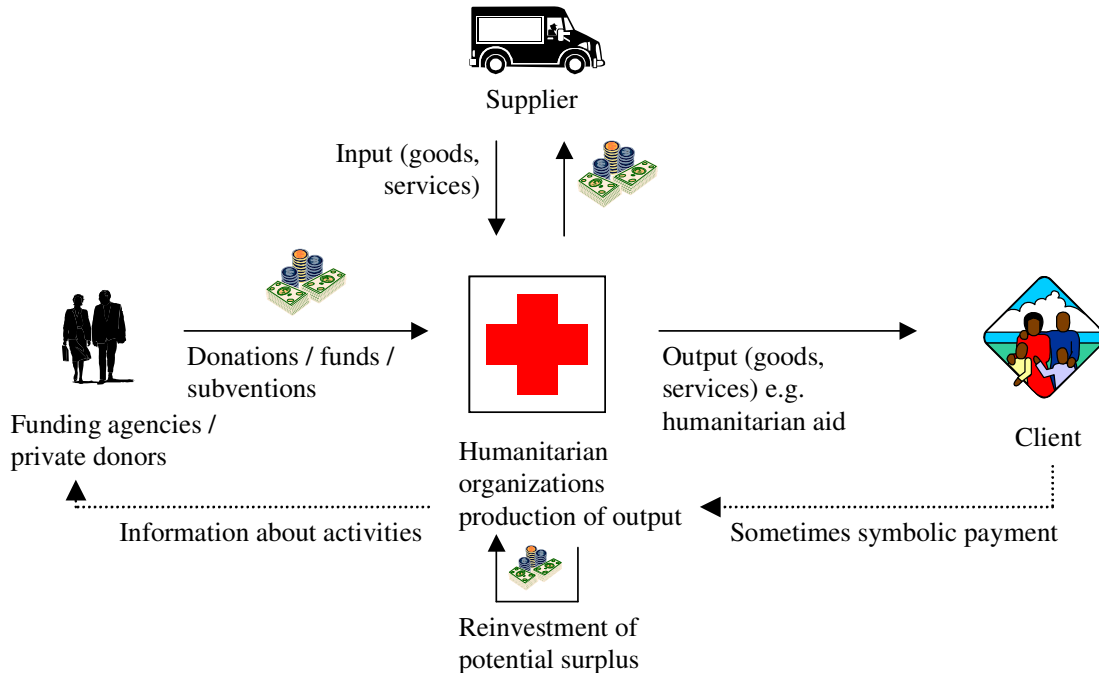

Figure 1: Interrupted control loop in humanitarian organizations

Figure 1 illustrates resources flow in development projects. Two potential deficiencies in the control loop of an internationally working humanitarian organization have been identified:

- On the one hand the information feedback from field projects to humanitarian organizations - which can be an information flow within the same organization - is often insufficient (dotted line on the right side of Figure 1).

- On the other hand the information flow from humanitarian organizations to donors which is cross-organizational information flow is weak (dotted line on the left side of Figure 1).

These deficiencies of the system are our starting point for improving the allocation of available resources and the management of humanitarian projects.

1.3   Characteristics of Development Projects

Development projects are medium to long term. The projects have many stakeholders as described above. The stakeholders are paying attention to the well-going of the project. They are interested in sharing information to avoid repeating errors and foster organizational learning. Information about projects may be stored in many different information systems and project management systems.

Stakeholders of a project communicate through various channels. Every group is interested in specific facets of information about projects [20]. Increasing amounts of information are exchanged electronically. Many organizations publish facts about their past, ongoing or planned projects on the Internet now.

More detailed information like project reports are exchanged directly between project participants. However, there is little standardized electronic data exchange between the stakeholders. There is no common standard for the exchange of project information and more detailed reports. This issue will be considered later. For an analysis of websites that publish information on development projects see [21].

Although interested people can find certain information on websites of organizations it is still difficult to get an overview of what is undertaken by different independent groups, e.g. in a region. "The effectiveness of foreign aid is impaired by deficient information, fragmentation, and lack of coordination." [22]

After these general considerations we would like to look more closely at benefits of information sharing across organizations as well as to related problems and barriers.

1.4   Benefits of Information Sharing across Organizations: Closing the broken Control Loop

To close the broken control loop, humanitarian organizations have to invest some of the money they get and a lot of time in reporting and evaluations [6, 16]. They see this often as an administrative burden with no value added. The reporting system is first and

foremost an instrument for controlling. But depending on the report, valuable information can be found for future and ongoing projects. Therefore one should consider whether and in what form such project reports and evaluations could be made available. The management of humanitarian projects can be improved by the documentation (explicit knowledge) and handing over of experience (implicit knowledge) [23, 24]. These aspects have been treated in the field of knowledge management. Creech and Willard [25] discuss how sustainable development can be achieved by using knowledge management concepts.

The donors must be informed about the activities of the humanitarian organizations, in order that they can control what happens to funds made available. In case the results achieved are evaluated as positive, the donors will hopefully increase their proximate funding, which means a more effective distribution of funds from outside of the humanitarian organizations.

To keep administrative costs for reporting as low as possible while having the required information available, reports could be composed of various reporting components or modules. These modules could subsequently be joined according to the information needs of the recipient. A platform for the exchange of standardized information used by all stakeholders for communication would be very helpful in this respect.

