Communication-Focused Business Process Redesign: Assessing a Communication Flow Optimization Model Through an Action Research Study at a Defense Contractor

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Abstract—*It can be argued that process redesign has a long history, going as far back as Taylor's scientific management and reaching its peak in the 1990s with business process re-engineering. Throughout most of its history, operational-level approaches to process redesign maintained a focus on "workflows," or the chronological flows of activities in processes. It is argued in this paper that while this makes some sense in materials transformation processes whose final product usually is a tangible manufactured item (e.g., a car engine), this orientation is fundamentally inconsistent with the communication-intensive nature of the vast majority of processes found in organizations today. This paper attempts to show that a focus on communication flow representations and methods is likely to lead to better process redesign outcomes than is a focus on representations and methods in connection with "workflows." It does so by developing a set of research questions based on the communication flow optimization model and answering those questions in the context provided by three process redesign projects conducted at a defense contractor in the U.S.*

Index Terms—*Action research, communication flow optimization, data triangulation, organizational communication, process redesign, qualitative research.*

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Recently, organizational development approaches centered on business process redesign (or, simply, "process redesign") have become popular, particularly due to the emergence of business process re-engineering in the late 1980s and early 1990s [1], [2]. In spite of this recent popularity, an argument can be made that process redesign is a much older approach than re-engineering, one that has probably influenced management thinking since management's emergence as a separate field of study and practice. According to this view, process redesign can be seen as dating back to the early 1900s, when Frederick Taylor [3] published *The Principles of Scientific Management*. The scientific management movement strongly influenced organizational development ideas and approaches throughout the Second Industrial Revolution (1850–1950). During this period, process redesign was primarily concerned with productivity (i.e., efficiency) improvement in manufacturing plants and was centered on the optimization of "times and motions" in situations of high work specialization and division of labor.

Taylor was faced with the challenge of increasing productivity in manufacturing plants employing a workforce that was largely uneducated and unskilled. His solution involved an emphasis on the use of standard work methods and a strict division of labor. In Taylor's time, manufacturing was the main wealth creator, unlike today, when service is the main contributor to the gross national product of most developed and developing countries. Accordingly, Taylor's approach involved breaking processes down into simple sequences of physical motions to be carried out in the minimum amount of time and with the minimum amount of effort by specialized manual workers.

The value of Taylor's approach in rationalizing production is indisputable, and its impact on the development of mass-production techniques has been widely recognized. Yet, it provoked resentment and opposition from labor representatives when carried to extremes, which seems to have happened often [4]. This might have been at least partially motivated by Taylor's depiction of workers in general as mindless executors of activities designed by management, as "stupid" and destined to back-breaking manual work as an "ox" [3].

Even though it often raised factory workers' salaries, Taylor's scientific management tied individual financial compensation to increased productivity and led to what many believe to have been as a dehumanization of the workplace. This set the stage for more "humane" schools of management to emerge and flourish. The work of Elton Mayo in the early and mid-1900s [5] and that of others, such as McGregor, Maslow, and Herzberg, represented the emergence of the "humanist" school of management [4], [6], [7], which tried to shift the focus of organizational development from processes to people. While these management thinkers, who were very successful during the mid-1900s, proposed ideas that minimized the importance of processes as competitiveness drivers in organizations, process redesign was far from dead.

The work of the humanists set the stage for the emergence of total quality management [8], which not only succeeded scientific management as a process-based method for organizational development, but also represented a shift in focus from productivity to quality in the improvement of processes [9]. While heavily based on statistical methods in its inception, this approach soon acquired a broader orientation [9]–[11]. Total quality management began in Japan after World War II, largely due to the work of William Deming and Joseph Juran, and is widely credited as having propelled Japan to economic superpower status [9], [11]–[14]. In the 1980s, total quality management became widely practiced in the U.S. and other Western capitalist countries [8], [9], [11], [14]. Similar to scientific management, its primary focus was the improvement of manufacturing operations.

Business process re-engineering [15], [16] replaced total quality management as the predominant school of thought in connection with process redesign in the early 1990s. Michael Hammer (together with James Champy) and Thomas Davenport independently developed business process re-engineering as, respectively, a better alternative (Hammer and Champy's version) and a complement (Davenport's version) to total quality management. Their work was based on the premise that the incremental gains in productivity obtained through the implementation of total quality management methods were insufficient for organizations to cope with the accelerated rate of change of the 1990s, brought about by new information technologies [15]–[18]. Different from scientific management and total quality management, business process re-engineering was presented as a method for the improvement of service as well as manufacturing operations.

In spite of being touted as a new idea, business process re-engineering was built on ideas and methods that were similar to those proposed by Taylor's scientific management [19], [20]. This is particularly true of operational versions of business process re-engineering [2], [21], which, unlike more strategic ones [22], [23], look into the workings of individual processes in order to improve them. In fact, throughout the history of process redesign, operational-level approaches to process redesign consistently maintained a focus on workflows, or chronological flows of activities in processes [24]. While this orientation makes some sense in materials transformation processes, whose final product is a tangible manufactured item (e.g., a car engine), this orientation is fundamentally inconsistent with the communication-intensive nature of the vast majority of processes found in organizations today.

This paper attempts to show that a focus on communication flow representations and methods is likely to lead to better process redesign outcomes than a focus on workflows. It does so by developing and answering a set of research questions based on the communication flow optimization model proposed by Kock [25], [26] and Kock and Murphy [27]. This exploratory action research studies three process redesign projects at a defense contractor in the U.S. The communication flow optimization model provides a theoretical basis for the claim that the focus of process redesign should be on how communication interactions take place in a process, and also provides guidelines on how process redesign can be accomplished in a way that is consistent with that focus.

This paper is organized as follows. The section Research Background reviews process redesign methods and argues that the current focus on activity flow representations and methods is problematic because of the communication-intensive nature of processes in today's organizational environments. The section A Communication Flow Optimization Model describes a theoretical process redesign model that addresses the problem identified in the previous section. The next section, Research Questions, derives a set of research questions from the communication flow optimization model that are used to guide the exploratory study. The section Research Method then discusses the research approach used, action research, and provides details on the researcher, the process redesign groups, the data collection and analysis methods, and key ethical considerations. The Results section follows, where evidence in connection with the research questions is summarized. Finally, the Conclusion summarizes the main contributions of the paper, discusses implications from the study for researchers and managers, and reflects on limitations of the study and ways in which future research can address those limitations.

