ABSTRACT: The impact of digital libraries on information processes steadily increases. Today, users may choose from a rapidly increasing number of digital libraries with various characteristics. Business models for digital libraries evolve from mere content providers to sophisticated service suppliers. They offer a rich variety of information services combined with collaboration, e-learning and portal features. Traditional classification schemes for digital libraries do not sufficiently take this development into account or fail to meet it at all. In this paper we present a novel approach to the classification of digital libraries. It is based on business model characteristics with special emphasis on the evolution of digital libraries from content to information service providers. Our classification approach helps suppliers to communicate benefits and features of their libraries more effectively. It also supports customers when selecting an appropriate digital library.

Subject Headings and Descriptors
H.3.5 [Online Information Services]:
Web-based services; H.3.7 [Digital Libraries]: Systems issues

General Terms
Digital Information Processing, Digital Libraries Classification

Keywords: Digital Libraries, Information Processing, Digital Libraries Evaluation

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1. Introduction

The impact of digital libraries on information processes steadily increases. The 21st century will probably see the complete breakthrough of digital libraries into the Gutenberg Galaxy. During the last years the number of digital libraries has rapidly increased. They offer various information products and services. Traditional business models for digital libraries evolve from mere content suppliers to sophisticated service providers. They offer a rich variety of information services combined with

- collaboration functions, e.g. AARLIN [1], Merlot [2],
- e-learning services, e.g. COLIS [3], [4], CLOE [5], and
- portal features, e.g. ACM [6], DSAL [7].

A rich variety of business models for digital libraries and information services has emerged. Traditional classification schemes for digital libraries do not sufficiently take this development into account or fail to describe it at all.

We are currently involved in the DMGLib (Digital Mechanism and Gear Library, http://www.dmg-lib.org) project [8]. The objective of DMGLib is to provide a digital library for mechanical engineering. DMGLib offers a vast amount of digital documents representing more than 1,000 gear models, 100 machines, 3,500 photographs, 100 videos and animations, 400 books published before 1898 and nearly 10,000 mechanical engineering documents, technical reports, patent specifications, and research papers. The DMGLib-project is supported by the Deutsche Forschungsgemeinschaft (DFG; German Research Foundation). When the financial support – now granted by DFG – ends, DMGLib will have to generate new sources of revenues.

The objective of this paper is to propose a novel approach to the classification of digital libraries. Classification approaches for digital libraries are well known in the research context of evaluating digital libraries [9]. Within the framework of the DELOS-project [10] the “Interaction Triptych Model” [11] was presented. The main structure of this model uses technology, data, and users as primary classification criteria. The approach defines a number of metrics for the classification of digital libraries [11], [12]. Results of a survey conducted by the DELOS-project have been fed into a database (http://www.sztaki.hu/delos_wg21/metalib/). It is structured according to the classification scheme indicated above. It offers classified information on each digital library.

Our approach is based on business model characteristics and takes into account the evolution of digital libraries from mere content providers to sophisticated information service suppliers. A classification scheme that encompasses recent trends might help suppliers to communicate benefits and features of their libraries more effectively. It might also help customers when selecting an appropriate digital library. Our approach also supports the development of a business model for the DMGLib-project.

In the next section we define basic terms for our classification. The third section gives an overview of traditional classification schemes for business models of internet-based enterprises which we call e-business models. In the fourth section we outline our classification approach for digital libraries. We do this in four steps. First, we identify criteria that are best suited to distinguish business models for information services. In the second step we select criteria to classify business models for digital libraries. The third step is dedicated to evaluating our classification approach. We do this by classifying a sample of 50 digital libraries. In the fourth step we discuss our classification approach for the digital libraries market. The paper concludes with a short summary and an outlook to future research directions.

2. Definitions

2.1. Business Model

TIMMERS defines a business model as “an architecture for the product, service and information flows, including a
description of the various business actors and their roles; and a description of the potential benefits for the various business actors; and a description of the sources of revenues” [13]. Based on this definition WIRTZ [14] suggests design components for a business model. He describes six sub-models (“capital model”, “procurement model”, “goods and services model”, “distribution model”, “market model”, and “service supply model”). PIGNEUR as well as DUBOSSON-TORBAY et al. define a business model as “architecture of a firm and its network of partners for creating, marketing and delivering value and relationship capital to one or several segments of customers in order to generate profitable and sustainable revenue streams” [15], [16]. Various authors have suggested similar definitions [17], [18], [19], [20], [21]. They considered improved presentation and analysis of business activities as major objectives of a business model [14], [21]. They point out that a business model is closely related to, but different from the terms “strategy” and “business processes”. A corporate strategy is no prerequisite for implementing a business model, although usually a business model is derived from the corporate strategy [22]. A business model can be regarded as a tool to implement a corporate strategy [20]. OSTEWALDER and PIGNEUR describe a business model as the “missing link between strategy and business processes” [23]. They point out that “a business model is the conceptual and architectural implementation (blueprint) of a business strategy and represents the foundation for the implementation of business processes and information systems” [23].

