

HOW DIGITAL IS COMMUNICATION IN YOUR ORGANIZATION?

A Metrics and an Analysis Method

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Keywords: Categories of communication forms, CCF, taxonomy of communication media, digital media, metrics, measuring organizational communication, genre theory, measures for digitalisation, IT investment paradox

Abstract: Novel innovations in the area of digital media are changing the ways we communicate and organize. However, few practical measures exist for analysing the digitalisation of organizational communication as an intermediate factor in the initiatives to adopt new information and communication technologies (ICT). Building upon the genre theory of organizational communication, a categorization of communication forms, and quantitative measures we suggest such metrics and a measurement method. A case study applying them in an industrial organization suggests the method and metrics to be applicable for quantifying how new information systems affect to organizational communication as well as for anticipating their digitalisation impact prior to the implementation. The metrics provide a basis for further work on analysing correlation between organizational performance and adoption of information and communication technology.

1. INTRODUCTION

Digital media have increasingly reshaped organizational communication and the whole concept of organizing throughout the 20th century (Yates, 1989). Digital convergence and development in information and communication technology (ICT) will continue to bring novel means for organizational communication. Empirical research suggests that the adoption of ICT would appear economically valuable when complemented with changes in organizational design and work practices, such as increasing use of teams, redesigned business processes, and broader decision-making authority (Brynjolfsson, Hitt, and Yang, 1998, Dans 2002, Francalanci and Maggiolini 2002). However, the justification and evaluation of ICT investments has emerged as a complex issue often labeled as the “IT investment paradox” (van Grembergen, 2002).

The literature proposes a plethora of methods and techniques for the evaluation of ICT investments

in organizations. Renkema and Berghout (1997) divided the methods into the financial, multi-criteria, ratio, and portfolio approaches. All of these aim at evaluating the expected financial and non-financial benefits of an investment. The methods vary in the degree, to account for the non-financial benefits and non-ICT investments. Methods of the popular ratio approach have proposed such ratios as ICT expenditures against total turnover and all yielding that can be attributed to ICT investments against total profits. According to Renkema and Berghout (1997), the available non-financial evaluation methods are hardly underpinned by a theoretical basis. Furthermore, the available methods tend to focus on the evaluation criteria and to pay less attention on the evaluation process.

The convergence of ICT remained somewhat absent in the methods reviewed by Renkema and Berghout (1997) - the term 'communication' was not mentioned. In general, among the various evaluation methods of the adoption of ICT in organizations, the traditional “black box” analysis relates the amount of such investments straightforwardly to the performance measures of the organization (Soh and

Markus, 1995; Berghout and Renkema, 2001, Francalanci and Maggiolini, 2002). However, according to Soh and Markus (1995) and Bakos and Kemerer (1992) it would be more relevant to examine **intermediate outputs directly linked to IT** than profit or other financial measures of performance.

We hypothesise that organizational communication represents an intermediate output that should be measured. The more the organization invests on ICT technology, the more digital organizational communication is likely to get, which will furthermore impact organizational performance. This hypothesis is often motivating the development of IS in general, as we speak of e-“everything” (e-government, e-business, e-learning), mainly focusing nothing but organizational communication.

This paper pursues a **metrics for measuring adoption of ICT in organizational communication**, according to the following criteria:

1. **Organizational communication.** It should conceptualise and measure organizational communication throughout the organization.
2. **Quantify for humans** the amount of information exchanged in organizational communication in units relevant for human perception rather than units relevant for computers. I.e. we should not measure bits rather than information exchanged in the organizational processes enabling evaluation of impacts of ICT on specific organization units or business processes in the future.
3. **Categorize for computer support** for analysing ability of computers to support the communication. If we wish to be able to evaluate the benefits of using computers we must be able to distinguish such communication that can be aided by computers from such that cannot, preferably in an ordinal scale.
4. **Measurable** with a reasonable effort whereas the level of detail should still be elaborate enough, though, to analyse organizational communication in context.

In the future, we wish to investigate with the metrics developed, how the digitalisation of organizational communication will impact performance. This involves such research questions as: how much does the adoption of ICT change organizational communication or does this greater utilization of ICT correlate with business results?