Research Background

Much research on process redesign was conducted in the 1990s, addressing important questions raised by re-engineering. Success factors and preconditions for effective process redesign have been identified [23], [28]; new methods and techniques for managing change in connection with process redesign have been proposed [29], [30]. Potentially damaging "myths" have been identified [31], and the role of information technology in process redesign efforts has been clarified [32]. New insights on the implementation of new process designs have been gained [33], and new methods and information technology tools to support process redesign have been proposed [25], [34].

One area that has received relatively little attention, however, is that of process representation frameworks and their impact on process redesign [35]. This is an important area of research because it addresses the representational lenses that influence how processes are redesigned [16], [35]. For example, a focus on the flow of activities in a process (or workflow) is likely to lead to changes in how activities flow in the process, whereas a focus on the flow of information in a process is likely to lead to changes in how information flows in the process [15], [25].

An analysis of process redesign practices throughout the 100-year period from the development of scientific management to the emergence of business process re-engineering suggests an interesting, perhaps cyclic, pattern. Even though business processes changed significantly since Frederick Taylor's times, the process redesign practices employed then seem very similar to current practices in terms of the focus of process redesign, which has consistently been the sequence of activities, or "workflow," of a process [20], [24], [25].

The scientific management method [3] broke down a business process into component activities, which were then represented by both a pictorial as well as a quantitative model. The pictorial model depicted the flow of execution of the activities and the associated motions, whereas the quantitative model included information about physical distances associated with motions and the times needed to perform each of the activities. Taylor showed that managers could empirically devise optimal (or quasioptimal) business process configurations that could then be standardized through financial incentives to workers [3], [36].

Many have argued that business process re-engineering is a modernized version of scientific management [19], [20], [24], [37]. Re-engineering's popularity reached its peak by the mid-1990s and has slumped since due to a number of reported failures. James Champy, one of re-engineering's pioneers, argued that 70% of all re-engineering projects failed to achieve their goals [38]. In spite of this, re-engineering created renewed interest in process redesign, making it one of the most widely practiced modern forms of organizational development [39]–[41]. However, unlike during the heyday of scientific management, when business process improvement meant materials flow improvement, today most of what flows in business processes is information. As pointed out by Peter Drucker: "In 1880, about nine out of 10 workers made and moved things; today, that is down to one out of five. The other four out of five are knowledge people or service workers" [42, p. 50]. A study by Kock and McQueen [24] shows that even in manufacturing organizations, approximately 80% of what flows in business processes is information, while the other 20% is made up of materials (in service organizations, these proportions are usually very close to 100% and 0%, respectively). These figures seem to confirm claims that we are living in an information society [43] and that organizations have become information organizations [44]. The high proportion of information flow is also consistent with the widespread use of information technologies in organizations, and its increasing importance in the improvement of business processes.

In spite of the above, most process redesign practices today mirror Taylor's approaches of the early 1900s in one key respect: they appear to be tailored to the optimization of the flow of materials, which involves sequences of interrelated physical actions, and not the flow of information [25], [35], which involves communication. Most of today's process redesign practices focus on the analysis of business processes as sets of interrelated activities and pay relatively little attention to the analysis of the communication flow in business processes [24], [45], [46]. Systems analysis and design methods [47], [48], on the other hand, do address communication in processes, but they have traditionally been relegated to process automation and have seldom been applied to process redesign [24], [46], [49]. More recently, object-oriented analysis and design methods have contributed a more communication-oriented view of processes, particularly those in connection with the unified modeling language [50], [51], but they have also been faulted by what some see as an excessive activity orientation (see, e.g., Chuang and Yadav [52], who use this argument to explain the relative lack of success of object-oriented analysis and design methods in comparison to object-oriented programming methods).

A focus on the flow of activities makes particularly good sense in manufacturing processes involving sequential steps that add complexity and value to tangible items. Since manufacturing processes embody action in the physical sense, they can generally be easily represented as chronological sets of activities that bring tangible items together, such as car parts or chemical components, to produce other complex and value-added tangible items, such as a car engine or a complex chemical product. That is, it is natural to think of manufacturing processes as sequences of activities. However, this is not the case with nonmanufacturing processes in general, where the output of the process is often a service (which is usually consumed while it is produced) or an information product (e.g., a report or a computer program). It has been argued that in nonmanufacturing processes in general, activity flow-based modeling attempts usually lead to overly complex and somewhat misleading representations, which are not useful for process redesign [24], [25].

Perhaps due to manufacturing processes' key role in wealth creation, the most widely adopted normative approaches for process redesign embody general guidelines that place no special emphasis on the redesign of communication activities, thus, arguably disregarding the information-intensive nature of business processes [24]. This is also true for the U.S. Department of Defense (DoD) and its contractors (arguably the single largest group of employers in the U.S.), where the IDEF0 approach for process redesign [53], an activity flow-based approach, has been chosen as the official process redesign approach and is by far the most widely used [27], [54]. One widely used activity flow-oriented approach proposed by Harrington [49] states that "As a rule [information flow diagrams] are of more interest to computer programmers and automated systems analysts than to managers and employees charting business activities" [p. 108] (see also [46]). While this opinion is obviously at odds with the notion that information processing is the main goal of business processes [55], it is in line with re-engineering's original claims [16] and most of the current process redesign practice.

The communication flow optimization model [24], [25], [27], [56], [57] is an attempt to address the problems above from a theoretical perspective. The theoretical model forms the basis from which the research questions that guide this study were derived, and it is discussed in the section below.

The Communication Flow Optimization Model

The communication flow optimization model [24], [25], [27], [56], [57] was developed based on grounded-theory research [58]–[60]. Given space limitations, the model is only briefly summarized here (see particularly Kock [25] and Kock and Murphy [27] for more details). It emerged from real-world process redesign projects conducted over a period of six years. Evidence from those projects suggested that the flow of information could generally be seen as analogous to the flow of materials in processes, and that the former (i.e., the flow of information) could be subsumed by the communication flow, the web of communication interactions of a process. One of the key findings of those projects was that the communication flow structure of processes was a particularly strong determinant of most of the quality and productivity problems associated with processes, more so than either the activity flow or the material flow structure of the processes. Nevertheless, the evidence also suggested that, unlike in traditional systems analysis and design projects [47], [48], process redesign groups rarely favored communication flow representations of processes over activity flow representations early on in their projects because the former were seen as more difficult to generate and less natural than the latter. The theoretical model proposes that communication flow representations of processes are perceived as more difficult to generate than activity flow representations because the latter are better aligned with the way humans are cognitively programmed to envision action in the physical sense. That is, processes, which essentially represent action, are more naturally seen as sequences of interconnected activities than as communication interactions.

