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Informing Science: The International Journal of an Emerging Transdiscipline

(Volume No. 27, Issue No. 2, May-August 2024)

Contents

A Groupware-based Peer Review Process:
An Exploratory Case Study

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A B S T R A C T

This paper uses Lewin's planned change theory and Rogers' diffusion of innovation theory as lenses through which to describe what occurred in an organizationally flat, team-based organization when it rolled out a groupware-based peer review process. The Information Systems Department wanted to implement a high-level groupware product.   The Human Resource Department wanted to enable team members to rate each other on their teambuilding skills as well as provide a criterion to be used by the organization's Policy Committee in awarding biannual bonuses.   Literature related to corporate peer reviews as well as the use of groupware provided the basis for questions posed.   Both nondirective and focused interviews were conducted with key players and a sampling of actual evaluation data was collected. Analysis indicated that perceived management (non)commitment to using peer review data and issues of confidentiality may have led many individuals to be skeptical about the value of a peer review.   As to the use of groupware to enable the evaluation, users were quite pleased; however, planners' initial resistance to using this technology was evident and early efforts to devise usable reports were troublesome.

Keywords: groupware, peer review, planned change, innovation

Background to the Problem

The ability to work effectively as a member of a team is a vital skill in most organizations. Teams have been described as the basic business unit of the global economy and teamwork as "the final ingredient that makes all the other parts add up to something greater than the sum of their parts" (O'Hara-Devereaux & Johansen 1994, pp. 138-139).

Teams have advantages over traditional hierarchical organizational structures as teams can be flexible and respond creatively and quickly to changing economic and social forces.   Effective teamwork mandates that individuals have a wide range of communication skills and styles, including the ability to give and take frank criticism, provide selfexamination of team effectiveness, and accept shared responsibility for outcomes (Weisbord, 1987).

As teamwork becomes more and more the norm for the way work is done, the issue of compensating individual team members for group productivity becomes apparent. Compensation is more than just salary--it tells us how well we are doing; it tells us the value of our work within the larger organization; and it tells us our value as compared to our fellow workers. In most organizations, compensation figures are computed based on set salaries or hourly wages. In creasingly, however, organizations are experimenting with systems whereby employees are rewarded for extraordinary efforts (Flynn, 1994; Work week: Evaluations, 1995).   The resulting problem is how to allocate reward dollars to individuals for team outcomes.

As a potential response to this problem, some corporations are adopting aspects of university faculty peer review systems. In university merit/performance systems, the basic premise is that members of an academic community are able to give honest, evaluative, and constructive feedback to each other. Peer review appears to work in academe, if no other reason than historically, "it's the way we have always

done it."

Several distinctions complicate corporate peer evaluation efforts, however. One primary problem has been identifying and measuring specific performance outcomes for diverse job categories. Effective work teams are often made up of individuals who have a wide range of content expertise and come from differing organizational levels; teams are often not truly "peer." The second problem has been behavioral, how to get the itself to accept changes in the way its compensation figures are determined. Additionally, since teams may exist for short periods of time or be ongoing; how often should reviews be done? In a given group, particularly a virtual group, an individual may have more--or less-- responsibility than others; should criteria differ? Problems can also arise as the very concept of peer evaluation differs from most existing corporate evaluation norms and individuals= experiences with how evaluation should take place. These problems compound when a flat organization rewards team than individual efforts rather efforts. Even when concrete team outcomes are measurable, the question is how to recognize and compensate a specific individual for his or her contribution to a final product.

Team peer evaluations also add new layers of administrative issues for human resource professionals. Even if everyone understands and buys into the peer evaluation process, it is difficult to ensure the compilation of anonymous data in a timely manner and in an appropriate format for those who will use it. This is why groupware was considered to be a potential enabler of the peer review process, as it supports group processes and productivity (as opposed to individual productivity). Often called group support systems (GSS) or electronic meeting systems, groupware products are evolving.