In the remainder, Section 2 reviews the theories of media use in organizational communication, especially the genre theory and taxonomies of media, needed to satisfy criterion 1. Section 3 represents the categorization of communication forms and quantitative metrics, conforming criteria 2 and 3. Section 4 illustrates the measures by using

them for an analysis of communicative practices in an industrial target organization. Section 5 discusses the contribution of the developed measures. Section 6 concludes and suggests tracks for subsequent research efforts with remarks of the applicability of the measures in light of criterion 4.

2. THEORETICAL BACKGROUND

2.1 Theories of Media Use in Organizational Communication

According to two literature reviews (Carlson and Zmud, 1999, Ngwenyama and Lee, 1997) the influential theories of media use in organizational communication since the mid-1980s include media / information richness theory (Daft and Lengel, 1986) elaborated in media synchronicity theory (Dennis and Valachich, 1999), critical mass theory (Markus, 1990), social influence model (Fulk, Schmitz and Steinfield, 1990), the “emergent network perspective” (Contractor and Eisenberg, 1990), channel expansion theory (Carlson and Zmud, 1999), critical social theory (Ngwenyama and Lee, 1997), and the genre theory of organizational communication (Orlikowski and Yates, 1994).

The seminal media/information richness theory (Daft and Lengel, 1986, Daft et.al. 1987, Trevino, Daft and Lengel 1990) discussed the equivocality of communication to be linked directly with the medium used. The social definition theories of the 1990s highlighted the idea that the properties of a medium alone explained the relationship between organizational communication and media use insufficiently. The phenomenon should be regarded, instead, as complex interaction between technology, people, and organizational context (Markus 1994, Ngwenyama and Lee, 1997). The most radical standpoint even stated, “There is no such thing as pure technology.” (Contractor and Eisenberg, 1990 p. 143) - technology and media without a particular socio-organizational context. Our basic standpoint, however, is that communication technology can exist independent of a particular organization in which it will be applied. To establish the measures for digitalisation we need analytical concepts for structuring both such generic features of media and the socio-organizational contexts of communication, and to be able to connect these in a meaningful way. The media-attributes and design-choices theory (Sillince, 1997) introduces 17 generic media

attributes and attempts to connect (two of) them directly to the choices of organization design affecting communication.

However, none of the above-mentioned theories alone proved straightforwardly useful for conceptualising simultaneously communication media and their application context for our research goals. We thus elaborated a framework, in which the socio-organizational side of organizational communication is conceptually structured by genre theory and merged with a categorization of communication media.

2.2 Genre Theory of Organizational Communication

A genre of organizational communication represents a typified and recurrent communicative action that can be identified by its communicative purpose(s) and, to some extent, by its form(s) (Yates and Orlikowski, 1992). The communicative purpose refers to social motives and topics expressed in a recurrent communicative context and the form includes certain structural features, communication media, and a symbol system to represent information, which all should be commonly recognized in the community in question (Yates and Orlikowski, 1992). A genre can be more or less widely enacted within the community (Yates, Orlikowski, and Okamura, 1999) or in other words, genres can be put on a scale from hard to soft (Schultze and Boland, 1997). From our point-of-view, a soft genre involves the use of varying communication forms for communicating instances of that genre thus affecting the heterogeneity of forms within the genre and its enactment.

Each community, an organization for example, has a repertoire of genres that can be identified with it (Orlikowski and Yates, 1994). For instance, a software development organization typically communicates through a set of genres: requirements specification documents, project plans, project meetings, budget documents. A set of genres can also interrelate in a wider communicative process thus forming genre systems (Bazerman, 1994, Yates, Orlikowski, and Rennecker, 1997).

Since the 1990s, genre theory has invoked increasing interest to guide research efforts on information systems (Päivärinta, 2001). Empirical efforts to identify organizational genre repertoires have reported hundreds of genres that can be found in organizations, denoting that this approach would provide a detailed, yet comprehensive and comprehensible, view on organizational communication (Karjalainen, Päivärinta, Tyrväinen, and Rajala, 2000, Tyrväinen and Päivärinta 1999).

At least one practical method to identify and analyse genre repertoires has been established by Päivärinta, Halttunen, and Tyrväinen (2001), with promising practical experience of its usefulness in efforts for information systems development (Päivärinta and Peltola, 2001). Genre taxonomies have recently been suggested as a conceptual basis to benchmark communication practices between organizations (Yoshioka, Herman, Yates, and Orlikowski, 2001). Hence, we regarded genre theory as a suitable conceptual basis to start with for our research purposes.