According to the model, optimal communication configurations can be obtained by redesigning the flow of communication in processes through the application of relevant process redesign guidelines. It is hypothesized that the level of optimization of the communication configuration of a process will account for a substantial amount of the variation in quality and productivity achieved through the redesign. Process productivity is measured through the ratio of output capacity (e.g., the number N of complete insurance policies executed per month by an insurance underwriting process) versus costs (e.g., the direct and indirect costs associated with executing N insurance policies). Process quality is measured as the customer satisfaction in connection with the outputs of the process, where a customer can be internal (e.g., an insurance agent) or external to an organization (e.g., an insured corporation or individual).

While acknowledging differences between manufacturing and nonmanufacturing processes, the communication flow optimization model argues that a focus on the flow of communication within a process, on average and when applied to a number of processes, will lead to better process redesign results than will a focus on other elements, including activities and/or materials. The model does not dismiss the usefulness of process redesign techniques based on operations research, linear programming, and other traditional assembly line and factory design techniques [61]–[64], whose focus on times and motions often leads to quantum-leap productivity gains. Nor does the theoretical model dismiss the usefulness of methods that address coordination issues among processes. By expanding their scope beyond the individual process, such coordination improvement methods often require the consideration of process dimensions other than the communication flow dimension, including various sociotechnical dimensions [35], [65], [66]. Rather, the communication flow optimization model argues that at the individual process level, where usually redesign is done by looking at how elements (e.g., activities, materials, data) flow within the process [2], [67], a focus on communication interactions is likely to yield results that are, on average, better than if other elements were targeted. The key reason for this is, according to the theoretical model, the higher frequency in organizations today of communication-intensive processes, whose quality and productivity are more strongly determined by their "flow of communication" than non-communication-intensive processes.

Even though its scope is relatively limited, the communication flow optimization model provides guidance for efforts that take a more operational approach to process redesign, rather than a more strategic one, where the focus may be on broad management strategies and not necessarily on how individual processes are executed [1], [38]. The model addresses an important gap, since a large number of process redesign efforts are conducted at the operational and individual process levels, or at least start at those levels.

Research Questions

The research questions that guided this action research study were derived from the communication flow optimization model. The questions are answered within the context provided by three process redesign groups conducted with a U.S. defense contractor. The researcher provided methodological facilitation to the groups. To avoid facilitation-induced bias, as well as foster a multiple-perspective view of the targeted processes, the process redesign groups were encouraged by the researcher to generate both communication flow as well as activity flow representations.

Given the emphasis of contemporary process redesign practices on activity flows [25], [35], the study addressed two key predictions of the communication flow optimization model: (a) process redesign groups would favor activity flow representations of processes over communication flow representations early on in their projects because the latter would be seen as more difficult to generate or less natural than the former; and (b) a focus on communication flow, on average, would lead to better process redesign results than would a focus on the flow of activities. Four research questions were formulated and answered based on the action research study.

Q1: *Will process redesign group members perceive communication flow representations of business processes as more difficult to generate than activity flow representations?*

Q1 follows from the communication flow optimization model's argument that processes, which essentially represent action, are more naturally seen as sequences of interconnected activities than are communication interactions. It is important to answer this question empirically to assess the communication flow optimization model's claim [27] that process redesign groups rarely think of processes in terms of communication interactions at the outset of their process redesign efforts, rather thinking of processes in terms of chronological sequences of interrelated activities or activity flows. This claim is central to the model because it provides an explanation for the apparently generalized preference for activity flow-based process redesign approaches [25], [35]. The model also predicts a "change of mind" after the beginning of a process redesign project, reflected as a preference for communication flow representations, particularly as the project moves from process analysis to process redesign. The key reason for this is the heavy role that information technologies are likely to play on process redesign implementations, and the consequent need to address the flow of communication in the processes targeted for redesign [25]. This leads to the next two research questions.

Q2: *Will process redesign groups employ communication flow representations of business processes more extensively than activity flow representations when making redesign decisions?*

Q3: *Will process redesign groups employ communication flow representations of business processes more extensively than activity flow representations when making decisions about information technology solutions to implement the redesigned business processes?*

Q2 and **Q3** follow from the model's claim that, at the process level of analysis, a focus on the flow of communication is likely to yield results that are better than if other elements were targeted, including activity flows. Those two questions provide the basis on which to investigate whether process redesign groups will behave when given the choice between communication flow and activity flow representations during the project: (a) according to predictions based on the model and (b) rationally [55] by choosing the one type of representation that is likely to yield the best results. However, if this choice is made, one key consideration will still remain, formalized through research question **Q4**.

Q4: *Will process redesign groups that employ communication flow representations of business processes more extensively than activity flow representations, when making redesign decisions and when making decisions about information technology solutions to implement the redesigned business processes, generate more successful redesigns than groups that do not?*

Q4 makes explicit a reasonable assumption in connection with **Q2** and **Q3**: the choice of focusing on communication flow representations rather than on activity flow representations will only be meaningful if it leads to increased process redesign success. For the purposes of this study, process redesign groups were considered as either successful or unsuccessful, according to criteria proposed in the process improvement literature [15], [16], [68]. Following those criteria, process redesign groups were categorized as successful if the process changes recommended by them were implemented fully or partially and led to "positive" observable results (e.g., improvements in customer satisfaction, cost reductions, and/or production capacity increases).

Process redesign groups may decide to use communication flow representations of processes more extensively than activity flow representations when making redesign decisions and when making decisions about information technology solutions to implement the redesigned business processes. However, if those preferences lead to no improvements in the outcomes produced by the process redesign groups (and, consequently, in their likelihood of success) then there is no reason to believe that those preferences are warranted. **Q4**, which is the most difficult to answer in practice because it entails an assessment of the actual business impact of process redesign groups, can be seen as a "reality checkpoint" in the broader operational theoretical framework represented by the four research questions.

Research Method

Action Research Peters and Robinson [69], as well as Elden and Chisholm [70], provide general discipline-independent reviews of action research. Lau [71] presents a review of action research within the field of information systems research, where research on process redesign has flourished since the mid-1990s. There is a body of literature on the use of action research in organizational studies in general, as well as in the more specific context of information systems research [72]–[78]. This literature is not reviewed here. Rather, a concise definition of action research is borrowed from Rapoport [79]: "Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework" [p. 499].

