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A Conceptual Analysis of Functions, Processes, and Products in the Scholarly Communication Chain

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Abstract. This paper summarizes the user needs, functions and information processes in the scholarly communication chain, with an emphasis on the publisher's role. Furthermore, it presents how product functionality, core benefits, attributes and features relate to each other and how a publisher can seek a competitive edge by differentiation of products and in processes executed. It shows how the functions and information processes are interrelated with the user needs and how an analytical approach can be adopted towards these needs when developing a product.

1 Introduction

When expressing the roles of the traditional actors in the scholarly publication chain in communication terminology, the author is the sender and the reader is the receiver of a message and the communication is done by means of communication channels [1]. The publisher's responsibility in this is to package the sender's message as clearly as possible and to distribute it as widely as possible; the library's core function is to pick up as many relevant messages as possible on behalf of the reader and to provide access to them. Following this reasoning, packaging and collecting relevant messages are activities to enrich the information, and the distribution and access provision are logistical tasks, necessary for the transportation of the information.

Digital developments have caused major changes in how these core functions are performed, both for libraries and for publishers. The library's emphasis has shifted from ownership to an access model in which the library functions as a gateway to information embedded in a network [2]. Libraries are becoming virtual collections,

providing pointers and access to digital copy stored elsewhere [3] [4]. When a digital library points to relevant information sources and when documents are created and stored digitally, libraries can readily include documents that have not officially been published via traditional channels, also referred to as institutional publishing [5].

Publishers have seen changes in production methods and in the end product, the journal article. In an electronic environment, an article is written, produced, stored, and distributed digitally. Multiplication of the original work has become redundant and the publisher's core task of distribution is replaced by providing access to a singular copy.

These changes in the core functions of libraries and publishers demonstrate room for a backward and forward integration in the traditional information chain.

1. Institutional publishing fits the core functionality of a library in the sense of collection management, and yet, it fits the core functionality of a publisher as well.
2. When the singular electronic copy of an article has become the end product of the publisher, the publisher will store the single copy in its own repository, offering clients access to that repository. The publisher's repository becomes the digital library to which access is offered, and fulfils here a collection management task originally reserved for libraries.

In addition to this backward and forward integration, new actors are entering the information chain, some with roles fitting neither the role of a publisher nor that of a library. And thirdly, new products have been developed, such as electronic journals, archives, and knowledge environments or refereed portals.

These changes in the order of the information chain and in information products are mainly technologically driven. Recent advances have enabled more options. Despite the serials crisis and the subsequent strive for free or low-priced journals, which have irrefutably contributed to the changes in electronic publishing, the average use value of a journal exceeds the average purchase value by at least four times [6] And as for social factors for change, the acceptance of new electronic publication methods is slower than might be expected [7], even among the youngest generation of scientists [8].

This conclusion makes a closer look at Porter's theory on competitive strategy relevant. 'Technological change is one of the principle drivers of competition. It plays a major role in industry structural change, as well as in creating new industries. It is also a great equalizer, eroding the competitive advantage of even well-trenched firms and propelling others to the forefront' [9].

This paper seeks to contribute to a better understanding of the roles that the actors play, their competitive strengths, and the viability of new publication products. This is done by presenting a conceptual analysis of the various functions, information processes, and products. It will be considered how a competitive edge

can be created by features, benefits, and attributes. This all should be based on the needs of the scholarly community, and these needs provide the starting point.

2 Science as an Institution and the Functions of the Scholarly Communication Chain

Merton has formulated four norms for the conduct of science – universalism, communality, disinterestedness, and organized skepticism –, which have been influential in the practices of current scientific communities [1, 7] Universalism refers to the assessment of work on the basis of pre-established, impersonal criteria; communality implies that the acquired knowledge should be shared and be made common property; disinterestedness suggests that the advancement of knowledge should be scientists' prime concern, rather than personal motives; and organized skepticism requires a permanent critical approach to accepted knowledge.

Additionally, the scientific community holds the belief that science explores the world in a unique way. Within science, true discoveries can only be made once, as only one true world exists. This assumption evokes the need to claim priority, 'preempt(ing) the work of others' [10]. This need for priority claim correlates with the need for recognition that authors seek. Although this need seems to conflict with the norm of disinterestedness, recognition is the reward system that science has developed to promote its institutional goal, the progress of science [7].

