ASYNCHRONOUS GROUPWARE SUPPORT EFFECTS
ON PROCESS IMPROVEMENT GROUPS:
AN ACTION RESEARCH STUDY

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ABSTRACT

We report in this paper on a study of seven process improvement groups in two New Zealand organisations. All groups followed the same group methodology, MetaProi, and were facilitated by the researcher. The research approach used was action research. All groups interacted with the support of an e-mail conferencing tool. Six of the groups used e-mail conferencing as the main medium of interaction, and their members interacted through the e-mail conferencing system during 67 to 89 per cent of the time. One of the groups conducted most of the discussion through a face-to-face meeting, using e-mail conferencing during only 18 per cent of the time. Five of the groups were successful in generating and either fully or partially implementing process redesign proposals. Two of the groups failed to generate any process redesign proposal. Research data was collected through participant observation, unstructured and structured interviews, and in the form of e-mail discussion transcripts. This research data indicates that the asynchronous groupware support increased process adoption, hierarchy suppression, departmental heterogeneity, and contribution length, and decreased discussion duration, cost, and interaction in process improvement groups.


1. INTRODUCTION

The concept of business process has been the basis of several organisational development movements, in particular the total quality management (TQM) and the business process re-engineering (BPR) movements, whose peaks of worldwide attention occurred respectively in the 1980s and 1990s. In addition to their focus on business processes, these movements also share some other characteristics. Among these characteristics is one of particular importance in this study, which is their reliance on small groups, i.e. with 3 to 15 members, with well defined member roles to generate and coordinate the implementation of process improvement proposals (Deming, 1986; Ishikawa, 1986, Walton, 1991; Hammer and Champy, 1993, Soles, 1994). We refer to these small groups in this paper as process improvement (PI) groups.

The general literature on empirical studies of groupware support for groups widely acknowledges some effects that indicate potential benefits of its use as a tool for PI groups. Among these effects are better support for group activities, and positive effects on individual and group behaviour. For example, Sproull and Kiesler (1991) argue that communication becomes faster and cheaper, and that individuals communicate more openly; Wilson (1991) points out that paper flow in organisations is reduced, Brothers et al. (1992) argue that group discussion data is recorded in a more efficient way, Clement (1994) argues that cross-departmental communication is increased, Nunamaker et al. (1991) show that individual contributions are better distributed in group discussions, Chidambaram and Kautz (1993) argue that ideas are separated from individuals and are thus considered on their own merit, and Sheffield and Gallupe (1993) show that the repetition of old ideas in meetings is reduced and that commitment towards group decisions is increased. Most of these examples analysed the impact of asynchronous (e.g. e-mail) and synchronous groupware (e.g. GDSS) in comparison to similar face-to-face situations.

In spite of the potentially positive effects that groupware may have on PI groups, related empirical research has been limited. There have been some representative examples of research studies where groupware was used to support PI groups, such as Pietro's (1992) study of quality improvement groups, Dennis et al. (1993) study of one business process re-engineering group, and Dennis et al. (1994) study of business process modelling groups. These studies, however, have focused on synchronous groupware tools,
particularly GDSSs. We try to provide a shift of focus in this paper by focusing on the effects of asynchronous groupware support on PI groups. The asynchronous groupware tool used was e-mail conferencing (EC) and the main research approach used was action research.

2. RESEARCH METHOD

Organisational action research studies are characterised by the researcher applying positive intervention to the client organisation, while collecting field data about the organisation and the effects of the intervention (Lewin, 1946; Peters and Robinson, 1984; Jonsson, 1991). The client organisations of this study were School (pseudonym), a school of studies of a New Zealand university and MAF Quality Management (MQM), a branch of the Ministry of Agriculture and Fisheries of New Zealand, with offices spread throughout the country. Staff from eighteen different MQM offices and two departments in School participated in the research project.

The specific action research approach followed is detailed in (Kock, McQueen and Fernandes, 1995) and (Kock, McQueen and Scott, 1995). The approach is centred on the action research cycle proposed by Susman and Evered (1978), which comprises five stages: diagnosing, action planning, action taking, evaluating, and specifying learning, as shown in Figure 1.