The roots of organizational action research are in studies of social and work life issues [80]–[82]. Organizational action research is often uniquely identified by its dual goal of improving the organization (or organizations) participating in the research study, and, at the same time, generating knowledge [70], [71]. Although typically applying very little, if any, control on the organization being studied, the action researcher is expected to apply positive intervention on the organization [83], which is often realized by the researcher providing some form of service to the organization and its members. One of the key reasons for the emergence and relative success of action research has been the recognition that the behavior of an organization, group, or individual can be more deeply understood if the researcher collaborates with the subject or subjects being studied. In the case of an organization, this can be achieved when the researcher facilitates improvement-oriented change in the organization, as was the case in the study described in this paper. The collaboration between researcher and subjects that characterizes action research is believed to foster free information exchange and a general commitment from the researcher as well as the subjects toward both research quality and organizational development [80].

Action research was employed in the investigation described in this paper because it allowed for close examination of real-world business situations in their full complexity. Furthermore, action research is a particularly useful approach for the study of these relatively new business topic and research questions.

The Role Played by the Researcher The researcher provided process redesign training and facilitation to the members of three process redesign groups involving employees and management from one major defense contractor based in the U.S. The researcher had been providing training and group facilitation services to the organization for three years before this research project was conducted; this facilitated site access. The researcher has provided those previous services, as well as the services provided as part of this action research project, in the capacity of a paid consultant.

The researcher initially provided hands-on training to employees (mostly engineers and software developers) and managers on a variety of process redesign methodologies, including activity flow and communication flow-oriented methodologies. That training was provided at the request of the organization's senior management, who selected the participants in consultation with other areas of the organization. Following the initial training, employees and managers voluntarily formed process redesign groups to address key problems in connection with processes involving their departments. The researcher then facilitated the work of those groups by meeting with them on a weekly basis during a period of approximately four months.

The facilitation provided by the researcher was solely methodological (e.g., no specific process redesign suggestions were offered) and also "methodologically neutral" so as not to bias the perceptions of the subjects about the redesign approaches used. The process redesign groups conducted their work independently from each other.

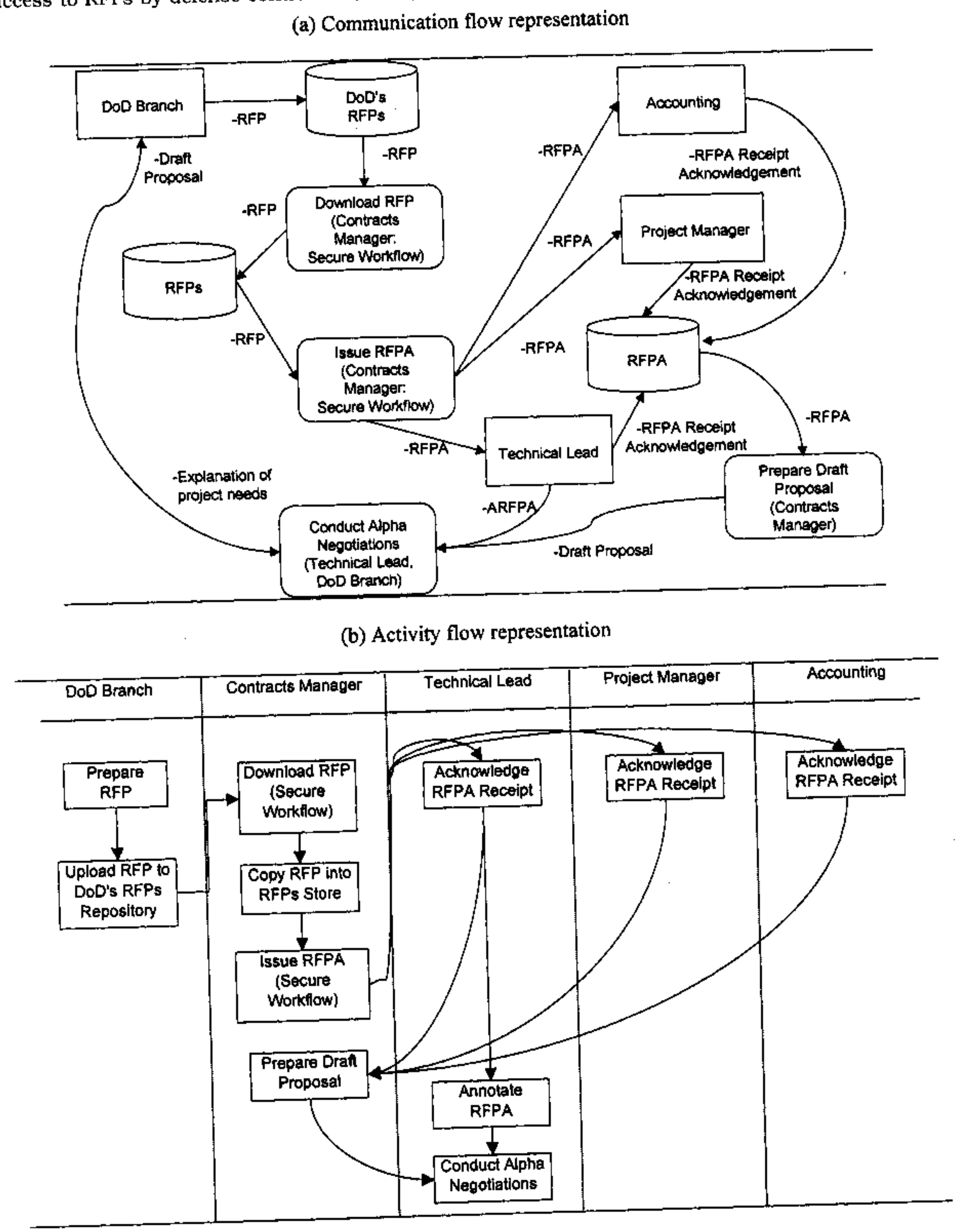
The Process Redesign Groups A process redesign group is typically small in size (usually fewer than 15 members) and has a short lifetime (from a few days to typically no more than a few months) during which its members define, analyze, and search for alternatives to improve one or a few organizational processes [21], [84], [85]. Each of the process redesign groups studied lasted approximately three months, had a "core" membership of three to five members (assigned nearly full-time to the process redesign projects), and had a "peripheral" membership of five to ten members (external advisors, consultants, and administrative support personnel assigned on a part-time basis to the process redesign projects). All of the groups were cross-departmental (i.e., they involved members from more than one department) and targeted cross-departmental processes (i.e., processes that involved more than one department in their execution). The term departments is used here to refer to organizational units that aggregate employees with expertise in related organizational functions (marketing department, computer support department, and quality control department). The process redesign groups targeted the following processes: organization-wide security systems implementation, large-scale software development, and documentation of engineering activities.