Contrary to physical goods, the value of information rises if it is shared [25]. This idea is the basis for most benefits of knowledge sharing discussed in theory and practice.

1.5   *Problems and barriers to Information Sharing*

Although the benefits of information sharing may be quite obvious, information is often not exchanged freely, even in a non-profit environment where financial objectives are not at the top of the goal hierarchy. Various barriers can be determined that prevent organizations or individuals to share information. Some of the problems are categorized here in three fields:

- Organizational problems,

- cultural problems and

- technical problems.

Organizational Problems relate to the specific nature of non-profit organizations and humanitarian projects. Some of these problems are:

- Coordination of projects / transparency:

There is a great number of non-profit organizations respectively NGOs working in the field of humanitarian projects. Obviously it is very difficult (and not absolutely necessary) for these organizations to be fully informed about all development projects which are planned or carried out by other humanitarian organizations. On the other hand experience has shown that uncoordinated help within a region can be highly counter-productive, even if the organizations have similar objectives [10]. It is also a fact that problems of coordination are omnipresent even within humanitarian organizations, which are usually structured in a federal, decentralized way.

- Geographical distance:

Development projects are international. Organizations from different countries cooperate. The distance between the stakeholders makes coordination and information sharing more difficult.

- Decisions are influenced by politics:

A great percentage of the funds that humanitarian organizations need to carry out projects come from governmental funding agencies. They usually pursue political objectives and influence the decision making process in development organizations. Information about needs of people and effectiveness of projects is sometimes neglected in this context.

- Competition between organizations:

Several organizations work in similar fields and compete for the same resources (donations, credits etc.). They do not want to share information although they may have the same objectives, i.e. help needy people.

- Confidentiality of certain information:

Not all information is suited for sharing, e.g. published information about projects in totalitarian countries may endanger the participants.

- Lack of motivation for information sharing:

Information sharing needs a big effort of the stakeholders. They have to see the benefits of sharing for their organization and for themselves.

Cultural Problems relate to people and their customs:

- Variety of stakeholders and of information exchange:

As seen above, stakeholders are located in various countries. They speak various languages, have different education levels and diverse cultural backgrounds. This makes communication and coordination within and between development projects difficult.

- Information is power:

Information is often used to control the power – by not sharing information, a person or institution may maintain its competitive advantages and influence.

Technical Problems can relate to infrastructure and information systems:

- Infrastructure:

Lack of telecommunication and IT infrastructure in developing countries is a challenge for worldwide information exchange. Employees or volunteers can only communicate under difficult circumstances with their headquarters.

- Differing requirements of institutional donors for project reporting / costs of information exchange:

Although project reports and evaluations mostly contain similar information, every organization has its own structure and format. This is a challenge for information exchange.

Reporting within humanitarian organizations and especially between them and institutional donors is costly and time-consuming, because every institution wants customized information.

- Heterogeneous information systems:

Information has to be put in a format that can be exchanged electronically between information systems. The lack of information exchange standards in the humanitarian field and especially for project reporting and evaluation is a barrier to information exchange across organizations.

- Accessibility of information:

A lot of information is not used because it is not available to potential users at the right time the right place and the right format.

The order of the problems and barriers has been chosen deliberately. It is not an exhaustive List of problems. Organizational and cultural barriers are much more difficult and time-consuming to overcome. It takes a lot of effort to change habits and prejudices. Denning [2] states that knowledge management in the World Bank is 80% brainpower and 20% information technology.

On the other hand, technical problems can inhibit information exchange altogether. Information and communication technology is the enabler for information exchange across organizations.

This is why we will focus on proposing a technical solution for information sharing in the humanitarian field. The concept will take into consideration organizational and cultural aspects, although there is no technical solution for many of them. The concept should address the problems related to reporting to multiple partners, simplify reporting between humanitarian organizations and institutional donors and make experience from past projects available.

2   Information Exchange between Heterogeneous Information Systems

Three problem areas have been outlined in the previous chapter. Now, we will present ways of approaching technical problems related to information exchange. We will first discuss architectures that enable information exchange between information systems of

different organizations. Then, information systems used in humanitarian organizations are classified.

Information can mostly be stored and exchanged electronically. The systems involved in exchanges can be very heterogeneous (i.e. they run on different operating systems, on different types of computers, they are based on different data models, they are programmed in different languages). To enable them to communicate with each other integration concepts have been proposed. Some integration architectures are discussed now. We only consider Extensible Markup Language (XML) as data transport format although some of the architectural options have also been realized with other formats like UN-EDIFACT [26].

2.1   Architectures to Integrate Heterogeneous Information Systems

Information systems (IS) can build on a variety of data models (e.g. hierarchical, relational, object-oriented, XML). Raghavan and Garcia-Molina [27] classified existing architectures for tying different IS into three categories:

- Layered architectures,
- loosely coupled architectures and
- extension architectures.

In systems with a **layered architecture**, an IS of one type is implemented as an application that operates over an IS of another type. The main advantage of this approach is that the top-level system can leverage the facilities of the underlying one, without significant additional development time and effort. However, the challenge lies in mapping the data types and operators used by the top-level system in terms of the types and operators supported by the underlying IS [27].