Based on this understanding we define business models as strategic tools that provide a basis for the description and analysis of business concepts [21]. A business model describes in a concise form how a supplier creates value for his customers and generates revenues.

2.2. Information Service

We use a classification of goods introduced by CORSTEN [24] to allow a better understanding of the term information services. CORSTEN distinguishes real and nominal goods. Real goods may be material or immaterial. Services are immaterial real goods and may - like all goods - satisfy demands. Services can be characterized in more detail by the following criteria:

- It is necessary that customers participate in service provision.
- Usually customers and service providers intensively interact during the process of service provision.
- Service definition, design, provision and delivery form a multi-staged process.
- Service provision and consumption usually happen simultaneously.
- Services are immaterial goods.

We use these constitutive characteristics to distinguish the terms “services” and “products”.

According to SCHMIDT information services are goods that satisfy actual and latent needs. Information services are responses to concrete information problems [25]. Often the term information service is used to denote all online businesses that give clients access to information or answer user-specific requests. However, this definition seems to be too general. According to this definition nearly all service and product suppliers on the internet could be classified as information service providers. For example, an electronic shop that provides customers with detailed product information or an internet travel agency that provides additional information about weather conditions would have to be called an information service provider. Further criteria are needed to properly define the business model information service provider. (We use the terms “information service provider” and “information service supplier” synonymously.) We use three more criteria to specify business models as information services:

1. The supplier’s major objective is to provide information services. Business models that provide information as additional service to support the core supply only (for example, commerce transactions), are not classified as information services.
2. The customer’s major objective is to access information services. He does not visit the information service provider’s site for any other reason. He searches for information because he seeks to solve an information problem.
3. The provision of information services often aims at making profits.

If a business model comprises more than one product or service, we identify the major service and assess if this service is to be classified as information service. If this is not the case, we do not include this business model in our analysis.

2.3 Digital Library

A generally accepted definition of the term digital library has not yet emerged [26], [27], [28]. The diversity of definitions in the literature shows that it is difficult to clearly define this term. Besides the term digital library other frequently used terms are electronic library, virtual library, and e-library. Many authors use these terms synonymously [29]. Other authors make a distinction and refer to virtual libraries as ordered link collections for selected information sources [30]. Contrary to traditional libraries, virtual libraries do not store information sources. Instead, they establish interconnections and links to information sources. An electronic library is a library that offers digital or digitized information sources and computer aided information services. UMSTÄTTER combines the terms “virtual” and “electronic library” to the new expression “digital library” [31].

A similar variety of definitions can be found for digital libraries. MATSON and BONSKI, for example, propose the following definition: “A digital library is a library that maintains all, or a substantial part, of its collection in computer processible form as an alternative, supplement, or complement to the conventional printed and microfilm materials that currently dominate library collections” [32]. Another frequently quoted definition was published by LESK. He describes digital libraries as, “organized collections of digital information. They combine the structuring and gathering of information, which libraries and archives have always done, with the digital representation that computers have made possible” [33]. Other authors do not define the term explicitly, but list essential definition elements.

- The digital library is not a single entity;
- The digital library requires technology to link the resources of many;
- The linkages between the many digital libraries and information services are transparent to the end users;
- Universal access (any time and anywhere) to digital libraries and information services is a goal;
- Digital library collections are not limited to document surrogates: they extend to digital artefacts that cannot be represented or distributed in printed formats” [34].

WATERS combines various definitions and develops a more comprehensive definition. He describes digital libraries as, “organizations that provide resources including the specialized staff to select, structure, offer intellectual access to, interpret,
distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities" [29].