The literature suggests that, generally speaking, successful process redesign groups usually conduct their activities along three main conceptual stages, namely definition, analysis, and redesign [15], [16], [18], [46], [49], [86]–[88]. In the definition stage, the process redesign group selects a process for redesign. In the analysis stage, the group studies the process in detail. Finally, in the redesign stage, the group proposes process design modifications. These stages are followed by the implementation of the modifications. The process redesign groups studied followed this general structure.

In the analysis stage, each process redesign group developed both communication flow and activity flow representations of their target processes. Communication flow representations were adaptations of data flow diagrams [47], [48] and were generated following the modified format proposed by Kock [25]. Activity flow representations followed the general format proposed by Harrington et al. [46] for functional timeline flowcharts. While both types of representations contained different types of information, they generally embodied the same amount of information (i.e., neither was substantially more information rich than the other). See Fig. 1 for simplified examples of both types of representations (actual representations involved substantially more symbols).

Fig. 1 depicts a partial process whereby a defense contractor specializing in software development projects responds to a request for proposals issued by a branch of the U.S. DoD. Fig. 1(a) focuses on the flow of communication in the process. Fig. 1(b) focuses on the flow of activities. In the simplified examples shown in Fig. 1, the process is represented up to the "Alpha Negotiations" stage, whereby a software development expert referred to as the "Technical

Fig. 1. Process representations used—simplified defense contractor example (DoD: U.S. Department of Defense; RFP: Request for Proposal; RFPA: RFP Announcement; ARFPA: Annotated RFPA; Secure Workflow: DoD system that allows selective access to RFPs by defense contractors).



Lead" negotiates the terms of the possible future contract between the DoD and the defense contractor.

In Fig. 1(a), plain rectangles represent organizational functions (i.e., individuals, areas comprising groups of individuals, or organizations external to the process under consideration). Rectangles with rounded edges represent activities. Each activity is represented by the name of the activity, followed by the organizational function(s) that execute(s) the activity and a specialized artifact(s) or system(s) used in the execution of the activity—both within parentheses. "Drum"-like symbols represent information repositories, and arrows represent the flow of information in the process.

In Fig. 1(b), organizational functions are shown at the top of each column, which contains the activities executed by each organizational function. Plain rectangles represent activities, and the text inside has the same meaning as in Fig. 1(a). The arrows represent the flow of execution of the activities.

In the redesign stage, each process redesign group independently proposed several major process changes, without interference from the researcher. A list of generic process redesign guidelines, compiled from a large body of literature on process redesign by Kock [25], was provided to the groups to guide their work. To avoid biasing group member decisions, the guidelines were chosen so that (a) three of the guidelines were more meaningful in the context of communication flow than activity flow representations, (b) three of the guidelines were more meaningful in the context of activity flow than communication flow representations, and (c) two of the guidelines could be applied in both contexts. See the Appendix for detailed descriptions of these guidelines.

Communication flow and activity flow representations of the new processes, with major changes incorporated into them, were then generated. Following this, each process redesign group developed a generic information technology solution (i.e., a product-independent computer-based infrastructure and system specification) to implement the new process. These generic information technology solutions were illustrated through rich pictorial representations with icons representing computers, databases, and organizational functions. Process redesign group members generally saw these pictorial representations as important aids in explaining the new processes to peers and managers.

The above stages were followed by the implementation of the recommended process changes; this lasted from three to six months. Process performance reviews were conducted approximately nine months after the implementation of those changes. The reviews were based primarily on unstructured interviews and aimed at assessing the bottom-line business impact of the process redesign projects.

Data Collection and Analysis Three main types of research data were collected and compiled in connection with the process redesign groups: focus group discussion notes [89], [90], participant observation notes [89], [91], and unstructured interview notes [92], [93]. Focus group discussions were conducted twice with process redesign group members, once midway through and once at the end of the work of each process redesign group. Participant observation notes were generated based on direct observation of process redesign group members as well as other employees who peripherally involved with process redesign groups. Unstructured interviews were conducted with all process redesign group members, as well as with other employees who, although not directly involved in process redesign groups, interacted with group members or were directly affected by the work of the groups. Over 60 interviews were conducted in total.

In contrast to experimental studies, control groups are not normally employed in action research. Thus, action researchers often have to rely on "comparison" data [94] to draw conclusions based on the data collected through their investigations. This study relied on previously published comparison data related to the success rates of early process redesign projects. These rates were obtained from a large multinational survey of success rates of process redesign attempts based on total quality management principles [95], and a large survey of American and European companies of process redesign attempts employing business process re-engineering principles [38]. As previously mentioned, for the purposes of this study, process redesign groups were seen as either successful or unsuccessful, according to criteria proposed in the process redesign literature [15], [16], [68]—process redesign groups were categorized as successful if the process changes recommended by them were implemented fully or partially and led to positive observable results.

In order to increase the robustness of the data analysis, the three sources of research data—focus group discussion notes, participant observation notes, and unstructured interview notes—were extensively triangulated [94], [96], [97]. The data set was thoroughly examined for evidence in connection with each of the research questions, and all the evidence obtained was carefully compared and checked for inconsistencies. Additionally, the study employed Scriven's [98] modus operandi approach, whereby the researcher searches for clues as to whether or not expectations clearly match the evidence at hand (see [94]). The application of the modus operandi approach entailed asking what would have been expected from an event, in terms of evidence arising from the data analysis, if the researcher's predictions (based on the theoretical model) were wrong.

Ethical Considerations
Permission to use the research data for analysis was sought and obtained from the management of the organization, as well as from each individual contributor. The anonymity of the organization and of all individual contributors has been protected. Given that the organization studied was a defense contractor, all information deemed as classified or sensitive has been disguised.

RESULTS

The following paragraphs provide a discussion of evidence in connection with each of the research questions that guided the study of the three process redesign groups, referred to below as G1, G2, and G3. Because the research was conducted at a defense contractor that viewed much of the information about its internal operations as classified, no further details about the individual groups and the processes they targeted can be provided here. Rather, the evidence presented and discussed in this section relates specifically to the research questions.

Different pieces of evidence presented here are given codes that are later used to summarize them in a table. The codes are built on acronyms that indicate the source of each piece of evidence: unstructured interview notes (UIN), participant observation notes (PON), and focus group discussion notes (GDN).