2.3 Taxonomies for Communication Media

The concept of genre structures organizational communication, and declares that certain media can be characteristic for certain genres (Yates and Orlikowski, 1992). The literature provides taxonomies for classifying media, which could be linked with genre analysis. Zmud, Lind, and Young (1990) studied organizational communication channels that managers and professional staff used for their work in the corporate headquarters of a manufacturing firm. The researchers and the sponsors of the study selected 14 communication channels within 5 categories jointly (table 1). Although being a step to the direction of our needs, this taxonomy does not provide sufficient detail for analysing various ICT media from the viewpoint of computer support or automation. For example, it does not separate XML-based e-business formats enabling semi-automated or fully automated (communicative) business transactions from less automated digital media, such as e-mail.

Table 1 Communication channels of Zmud et al. (1990)

face-to-face	one-to-one consultations (formal) one-to-one chats (informal)
Group	group meetings (formal) group gatherings (informal)
Written	handwritten notes typed or printed memos or letters printed documents or reports charts and graphics computer reports
traditional communication technologies	phone voice conferencing facsimile
computer-mediated communication technologies	electronic mail voice messaging

Daft and Lengel (1986) argued that media richness represents the means to resolve equivocal communication tasks, in which the volume of information is the traditional means for managing uncertainty. In decreasing order of equivocality and uncertainty of the communicative task in question, preferred media is face-to-face, telephone, personal documents, impersonal written documents and numeric documents (Daft and Lengel, 1986). Or listed by the structural characteristics, one could relate these categories from group meetings, integrators in between organizational boundaries, direct contacts, planning, special reports, to formal information systems and rules and regulations, respectively. For our purposes this classification (as well as a later work on media synchronicity theory by Dennis and Valacich (1999)), however, lacks detail in distinguishing between various ICT-supportable media.

Yoshioka et. al. (2001) proposed use of taxonomic categories on the dimensions for genres and genre systems reflecting the questions why, what, how, when, where, and how (5W1H). Out of these, the question "How" addresses the form of a genre/genre system referring to observable features including structural elements, medium, and linguistic features, but does not construct a categorization for them. They have also implemented a prototype of genre taxonomy with 14-15 generic genres: such as business, letter, memo, expense form, report, face-to-face meeting genre system, personal homepage. This kind of taxonomy matches with hard genres (Schulze and Boland, 1997) that have only a single form, while a soft genre - such as a customer complaint - may be communicated verbally, by phone, by fax, via e-mail, and via a customer complaint database system. We wish to separate the communication forms - such as face-to-face meetings and fax - from the communicative purpose of a genre. Thus neither the dimension "How" nor the prototype taxonomy matches the goals of this study.

Slywotzky and Morrison (2000) suggest one of the few operationalized measures for adoption of digital media in organizational communication and business processes in their book "How DIGITAL Is Your BUSINESS?". They define the estimated Digital Ratio of a business based on a profile of percentages of the functions of an organization. The Digital Ratio of each function (e.g. selling, delivery, supply chain...) is defined by manager judgement on scale of 0%, 10%, 20%, ... (Slywotzky and Morrison, 2000 pp.15-16). However, due to a low level of detail in data collection and the subjective nature of analysis, the approach of Slywotzky and

Morrison is rather unlikely to produce accurate estimates on the issue. A case study related to this issue (Tyrväinen and Päiväranta, 1999) suggests it rather difficult to produce a consistent overview of the situation in a large organization with hundreds of genres without a more structured approach and a participation of several stakeholders. I.e. relying on simplified estimates based on manager judgement produces highly error-prone results. Further, as the classification used by Slywotzky and Morrison (2000) was simply digital vs. analogue, this approach is not able to make difference in between e-business media and digital images, for example.

3. A METRICS AND AN ANALYSIS METHOD

3.1 A Categorization of Communication Forms

We pursued measures for the ability to use computers to manage and automate communication in organizations. Thus, our categories try to reflect increasing ability to utilize the benefits of computers - starting from non-mediated communication, through communication mediated by computers, until the extreme of formal data structures processed, analysed, filtered, restructured and interpreted by computers. Figure 1 represents the categories and their mutual inclusion on the left. On the right, there are some typical examples of ICT tools and technologies used for the upper categories as well as examples included in the non-mediated categories.