The DELOS-project extends this definition. According to its vision the New Generation Digital Libraries “should not just be seen as static information repositories but as growing, interactively, and collaboratively used nuclei of what will be at some stage, a good part of human knowledge that depends as much on information as on communication.” [35]

Based on these definitions and the discussion of the term information services we propose the following definition of digital libraries. They are structured electronic collections of documents. Digital libraries comprise documents in heterogeneous media forms; e. g. text, structured data, pictures, audio, video, and executable software. Digital libraries are accessible via internet technologies or they are available on CD-ROM, DVD, or other media. They support activities to satisfy information needs and help to solve specific information problems. Digital libraries perform a wide range of different activities. In the most basic form digital libraries transfer traditional services of classic libraries (structuring, classification und provision) to the digital world. More sophisticated business models provide additional services (e. g. collaboration or e-learning services). Specialized business models provide particular information services across multiple digital libraries (e. g. meta classification schemes or searching facilities). We refer to all these business models as digital libraries. Our definition includes New Generation Digital Libraries in the sense of the DELOS-project. Digital libraries are a specific form of information services.

3. Classification Approaches for E-Business Models

Before introducing a new classification scheme for business models of digital libraries, we give an overview of classification schemes for internet-based business models (e-business models). We then identify criteria for classifying business models and analyze the suitability of several approaches to classify business models for information services. In the next section we transfer our results to the classification of digital libraries.

3.1 Classification by TIMMERS


3.2 Classification by WIRTZ et al.

WIRTZ ET AL. use service provision as major criterion for their classification [14], [37], [38], [39], [40]. They identify four generic business models: content, commerce, context, and connection. These four generic models are specified into business model variants. The authors use two more criteria for this specification: revenue type (for all generic business models) and transaction phase (for commerce only).

3.3 Classification by BARTELT/LAMERSDORF

In a first step BARTELT and LAMERSDORF divide internet based business models into the main classes e-commerce, e-information and e-cooperation[41]. Examples for e-cooperation business models are supply chain management, virtual companies and collaboration platforms. E-information covers business models that primarily support information procurement. E-commerce business models focus on trading goods. Information services best fit into the e-information class.
In their first papers BARTELT and LAMERSDORF focused on e-commerce business models. They developed a classification scheme that uses two criteria: subject and behaviour. Subjects may be suppliers, customers or mediators. Behaviour describes whether the supplier or the customer initiates a trade transaction.

In further papers the authors include e-information business models [42]. However, BARTELT ET AL. do not modify their classification shown in Table 2. They develop a new phase model for e-information business models. It consists of five phases: registration, processing, storage, search and delivery. BARTELT ET AL. use these phases for a detailed description of the five e-business model classes.

### 3.4. Discussion of the Classification Approaches

The three classification approaches discussed in the previous sections have little in common in regard to structure and choice of classification criteria. The reason for the differences is primarily that the approaches focus on different subjects. All approaches have in common, however, that they use only few criteria for the classification. This is also the case in various other approaches that classify e-business models [43].

TIMMERS focuses on business models that support commerce transactions. Information services can only be found in information brokerage (information services that add value to data available on the internet) and virtual community (communities, where members share information with other members). All other business models described by TIMMERS do not cover information services.

The classification proposed by WIRTZ et al. covers information services in the business model types content and context only. The two other business models, commerce and connection, do not comprise information services.

BARTELT and LAMERSDORF focus on e-commerce business models and mention information services (e-information) only briefly. However, they do not suggest a classification of business models for information services on the internet.

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Table 1. 4C-Net-Business-Model Types [40]

<table>
<thead>
<tr>
<th>Business Model Types</th>
<th>Content</th>
<th>Commerce</th>
<th>Context</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>collection, selection, systematisation, compilation, and provision of information</td>
<td>initiation, negotiation and/or processing of business transactions</td>
<td>classification and systematisation of information available on the internet</td>
<td>providing tools and services for information exchange and communication</td>
</tr>
<tr>
<td></td>
<td>online provision of consumer centred, personalised content</td>
<td>supplement or substitution of traditional commerce transactions on the internet</td>
<td>reduction of complexity, navigation</td>
<td>creation of interconnections to support communication</td>
</tr>
<tr>
<td></td>
<td>indirect revenues</td>
<td>transaction dependent, direct and indirect revenues</td>
<td>indirect revenues</td>
<td>direct and indirect revenues</td>
</tr>
<tr>
<td></td>
<td>e-information, e-entertainment, e-infotainment, e-education</td>
<td>attraction, bargaining/ negotiation transaction</td>
<td>search engines, web catalogues</td>
<td>intra-connection, inter-connection</td>
</tr>
<tr>
<td></td>
<td>ft.com time.com</td>
<td>dell.com, amazon.com, ebay.com</td>
<td>google.com, yahoo.com, lycos.com</td>
<td>aol.com, gmx.de, pobox.com, xing.com</td>
</tr>
</tbody>
</table>

Table 2. E-Commerce business model classes by Bartelt/Lamersdorf

BARTELT and LAMERSDORF introduce more criteria, but do not use them in their classification, for example business relation type, trade transaction phase and revenue type [41]. Still, trade transaction phases play an important role in their classification. They are used for a more detailed description of the five e-business model classes shown in Table 2. BARTELT and LAMERSDORF subdivide trade transactions in six phases: need identification, product brokering, merchant brokering, negotiation, purchase and delivery, product service and evaluation.
We conclude that the approaches to classify e-business models discussed in previous sections are neither appropriate for classifying information services nor for digital libraries. Little attention is paid to the rapidly growing field of information services.