Q1: *Will process redesign group members perceive communication flow representations of business processes to be more difficult to generate than activity flow representations?*

Had group members perceived activity flow representations as more difficult to generate than communication flow representations, which would suggest a negative answer to **Q1** and contradict the communication flow optimization model, one would expect most of those who discussed the relative difficulty of each process representation approach to say so in unstructured interviews and focus group discussions (i.e., that they perceived activity flow representations as more difficult to generate). If that were the case, one would also expect most groups to generate communication flow representations before they did activity flow representations because it seems natural that they would generate the easiest type of process representation first, and then the most difficult. Neither of these expectations matched what actually happened.

The analysis of the UIN suggested that most (more than two thirds) of the group members who were interviewed perceived communication flow representations as more difficult to be generated than activity flow representations (UIN.E01), which suggests a positive answer to **Q1**. The quote below is representative of the comments provided in interviews regarding this perception pattern.

> *The flowcharts are easier to create because they are basically what we do ... the other diagrams, the [communication flow diagrams], are not as easy to work out; they show the forms, documents, faxes, emails that we send back and forth, but not really what we do ... When we think about the things that we do, we think in terms of steps, or activities, not documents going back and forth.*

The magnitude, or strength, of the perception above is unclear, but a content analysis [89], [90] of interviews points to a slight difference in difficulty (suggested by the absence of superlatives and other modifiers, e.g., *very*, *drastic*, *a lot*, etc., that would indicate a stronger perception trend).

The perception above is consistent with the analysis of PON: All groups generated activity flow representations of their targeted processes before they generated communication flow representations (PON.E01) and then generated communication flow representations based on those initial activity flow representations. This suggests a positive answer to question **Q1**. That is, if a group generated the easiest (or most "natural") type of representation first, it would seem that groups (i.e., the majority of their members) saw activity flow representations as easier to produce than communication flow representations.

A third pattern of evidence in support of a positive answer to **Q1** comes from focus GDN, which suggested that most (all but one individual) of the focus group discussion participants perceived communication flow representations as more difficult to generate than activity flow representations (GDN.E01). The one individual who disagreed was neutral in his view; he did not think that either representation was more difficult to produce.

Q2: *Will process redesign groups employ communication flow representations of business processes more extensively than* *activity flow representations when making redesign decisions?*

Research question **Q2** does not relate perceptions but actual behavior and assumes that the behavior of the group members indicates an underlying difference in usefulness between process representations (which, given the answer to **Q1**, could be the opposite of the perceived ease of use of the representations). Thus, the key type of evidence to answer the question comes from the researcher's participant observation of the process redesign groups (discussed below). Nevertheless, it is interesting to note that most group members perceived communication flow representations to be more useful than activity flow representations when used as a basis for process redesign decisions. The quote below illustrates this perception.

> *[Communication flow diagrams] are really where you see that useless and inadequate tasks are being executed. Why does a piece of information go from A to B, and then from B to C, when it could go straight from A to C? When you see in a [communication flow] diagram the same piece of information going back and forth, without being turned into something else, you immediately know that something is wrong. Activity flow diagrams tell you nothing about that kind of problem.*

Participant observation notes (PONs) provided relatively strong evidence in connection with **Q2**. In one of the groups (G1), seven out of eight process redesign decisions were made entirely based on communication flow representations of its target process (PON.E02). In another group (G2), five out of eight process redesign decisions were entirely based on communication flow representations (PON.E03). In the remaining group (G3), three out of four decisions were made in the same way (PON.E04). That is, in all of the process redesign groups, communication flow representations were used significantly more extensively than activity flow representations as a basis for making process redesign decisions, providing support for a positive answer to **Q2**.

Q3: *Will process redesign groups employ communication flow representations of business processes more extensively than activity flow representations when making decisions about information technology solutions to implement the redesigned business processes?*

As with **Q2**, research question **Q3** does not relate perceptions but actual behavior. Therefore, similar to what was done in connection with **Q2**, the key type of evidence to answer the question comes from the researcher's participant observation of the process redesign groups (discussed below). Nonetheless, perceptions by group members also allow for a tentative positive answer to the research question, as they suggested that most group members perceived communication flow representations to be more useful than activity flow representations when used as a basis for making decisions about information technology solutions to implement the redesigned business processes. This is illustrated by the quote below, which is representative of statements made by group members in unstructured interviews.

> *When one looks at a generic IT solution to automate a redesigned process, it looks almost like the [communication] flow representation of the process, because both show essentially the same thing – the flow of information in the business process – one with technology [details] and the other without. The activity diagrams are almost useless at that point, unless you want to make a presentation for management or something like that ... even so, the [communication flow] diagrams are probably better, because they show more or less how databases will be set up and which people will need to access data in them.*

PON also suggested the existence of relatively strong evidence in connection with the use of communication flow representations when making decisions about information technology solutions to implement the redesigned business processes. In all of the three groups the generic information technology solution and rich pictorial representation were developed entirely based on communication flow representations (PON.E05). This provides support for a positive answer to question **Q3**.

Q4: *Will process redesign groups that employ communication flow representations of business processes more extensively than activity flow representations, when making redesign decisions and when making decisions about information technology solutions to implement the redesigned business processes, generate more successful redesigns than groups that do not?*

This is a difficult question to answer based on this study because the sample of process redesign projects studied was small, and, thus, no statistical analysis could be performed on evidence pertaining to **Q4**. Nevertheless, two assumptions seemed appropriate and useful in analyzing the evidence with the goal of answering this research question. The first assumption was that the three process redesign groups studied should be seen as a homogeneous set of data points since they all employed communication flow representations more extensively than activity flow representations to make redesign and information technology solution decisions. The second assumption was that, to provide a negative answer to **Q2**, one would expect: (a) that most group members would provide hints in focus group discussions and/or unstructured interviews that they perceived their groups as not very successful (here more in-depth probing was critical because most people are reluctant to admit failure in connection with tasks performed) and (b) that an inspection of the outcomes of the actual implementation of the redesigned processes would suggest a rate of success lower than that reported in the general literature on process redesign (arguably the latter, based on our previous discussion, is largely based on activity flow-oriented process redesign projects). As it will be shown below, the evidence supported neither of these two expectations.

Focus GDN suggested that all groups' members perceived their groups as likely to be very successful according to the adopted criteria for success—that recommended process changes that were implemented fully or partially and led to "positive" observable results (GDN.E02), providing support for a positive answer to **Q4**. No evidence from unstructured interviews contradicted this general perception.

Moreover, UIN suggested, based on interviews with managers (who had not been "core" group members) after the new process implementations, that all of the three groups recommended process changes that were successful according to those same criteria (UIN.E02). If the success rate here were equal or lower than the success rates of process redesign projects reported in the literature, which have been consistently found to be 34 percent or less [38], [95], one would expect no more than one group out of three to be successful. Therefore, this evidence cannot be seen as contracting the positive answer to **Q4** provided above based on focus group discussions and unstructured interviews.