Based on these values, knowledge needs to be attributed to the appropriate scientist, it needs to be disseminated, shared, certified, modified, and preserved for posterity. These values define the functions that the scholarly communication chain needs to perform. Kircz and Roosendaal have defined four functions of the scholarly communication chain: registration, awareness, certification, and archiving [11]. And Smith has distinguished four phases in the body of science: creation, communication, criticizing & modification, and integration [12]. These distinctions also provide the basis for the functions that publications and journals fulfill. Based on the definitions of Kling and McKim [13] and of the International Working Group [14], the three functions of a publication are priority claim, communication, and acceptance [15]. In line with these functions, the journal's role is to provide current awareness, archival recording, priority claim, and quality control [16, 7].

3 User Needs

The starting point of all activity in the information chain is the users' information needs. In various studies [17–24] empirical data has been collected on user needs[1],

[1] The recent user study *Authors and Electronic Publishing*, published by the ALPSP 2002, has not been included in this overview due to time constraints. The issues pre-

and although different research methods have been used and different domains have been investigated, the overall picture emerges that readers want relevant material that is easily obtainable, and that authors seek recognition and dissemination.

In the list below, all findings have been grouped around these four main information needs.

Authors

Recognition

- Recognition of their intellectual property (e.g., by consolidation of their work, authenticity, priority claim through rapid dissemination);
- Academic reward (e.g., tenure or promotion);
- Visibility of their work amongst colleagues (e.g., through abstracting & indexing services, alerting services, retrievability);
- Credit and reputation for their work (e.g., by being cited, by being visible);
- Perceived quality of their work (e.g. by being published in reputable journals).

Dissemination

- Visibility of their work among colleagues (e.g., through abstracting & indexing services, alerting services, retrievability);
- Widest possible dissemination;
- Speed of publication (including quick peer review, quick production and rapid awareness);
- Permanence (e.g., document integrity and performance of archival functions).

Readers

Relevance

- Customized features (e.g., personal search profile, electronic bookmarking, alerting services);
- Information cues (including quality indicators) in order to assess the relevance (e.g., keywords and other metadata, abstracts, peer review);
- Information management (e.g.,. ordering, sorting, collection context);
- Retrieval systems (e.g., catalogues, search engines, hypertext links, browsing facilities).

Obtainability

- Accessibility (e.g., easy or no passwords, free or simple access, searchability);

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sented in this ALPSP report agree with the findings presented here. This ALPSP report is very comprehensive, though, and quantifies the needs and is an important study on user needs.

- Desktop delivery (e.g. networked environment, full-text access, downloading options);
- Wide range of journal titles, including back issues (e.g. aggregated collections);
- Seamless environments (e.g., portals, aggregated collections);
- Hypertext links.

Apart from these information needs, other user requirements have also been formulated, pertaining to information seeking behavior and electronic journal acceptance. These requirements do not change the four main information needs discussed above, but have implications for how these information needs are addressed.

4 Information Processes

Based on the functions and user needs described, the following seven information processes necessary for the functioning of the scholarly communication chain are defined:

- Peer Review
- Production
- Preservation
- Storage
- Access
- Publicizing
- Retrieval

Traditionally, publishers have organized the peer review process and took care of the production, distribution and publicizing. For digital publications, the relevant information processes have become peer review, production, storage, access, and publicizing. These processes will briefly be described below.

Peer Review. The peer review system has been criticized over the last ten years. The system causes a high workload for peer reviewers, a delay in the publication process [25, 26], and the anonymity of the system entails a degree of unaccountability, leaving room for unjust rejections and conservative acceptance policies [27, 28]. The interactive quality of the internet may lead to alternative – more open – forms of peer review [29], but overall the traditional peer review system is still valued.

Production. The production methods have drastically changed from a graphical to a digital expertise. The contents – expressed in a long sequence of bits and bytes –, are codified through a platform independent language, and can then be presented in any chosen form [30]. The published article is the result of these three

components -contents, structure and form- and article design should address these three levels.