Loosely coupled architectures isolate the integration logic in a separate integration (or mediation) layer. This layer provides a unified access interface to the integrated system using its own data and query languages. The fundamental challenge in this architecture is to design efficient mechanisms to translate queries expressed in the unified model in terms of the query capabilities of the individual IS. The advantage is that unlike the layered and extension architectures, modifications to the individual IS are minimal or

completely unnecessary. This approach is also known as mediator-wrapper-architecture [28-30].

Finally, **extension architectures** enhance the capabilities of a particular type of IS by using an extension module that provides support for new data types, operators, or query languages usually available only in the IS of another type. When extension interfaces are available in the original IS the extension module can be implemented using these interfaces.

The more autonomous the systems and the more heterogeneous the data to be integrated are, the more difficult it is to implement a **tightly coupled** architecture [31]. **Loosely coupled** architectures give less functionality, but they do not require having full control over the systems that exchange information. The underlying systems can change without having to change the whole distributed system.

A major problem when integrating information from heterogeneous systems is the mapping of the involved data models or schemas [32]. There are tools that can help with this task, but human interaction is necessary to resolve ambiguities.

A vision for information exchange between loosely coupled systems is the **service-oriented architecture (SOA)**. "In essence, SOA is a way of designing a software system to provide services to either end-user applications or other services through published and discoverable interfaces." [33]

The idea to use services, which are coarse-grained software entities that use a message-based communication model, has been around for some years. SOAs have mainly been implemented within companies. With the rise of Web Services (WS) [34] and related standards like WS-Security [35] and Business Process Execution Language for Web Services (BPEL4WS) the SOA vision begins to be feasible for cross-organizational information exchange [36]. Business Process Execution Language for Web Services [37] allows organizing multiple WS to a cross organizational business process. The information flow can be modeled in a flexible and platform-independent way.

Another option for data integration is the **data warehouse approach** [38, 39]. In this type of architecture data from different systems are extracted, transformed and finally

loaded (ETL-process) into a centralized database. This data warehouse can be queried by online analytical processing (OLAP) tools that provide drilling functionalities. Quantitative data can be analyzed with great flexibility.

The difference between the data warehouse approach and the tree approaches described before is, that data is duplicated and stored centrally.

Data warehouses are not useful for the storage of qualitative information like project reports in humanitarian organizations. This makes them unsuitable for the context of information sharing between humanitarian organizations described in section 1 .

A loosely coupled mediator-wrapper-architecture was chosen to implement the **Development Information Exchange System (DIES)**. This kind of architecture has the advantage that underlying systems do not have to be modified and that it is easy to add new systems to the exchange platform. It is a suited architecture to integrate heterogeneous information systems (cf. 1.5 Problems and barriers to Information Sharing) [29].

The DIES will represent a mediator which gives an abstract, integrated view on the data stored in the data provider systems. The mediator can be implemented as one or several services which can be used by other systems. The mediator will also have a graphical user interface for direct use by human users through the World Wide Web (WWW). For a mediator to work there has to be a common exchange standard. This standard will be XML. The schemas used to define the structure of the XML will be described in chapter 3.2 Proof of Concept of the DIES.

2.2   *Types of Information Systems in Humanitarian Organizations*

Stakeholders that are interested in information exchange usually store and manage their data in own information systems [40]. Depending on their focus these systems can be classified. We can find project management systems with an operational focus, monitoring systems with a financial focus or organizational memory information systems with a focus on knowledge management and organizational learning.

Figure 2 shows different types of information systems, organizations that typically use them and the main focus of the systems. It shows how a DIES could act as mediator to integrate these systems.
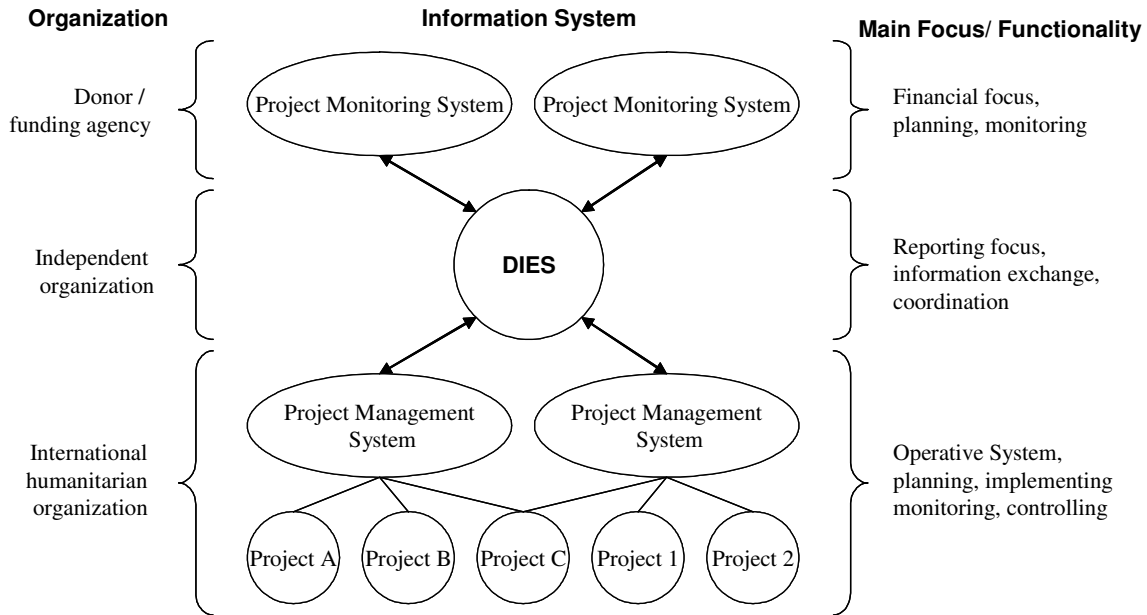

Figure 2: DIES as interface between different information systems

The DIES can be used on different organizational levels: Between organizations (as shown in Figure 2) or within international organizations with a federative structure for the integration of their own heterogeneous systems.