![Figure 1: The action research cycle](image)

In the stage diagnosing researcher and client organisation identify and specify an opportunity of improvement in the client organisation and match it with the research goals. In the action planning stage researcher and client organisation consider alternative courses of action to attain the improvement identified, and devise a plan to implement one of these alternative courses of action. In the stage action taking researcher and client organisation implement the devised plan. In the stage evaluating researcher and client organisation assess the outcomes of the plan implementation. Finally, in the stage specifying learning the researcher structures the information generated in the previous stage as general findings.

The study consisted in facilitating and studying 7 EC-supported PI groups in the client organisations. These groups are referred to, in this paper, as G0 (at School) and G1-G6 (at MQM), and have their main features summarised in Table 1. This table shows the number of members in each group, the number of electronic postings contributed by group members, the duration of the group in days, the number of departments and offices (or physical sites) represented in each group, and the group's scope of change.

Departments are defined here as areas comprising interrelated functions performed by staff who share knowledge to perform interrelated activities1, and may comprise staff based at different locations. This departmental structure mirrors the one used by MQM to classify staff according to service supplied, which is the basis for MQM's management structure2, where departments are part of a core business, or a support division. This research study involved two main core businesses

1 Function interrelation was due to common knowledge required to carry them out (e.g. meat handling inspector and meat processing consultant), rather than to being part of the same business process (e.g. quality systems consulting).

2 A dairy and food training manager in an office on the bottom tip of New Zealand's South Island, for example, ultimately reports to the national dairy/food manager based in Hamilton.
at MQM: food, which comprised departments supplying dairy and meat-related services; and plant, which comprised departments supplying plant-related services. The research also involved two support divisions at MQM: information systems (IS) regional support, and communications support, which comprised departments supplying public relations, media liaison, document design, and business communication consulting services. School was considered as a business itself, from which one academic department and one support department participated in the study. Offices are defined here as physical aggregations of staff in the same building, typically in different cities.

The computer tool used to support the PI groups was a simple EC prototype, implemented using Groupwise functions. Group e-mail distribution lists comprising PI group members were implemented for each of the PI groups using Groupwise rules. The group distribution lists used in the research were similar to Internet list servers' electronic mail distribution lists (e.g. BPR-L and ISWorld). The groupware tool allowed PI group members to exchange electronic messages within the group, and with staff of the respective organisations, as well as post messages and replies to the whole group. Spreadsheets, flow charts, presentations, and graphs could be attached as files to electronic messages, and read by recipients. Attachments could be read by clicking on icons on the computer screen.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of members</th>
<th>Number of electronic postings</th>
<th>Duration (days)</th>
<th>Departments involved</th>
<th>Offices (sites) involved</th>
<th>Scope of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>G0</td>
<td>7</td>
<td>21</td>
<td>33</td>
<td>2</td>
<td>1</td>
<td>interdepartmental</td>
</tr>
<tr>
<td>G1</td>
<td>5</td>
<td>7</td>
<td>26</td>
<td>1</td>
<td>1</td>
<td>departmental</td>
</tr>
<tr>
<td>G2</td>
<td>5</td>
<td>9</td>
<td>25</td>
<td>1</td>
<td>4</td>
<td>interdepartmental</td>
</tr>
<tr>
<td>G3</td>
<td>7</td>
<td>4</td>
<td>14</td>
<td>1</td>
<td>6</td>
<td>business</td>
</tr>
<tr>
<td>G4</td>
<td>11</td>
<td>18</td>
<td>29</td>
<td>4</td>
<td>5</td>
<td>business</td>
</tr>
<tr>
<td>G5</td>
<td>15</td>
<td>23</td>
<td>28</td>
<td>6</td>
<td>10</td>
<td>departmental</td>
</tr>
<tr>
<td>G6</td>
<td>14</td>
<td>6</td>
<td>10</td>
<td>3</td>
<td>8</td>
<td>interdepartmental</td>
</tr>
</tbody>
</table>

Table 1: PI group features

PI groups consisted of members from one or more departments, located in one or more offices. The scope of change of a PI group was said to be "departmental" when processes comprised by only one department were redesigned, even though the changes might have affected processes in different offices. The scope of change was called "interdepartmental" when the processes redesigned involved more than one department, but not a whole business. The scope of change was said to be "business" when the process redesigned involved the whole business, even though the PI group involved members of only one department (as in G3).

The groups followed a group methodology called MetaProi, discussed in detail in (Kock, 1995). MetaProi was devised by the researcher (first author of this paper) based on normative frameworks for PI (Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993; Guha et al., 1993; Wastell et al., 1994; Kock, 1995a), case studies (Dingle, 1994; Caron et al., 1994), and a previous action research project that examined the general effects of EC support on PI groups (Kock and McQueen, 1995).