Other issues in the production process relate to the consolidation and identification of the article. The consolidation of an article guards the integrity and authenticity of the document. The integrity refers to 'those features of an information object that distinguish it as a whole and singular work' [30] and the authenticity ensures that the contents presented in the document are equal to the contents of the original work [14]. The need for a persistent identification is directly linked to the needed for unambiguous referencing, as well as for accrediting purposes, retrieval and access [31].

Storage. The singular nature of the digital copy has made the need for multiplication and physical distribution obsolete. Instead, the single copy is stored in a digital warehouse and access to the warehouse is provided. This results in the need for information storage processes. Practically, these are very similar to preservation processes and issues, but the time period for which the information is stored is shorter and the motivation is different. Publications are not stored to safeguard cultural heritage for posterity, but to provide access as long as users ask for it.

Still, the same technological issues of obsolescence and document integrity rise. As these issues can best be addressed when the initial document is well-structured, the responsibility for storage and archiving issues is partly placed with the publisher [30]. Likewise, the repository and the enduring archive are placed for similar organizational issues, for which standards have been set by the OAIS model [32].

Access. Access can be approached from two angles. First, there are technical aspects, which are inextricably bound up with the storage function. Especially when access is license-based, this entails a few administrative processes, that do not per se have to be performed by the publisher, but can be outsourced. Secondly, access can be viewed from a user-oriented approach, which places the information needs of the user central, rather than the publications in the repository. In this user-oriented approach, aggregated access and retrievability become the main information processes.

Publicizing. It is important to announce publications, as electronic documents are intangible and become invisible when they have not been publicized. Announcing can either be product-driven or user-driven. Publishers generally adopt a product-driven action, as they, and the authors, have an interest in promoting their publications to a wide audience. A user-driven approach focuses on a user's interest profile and will present relevant publications, irrespective of the publisher.

5 Product Development

Technological advances have created new opportunities in electronic publishing, allowing new actors and new products. In order to be useful, the product should address a user need. Earlier it was shown how the user needs relate with the four functions of the scholarly communication chain. In product development, however, not only is the function that is performed important, but also *how* this is done.

In *Principles and Practice of Marketing*, one of the current standard reference works, a product is defined as 'anything that can be offered to a market for attention, acquisition, use or consumption that might satisfy a want or a need' [33]. Within a product, three levels can be distinguished:

1. The core product, representing the core benefit or the problem-solving services;
2. The actual product, turning the core product into a perceivable set of characteristics; and
3. The augmented product, providing additional services and benefits enhancing the core and actual product.

With the found user needs in mind, the core benefit of a product becomes easily identifiable. A product should for instance deliver priority claim, recognition, visibility, or dissemination. The core benefit addresses the core function of an information product. The augmented product aims to provide the customers with long term satisfaction: e.g., author support, installation support, and customer services. Both the core and augmented product level are rather abstract and not directly visible in the product.

The actual product is the most tangible of the three levels. A journal, an archive, a portal, a catalogue, and a search engine are all examples of the actual product level of a product. The actual product has five characteristics:

1. Product quality, referring to the quality level at which a product performs its functions;
2. Features, allowing the product to distinguish itself from the competition;
3. Design, supporting the functionality as well as the looks of the product;
4. Branding, seeking customer loyalty; and
5. Packaging and labelling, which apart from their functionality of transportation and information about the product, have the potential to attract and convince the customer.

By product quality values such as fast, comprehensive, accurate, reliable, easy, flexible, efficient, effective, selective, etc. should be understood. These qualities decide in what manner the user needs will be addressed, how the product should be designed, and which features should be chosen. Product quality, features, and design are product attributes that decide the functionality of the product, whereas

branding, packaging and labelling represent marketing notions that attract the user's attention. All five characteristics influence the criteria of choice of the scientist and help the product to stand out.

6 Competitive Advantage

Porter presents differentiation as a competitive strategy [34]. Although competition in the information chain may not be as cutthroat as in other industries, this differentiation theory provides principles of how publishers can position themselves among other publishers and how user needs can be addressed at best.

Differentiation is defined as the goal to be unique at something that is valuable to the buyers. It can be achieved by:

- Product differentiation, thus making products distinguishable from others.
- The scope of the organization referring to the range of processes or functionalities an organization has chosen to perform.
- The performance or quality of these processes.
- Interlinking activities, referring to coordinating internal business processes and to cooperation and partnerships for activities external to the organization.