4. Classification Approach for Digital Libraries

To develop a classification for digital libraries we derive criteria and their characteristics from existing e-business models and identify additional classification criteria from the literature [19], [20], [21], [45]. Subsequently, we select relevant criteria and develop a classification that is applicable to digital libraries. Afterwards, this classification approach is evaluated whether it is adequate to specify business models for digital libraries.

4.1. Classification Criteria

In the previous sections we have identified potential criteria for characterizing e-business models for information services. To qualify as criterion for the classification, an attribute should be determinable and discriminating. The criteria functional integration and innovation level by TIMMERS for example have a low discriminatory power or are difficult to determine. Consequently we will not use them in our approach. A classification by trade transaction phases is also not helpful because this paper focuses on information services, and more specifically on digital libraries. In the next sections we present and discuss criteria that might be helpful for classifying e-business models for information services.

Role and Behaviour of the Actor

This criterion describes the role of the actor, who conducts the business and his behaviour during the initiation of business relationships [41]. We distinguish three roles, supplier, customer, and - where applicable - mediator. Suppliers provide services. Customers consume services. Mediators support providers and consumers by interconnecting the two parties. We distinguish two behaviour types during the initiation of a business relation:

- passive behaviour, i.e. supplier publishes his services and waits for customers
- active behaviour, i.e. supplier directly approaches customers

Business Relation Type

Business relation type characterizes the role of business partners in a business relation [40]. Since we analyze commercial information services only, we focus on the relation types Business-to-Consumer (B2C), Business-to-Business (B2B) and Business-to-Government (B2G). We assume that consumers and public institutions do not aim at making profits.

Cardinality of Business Relations

Cardinality of business relations describes the number of players interacting in a particular business model [46]. Four variants can be identified. The first variant is a direct service relation; one supplier delivers customised services for exactly one customer (1:1). The most common variant is the 1:n relation; one supplier offers services to n customers. Furthermore, marketplace-structures (m:n) exist with multiple suppliers and multiple customers.

Personalisation Level

Personalisation level describes to which extent services are customised to the customers’ individual preferences [47]. Depending on the initiation we identify two types:

- push-personalisation: personalisation governed by the supplier (CRM-based), example: amazon.com
- pull-personalisation: personalisation governed by the user, example: my.yahoo.com

Service Type

Service type describes the functional direction of the service. According to WIRTZ ET AL., two types of information services can be distinguished: content and context [40]. We add the service type community [36].

Revenue Type

Revenue type describes how the information service supplier generates revenues [47]. We distinguish two revenue types: indirect and direct revenues. If a consumer directly pays for a service we call this direct revenue. Indirect revenues are generated by advertising, sponsoring or provision models.
4.2. Selection of Criteria for Classifying Digital Libraries

Based on the criteria discussed above we will now select criteria that facilitate the classification of business models for digital libraries.

We use the attribute “service type” to distinguish business models for digital libraries on the highest level. The service types content, context and community are often used in e-business models for information services. Furthermore, these types are sufficiently specific to achieve a clear distinction of business models for information services. Since a supplier often provides several service types it is necessary to complement the three generic types content, context and community with another type that we call “portal.”

KALAKOTA and ROBINSON define a portal as a platform that offers “an aggregated set of services for a specific well-defined group of users.” [48].

In order to describe the classes of business models for digital libraries in more detail we use the criterion “information spectrum” to distinguish subclasses within the classes content, context, and community. We use a different structure for establishing subclasses in the class portal. A vertical portal provides services specialized on particular topics, geographical regions or customer groups. A horizontal portal is not focused on specific topics, regions, or customer groups.

As we will show in the following section, these two criteria support a detailed classification of business models for digital libraries. The other criteria mentioned in section 4.1 may facilitate extensions, modifications and specifications of our approach. However, they are not necessary for a first classification of business models for digital libraries.