Level 1 groupware products include screen sharing capabilities and electronic mail. Level 2 groupware products are virtual toolboxes of support for group processes such as group writing, idea organizing, and voting. Level 2 products can perform data manipulation and statistical analysis as well as provide hardcopy printouts of exact textual discussions (Vogel, 1990). Level 3 systems, currently under development, include filtering systems, agents, and tools such as Roberts Rules of Order (Hsu, 1993).

An Exploratory Case Study

This paper demonstrates how an information systems director, a human resource executive, and a corporate trainer worked together to design and implement a technology supported peer review system and the results of that effort.

This is an exploratory case study showing how two innovations--a peer review process and a Level 2 groupware product--were rolled out together as a means to enable the peer review process to happen easily, anonymously, and efficiently. The specific groupware used was GroupSystems for Windows™, which allowed peer groups to complete reviews at their own time and in their own offices (different time/different place). The statistical reports generated through the system were expected to provide useful performance data quickly.

Individual team members rated and described each other's contributions to a team's performance, and these ratings were to be used to provide feedback to individuals on their teambuilding skills as well as serve as one criterion for Policy Committee members who were awarding biannual bonuses. While peer review had no history in this organization, a bonus system was already in place as an established compensation method. Moreover, for most users, this was their first experience using a Level 2 groupware product.

Prior Research

Evidence exists that team-based peer review procedures are being implemented in organizations; however, the findings are mixed. In a survey investigating self-directed teams, Hitchcock (1996) found

that linking peer reviews to merit pay was not well received. However, peer reviews were more accepted in field studies where it was reported that management had clearly identified team priorities, results, and appropriate measures (Talbott, 1994; Zigon, 1997). It is clear that organizations are working to develop measures of team performance, citing the need for the soft skills required for effective teamwork (Covey, 1996). Peer reviews have been described as a way for teams to support each other in improving both individual and organizational performance ("The Power of Peer Review," 1994).

Studies related to the use of information technology have shown that groupware can support data collection, processing, and distribution. Groups using technology work longer (Steeb & Johnston, 1981; Gallupe & McKeen, 1990; Caouette & O'Connor, 1998) and have higher quality outcomes on certain tasks, such as idea generation (Valacich, in press).   Longitudinal research suggests this can be heightened over time (Hackman, 1991; Martz, Vogel, & Nunamaker, 1992). Other studies, however, have shown that some users do not like using the computer, depending upon their own expectations, previously existing organizational norms, and/or their own experiences in using the groupware previously (O=Connor & Bronner, 1995).   As groupware has been implemented, the tools have been adapted to the context and the priority of the task (Bikson & Eveland, 1996). In an investigation of a Level 1 system, team members using groupware reported more confidence in their outcomes (McClernon & Swanson, 1995). Increased information handling also raises questions regarding who has access to information and additional questions related to problems of misinterpreting information (Smith & Vanecek, 1990).

This case research was guided by the following questions:
What formal and informal activities related to the rollout of the technology-based peer review process took place?
What were individual reactions to the peer review process?
What impact (if any) did the use of the technology have on the overall value of the peer review process?

The Research Method
This corporation was a specialized financial-guarantee insurance company based in New York City where deals were the basis for a project director assigning the right mix of individuals to work together. Rarely did the exact same team work on a given deal and deals could take as little as two hours or as long as six months to complete. The corporation also had a history of using computers in all phases of their day-to-day work and some individuals had had some experiences using an earlier version of the groupware, GroupSystems V.   Because it was organizationally flat, this medium-sized corporation provided a useful backdrop for an investigation of peer review and groupware as teamwork was the primary form of decision making and all employees were technologically adept.
The case study has been called the most famous (or infamous) methodology in business education (Gay & Diehl, 1992).   As a research method, case study has a history of being used successfully in investigating human resource development in small to medium sized companies (Rowden, 1995). A case study allows many variables to be examined at the same time in a real-world context. While insights garnered from case study research lack generalizability, they do provide insights as to what happened and why when investigating a new phenomenon (Gay & Diehl, 1992).   The case discussed here can be labeled "partnership research." In partnership research, the research problem is derived from practice, but both partners anticipate using the results of the research for different purposes (McLean, 1995); the organization to improve practice and in this instance, the researcher to improve education.