In addition to the basic distinction between analogue and digital communication, we elaborate the media categories further by separating stored communication from non-stored, permanently stored from transient communication, and one-to-one from group communication. Table 2 contains descriptions of the categories of communication forms (CCF) in increasing order of formality, i.e. ability to computers to interpret the contents of the communication form. Increasing formality matches roughly to the amount of metadata available for computers for interpretation of the actual data related to communication in the medium in question, as well as decreasing granularity of digital communication, i.e. size of managed content objects.

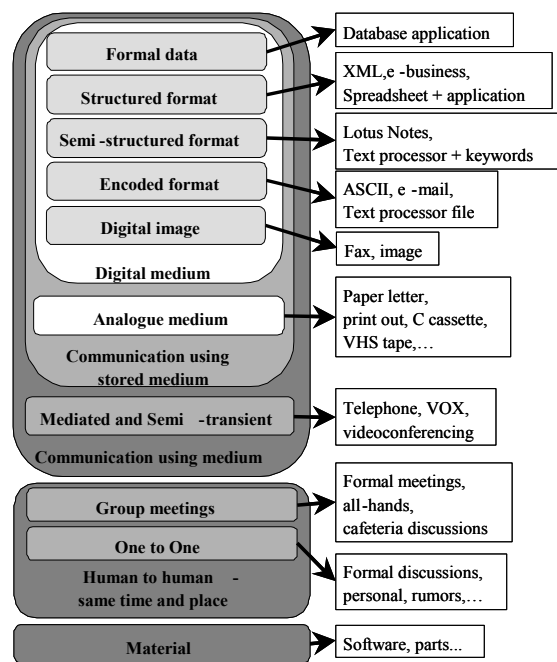


Figure 1. Taxonomy of categories of communication forms and examples of communication forms.

Table 2. Descriptions of the categories of communication forms.

CCF	Description
Material	Information objects exchanged in between organizational entities, that cannot be classified as information exchange in between humans, although were identified as "information objects" important for the organization. For example, software distribution media, products and parts.
1-to-1, f-to-f	Personal face-to-face meetings in the same place and time include both formal person-to-person meetings and informal, casual meetings, such as discussions in cafeteria, etc.
Group Meeting	Formal group meetings and informal, spontaneous face-to-face meetings. Memorandums composed /distributed are classified to other categories.
Mediated / Semi-Transient	Mediated communication used for emulating face-to-face communication. Data is transmitted by computers or by other ICT equipment. Examples: phone calls, teleconference and videoconference. Mediated communication captured and stored temporarily is called here semi-transient communication. Typical examples include answering machine messages and VOX.

Analogue	This category includes data stored on some analogue medium, typically paper, microfilm, or VRC/audio tapes. Machines can copy this data, but storage and distribution requires manipulation and transportation of the physical media. Data management is based on metadata (reference) information stored separate from the data.
Digital Image	Digital data with no or minimal encoding of semantic information. Data can be stored, copied and transmitted by computers, but operations cannot make use of the meaning of the content. Examples: fax, bitmap images scanned from paper or used for storing digitised documents, and graphical encoding formats (e.g. GIFF, JPEG).
Encoded	Digital data intended for human use with encoding applicable for simple generic tools, e.g. by searching strings. Typical formats and tools include ASCII, UNICODE, mail messages, and word processor files.
Semi-Structured	Digital data containing both large bodies of natural language interpreted only by humans and sufficient structured (meta-)data for major computer applications, e.g. for workflow control and sophisticated data manipulation and retrieval. Examples: Lotus Notes databases with applications, spreadsheet applications, document templates with applications assuming procedural interpretation for the fields.
Structured	Digital data presented through displays or forms for humans. The content can be interpreted both by humans and specific computer applications without human intervention. Examples include RosettaNet applications, eBusiness messages, XML documents, and pre-defined spreadsheet sheets used for collecting data for computerised applications, such as collecting customer orders.
Formal	Digital data intended for computer use and interpreted by computers. The context needed for interpretation is predefined by a database schema or similar means. No common sense nor world knowledge of humans is needed for this process.