4.3. Evaluation of the Classification Approach

In this section we apply our business model-based classification scheme to digital libraries. A selection of 30 international providers (taken from dmoz.org), 10 German digital libraries (taken from the ranking at yahoo.de) and 10 examples, randomly chosen from the result of a google-query (search string: „digital libraries“, in a Boolean term with „collaboration“ or „e-learning“) was made. The classification of this sample is based on the following criteria.

All digital libraries that focus on the collection, systematisation and provision of digital content are assigned to the class content. The separation into the three subclasses generalist, theme specialist and information specialist is based on the level of specialisation to a topic, medium, or region. Generalists, e. g. the American Memory from the Library of Congress, have no limitations to specific themes, media or regions. Although the American Memory from the Library of Congress focuses on historic information, it also provides interesting information about current events and the recent past. Theme specialists focus on a specific media type (e. g. the open-video-project), a theme (e. g. DLNET for engineering and technology) or a region (e. g. Digital South Asia Library). Information Specialists offer highly specialised information in a focused field, such as the Ethnomathematics Digital Library.
Context and community are classes that represent functional extensions of the classic library business model. Context comprises digital libraries which do not only provide their own sources to customers, but expand their services to retrieval, classification and provision of third-party information.

Table 6. Classification of Digital Libraries¹

<table>
<thead>
<tr>
<th>Class</th>
<th>Sub-class</th>
<th>Instances</th>
</tr>
</thead>
</table>

¹The instances for the classification are results of a survey conducted in summer 2005. Therefore the classification shown in Table 6 is not necessarily a reflection of the current state of the art. It is rather an illustration of the former situation.
services. The distinction into subclasses uses the same principles that we have already described above. Citeseer, for example, focuses primarily on publications in computer and information science, ELPUB for publications in the context of electronic publishing. They are typical representatives of the subclass theme-specialist.

Community describes business models of digital libraries that expand their services by providing collaborative services for customers. Users of digital libraries in the class community may share information with other users by applying synchronous or asynchronous communication platforms. Another feature of digital libraries in this class is providing e-learning systems. Examples for digital libraries in the class community can be found at major multi-national research projects (Ariadne: http://www.ariadne-eu.de, Merlot or eduSource: http://www.edusource.ca). We use the same criteria to form subclasses as in the classes content and context.

Business models of digital libraries in the class portal integrate content, context, and community services. The California Digital Library, for example, provides also access to the papyrus collection of the University of Berkeley or - together with Counting California - access primarily on publications in computer and economic data produced by government agencies. We distinguish portals into horizontal (for universal, neither thematically nor regionally limited information services) and vertical portals (for highly specialised services; e.g. G-Portal, [1]).

4.4. Conclusions

The transfer of the classification approach for information services to the field of digital libraries leads to the following insights:

• Our evaluation shows that all digital libraries in our sample can be classified with our classification scheme.
• Although the nature of our study is such that no scientifically valid conclusions can be drawn, the evaluation at least indicates that our classification scheme is sufficiently comprehensive.
• In section 4.1 we have discussed several criteria that facilitate extensions, modifications and specifications of our classification. We assume that these criteria support the adaptation of our approach to future developments in the field of digital libraries.
• The classification of digital libraries shows that most libraries belong either to the class content or portal.
• From the sample that we used in this paper, only very few digital libraries fall into the classes context and community.
• A more comprehensive empirical study could assess whether this is also true for a larger sample of digital libraries.
• If this should be the case, we suggest that providers of digital libraries consider expanding their services to community and context. Collaboration and e-learning features, for example, could help to attract more customers and to generate new revenue sources.

5. Summary and Future Research

The objective of this paper was to evaluate the applicability of an e-business model-based classification approach for information services provided by digital libraries. The evaluation illustrates the suitability of our classification scheme. We have indicated how our classification scheme can be extended and adapted to future developments in the field of digital libraries. While we stress that no general conclusions can be drawn from our observations, we can say with confidence that the results represent an interesting option to classify digital libraries. Our classification approach might help suppliers to communicate benefits and features of their libraries more effectively. It might also support customers when selecting an appropriate digital library. Currently, our classification approach is used as a basic structure for developing a business model for the DMGLib-project [49].

The classification scheme introduced in this paper should also be useful in guiding future research efforts. First, our business model-based classification approach could be compared to other classification schemes for digital libraries. Second, the usability of our approach should be tested in a more comprehensive empirical study. Third, criteria that we have only indicated in our paper should be assessed as to whether they support a more detailed classification of digital libraries. Future research projects might also aim at extending and modifying our approach with more criteria.

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[4] Collaborative Online Learning and Information Services (COLIS), http://www.colis.mq.edu.au
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