Table I summarizes the main pieces of evidence discussed above in connection with the research questions. Table I shows individual patterns of evidence. As above, the evidence is grouped based on its source and indicated by specific acronyms that point to the source of each piece of evidence: UIN, PON, and focus GDN. Fig. 2 provides a description of each evidence pattern shown in Table I.

The patterns of evidence summarized above provide general support for positive answers to all of the research questions. Since the questions were developed based on the communication flow optimization model and positive answers are aligned with predictions based on the model, it can be concluded that the patterns of evidence also provide general support for the model. Consistent with the model's predictions, process redesign group members seemed to perceive communication flow representations of processes as more difficult to generate than activity flow representations. Given their behavior, it is plausible to conclude that this was related to activity flow representations being better aligned with the way humans are cognitively programmed to envision action in the physical sense.

TABLE I
SUMMARY OF THE KEY PIECES OF EVIDENCE IN CONNECTION WITH THE RESEARCH QUESTIONS

	Unstructured interview notes	Participant observation notes	Focus group discussion notes
Q1	UIN.E01	PON.E01	GDN.E01
Q2		PON.E02 PON.E3 PON.E04	
Q3		PON.E05	
Q4	UIN.E02		GDN.E02

Also, consistent with the communication flow optimization model's predictions, process redesign group members shifted their behavior away from their initial perceptions (which were more favorable toward activity flow representations), employing communication flow representations of business processes more extensively than activity flow representations when making decisions in connection with process redesign itself and information technology solutions to implement the redesigned processes. This shift apparently had no negative impact on group success; in fact, the evidence suggests a positive impact, though based on a small sample. Moreover, it is fair to assume that process redesign group members made a rational and relatively well-informed choice, particularly given that they were involved in real process redesign projects, with all the personal risks associated with not doing a good job. Thus, it is reasonable to conclude that a focus on communication flow structures in processes is indeed advisable as an alternative to the currently more widespread focus on workflows, especially when time constraints force practitioners to use one single process redesign approach—a situation that is becoming increasingly common in business [99].

CONCLUSION

This paper reviewed the literature on process redesign and identified a problematic focus on workflows (or chronological sequences of activities), particularly in operational-level process redesign approaches. Building on the communication flow optimization model, it is shown that, if emphasis must be placed on a single process redesign approach due to time constraints, that emphasis should be on communication flows, as opposed to the ubiquitous contemporary practice of placing emphasis on workflows. This is an important contribution, because it signals the need for a reorientation of process redesign practices to meet the demands posed by the communication-intensive nature of contemporary business processes. Given the current predominance of workflow-based process redesign approaches [35], [49], this reorientation may have a deep impact on the future practical success of operational-level process redesign approaches. The recent emergence of virtual organizations, virtual teams, and e-business, and the consequent explosion in organizational communication demands [100]–[102] is likely to make this reorientation even more urgent in the near future.

Still, much more research is needed to further test and refine the communication flow optimization model. Notably, it is not clear from this research study whether a limited use of activity flow representations may be beneficial early on in process redesign projects whose focus is on communication flow representations and techniques. This issue is addressed below in our discussion of implications for future research, which is followed by a discussion of implications for practice and limitations of the research study.

Implications for Future Research One key area of future research relates to the refinement of the communication flow optimization model. In particular, the combination of communication flow-based representations and techniques with other types of representations and techniques, including activity-based ones, needs to be assessed. This follows from one of communication flow optimization's own theoretical propositions, supported by this research, which states that activity flow representations are easier to generate than communication flow representations. It may be advantageous to generate simplified activity flow representations as an initial step in the analysis of a business process before communication flow representations are generated. Since the process redesign groups investigated did that, it is not clear what would have happened had they not followed that path. This suggests that even though a focus on activity flows may be undesirable, as argued by the communication flow optimization model, a limited use of activity flow representations may be beneficial. This issue should be addressed in future research.

This study also provides the basis on which other methods and techniques can be developed and investigated in areas that are related to but go beyond the scope of business process redesign. Information systems design is one such area. For example, the recent success of object-oriented programming has led to the emergence of object-oriented analysis. However, the scope of use of object-oriented analysis pales when compared with that of its object-oriented programming. Chuang and Yadav [52] argue that this is due to object-oriented analysis' excessive

Fig. 2. Summary of the key pieces of evidence in connection with the research questions. Descriptions of the individual patterns of evidence.

Evidence	Description
UIN.E01	Most of the group members (more than two thirds) interviewed perceived communication flow representations as more difficult to be generated than activity flow representations.
UIN.E02	All groups recommended process changes that were implemented fully or partially and led to "positive" observable results, according to interviews with managers (who had not been "core" group members) after the implementations.
PON.E01	All groups generated activity flow representations of their targeted process before they generated communication flow representations.
PON.E02	Most (seven out of eight) process redesign decisions made by group G1 were entirely based on communication flow representations of its target process.
PON.E03	Most (five out of eight) process redesign decisions made by group G2 were entirely based on communication flow representations of its target process.
PON.E04	Most (three out of four) process redesign decisions made by group G3 were entirely based on communication flow representations of its target process.
PON.E05	All groups developed a "generic" information technology "solution" and rich pictorial representation entirely based on communication flow representations of its target process.
GDN.E01	Most (all but one individual) of the focus group discussion participants perceived communication flow representations as more difficult to be generated than activity flow representations.
GDN.E02	All group members perceived their groups as very successful according to the adopted criteria for success – that recommended process changes that were implemented fully or partially and led to "positive" observable results.

activity orientation, which they addressed by developing and validating a new methodology for object-oriented analysis. This new methodology built on early communication flow optimization model principles proposed by Kock and McQueen [24], and suggests the potential of the model to serve as a basis for the refinement of that methodology and development of other methodologies.

Implications for Practice A key implication of this research for managers involved in operational-level process redesign projects is that they should carefully consider the focus of their projects, especially when the goal is to redesign individual processes with an eye on quality and productivity improvements. If that focus is on activities and their flow, as advocated by proponents of popular activity flow-based methods such as Hammer's [1] and Harrington et al.'s [46], they should consider shifting that focus toward communication and its flow in business processes.

At a minimum, managers should strive to strike a balance in process redesign projects between activity flow and communication flow methods and techniques. This is particularly important in broad projects that target primarily service processes, where the flow of materials is minimal, such as the recent organization-wide initiatives by the U.S. DoD to improve acquisition practices [103]. In projects of such magnitude, even single-digit success rate increases can lead to savings in the range of millions of dollars.