Data Collection and Analysis

To determine the value of the peer review process from management's viewpoint, I conducted nondirective (unstructured), face-to-face interviews with the chief executive officer, the information systems director, the human resource executive, and the corporate trainer at all stages of the process. The nondirective interview is flexible and because as the interviewer does not provide direction, respondents "can be encouraged to relate their experiences, describe whatever events seem real to them, provide their own definitions of the situations, and to reveal their opinions and attitudes as they see fit" (Frankfort-Nachmias & Nachmias, 1996, p. 235).   Nondirective interviews were considered an appropriate data collection method because the topic of a technologysupported peer review could be perceived as complex and emotionally loaded (Merriam and Simpson, 1995).   Nondirective interview data can provide insights not only on what happened, but how and why and from various perspectives.

To see first-hand how the peer review instrument was used, I reviewed (anonymously) responses to the peer review instrument. Additionally, focused (structured) telephone interviews were held with four participating individuals who volunteered to discuss their experiences.   While the focused interview is the least flexible of interviews, its use reduced the risk that the order and the wording of questions would influence responses (Frankfort-Nachmias & Nachmias, 1996).   The interview guide was divided into two parts, one evaluating the peer review process itself and the other the use of the groupware (see Appendix A).   All interviewees were assured of complete confidentiality; I would be the only person to have access to the interview data or to know who had been interviewed.   The focused telephone interviews, which ranged in length from 20 minutes to 55 minutes, were tape recorded and subsequently transcribed.   Data were analyzed by examining recurring themes and triangulating findings to ensure reliability.

The Peer Review Process

Results The introduction section of the peer review questionnaire I had drafted set out objectives and guidelines (see Appendix B). The peer review questions themselves were based on the ten attributes of effective team work: commitment, acceptance, clarification, belonging, involvement, support, achievement, pride, recognition, and satisfaction (Kormanski & Mozenter, 1987).   Specific attributes were described relative to the work being done, and required respondents to rate each of his or her team members on a five-point Likert scale and to offer a critical incident as evidence of the rating.   For example, an item measuring support read:

He/she has good communication skills; motivates the team; serves as a role model; takes time to mentor/coach; provides timely feedback; is approachable; demonstrates sensitivity; does not favor one team member over another.   Rating:

_____

Critical Incident:

Much thought and discussion went into the final decision to have raters electronically sign their evaluation reports.   Because it was deemed important to have some level of accountability, raters were asked to add their names to their evaluations. Reviewers were promised that they would only be connected with a specific review should it be apparent that a review was not given seriously or was extraordinarily negative. Additionally, individuals were repeatedly assured that no one other than the human resource executive who was compiling the data could know specifically who had said what about whom, and this information would not be readily available as the sign "sheet" was only linked to the

the reviews and not automatically available.

Team members had access to the software and the evaluation files via a local area network that connected their office computers to a central file server. Within the groupware, the information systems director had established an electronic folder for each of four specific deals (projects), and the twenty individual reviewers had access to only those folders for which he or she was a deal participant.   Signing on required users to click on the Agenda icon, and then identify a specific deal. At that point, eligible reviewers were automatically ushered into the vote tool, where they were asked to "click" the name of the individual they were rating, then rate the individual as described earlier. Changes could be made on evaluations up to the point when the ballot was cast.

Compiled results would be available to the human resource executive, who would compile ratings on individuals and forward the ratings to the individual's manager and the organization's 12-member Policy Committee. Managers could share results with the individual being rated and the Policy Committee would have an additional criterion for the biannual bonus discussion process.