3.2 Measures Used

We use two basic quantities for communication: count of communication instances and volume of the instances. We further separate unique communication entities (Unique Instances, and Unique Volume) from the quantities including also copies of unique communication entities - Instances or Copies and Volume or Copy Volume, respectively. To be more specific, Unique instances (UI) refer to the distinct instances of a genre communicated excluding duplicates, e.g. a single

mail message sent to several recipients or a broadcast is considered to be a single unique instance. A single annual report is being produced per year, whereas several invoices can be produced daily. Copies refer to the average number of copies delivered to distinct receivers of the UI. A project status meeting is the only copy of the communication act whereas the corresponding digital document - the memorandum – can be copied by e-mail and sent to tens of persons.

Size of instances refers to the average amount of information per instance of a genre. This varies from multi-volume contracts and manuals to acknowledgement notes or “Please call ...” notes. The size of an UI (being equal to the size of instance) is measured in Pages that refer to amount of information equal (for a human being) to view the size of a visual letter / A4 page. For the stored forms of communication this matches the number of printed pages in a paper version of a typical instance of a genre. A Page is considered to be roughly equivalent to 1-3 kilobytes of plain ASCII encoded text or about a megabyte of bits of a digital image. This approach aims at filtering out the physical size, size in bytes, and other medium-dependent aspects as technical details. Moving over from ASCII text to bitmap increases the amount of bits by factor of 100 or 1000 but does not affect the amount of information communicated nor the size of instances when measured in Pages. (For further discussion on quantitative metrics on information see (Landauer, 1986, Lesk, 1997, and Lyman, Varian, Dunn, Strygin, and Swearingen, 2000))

To sum up, the calculation process described next involves three orthogonal dimensions:

1. **Genres**, i.e. calculations per one genre or summaries of all genres.
2. **Categories of communication forms (CCF)**, i.e. calculations per one CCF, per a group of CCFs (such as Stored or Digital communication forms only), or per all communication forms.
3. **Measurement units** are further composed out of 3 dimensions:
 - a) **UI or Copies**, i.e. whether all copies of genre instances are calculated.
 - b) **Instances or Pages**, i.e. counting items and measuring their volumes.
 - c) **Absolute or proportional**, i.e. absolute values or percentages against organizational totals, such as all / all stored communication.

3.3 Genre Identification and Calculation Process

The analysis method consists of three main processes: 1) genre identification, 2) metadata

annotation, and 3) calculation. We adopted a previously suggested genre identification process (Päivärinta et.al. 2001) and tailored the associated metadata collection process for our purposes. The basic concepts of this method are:

- **Stakeholders** having interests to participate in the analysis.
- **PUI entities** producing or using information in the domain of interest (PUI = Producer or User of Information), including both external organizations and the internal entities of the organization, such as business processes, departments, functions, roles, or individuals.
- **Genres** in the domain of interest.
- **Properties** of the identified genres defining the metadata gathered about the genres from the stakeholders for the analysis.

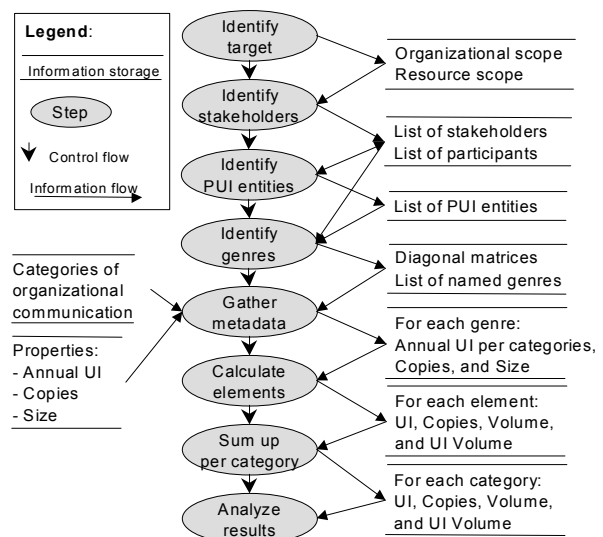


Figure 2. Phases of the analysis process for genre identification, metadata annotation, and calculation

Figure 2 depicts our analysis process as a data flow diagram. After defining the domain of interest, the stakeholders of data collection are identified. A number of group meetings are conducted to identify PUI entities and the genres emerging between them. From this on we diverge from the original method (Päivärinta et. al. 2001). Instead of defining the properties to be identified for further analysis we make use of a fixed set of genre properties based on our metrics. For each genre (each row in Figure 3), we collect the following metadata:

- Category or categories of communication forms used by the genre.
- Number of annual unique instances (UI).
- Copies (instances) per UI.
- Average size of instances.