All PI groups had a leader, a facilitator and ordinary members. The facilitator in all groups was the researcher. All group leaders and ordinary members were staff of the client organisation. The researcher provided technical and methodological support to the PI groups by interacting mostly with group leaders. The researcher influenced the structure of PI discussions by helping the leader to build messages where individual contributions of group members were summarised and group stages were initiated and completed. No influence on the content of group discussions was exerted by the researcher.

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3Groupwise is an asynchronous group support system commercialised by Novell Corporation.
4Groupwise rules are simple programming structures that enable users to associate actions, such as distributing a message to a list of users, to certain events. An event may be an incoming message with a specific subject for example.
5BPR-L, administered by the University of Delft in the Netherlands, is a forum for the discussion of issues related to business process redesign. ISWorld, administered by the University College Dublin in Ireland, is a forum for the discussion of issues related to information systems research.
2.1. Research framework and data sources

A set of seventeen variables provided a basic framework for data collection. Those variables were derived from a set of seventeen research questions concerning three units of analysis, which were called PI group member, PI group, and organisation. Two of the units of analysis, organisation and PI group, represented abstract entities - respectively the client organisation and the PI group. The third unit of analysis, the PI group member, represented a real entity - the PI group participant. The seventeen variables initially defined described attributes of the three units of analysis. Six of those variables were related to the unit of analysis organisation; eight to the PI group; and three to the PI group member. This article deals with the PI group unit of analysis.

Research questions associated to the unit of analysis PI group were derived from literature review on small group theory (e.g. Shaw, 1981; McGrath, 1984) and empirical research on group effects of groupware support for work groups (e.g. Nunamaker et al., 1991; Ellis et al., 1991; Markus, 1992; Pietro, 1992; DeSanctis et al., 1993; Sheffield and Gallupe, 1993; Alavi, 1993; 1994; Gallupe et al., 1994).

Data was collected through participant observation, interviews, questionnaires, and compilation of transcripts of electronic messages from PI group members. Complementary data about the organisation and its main processes was obtained from internal archival records, such as service records and memoranda. Another source of complementary data were documents published by the organisation, such as advertising material and the organisation's internal newspaper.

Participant observation notes were generated based on the facilitation of PI groups, and formal and informal interactions with staff. These notes were the result of perceptions and reflection about the researcher's interactions with the client organisation and were intentionally framework-free, that is, they were not necessarily related to the set of research variables initially defined. This approach was adopted to provide a balance between framework-free sources of data (e.g. transcripts of electronic discussions, participant observation notes) and framework-bound ones (e.g. structured interviews). This was done to prevent the researcher from leaving out relevant effects unrelated to the initial set of research variables.

Interviews were of two types, structured and unstructured. Both types of interviews were based on open-ended questions (i.e. not restricted to a set of pre-defined alternatives). Structured interviews were based on a pre-defined list of questions, and were taped and later transcribed. From 3 to 6 unstructured interviews per group were performed with group leaders and staff. These interviews lasted from 1 to 3 hours and were not taped. Data obtained through unstructured interviews was merged with participant observation notes for later analysis.

Structured interview respondents were PI group members who were based in Hamilton. Questionnaires with open-ended questions were sent via electronic-mail to PI group members based in offices outside Hamilton. The questions in the questionnaires were the same as those used in the structured interviews. Some of the completed questionnaires were followed up by phone to clarify incomplete responses or unclear statements. PI group members were interviewed or received questionnaires within a week after the completion of their groups. Transcripts of nine structured interviews and seven questionnaires were obtained.

Participant observation notes were indexed by date and topic. These topics typically described a person or specific PI group and an event observed (e.g. John ignored other member's requests, Trish's group has had a low degree of interaction so far). Transcripts of interviews were indexed by the respondents name and topic. These topics were normally tightly related to one of the seventeen research variables. Transcripts of electronic messages from PI group members were indexed by PI group and date. Overall, approximately 135,000 words of descriptive qualitative data were generated. Most of it was in the form of interview and questionnaire transcripts (59% of the total), followed by participant observation notes (23%), and transcripts of electronic group discussions (18%).