Limitations of This Research Study Like any research study, this study's limitations need to be acknowledged. One of the main limitations of this study is the small sample of process redesign projects investigated. While the research approach used, action research, makes it impractical to study samples of much larger size than that targeted by this study, these data provide an exploratory basis on which further confirmatory research based on larger samples may be conducted. If this limitation is properly addressed, additional insights into the predictive power of the communication flow optimization model can be obtained.

Another way in which the above limitation could be addressed without resorting to other research approaches would be to conduct similar action research studies in the future, trying to ensure that the level of similarity with this study is high enough so that the research data obtained through those studies could be combined with the data collected in this study. This could be done iteratively until the combined sample size obtained is large enough to allow for unequivocal conclusions in connection with the validity of the communication flow optimization model's predictions, particularly regarding process redesign group success.

APPENDIX

PROCESS REDESIGN GUIDELINES USED

The process redesign groups used the following guidelines, which have been compiled from a large body of literature on process redesign and are discussed in more detail by Kock [25]. In the list below, also used in a previous study by Kock [26], each guideline, written in generally the same language and rationale as those presented to the participants, is followed by a brief description of why it may lead to process improvement.

In order to provide a balanced set of guidelines for the participants and avoid biasing their preferences, the guidelines were distributed as follows regarding the most natural context of application. Guidelines one through three are more meaningful in the context of communication flow than activity flow representations. Guidelines four and five can be applied in both contexts. Guidelines six through eight are more meaningful in the context of activity flow than communication flow representations.

(1) *Foster asynchronous communication.* When people exchange information they can do it synchronously, i.e., interacting at the same time, or asynchronously, i.e., interacting at different times. One example of synchronous communication is a telephone conversation. If the conversation takes place via e-mail, it then becomes an example of asynchronous communication. It has been observed, especially in formal business interaction, that, almost always, asynchronous communication is more efficient. For example, synchronous communication often leads to wasted time (e.g., waiting for the other person to be found) and communication tends to be less objective. Asynchronous communication can be implemented with simple artifacts such as in- and out-boxes, fax trays, and billboards. These artifacts work as dynamic information repositories.

(2) *Eliminate duplication of information.* Static repositories, as opposed to dynamic repositories, hold information in a more permanent basis. A student file maintained by a primary school, for example, is a static repository of information. Conversely, the data entry form used to temporarily store information about a student that will be entered into the student file is not a static repository. Duplication of information in different static repositories often creates

inconsistency problems, which may have a negative impact on productivity and quality. Kock [104] describes a situation where a large auto maker's purchasing division tried to keep two supplier databases updated: one manually and the other through a computer system. Two databases were being kept because the computer database had presented some problems and, therefore, was deemed unreliable. This, in turn, was causing a large number of inconsistencies between the two databases. Each database stored data about over four hundred parts suppliers.

(3) *Reduce information flow.* Excessive information flow is often caused by an over-commitment to efficiency to the detriment of effectiveness. Information is perceived as an important component of processes, which drives people to an unhealthy information hunger. This causes information overload and the creation of unnecessary information processing functions within the organization. Information overload leads to stress and, often, the creation of information filtering roles. These roles are normally those of aides or middle managers, who are responsible for filtering in the important bit from the information coming from the bottom of, and from outside, the organization. Conversely, excessive information flowing top-down forces middle managers to become messengers, to the damage of more important roles. Information flow can be reduced by selecting the information that is important in processes and eliminating the rest, and by effectively using group support and database management systems.

(4) *Reduce control.* Control activities do not normally add value to customers. They are often designed to prevent problems from happening as a result of human mistakes. In several cases, however, control itself fosters neglect, with a negative impact on productivity. For example, a worker may not be careful enough when performing a process activity because he knows that there will be some kind of control to catch his mistakes. Additionally, some types of control, such as those aimed at preventing fraud, may prove to be more costly than no control at all. Some car insurance companies, for example, have found out that the cost of accident inspections, for a large group of customers, was much more expensive than the average cost of frauds that that group committed.

(5) *Reduce the number of contact points.* Contact points can be defined as points where there is interaction between two or more people, both within the process and outside. This involves contacts between functions, and between functions and customers. Contact points generate delays and inconsistencies and, when in excess, lead to customer perplexity and dissatisfaction. In self-service restaurants and warehouses, for example, the points of contact were successfully reduced to a minimum. Additionally, it is much easier to monitor customer perceptions in situations where there are a small number of contact points. This makes it easier to improve process quality.

(6) *Execute activities concurrently.* Activities are often executed in sequence, even when they could be done concurrently. This has a negative impact primarily on productivity, and is easier to spot on process flowcharts than in data flow diagrams. In a car assembly process, for example, the doors and other body parts can be assembled concurrently with some engine parts. This has been noted by several automakers, which, by redesigning their processes accordingly, significantly speeded up the assembly of certain car models.

(7) *Group interrelated activities.* Closely interrelated activities should be grouped in time and space. Activities that use the same resources (i.e., artifacts or functions) may be carried out at the same location and, in some cases, at the same time. Kock [25] illustrates this point using the case of a telephone company that repaired external and internal house telephone connections. This company had two teams, one team for internal and another for external repairs. An internal repair occurs, by definition, within the boundaries of a commercial building or residence; external repairs involve problems outside these boundaries. Whenever the telephone company received a customer complaint, it used to send first its internal team. Should this team find no internal connection problem, the external team would then be dispatched to check the problem. It took a process improvement group to show the company that it was wasting thousands of dollars a year, and upsetting customers due to repair delays, by not combining the two teams into a single repair team. This was because, when complaints were categorized and counted, it was found out that most of the problems were external.

(8) *Break complex processes into simpler ones.* Complex processes with dozens (hundreds in some cases) of activities and decision points should be broken into simpler ones. It is often

much simpler to train workers to execute several simple processes than one complex process. It is also easier to avoid mistakes in this way, as simple processes are easy to understand and coordinate. In support of this point, Kock [25] discusses the case of an international events organizer, which was structured around two main processes: organization of national and of international events. After a detailed analysis of these two processes, which embodied over a hundred activities each, it was found that they both could be split into three simpler subprocesses: organization of exhibitions, conferences, and exhibitors participation. This simplification improved the learning curve for the processes, as well as reducing the occurrence of mistakes. It did not, however, lead to an increase in the number of employees needed. The reason is because, with simpler processes, one person could perform functions in various processes at the same time.

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