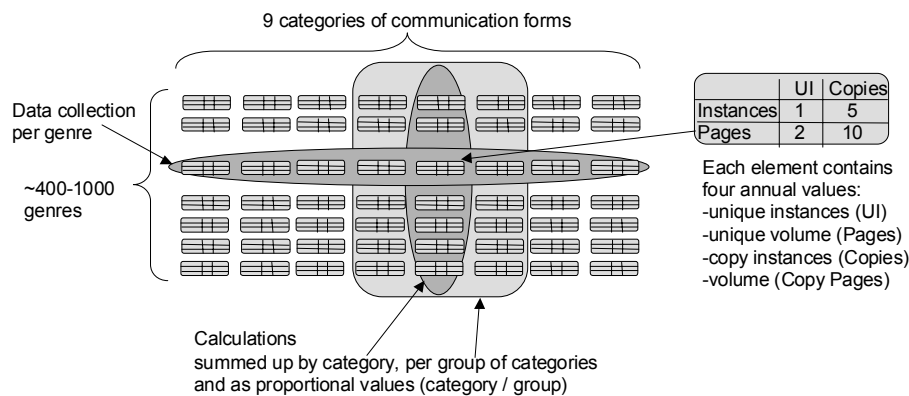


Figure 3. Data elements of the calculation.

The subsequent step calculates four values for each element, i.e. for each combination of a genre and a category (Figure 3): "Annual Number of UI", "Annual Number of Copies", "Annual UI Volume", and "Annual Volume" measured in Pages. The results are summed up per each category of communication forms, i.e., per columns in Figure 3. This produces four absolute measurement values for each category. Further, these values are summed up for groups of categories of communication forms, e.g., to four absolute measures of communication using Stored medium, four for Digital medium, as well as four values summing up all communication of the organization. These total sums are referred to with names like (number of estimated) "Organizational Total Annual UI" or "Organizational Total Annual Volume" (in Pages).

The proportional values are formed by comparing absolute values of a category(-ies) of communication forms with absolute values of a group of categories of communication forms. For example, "Organizational Stored UI Volume Percentage of Semi-structured communication forms" is calculated as "Organizations Annual UI Volume of Semi-structured communication forms" divided by "Organizations Annual UI Volume of Stored communication forms". As the applicability of the measurement unit "Page" is somewhat contradictory with the communication forms that do not use a tangible medium, we limit the use of the volume measures to the forms using medium. In the end, the results are analysed in relation to the meaningful decisions of the organization at hand (examples in the discussion section).

4. A CASE STUDY

The target organization to test the metrics was an independent unit of a multinational corporation,

involving c. 400 employees in Finland. The genre identification process, performed in fall 1999 in connection to an organizational development initiative, included 8 sessions with 3-5 participants, lasting 3 hours each, with a total of 3,5 person weeks of effort from the target organization and 8 person weeks from the

researchers, including the problem analysis. 744 genres were identified and named altogether.

Two persons, P1 and P2, participated in the analysis of the previously identified genres for our research purposes. Both of them have several years of experience with core processes, process development, and information systems of the organization. P1 can be best characterized as a manager of a central process while P2 carries the overall responsibility for the information systems of the target organization and has somewhat more overall knowledge over the genres in the target organization. The effort spent on the analysis of genres totalled five person days from P1 and P2.

Out of the over 700 genres originally identified, a subset of 10% was analysed both by P1 and P2 in order to save time and effort by picking up every 10th genre from the full list of genres. This is referred to as the "Subset" in later diagrams. As P1 and P2 were not familiar with all the genres, the unknown ones were filtered out from both of the data sets. Also the genres categorized as "Material" were filtered out. The "Full" filtered data set included 598 genres and the subset includes 54 genres. Some examples of the genres and metadata collected are presented in Table 2. Later on, the metadata was updated twice by P1 to conform to two changes in the ICT, concerning two genre systems: the adoption of a labour and travel cost tracking system and a new sales order processing system.