3. GROUP PROCESS FEATURES

The group process followed by the PI groups comprised three main stages, namely definition, analysis and redesign. A description of the above stages for each of the PI groups is provided in Table 2. The table shows in the first column the proportions of time calculated as spent by group members on interactions through the EC system (EC) and orally (OR), totalled based on interaction times reported by members in structured interviews. Almost all oral interactions were one-to-one conversations face-to-face or over the phone.
In the definition stage the group leader posts an electronic message to the group discussion with a general problem, a list of narrowly defined problems that are believed to be components of the general problem, a list of processes that are believed to be at the source of the problems, and a request for comments from group members refining this information and indicating which process (or few processes) the group should target. This first message is written by the group leader with the support of the facilitator.

In the analysis stage the group leader and the facilitator summarise the group discussion following the first message in a new electronic message posted to the group discussion. This message typically contains acknowledgments to individual contributions, a flowchart or textual description of the process that the group decided to target, performance-related information about this process (e.g. number and types of users complaints, leading time, overall cost), a list of proposed changes to the process with an indication of those who would be responsible for these changes, and a request for comments from group members refining the information provided and the proposed changes.

In the redesign stage the group leader and the facilitator summarise the member contributions in the analysis stage in a final electronic message posted to the group discussion. This message typically contains acknowledgments to individual contributions, and a brief plan with activities to be performed to implement the process changes agreed on by group members. This brief plan includes a description of the activities, deadlines for their implementation, and those who are responsible for carrying out the activities.
Further unstructured interviews with group leaders and a few managers revealed that the groups G0, G2 and G3 had successfully implemented all process changes agreed on by the groups, G1 and G5 had partially implemented their process changes and were in the process of implementing the remaining ones, and G4 and G6 had neither reached an agreement over process redesign proposals nor carried out any process change implementations related to initial general problem that was used as the basis for the formation of those groups.

### 4. THE EFFECT OF ASYNCHRONOUS GROUPWARE ON PI GROUPS

A quantitative analysis of the perceptions of PI group members gathered in structured interviews allows us to form a basic picture of EC support effects on the previously identified group-related variables. The frequencies of responses were interpreted based on the assumption that if most respondents (i.e. more than 50 per cent of the respondents) had the same perception, this would be an indication of a possible causal link. When this happened we tried to gather more quantitative or qualitative evidence to support the existence of that link, and also looked for disconfirmatory perceptions and related evidence. In addition, data on group interaction and contribution length of the groupware supported discussions was collected and

### Table 2: Description of group stages

<table>
<thead>
<tr>
<th>Group</th>
<th>Definition</th>
<th>Analysis</th>
<th>Redesign</th>
</tr>
</thead>
<tbody>
<tr>
<td>G0</td>
<td>8 problems and 3 processes were listed. 4 replies followed with comments and change suggestions.</td>
<td>2 processes were described (split into 5 activities each). 6 changes were proposed. 13 replies followed refining the changes.</td>
<td>5 refined changes were listed with implementation deadlines. 4 replies followed discussing implementation issues.</td>
</tr>
<tr>
<td>G1</td>
<td>3 problems and 2 processes were listed. 1 reply followed with change suggestions.</td>
<td>1 process was described (split into 5 activities). 8 changes were proposed. 2 replies followed refining changes.</td>
<td>8 refined changes were listed with implementation deadlines. No replies.</td>
</tr>
<tr>
<td>G2</td>
<td>3 problems and 2 possible processes with change suggestions.</td>
<td>1 process was described (split into 8 activities), with 3 proposed changes. 1 reply followed refining those changes.</td>
<td>3 refined changes were listed, to be implemented right away. 2 replies agreeing with changes and praising the initiative.</td>
</tr>
<tr>
<td>G3</td>
<td>3 problems and 2 processes were listed. 2 replies with general comments followed. (face-to-face meeting)</td>
<td></td>
<td>7 changes were listed, to be implemented right away. No replies.</td>
</tr>
<tr>
<td>G4</td>
<td>One main problem was defined in a general and abstract way. 7 replies followed with general comments and raising new issues. No agreement on what should be discussed was achieved.</td>
<td>Previous postings were acknowledged. A set of problems and guidelines for action was proposed. 4 replies followed. No agreement was reached.</td>
<td>Recognition that there was no agreement. Suggestion that the discussion should be resolved in a face-to-face meeting.</td>
</tr>
<tr>
<td>G5</td>
<td>4 problems and 5 processes were listed. 9 replies emphasising some of the problems and possible solutions.</td>
<td>2 causes were chosen based on the contributions and analysed. Change suggestions were requested. 5 replies with change proposals.</td>
<td>5 changes were listed with implementation dates. 5 replies with refinements and praising the initiative.</td>
</tr>
<tr>
<td>G6</td>
<td>A problem was defined and members were asked for information on how to build a software system to solve it. 5 replies followed supplying information. Leader was dissatisfied with the results and decided to use the group as a forum for permanent exchange of information about software requirements.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
analysed, and is presented at the end of this section.