Results
The work of both Everett Rogers and Kurt Lewin provided the lens for examining this case. Everett Rogers explained that characteristics of an innovation influence its infusion. Rogers explained that the rate of adoption differs depending on five characteristics: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1983).
This study involved the infusion of two innovations simultaneously, and these terms can help us understand the innovations' acceptance. As a means to put the case in perspective, Kurt Lewin's planned change model calls for continual progression through three stages: (1) unfreezing; (2) changing (or moving); and (3) refreezing. (Lewin, 1972) Unfreezing is the stage where individuals become aware of the innovation; changing involves actually using the innovation; and refreezing, a determinant of an innovation's acceptance, is where the innovation becomes "the way we do things around here."   These concepts will be used to describe what happened in this case and why.

What formal and informal activities related to the rollout of the technology-based peer review process took place?

Unfreezing Stage .   Training played a crucial role in the unfreezing stage. An informational meeting was held to describe the organization's rationale for implementing a peer review, as well as provide guidelines for how to provide constructive feedback. The procedures for the process were outlined and an opportunity for questions and discussion was provided. A week or so later, individuals were trained to use the software.

Changing Stage .   Upon the completion of each of four deals, the twenty participants in those deals were asked to complete the peer review instrument. The human resource executive, the information systems manager, and the corporate trainer were all available for questions and support throughout. These planners reported that users reported problems with the system and with a too-lengthy questionnaire. To address these concerns, procedures were changed mid-course to allow individuals to select only two or three colleagues to rate per deal, and not require responses to every question.

Planners also found that numerical ratings were often not consistent with the critical event described.

Despite initial training, describing critical events turned out to be a challenge for most respondents. Several individuals, however, were quite adept and at ease with the process; examples of appropriate critical events follow:

He has done a good job of assessing some of the underlying operational and credit issues and working through the details to make sure the transaction mechanics are properly structured.

Communications in the form of email status updates are a key strength. He has also done an excellent job of alerting team members and management of potential problems and delays in arranging liquidity.

She has very good judgment skills and knows when to stand firm and when to give in when negotiating this deal. She was able to develop a model to present value the arbitrage amount so we would know how much to take as an upfront fee. We were able to get an additional $500,000 in fees this year.

However, much of the resultant data was often vague or incomplete. The following critical incidents demonstrate these problems:

The best person to work with in this company!

He tends to employ his knowledge of the industry as it pertains to his area of expertise in a "take it or leave it" manner rather than trying to work with the team to achieve results.

She was good at keeping the customer happy and addressing customer concerns.

He definitely counts on others to do his work. He will generally take on the easiest components of the transaction, not caring much for the "details" such as legal documentation or other intricacies (mechanics) of the transaction. He is very quick, however, to opine in front of senior management, so that they have the impression he has done all the work.

What were individuals' reactions to the peer review process?   Overall, while it had been anticipated that team members would easily find words to describe each other's performance, many had difficulty in doing so. While it had been anticipated that completing reviews would take only a few minutes each, individuals reported spending up to an hour or two on a single review. While

it had been anticipated that the initial training on understanding the purpose of the reviews and completing reviews would be adequate, it was not.

Consistent with the work of Talbott (1994) and Zigon (1997), priorities, results and proper measures were important as several of those interviewed reported that they understood an official and an unofficial reason for the peer reviews.   Nearly all of the individuals interviewed reported they had never had any feedback: "I never knew what the results were or where they [reviews] went or how they were tabulated or what feedback was given." This particular interviewee related his lack of feedback to the unofficial reason that data were needed to deal with two individuals known to be non-performers and who were consequently moved to other positions.   The individual who did report getting feedback did not feel that data were used by top management as intended: "Eventually, yeah, I did get feedback. It [feedback] was very good and you know, that is why I say that it is all a political game here because despite the fact that I was ranked high in the company, I was passed over for promotion. …   Yes, I think it [the peer review process] is important, and it also needs to be treated importantly as well by senior management."   Later in the interview, she said: "Where the peer review process was meant to work was for those people who were most at risk from suffering from it."