On an average, a genre used communication forms from 1,77 CCFs. Most of the 598 genres (about 60%) used Encoded communication forms, while only about 30% of the genres used Analogue communication forms (e.g. paper). However, when using the volume measures, the Encoded communication form was second to the Analogue CCF. The calculation process resulted in c. 49'000 annual unique instances for the 54 genres implying organization's total annual UI to be about 680'000. Table 4 presents the figures calculated for the subset of 54 genres as well as the figures extrapolated to the organization's total 744 genres identified.

Table 3 Examples of metadata collected in the case study.

Producer	Genre	User	Categories of communication forms	Annual UI	Copies	Size in Pages
Sales	Request for support	Project organization	Personal, Mediated / Semi-Transient, Encoded	hundreds	some	2
Dept 1	Internal training	Dept 2	Group meeting	some	1	100
Purchasing	Order for work	Contractors	Mediated, Digital image, Encoded, Structured (60%)	thousands	1	1
Project dept	Schedule changes	Project dept	One-to-one, Group meeting, Encoded (dominating)	hundreds	tens	1
Sales	Permission to tender	Sales	Encoded	hundreds	1	1
Project dept	Project plan	Sales	Encoded	hundreds	some	3

Table 4. Organization's total Annual Volumes

	Subset (54 genres)	Estimated organization's total
Annual Unique Instances	49'000	680'000
Annual UI Volume / Pages	103'000	1'400'000
Annual Copies	170'000	2'300'000
Annual Volume / Pages	590'000	8'100'000

distribution of measures per categories of communication forms performed in the target organization is not reported here due to space restrictions.

5. DISCUSSION

We illustrated a genre-based analysis method for analysing the adoption of ICT in organizational communication quantitatively. The metrics used in the case study were able to quantify the impact of two technology changes on the digitalisation of two genre systems. With the suggested metrics, it seems relatively simple to simulate adoption of new technology by manipulating the data collected and reading the expected impact from the resulting metrics values – categories of communication forms of the genres to be managed by the new technology are simply changed from previous values (e.g. “Analogue / Paper”) to new values (e.g. “Structured / XML”) and the answer is read as the change of resulting metrics values.

The results presented here measure simply the degree of digitalisation of stored information, while use of the full categorization will give more accuracy for analysing technology adoption. For example, adoption of e-business standards requires use of Structured or Formal communication forms. A recent focused study (Tyrväinen 2003) estimated quantitatively the applicability of mobile content formats (MMS, SMS, XHTML, and XML) to organizational use by matching the properties of these formats with characteristics of the categories of communication forms. Assuming contemporary communication practices of the target organization to set upper limits for each format as well as some other assumptions of the study, the use of multimedia messaging (MMS) was estimated to be at the level of 5% of the use of SMS text messages. Also other similar applications are possible.

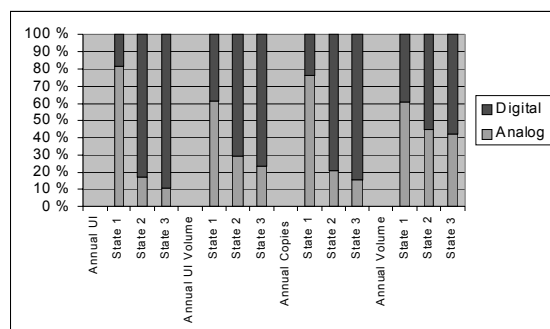


Figure 4. Analogue versus digital ratio for the subset for Stored information before, in between, and after two changes in information systems.

The digitalisation percentage of all Stored information was calculated three times - with respect to the original status of the organization as well as in between and after digitalisation of the two genre systems. Figure 4 represents the distribution of Annual UI, Copies, UI Volume, and Volume for the Subset in proportional values. From the two leftmost bars we can see that the first change (from State 1 to State 2) transformed over 60% of Annual UI from paper to digital communication formats. The changes in Annual UI Volume and Annual Volume were smaller implying that average size of instances as well as average number of copies per UI were smaller for the changed genres than the average ones. The second change (from State 2 to State 3) had less impact. Detailed analysis based on

Table 5. Alternative estimates of the total annual volumes of the target organization.