3 Development Information Exchange System (DIES)

Now that the situation has been described and some of the problems have been analyzed, a more detailed solution can be conceived. The state of the art will have to be taken into consideration. Detailed system requirements and specifications are not included in this paper.

3.1 Vision and Objectives of the DIES

The vision of the DIES is to help close the broken control loop. Its objectives are to enable organizational learning, enhance information sharing within and between organizations and to minimize administrative burden in the field of project reporting.

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Scenarios and use cases [8, 41] have been defined to determine the requirements for the Development Information Exchange System. One use case is called "Reporting of an international humanitarian organization to several donors". In this use case an organization implements a development project which is supported by several funding agencies. All agencies require information about the progress of the project and the usage of their funds. The humanitarian organization produces comprehensive internal project reports, which are stored in its project information system. Content and format are separated in its database. The comprehensive reports are registered in the DIES by the data owner. When a donor of the project gets the report through the exchange platform the DIES transforms and formats the data according to the requirements of the user.
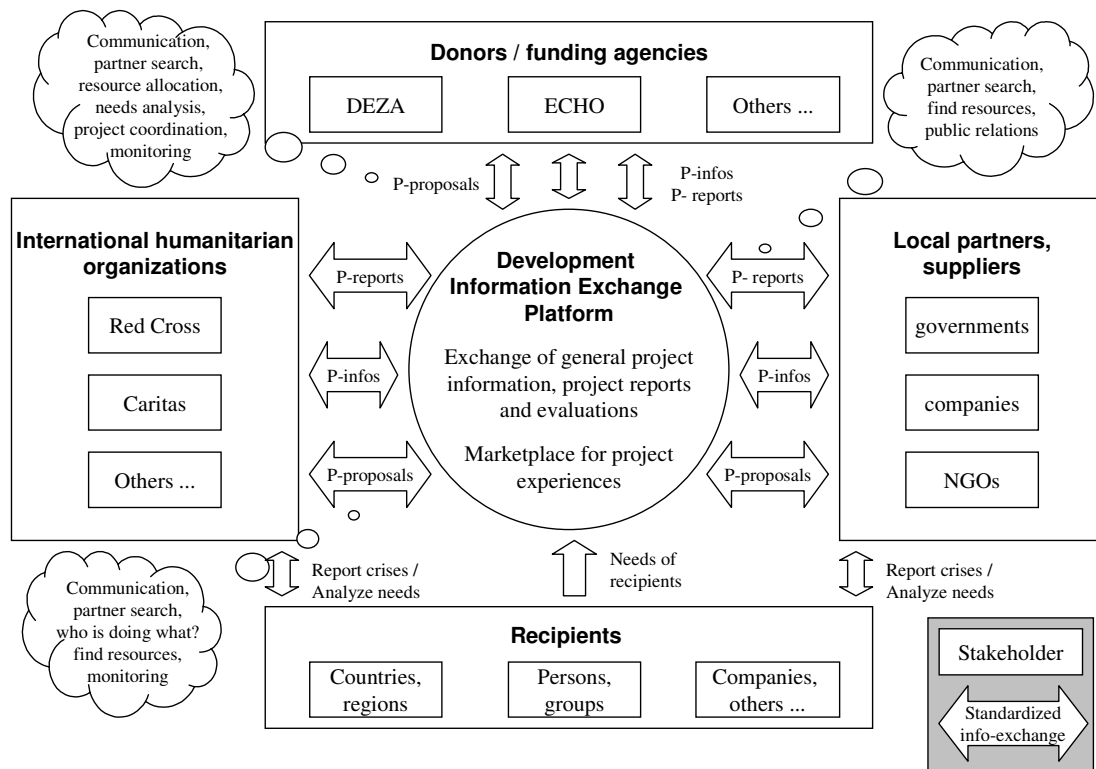

Figure 3: Information exchange with the DIES

From this and other use cases not described here, we can deduce some of the system requirements: The focus is on the exchange of project reports and evaluations. The DIES should enable platform-independent information exchange. Systems of data providers should not have to be modified. Data should not be duplicated on the DIES, i.e. data stays

on the source systems. In this way, the data provider systems stay autonomous. Another requirement is the separation of content and format of the documents to be exchanged.

Figure 3 shows the vision of a computer-based information system which could be used as a standardized platform for the exchange of project information and for the coordination of projects. Such a system would be set up independently of the NGOs and funding agencies.

In the boxes we find stakeholders described in previous sections. The clouds show possible uses of the system by the stakeholders. The broad arrows represent the standardized exchange of information through the DIES which is symbolized by a circle in the middle.