The peer review instrument itself, likewise, met with mixed reactions; one comment was "[I] worked in a very small (at that time) group of people so you really knew the players pretty well which is why it [the instrument] was easy to use, and I felt comfortable using it."   Another interviewee reported that "If someone gets all good [response], they are good. If you start asking questions with 1 through 5, people start to tune out…fade out. Probably too many questions and too many variations. Probably fewer

questions and just more casual: was the person weak, adequate, or strong? That is all that is really meaningful on a team.” The view that the questionnaire itself was too lengthy was explained, also: “The first one [deal], I think five people answered every one [question]. …..it was too long a process. And then I cut it down; I think I answered 6 or 7 which were the most important. Some of them didn’t apply for what some people were doing but that was my one feeling….that it was a little long. But it was very good.”

Concordant with Hitchcock (1997), peer review was not seen as an appropriate measure for bonuses. There was general wariness in thinking that evaluation data were actually used in determining a monetary award: “The role of a good manager is to figure out what motivates the people that he manages, and in some cases it is not necessarily monetary. So yeah, the bonuses were fine, but I know that the teams I worked on generated a lot of money for the company, and I believe bonuses were based on revenue, not personal qualities or anything.”

What impact (if any) did the use of the technology have on the overall value of the peer review process? Planners, including myself, initially considered that the reason the peer review process was not as successful as anticipated was because users were finding the technology difficult to use. However, this was not the case as only the information systems executive who set up the system and the executive who had been charged with compiling the review data expressed negative reactions to its use. Reports were not generated as quickly or as easily as had been expected, and learning to format the reports so that data would be more understandable proved to be a difficult (but eventually mastered) learning experience.

To the contrary, individual users reported that the groupware was an enabler: “Yes, I liked the fact that you could log on and log off, log back and then submit it….I was using it all the time.” Another said, “It was very user friendly once you got into it, so that was just fine.” Yet another user said, “I thought the system was pretty easy to use even though I missed the training. It seemed to follow through. And it made sense.” These technologically-literate individuals were quite at ease in understanding and using the system, and when asked if they would like to use the system in the future for such a process, responses were positive: “Yes, I would, definitely. Because it was very user friendly.”

Consistent with earlier studies (Steeb & Johnston, 1981; Gallupe & McKeen, 1990), individuals believed the groupware was an appropriate fit for the peer review task. However, no one took the promise of confidentiality seriously: “Given the way I thought this stuff was being essentially used, I would almost be more comfortable writing something on paper and handing it to somebody. …It may have been better if I knew exactly what was going to happen with this data. How was it going to be used or not used.”   Another interviewee said, “I think people took it with a grain of salt in terms of confidentiality. I think it depends on people, personalities, to keep this confidential or not.”   One interviewee said he told everyone he evaluated that he had given them high marks.

Lessons Learned

This paper described what happened when two innovations were introduced simultaneously. Results were mixed. Perhaps this is because while management was convinced of the value of peer review, individuals were skeptical. While top management was convinced of the value of groupware, implementers were not. To succeed, these two innovations—peer review and groupware— needed to be seen by everyone as having an advantage over the way bonuses were traditionally awarded if they were to refreeze, to become part of the organizational culture.

Lesson learned: No good idea succeeds on its own merits; continual experimentation with peer review and the use of distributed groupware systems is needed. Keep the process itself as simple as possible.

The dual goal of the peer review process, to provide descriptors of how individuals were able to work as part of a team for bonus deliberations as well as confidential feedback given to reviewers was not seen by those interviewed as complementary outcomes and were not totally understood. In terms of value, individuals needed more assurance that their reviews would be taken seriously and used for their intended purposes.   Only one of the individuals interviewed reported that she had had review feedback; and she had (mis)understood that the high marks she received from her colleagues would be used for promotion purposes, as opposed to bonus deliberations. Others reported that a perceived unofficial purpose, to remove specific individuals, dominated the process.