Product differentiation. Kotler's explanation of product levels, core benefits, and product characteristics can be applied to product differentiation. At the core, each product should address one or more user needs, such as priority claim, visibility, or dissemination, and deliver these as benefits like recognition, reputation, or dissemination.

Each publication product, whether a journal, an archive, a repository, an article, a portal or a search engine, is an actual product and thus can have any or all of the five characteristics mentioned above. Three of the five characteristics are the product attributes: the quality, the features, and design. The product attributes influence the functionality of the product. Together, the five product characteristics determine in what manner the main benefit is delivered. They allow the product to stand out, but they should always be based on a cost/benefit ratio, as they otherwise may become too expensive.

Process differentiation. Differentiation can also be achieved through the choice of activities and the quality sought in these processes. The quality norms of information processes depend on the benefits that the process and the product deliver.

A publisher can decide to narrow its scope by concentrating on the acquisition of publications and to outsource the electronic production expertise or the access administration. Backward and forward integration are situations where actors

widen their scope of activities. In both cases the interlinking of processes and seeking partnerships or cooperation is important. A company with a narrow scope of activities will need partners fulfilling the rest of the information processes, and organizations with a wide scope may not be able to develop all the expertise required by themselves, and need to seek specialized parties in that respect.

7 Towards a Framework

In a bird eye's view, the above has elucidated the user needs, benefits sought – also defined as the core function of the product –, processes and functions in the scholarly communication chain. We have seen how products address core benefits and how features and attributes are part of a product. They decide how the core benefits are delivered and allow a product to stand out. By distinguishing a product in the three levels – core, actual and augmented –, and by formulating features and qualities based on user needs, a publisher can deliver core benefits to the user at the best possible way. Secondly, it has been argued that user needs, benefits sought, information processes and the functions of the scholarly communication chain all are derived from the institutionalized body of science, causing an interrelationship. Thirdly, the differentiation strategy of Porter has been introduced explaining how a product or an organization can distinguish itself from from other products and organizations. Porter's theory may seem to imply a competitive policy, but even if a publisher's mission is not inspired by competitive motives, this theory provides a steppingstone to customer-oriented product development and invites to reflect on the information processes performed.

Figure 1 on the next page recapitulates the foregoing and demonstrates the various interrelationships. The core functions of three products have been given as an example-an article, a journal and an archive-, but other information products can be filled in as well. Features and other characteristics can then be added per product and per function addressed. As this is a more useful exercise in a real-life case, this has not been worked out here.

But apart from summarizing this rather conceptual perception, this table can also be applied as a framework assessing the activities of a publisher. At the moment, this framework lacks a list of qualities, defined per information process. Little[2] has been written about qualities sought and valid qualities can not be given here, although these should be included when assessing one's information processes and products delivered. Despite this imperfection, this framework can be used as an analytical instrument for publishers who seek to address user needs in the best possible way.

[2] The book *Value-Added Processes in Information Systems* by Robert Taylor (Ablex Publishing Corporation, 1986) is a study into qualities of information systems. Although this study does not cover publishing activities, it provides a very useful starting point.

Information Processes	Four Functions of the Scholarly Communication Chain	Readers Needs	Author Needs	Three Information Products of the Scholarly Communication Chain		
				Article	Journal	Archive
Production Storage	Registration		- Credit through citation - Recognition of intellectual Property - Permanence - integrity	Core function Priority Claim	Priority Claim	Priority Claim
Publicizing Access Storage Awareness	Awareness	- Customized alerting features - Information cues - Information mgt - Retrieval Systems - Accessibility	- Visibility amongst colleagues - Widest possible dissemination	Communication	Current Awareness	Dissemination
Peer Review	Certification	- Information cue - quality	- Perceived quality of work	Acceptance	Quality Control	
Preservation Storage	Archiving	- Accessibility	- Permanence - integrity - longevity		Archival Recording	
				+ product characteristics + product augmentation		

Fig. 1. *Functions, Information Processes, and Core Functions of a Product related to User Needs*

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