How the exchange works in detail will be explained in the next chapter, where we will show the prototype that was built to demonstrate the feasibility of the DIES concept.

3.2 Proof of Concept of the DIES

This chapter describes three parts of the DIES artifact: The exchange standard, the architecture and the web application.

Information Exchange Standard: idmlReporting

To easily collect data from different IS it is necessary to have an exchange standard that fulfills the information needs of the stakeholders of development projects. The emerging standard for this type of information is the International Development Markup Language (IDML). Various organizations already use IDML for sharing simple project information, among them the Development Gateway, the World Bank, OECD and UNDP [42, 43].

IDML as exchange standard is an XML-based set of tags and rules for the types of information that are unique to the development sector. Elements of the core activity schema include project titles, organizations that are involved and their roles, persons involved and funding details. Some of these elements can be found in any type of project. Others like "funding" or "organizations involved" are more specific to international development projects. Funding can come from various donors, and several organizations

can be involved. The content of the elements and attributes is probably the biggest difference between humanitarian projects and profit-oriented projects [44].

IDML is designed to give a high level description of activities in the development sector. It is not suited to exchange detailed project reports and evaluations. This is why a new exchange standard based on IDML was proposed by the author.

The schema was called **idmlReporting**. It is implemented as XML Schema [45]. Special attention was given to the reusability of certain parts of the schema by using complex types. The schema is divided into four parts:

- Detailed description,
- reporting,
- evaluation and
- financial information.

Figure 4 shows the structure of idmlReporting. The diagram shows the main elements of an idmlReporting Document. The child elements of "reportNumber", "detailedDescription", "reporting", „evaluation" and "financialInformation" are hidden (+ sign in Figure 4).

An idmlReporting document is composed of a root element "reportsAndEvaluations", which can contain an unlimited number of "reportAndEvaluation" elements. The element "reportAndEvaluation" is defined as complex type "reportType" (broken frame in Figure 4). The "reportType" contains the four above-mentioned main parts as well as metadata on the report (number, name, date, description). The dotted line between the elements tells us that they are optional.
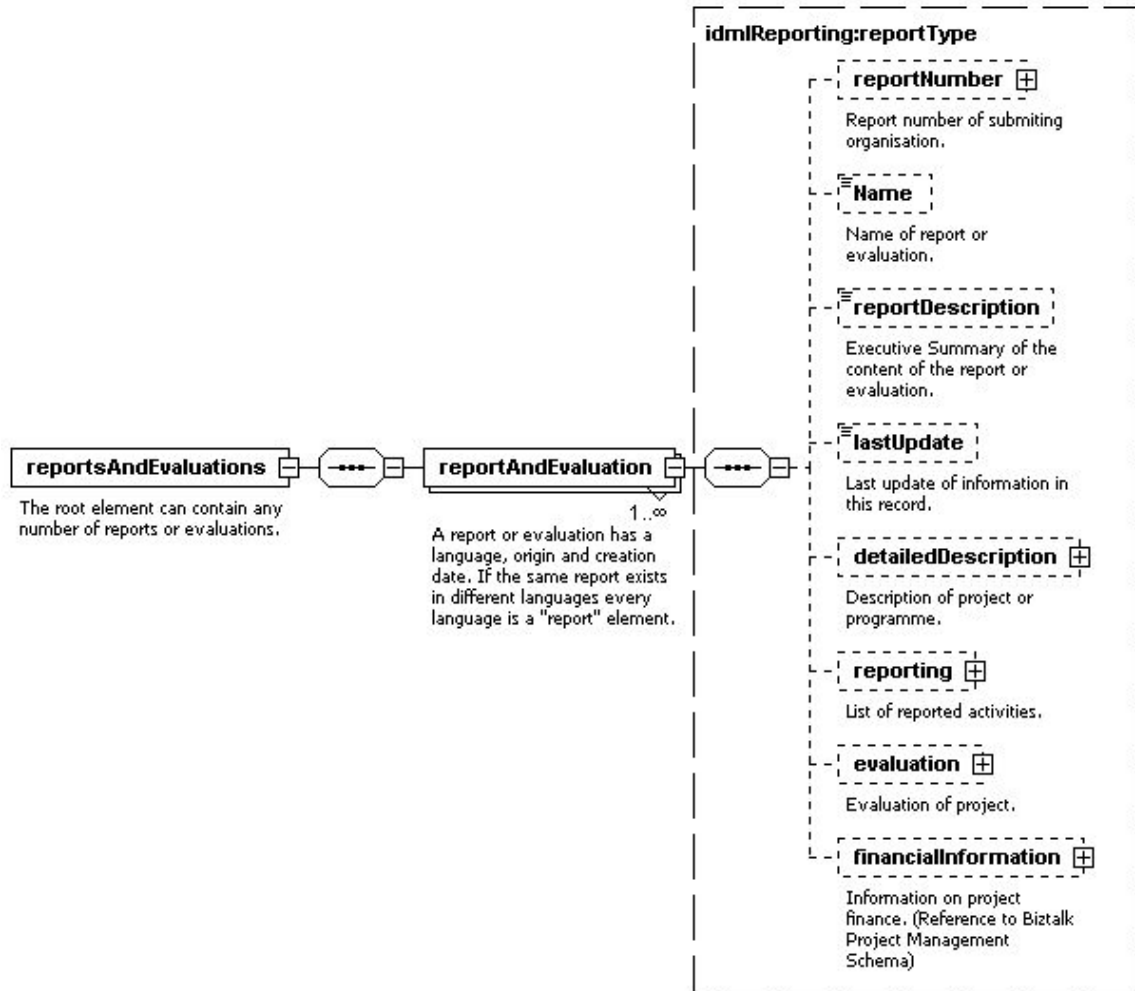
Figure 4: Tree view of the idmlReporting schema

An idmlReporting document can contain several reports and evaluations. It is possible to keep all information on one project together (e.g. project proposal, periodic project reports, an intermediate and a final evaluation) in one XML document. More information about idmlReporting as well as the full XML schema can be found in [46].