Lesson learned: State intended peer review objectives clearly; ensure everyone understand objectives; and followthrough on intentions.

Moreover, promises of confidentiality were not accepted at face value. Electronically signing reviews, meant to ensure review accountability, also meant that someone could know who said what. While this perceived lack of confidentiality was not cited as a major issue by individuals participating in the process, it may be seen as a potential stumbling block, thus inhibiting openness.
Lesson learned: Design the groupware system to ensure confidentiality.

Concluding Comments

The lessons learned here may initially seem obvious. However, we learn from our experiences and it is noteworthy to consider that this rather "ideal" site—an organization where individuals routinely work in teams and are technologically adept—had growing pains in establishing a technology supported peer review process. Given that teams are the building blocks of many of today's organizations, continued reports of strategies that assess individuals' teambuilding skills and reward good performance are valuable.   Management will increasingly be faced with issues of how to reward a given individual for team outcomes, and we need to learn from what others have done.

A peer review process would seem to be compatible with the way work is done in a team-based, technology-driven organization, and this investigation shows that even innovations that appear to be a perfect fit require planning and have their own learning curve.   Rogers' premise that the characteristics of an innovation impact its infusion into an organization is important here.   Key to the activity is that the technology-supported peer review process be considered valuable and an improvement over the way things are done-in this case, a bonus deliberation.   Perhaps more testing, or trialability, and experience in actually doing reviews, or observability, by both management and individual users will support the usefulness of these innovations. A shorter, more direct and truly anonymous questionnaire could reduce the complexity of the process, enhance validity, and provide more useful data. In short, to refreeze the peer review process in this organization, the value, compatibility, complexity, trialability, and observability of the two innovations investigated here must be continually addressed.

Epilogue

Refreezing Stage .   The purpose of this section is to complete Lewin's paradigm—unfreezing, changing, and refreezing. Since the conclusion of this investigation, the organization studied has merged with a much larger organization.   However, informal interviews with top management, confirmed by the focused interviews, suggest that the innovative culture of the smaller organization (the

one studied) is taking precedence. Despite mixed reviews on the peer review process, management is reportedly committed to both peer review and continuing its use of groupware; they consider this investigation to be a pilot study or learning experience. The human resource executive is currently working to revise the peer evaluation instrument and evaluate the fit of the specific groupware tools used in data collection as a means to ensure more useful reports.   In addition, information and operational training will be revised and more concerted efforts will be made to assure individuals that data will be used as planned.

In the short term, work will be done to ensure that the complexities of the peer review process are ironed out and another pilot test will ensure a more usable instrument and reporting process. In developing a blueprint for ensuring the success of both innovations, training will continue to play an important role in all stages of change, eventually changing the way "we do things around here."

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Appendix A
Structured Telephone Interview Guide
Focused Telephone Interview Guide

Thank you for taking the time to talk with me today.   As you know, we are discussing the peer review process you went through last year.   Your perspectives on both the peer review itself and your use of GroupSystems are needed.   Using the following scale, please tell me the number that describes the degree to which you agree or disagree with the following statements.   You will have an opportunity to explain your responses; the number is being used strictly as a way of getting you to begin discussing the statement.

5	4	3	2	1
Totally Agree	Somewhat Agree	Neutral	Somewhat Disagree	Totally Disagree

Part I.   Peer Review Process

1. Approximately how many reviews did you complete? _____   1 2 3 4 5

2. I understand why and how the reviews took place.

Comments: 1 2 3 4 5

3. The questionnaire was an appropriate and easy to use evaluation instrument.

Comments: 1 2 3 4 5

4. I was comfortable in making informed ratings of my team members.

Comments:

5. I was comfortable having team members rate my own performance.   1 2 3 4 5

Comments:

6. I have no doubts that data from reviews will be kept confidential. 1 2 3 4 5

Comments:

7. I personally believe that a peer review process is important.   1 2 3 4 5

Comments:

Is there anything else you'd like to talk about with regard to the peer review process?