4.1. Effect on previously identified variables

Consistently to this approach, the analysis of response frequencies pointed to five main effects of EC support on PI groups, as shown in Table 3.

Respondents consistently indicated that EC support increased group process adoption, hierarchy suppression, and departmental heterogeneity. Moreover, no respondent indicated a perceived decrease in these three variables as a result of EC support. Respondents also consistently indicated a decrease in group duration and cost, as a result of the EC support. In the case of these two variables though, there were a few dissenting responses.

4.1.1. Group process adoption and hierarchy suppression

The perceived increase in group process adoption fostered by EC support was strongly supported by the analysis of the interview transcripts, and participant observation during the face-to-face facilitation sessions with group leaders. For example, almost all replies from members referred to messages posted by the group leaders - this can also be observed in Table 2 - a behaviour not commonly seen in the PI groups we have facilitated in previous studies (Kock and McQueen, 1995). In those face-to-face groups leaders had typically to put a lot of effort into preventing group discussions from steering away from the main subject into new threads brought up by group members. In the EC-supported PI groups in our study not only this happened only once, in G4, but also most group leaders indicated that it seemed to be much easier to lead EC-supported PI groups than face-to-face PI group discussions. Moreover, two group leaders admitted having severely limited leadership skills and therefore not being able to lead a face-to-face group discussion with the members that were in their EC-supported PI groups. In one of these cases the group leader was one of the most junior staff in his group, and his national business manager was a member of the group. In the other case the group leader was the most junior person of his group. These cases also provide support to the perception that hierarchy suppression is increased by EC support.

It is important to explain the reason why we use in this study the term EC "support", rather than EC "mediation". The analysis of computer mediation effects would typically require us to run some PI groups where interaction was only through the EC system, and some PI groups where interaction was exclusively face-to-face (control groups). We however, opted to offer EC support optionally to the PI groups.

Requesting PI groups to interact only through the EC support system would allow us to make assumptions about EC mediation effects, but would at the same time apply artificial control on the PI groups being studied and probably bias the results - i.e. PI groups would tend to see their work as part of a field experiment, which could reduce their willingness to contribute to the group discussion or their commitment to the process redesign proposals generated by the group. Since this was an action research study, and therefore one of our goals was to actually improve the client organisations through the PI groups rather than use it as a laboratory, we offered both the group methodology MetaProi and the EC system as alternative tools to be used by the PI groups, that would in our view likely increase those groups' efficiency and effectiveness. We made it clear that we would make no opposition to a group decision of running the whole group discussion or most of it through face-to-face meetings, which was what group G3 did. Even so, all PI groups but G3 ran all their group discussions through the EC system, using face-to-face, phone and ordinary electronic mail messages only for one-to-one conversations.

4.1.2. Group departmental heterogeneity

Perhaps the preference of PI groups for the EC system over face-to-face meetings as the main communication medium was motivated by the higher departmental heterogeneity found in the

<table>
<thead>
<tr>
<th>Variable</th>
<th>Increase</th>
<th>Decrease</th>
<th>No effect</th>
<th>Do not know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process adoption</td>
<td>11 (61%)</td>
<td>0 (0%)</td>
<td>2 (11%)</td>
<td>5 (28%)</td>
</tr>
<tr>
<td>Hierarchy suppression</td>
<td>12 (67%)</td>
<td>0 (0%)</td>
<td>4 (22%)</td>
<td>2 (11%)</td>
</tr>
<tr>
<td>Dept. heterogeneity</td>
<td>16 (89%)</td>
<td>0 (0%)</td>
<td>1 (6%)</td>
<td>1 (6%)</td>
</tr>
<tr>
<td>Duration</td>
<td>2 (11%)</td>
<td>13 (72%)</td>
<td>2 (11%)</td>
<td>1 (6%)</td>
</tr>
<tr>
<td>Cost</td>
<td>1 (6%)</td>
<td>14 (78%)</td>
<td>2 (11%)</td>
<td>1 (6%)</td>
</tr>
</tbody>
</table>

Table 3: Effect of EC support on PI group
(Number shown are: number of respondents and approximate percentages)
groups, which may suggest a higher group site heterogeneity, as organisations often group together staff from the same department and separate departments by walls and distance (e.g. departmental staff are grouped on different floors or in different buildings). We found support for this hypothesis when we looked at the main reasons given by respondents for their perception that EC support increases departmental heterogeneity in PI groups. These reasons were:

- That EC support enables group discussions to be carried out without affecting individual timetables (8 respondents).
- That EC support reduces the influence of distance (5 respondents).