Architecture of the Development Information Exchange System

The DIES is a mediator through which semi-structured information that resides on autonomous IS can be accessed. The mediator communicates with wrappers which are built around the data provider systems. These wrappers enable the underlying IS to receive requests from the DIES and to generate IDML and idmlReporting documents. How such a wrapper can be built is discussed in [29, 44].

Figure 5 describes the architecture of the DIES and the process of information exchange through the system [47]. In the rectangles we see the systems of the data requestors and providers. The DIES is composed of a web server, a database with administrative information and an optional set of standard XSLT and XSL-FO stylesheets [48]. The arrows represent information flow.
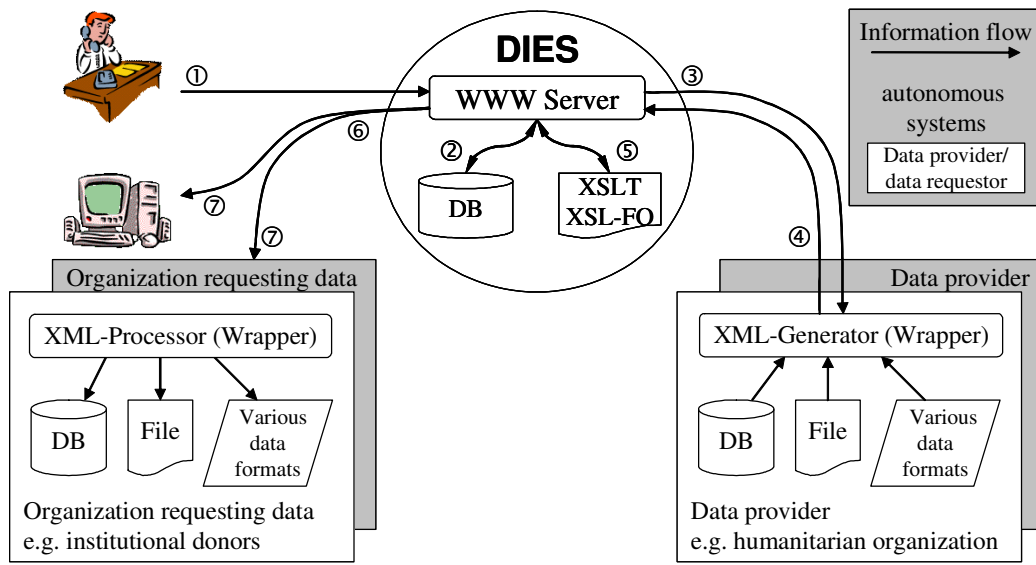

Figure 5: Architecture of the Development Information Exchange System

(1) A person or information system identifies itself on the DIES web server.

(2) The system authenticates the user and grants him access rights that are specified in the DIES database. The user selects a document from the list of available reports.

(3) The DIES calls the data provider system via WWW.

(4) The data provider sends back the requested XML document. An XML generator can be used to produce the document on-the-fly. This generator acts as a wrapper around the information system.

(5) The XML document is transformed and formatted depending on the user rights and the XSL stylesheet chosen. The stylesheet itself can be loaded from a data provider as well.

(6) The resulting document is sent to the client.

(7) It can be used as is or processed and imported into the systems of the requestor in an automated manner.

This architecture allows integrating any number of data provider systems in a loosely coupled way. Precondition for the connection of the system of a development organization is its ability to provide XML documents. These documents should follow the IDML and idmlReporting schemas which are the preferred exchange standards and used as a common language for communication in the DIES.

The architecture fulfills the basic requirements determined for an information exchange platform for humanitarian organizations. It has the advantage that information is entered, stored, and updated on data owners' systems. The reporting organizations keep full control over their data, which may help to avoid the "political" problems of implementation.

Web-based Information Exchange Platform (DIES Web Application)

The DIES web application runs on a web server and contains the business logic. It builds on the DIES database and defines what happens with the data. The application is implemented with Microsoft Active Server Pages [49]. The loading and manipulation of XML documents and XSL stylesheets is done via Document Object Model (DOM) [50].

The DIES web application enables authorized users to select project reports and to choose an output format. The documents are in XML format. The preferred schemas are IDML and idmlReporting, but any other exchange standard can be used. The transformation and formatting of the documents is done via XSL stylesheets.

The XML as well as the XSL can originate from any connected information system and is loaded by the DIES on-the-fly. Only the metadata about the documents and some administrative data is stored in the DIES database (Unique Resource Locators (URL), access rights of users, source system, etc.).