Part II.   Use of GroupSystems Technology

Using the following scale, please tell me the number that describes the degree to which you agree or disagree with the following statements.   Again, you will have an opportunity to explain your responses; the number is being used strictly as a way of helping you begin discussing the statement.

5	4	3	2	1
Totally Agree	Somewhat Agree	Neutral	Somewhat Disagree	Totally Disagree

1. Approximately how much time did you spend completing each review? ____   _____minutes

2. I routinely use computers in my daily work.   1 2 3 4 5

   Comments:

3.   I have used GroupSystems previously for other tasks.   1 2 3 4 5

Comments:

4. The GroupSystems training enabled me to competently use the system to   1 2 3 4 5
complete the reviews. Comments:

5. The system was an appropriate "fit" for the peer review process. 1 2 3 4 5

Comments:

6. The relative anonymity of the system allowed me to say things I
might not have said otherwise.   1 2 3 4 5

Comments:

7. I am looking forward to using GroupSystems again.   1 2 3 4 5

Comments:

Is there anything else you'd like to talk about with regard to the peer review process?

Appendix B

Peer Review Introduction

The objectives in implementing this peer review:

Self-development: feedback should be used as a means to behavioral change. Measure teamwork effectiveness: feedback from one's peers on how a team leader or team member is performing, and the resulting modified behavior, can lead to increased productivity. Development of a "partnership attitude." Provide the Policy Committee with another tool to be used in evaluating an employee.

Guidelines:

Reviews must be signed. Any review without a signature will not be used. Please rate each peer (team leader or team member) on the 5 point scale and add the critical event that supports your ranking. Any ranking without the corresponding critical event will not be used. A critical event is a specific situation where the skill/trait was observed by you. Criticism should be constructive. Review must be done on groupware.

Review on: _____ (name of person being reviewed)

Your name: ____

Rating scale	5	4	3	2	1
	Exceptional All facets	Superior Most facets	Consistently Capable	Could Improve	Improvement Required

ROADMASTER ROADING CONTRACTORS
CASE STUDY

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A B S T R A C T

Systems analysis students seldom experience the practical difficulties of the initial investigation into a client's requirements. They get little chance to practice the skills they need to investigate complex and confused problem situations, or to appreciate the wider organisational issues that can impact on a situation. This teaching case is designed to give students the opportunity to practice and apply investigation skills and to challenge them to consider the wider work environment when considering possible solutions to a problem situation. The case is conducted as a role-play, with students acting as systems analysts and teaching staff role-playing the clients. The students develop a report analyzing the client's situation based on the issues that arise during the interviews. Feed-back sessions focus on discussing how well the students applied various interviewing strategies previously covered in lectures, and on the wider organizational problems that could impact proposed information system solutions.

Keywords: IS education, case study, information requirements determination activities, information requirements determination issues, interviewing, organizational environment.

Introduction

This case is used in a third year undergraduate degree course on systems development, analysis and design. It is based on the author's experience as a consultant with the firm. Names have been changed to preserve confidentiality. The case illustrates the situations many software consultants face when working with small firms. They need to assess an organization's requirements in order to determine what assistance, if any, the software consultants can offer the organization. The organization's situation is often more complex than appears on the surface and even in small firms, personalities and politics can impact the initial analysis and ultimately the success of any implementation. The consultant's initial assessment generally cannot be charged to the client so there is a tension between the consultant's need to gather the necessary information as quickly as possible while at the same time ensuring that the assessment goes into enough depth to make an informed decision.

The case is conducted as a role-play with students acting as new employees of the software consulting and development firm, Software Unlimited. The instructor and teaching colleagues play the roles of three key interviewees from the client, a road construction-contracting firm, Roadmaster Ltd. The students' task is to use limited consultation time efficiently to analyze their client's situation. The problem situation is briefly outlined to them in a memo from their boss and a letter from the client. From this realistically vague introduction, they must inform themselves about the business they are investigating and plan the interviews they will conduct. Having carried out the interviews, the students must assess the situation, identify the problem areas and make recommendations about what can be done. Although there is a need for better information systems at Roadmaster, solving the problems with the current system will not immediately result in improved performance. Students need to identify that

other factors, such as job scheduling, control of raw materials usage and inter-personal conflicts between the key players, also need to be addressed if a satisfactory outcome is to be achieved.