The first reason can be interpreted as a reduction caused by EC support in the perceived disruption that PI group discussions can have on members' routine (or functional) activities. However, the second reason can only be explained by an underlying correlation in the organisations studied between departmental heterogeneity and site heterogeneity. This underlying correlation was confirmed by a correlation test between the numbers of departments and sites involved in the PI groups shown in Table 1. The Pearson correlation coefficient obtained for this test was 0.70 (P<0.05, 1-tailed test), which indicates a strong correlation between number of departments and number of sites in the PI groups studied.

In addition, only one group, G1, involved staff from only one department and who were located in the same site. While the members of this group found EC support useful, particularly because some of them worked in different shifts and the majority spent most of their time outside the office, other prospective leaders of similar groups did not show much interest in using the approach proposed by the researcher. A comment of one of these prospective leaders illustrates this lack of interest:

\textit{Why would we interact through [the EC system] when we can talk to each other at any time?...there is no use for this system here...}

These results suggest that the usefulness of EC support may increase with the number of departments involved in PI groups, even though it may also be useful to departmental PI groups provided there is some sort of time or distance constraint that prevents group members from meeting face-to-face (e.g. different shifts).

4.1.3. Group duration

A high percentage of structured interview respondents (72%) perceived EC support as decreasing PI group duration. The main reason given by these respondents was a reduction in group set up time, which was perceived as the time spent inviting prospective members to participate in the group discussion, choosing and booking a venue for group meetings, negotiating a meeting schedule, and reminding members to attend meetings. Obviously, the need for the three last activities would be totally eliminated in EC-supported PI groups were all interaction took place through the EC system.

However, a few respondents (2 out of 18, or 11%) were of the opinion that EC support actually increases PI group duration. These respondents were unanimous in the reason given for this: a perceived increase in the time that each member takes to contribute. In fact, several structured and unstructured interview respondents implicitly supported this view by noting that it was more time consuming to post a message to the group discussion than make an spoken contribution, and that the low control over individual participation in EC-supported PI groups allowed them to give low priority to posting messages to group discussions. We also compared the time required to create and post an electronic message with that required to make a spoken contribution, and to read a posting in a PI group discussion. This comparison was based on estimates of the spoken word rate in taped interviews$^6$ (3.33 words per second), the posting creation and typing rate in EC contributions (6.93 words per minute, or 0.12 words per second), and the word reading rate for electronic messages (2.89 words per second). The comparison indicates that it is severely more time consuming (3.33/0.12 = 27.75 times) to contribute through the EC system than it is to contribute in a face-to-face meeting. On the other hand, reading is only 1.15 times faster than listening.

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$^6$ We assumed here, based on our previous facilitation of face-to-face PI groups, that the average word input rate would be almost the same in taped interviews and face-to-face PI group meetings.
An analysis of the transcripts of electronic discussions also shows that there is a considerable lag between the leaders' messages and replies from group members. While the minimum lag was slightly less than one hour, the maximum lag was 193 hours, that is, over 8 days. The average lag was 73 hours, or approximately 3 days. This means that group leaders would typically have to wait 3 days for replies to their main messages, before they could proceed any further in the group discussion.

Finally, while the duration of 5 out of the 7 PI groups studied (G0-G2, and G4-G5) ranged from 25 to 33 days, G3 was completed in only 14 days. Since a narrow scope of change of G3 - "business" according to Table 1 - cannot be used as a valid explanation for the fact that this group was completed faster than the others, it seems to be plausible to say that G3 lasted less than the other groups because the analysis stage had been run through a face-to-face meeting.