The main menu of the DIES member website has three sections:

- *Development Information Exchange System* which groups the central functions of the system like view project information or register new XML documents and XSL stylesheets.

- *Members* which gives access to the list of DIES members and the administration of personal profiles.

- *Puclic Domain* where non-confidential information can be accessed without being authenticated.

If a user wants to get information on a specific project e.g. of a partner organization he can navigate to the "Display Project Information" page shown in Figure 6. Depending on the user rights he gets a list of documents that are accessible. Any of these documents can be formatted with one of the stylesheets available in the drop-down list. The stylesheets can be used to give only access to certain elements of a document.

In Figure 6 the user selected the XML document "Air Quality Project Bangkok (idmlReporting)" and the list of available XSL stylesheets is still open.
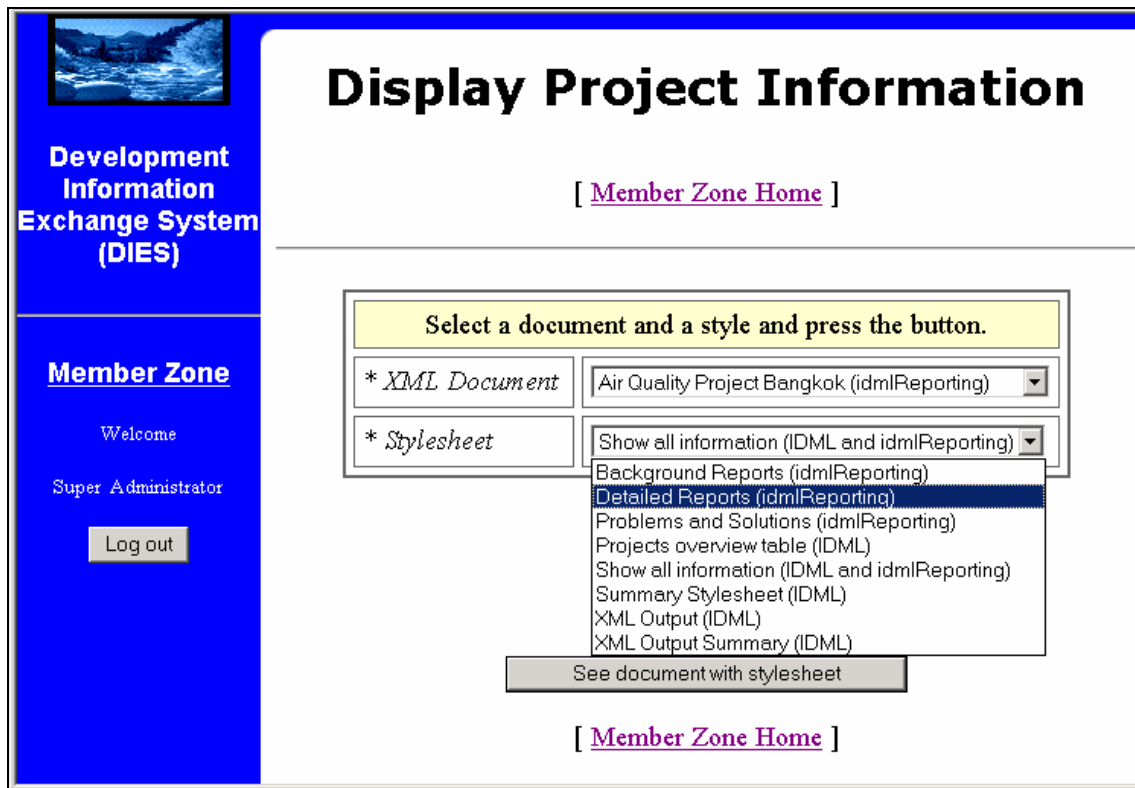

Figure 6: DIES web application – selection of document and stylesheet

Once the button "See document with stylesheet" is pushed the selected document is loaded from the URL registered in the DIES database. It does not matter if the document is stored locally or on another web server as long as the DIES has the proper access rights to the machine. Then the stylesheet is loaded and applied to the document. The result is a new document that is sent to the requestor.

All transformations are executed on the DIES web server. This ensures the platform independence of the output. It is important to note from a security point of view that the clients do not connect directly to the data provider systems.

The output can directly be displayed in the DIES. Depending on the stylesheet the result will be HTML or XML. A report in XML format can be chosen, if further processing and automated importing into information systems of the client is needed.

In this chapter we have seen the graphical user interface of the DIES. But the exchange platform can also be used by systems. In this case the DIES acts as a Web Service. A SOAP message [34] is sent to the DIES with information about the user, the data needed and the output format. The DIES retrieves the information form the sources and transforms it. The document is sent back to the data requestor within a SOAP envelope. The recipient can then further process the information.

4 Evaluation of the DIES

So far, we analyzed specific information exchange problems, proposed a concept to solve them and built a prototype as proof of concept. In terms of the design science paradigm we have an artifact now. An important part of the chosen methodology is the evaluation of this artifact. The evaluation should show if the proposed solution leads to any improvement of the situation.

A strengths weaknesses opportunities threats (SWOT) analysis of the architecture, the idmlReporting exchange standard as well as the DIES prototype was carried out. The SWOT analysis is a method often used in strategic analysis [51] or marketing [52]. Strengths and weaknesses relate to the artifact and the organization using it, opportunities and threats tell us about the future and relate to the environment of the DIES. Various evaluation criteria proposed in the information system literature [53] have been used to

rate the artifact. The requirements that were set up based on the problem description were also used to see whether the system may be useful.