	Average		Genre-based		Median	
	Subset	Total	Subset	Total	Subset	Total
Number of genres	54	744	54	744	54	744
Annual unique instances	941				30	
Instances per UI	22				3	
Size of UI	20				2	
TOTAL pages / Thousands	22 400	308 000	586	8 100	10	134
Pages per person day		3 500		92		2

In our case, the data was collected bottom-up using the processes of the organization as the baseline for the analysis of the genres. In Table 4 we estimated the total communication activity related with all processes of the target organization. If we divide the total figures with the number of employees and the number of working days per year (400 and 220, respectively), we end up with an average of 26 instances and 92 Pages per day. Are these figures realistic? Did it pay off to go through a relatively elaborate data collection and calculation genre by genre instead of using, e.g., average or median values? Table 5 compares the daily information exchange figures per person with our metrics and in relation to two alternative approaches.

Using the average figures of 941 annual unique instances per genre, average 22 instances per UI, each on average 20 Pages, we end up with on an average 3'500 Pages of information sent or received per person per day. With the median values the result is 2 Pages per person per day.

Landauer (1986) estimated that people take in and remember only about a byte in a second. But they read about 3 to 5 words per second i.e. about 600 KBytes or 300 Pages per day during office hours. Thus the magnitude of 90 Pages per day seems realistic as it excludes verbal communication and not all of the 90 Pages are read or written rather than just skimmed and forwarded. Further, this figure includes all the communication related with the business of the organization, but excludes private communication.

In the project "How Much Information?" at Berkeley, Lyman et. al. (2000, Executive summary, table 6. p.6) estimated about 7'500 million titles of unique office documents to be produced worldwide annually, adding up to 19 Terabytes - or 7'500 million pages, each containing 2,5 Kbytes of plain text per page (Lyman et. al. 2000, Print, table 1, p.2), i.e. one page per title. These accounted for 81% of all printed material produced in the World. In the target organization, the results suggested that each

person sent and received annually total 335 unique Encoded and Analogue communication instances and 1760 Pages. Assuming half of them to be sent and half received and further, 81% of the sent ones to be produced using word processors, we can calculate back-wards the number of employees needed to produce all the annual 7'500 million unique documents and pages. These are 55 million and 10,5 million employees, respectively.

The comparison of the three approaches for verifying the figures support the assumption that the quantitative results are within a sensible magnitude. The communication volume estimates resulted by using average values or median values were both beyond the limits of credibility.

In addition, the figure 92 measured here is rather close to the figure of 74 pages per day measured with the same method for university employees in another case study (Tyrväinen et. al. 2003). Thus we can state that a sensible approximation for a method to quantify the adoption of digital media and ICT in organizational communication has been found.

6. SUMMARY AND FURTHER RESEARCH

A novel metrics and an analysis method for categorizing and quantifying the adoption of ICT in organisational communication were introduced. In the case study we demonstrated the capability of the metrics to quantify the digitalisation of two genre systems. Majority of stored information in the target organization used to be distributed on paper while after the two changes the majority was manipulated in digital formats. With the data collected by the genre identification method and the subsequent analysis according to the metrics established, we expect to be able to estimate the organizational impact of adopting a new ICT in the future in a

focused way, as we can connect the analysis to focused organizational processes and units related to the analysed genres in context.

Further research is needed to promote the calibration, elaboration, and use of the analysis method and metrics. In the case study, the detailed analysis of every 10th of all genres minimized the effort needed from participants, being already able to capture the impact of both of the changes in ICT. Manipulation of the identified genres in an organization by harmonizing the genres and genre systems before their detailed analysis in order to reduce the number of genres for analysis would also aid the re-engineering or refinement of business processes.

Other extensions of the metrics and the method need to be tested in the future. First, empirical research on the correlation between organizational performance and the degree of digitalisation of communication is needed to verify the common hypothesis of ICT being beneficial. This work is already under way with some other organizations and will be reported in the near future.

Although our analysis process to test the metrics in the target organization was rather laborious pursuing an in-depth view on the reliability of the metrics, future research efforts could focus on a limited sets of genres and genre systems. A focus on certain generic genre taxonomies, e.g. such described by Yoshioka et al. (2001), could most probably produce quantitatively relevant research results on estimating the impact of digitalization across organizations with a modest effort. Organization-wide in-depth efforts, although more laborious, might produce additional qualitative understanding to the issue and to provide yet undiscovered research directions, as well.

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