While the results presented in this section point to EC support factors that may cause an increase in the duration of PI groups, these results also suggest that the combination of EC-supported and face-to-face group discussions is likely to decrease PI group duration, as the interview respondents' perceptions indicate. That is, while a purely EC-mediated PI group may not be completed in less time than a PI group in which interaction was purely face-to-face, the "support" provided by the EC system is likely to reduce PI group duration.

4.1.4. Group cost

A high proportion of structured interview respondents (78%) were of the opinion that EC support decreases the cost of running PI groups, which involved transportation and communication as well as member participation time costs. Respondents explained this reduction in group costs as resulting from three main factors: (a) A reduction in the disruption of member functional activities (i.e. the routine activities associated with their functional position in the organisation), and therefore of the costs generated by this disruption (e.g. quality costs); (b) A drastic reduction in transportation and communication expenses in groups involving members based in different cities, since PI group members would not have to travel to participate in the discussions nor would have to call their offices to be up-to-date with local developments; and (c) A considerable reduction in member participation times in the case of ordinary members, and a slight reduction in the case of group leaders.

While factor (a) is difficult to be measured, and factor (b) was too trivial to warrant further analysis, we thought that a simple quantification of factor (c) would lend more weight to our conclusions. In the structured interviews respondents were asked how much time they spent on the group discussion. That time averaged 1.5 hours for ordinary members, and 7 hours for group leaders. Some members who declared having participated in face-to-face PI groups before were asked to estimate the amount of time they would had spent on their PI group discussions, had those discussions been conducted only through face-to-face meetings. These estimates averaged 20 hours. This suggests that ordinary member's participation time had been reduced in approximately 92 per cent (1-1.5/20 = 0.925) due to the EC support, whereas the reduction for group leaders was of 65 per cent (1-7/20 = 0.65).

4.2. Group interaction and member contribution length

Two variables that were not part of our initial research framework, but whose dependence on EC support became evident during the facilitation of PI groups, are group interaction and individual contribution length. Group interaction was defined as the number of individual contributions per active group member (i.e. a group member who made at least one contribution to the group discussion). Member contribution length was defined as the number of words per contribution.

The interaction in face-to-face meetings can be rapid - e.g. McQueen's (1991, Chapter 4) field study of business meetings reported an average duration of 12 seconds for individual contributions. In a group with 7 members that met for 5 hours, for example, this rate would account for approximately 214 contributions per member (5*60*60/12/7 = 214.29). Given our previous estimate of 3.33 words per second for spoken contributions in face-to-face meetings, a typical individual contribution in a face-to-face meeting would have 40 words (3.33 x 12 = 39.96).

In the PI groups studied, however, the EC support was perceived as having considerably decreased group interaction. Almost invariably we noticed that group leaders expected to see more interaction in their groups, with some group leaders having the expectation that group interaction was going to be higher through the EC system than it would be...
in face-to-face meetings. The frustration of these expectations led a few group leaders to feel affronted and ignored by the other members, and in one of the cases (G6) this contributed to the group leader discontinuing the group discussion.

In order to quantify the impact of EC support on group interaction and contribution length, we calculated the number of words of individual postings in PI group discussions, as well as the number of messages per active member in each of the groups. The smallest posting was 3 words long, and the largest was 784 words long, with an average of 260 words per posting. In addition the number of postings per active group member varied from 1 (G6) to 4.2 (G0), with an average of 2.25 contributions per group member. These estimates, when compared with those for face-to-face discussions, indicate that while EC support can increase the length of individual contributions, it can also drastically decrease group interaction.

5. CONCLUSION AND IMPLICATIONS

This research has addressed the effects of asynchronous groupware support on group oriented factors for groups engaged in process improvement activities. From the view of the participants in the study, asynchronous groupware was perceived to have increased group process adoption, hierarchy suppression, departmental heterogeneity and contribution length, and decreased duration and cost. All of these effects are seen as positive improvements in the operation of these groups. However, asynchronous groupware as a medium for discussion seemed to be responsible for decreased interaction (turn sharing in the discussion) below that which might be expected to be typical of similar face-to-face meetings. This finding implies that while asynchronous groupware shows promise as a medium of support for limited duration process improvement activities as studied in this research, it may not be suited to other types of activities, such as business process re-engineering and decision making, where high levels of interactivity are seen to be beneficial, and longer duration activities where group social development and communication protocols extend over a longer period of time.

6. REFERENCES


DeSanctis, G., M.S. Poole, G.W. Dickson and B.M. Jackson (1993), Interpretive Analysis of Team Use of Group