4.1 Fulfillment of Requirements

The DIES fulfills both the functional and non-functional requirements for an information exchange platform in the humanitarian development sector to a great extent [15]. It can be run by an independent organization and it is accessible from anywhere via the WWW. Confidential information can be made accessible to authorized users while the costs for administering the platform are low because most tasks are managed by the users. General as well as specific project information like reports and evaluations can be exchanged in human and machine readable format thanks to XML and the idmlReporting schema. Information that is stored on project information systems of different organizations can be made accessible through the DIES. The information is updated and managed by the information owners, i.e. the humanitarian organizations or funding agencies. They are responsible for granting access rights to information as well as keeping data up-to-date.

4.2 Strengths and Weaknesses

From a technical point of view it is important to point out the capability of the DIES to couple autonomous information systems. These systems do not need to be adapted; they only need an XML generator as wrapper. The DIES represents the mediator in the mediator-wrapper-architecture (cf. chapter 2.1 Architectures to Integrate Heterogeneous Information Systems).

A strength of the architecture is that data is directly updated in the systems of the data providers. The platform allows the users to access up-to-date information. The DIES does not duplicate the data (non-persistent data); it loads data whenever a user wants to see a specific report.

A weakness of the concept is that documents that are to be exchanged have to be in XML format. Low-tech organizations may have difficulties to do this.

Furthermore, information that does not fit into the elements of the IDML or idmlReporting schemas may not be exchanged easily. In this case the schemas would have to be extended. The problem with extending or changing the exchange format is that

all data providers have to adapt the mapping between their information system and the schema to ensure that the wrapper still generates valid documents. The data requestors may also have to modify their XML processor for the import of the documents. Alternatively, different versions of the same schema could be used in parallel in the DIES. The exchange platform itself does not have to be modified when the exchange standard changes.

Another weakness may be the management of the access rights. Data owners can define access rights to their documents on the DIES web application. It is also possible to grant access to specific parts of the document by providing certain users only with stylesheets that filter some elements. However, if the user has access to various stylesheets on the DIES, it is difficult to avoid that one of these permits him to see confidential elements.

The performance of the system is the last weak point mentioned here. Documents have to be loaded from their original source. The size of these documents can be big compared to traditional web pages or word documents, since XML is used as exchange format.

However, the advantage of the XML tags is that a text may be searched, transformed or formatted seamlessly. Documents in IDML or idmlReporting format are structured and can be validated against the schemas. Well structured and standardized reports are easier to read and to understand. The structure is flexible since most elements are optional. The schemas are extensible and complex types can be reused in other schemas.

4.3   Opportunities and Threats

Some of the threats associated with the introduction of the DIES are related to the standardization of information exchange. A predefined exchange standard can limit the richness of reports or evaluations. Furthermore, it is possible that users do not like to be constraint to a predefined structure of their reports.

Another threat is that project participants might overestimate the possibilities of IT. For instance, they should not get the impression that the content of project evaluations will be generated automatically in the future.

An exchange platform that makes transparent certain information on projects can lead to changing motivations of project stakeholders. To ensure the success of information

sharing it is crucial to give the stakeholders incentives to cooperate. Ballantine et al. [54] give a good insight into this subject, which will not be treated in more detail here.

The opportunities for organizations to use a DIES concept are by far outnumbering the threats. As mentioned before, information sharing between stakeholders of development projects gives the opportunity to learn from past projects. It also improves the abilities to coordinate planned and running projects of various organizations. Sharing of information can also lead to collaboration opportunities with new partners.

The automation of parts of the information exchange process is another opportunity. It lowers the administrative costs and saves time – time that can be used to better fulfill the core activities of humanitarian projects.

5   Conclusions and Outlook

This article gave an overview of information sharing problems that occur in humanitarian development projects. Some problems can be addressed by a web-based exchange platform. The DIES concept is one possible answer to the question, what technical architecture could enable project stakeholders to share information across organizations. The DIES can be seen as a technical enabler for information exchange. But other barriers like cultural and organizational differences between organizations and people have to be addressed to succeed in the organizational learning effort. The stakeholders must be motivated and see a sense in using the DIES ("carpe DIEM").

The following conclusions can be drawn from the work that has been presented:

- The DIES can help to close the control loop. This makes project management more efficient.

- The proposed architecture solves an interface problem between the various partners and stakeholders of humanitarian projects.

The usage of the DIES can be seen as a first step towards a service-oriented architecture between humanitarian organizations. The next step could be the definition of cross-organizational business processes. These processes may be defined platform-independently with the Business Process Execution Language for Web Services. The

DIES Web Service could then seamlessly be integrated in the information flow and deliver documents that are routed to the next service or person in the business process.

Coordination of projects is very important to avoid inefficiencies. However, this coordination should not be done centrally. Democratic decision-making and decentralization are very important for NGOs. The DIES does not coordinate, but makes information available to enable the stakeholders to coordinate their activities. Therefore it promotes decentralized and well funded decision-making. The DIES may be one building block for improving the impact of development projects and may help humanitarian organizations to optimize the allocation of their limited resources.

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