Memo to the student "Software Unlimited consultants" from their boss

A couple of weekends ago, I spent some time with Monty Hedley, an old friend of mine, who's the Managing Director of Roadmaster Roading Contractors. I've now received the attached letter from him. He's looking for help in analyzing some problems that have arisen in his firm. I think this might be a good problem for you to work on as junior analysts – it's small enough for you to handle, but has sufficient complexity to extend you. I'd like you to meet with some of Monty's staff to explore their situation.

From what Monty has told me, there's not likely to be an easy solution. In fact, I'm not sure how clear Roadmaster is about what its problems really are. I don't know how much you can find out from one interview with the staff, so I don't expect you to come up with a complete solution straight away. But I do hope you can develop an initial assessment of the situation, and see if there's an opportunity for us to do business with Roadmaster.

When you meet with Monty's staff, try to find out what kind of help they'd like from us, and what we can offer them. This will be a 'free' session, part of developing potential business for us with this firm. After you have met, prepare a recommendation for me on what, if anything, we can do. I'd also like you to prepare a presentation for the Roadmaster staff on the results of your investigation.

Monty has been in business thirty years or more, and he's a pretty astute person, so you'll have to develop a clear proposal and figure out what key points are necessary to sell our services. This should be a good opportunity for you to show me that you can generate new business for our company.

Jane Brown

Letter from Monty Hedley

Jane Brown
Director Business Systems
Software Unlimited
HAMILTON

Dear Jane,

It was good to see you again last weekend. I hope you're happy with your driveway, now that we've got the water tables and culverts sorted out.

Thank you for taking the time to discuss our problems with this new Council roading contract. I'd like to take up your offer of an initial meeting with your consultants to get an objective perspective on the issues.

Let me go over the situation again. Our Contracting Division has traditionally done civil projects for local councils, and roading, drainage and farm site development work for local farmers. These are all one-off projects, where we go in, do the job and finish. We know what we're doing and we do it well. However we recently won a three-year on-going road maintenance contract with Waitomo Town Council, and that requires a totally different approach. It's a big contract, worth three million dollars over the three years, and so far it just hasn't gone smoothly. We started off just managing it like any other contract, but that hasn't seemed to work. There are a number of problems:

- We're getting complaints from the Council that urgent jobs aren't being done in time, and that job quality is not up to scratch. We have a contract supervisor, Ben Jackson, whose sole responsibility is this contract. He liaises with the Council on what work has to be done and schedules the men and machines accordingly. He says it's all the Council's fault, because they mark everything urgent, but I'm not sure about that.

• **We've had problems with the Council rejecting the amount we claim each month. Sometimes the amount they refuse to pay is substantial, thousands of dollars. It seems like there's disagreement about what work has been done, but I don't know why this should be happening, because we have procedures in place to request inspection of completed work.**
• **We're also losing money on the contract, and this is serious. We thought we'd done the quotation pretty well – George Small (our Contracts Manager) has never slipped up before, and we're not sure what the problem is. At first we thought it was just because of the disputes over payment of the claim, but I have a gut feeling that there's more to it than that.**

I've asked George to take a closer look into the running of this contract, but I'm worried that he's not up to speed with the computer systems that Ben is using, and that may be part of the problem. Even though I'm not sure that a new computer system will solve everything, it might help to have some insights from the experts in that area.

Unfortunately, I can't meet with your consultants myself, as I will be in Australia to inspect some new roading equipment that we badly need. However, I'll arrange for you to meet with George and Ben, and our Office Manager, Mary Goddard. George has full authority from me to take any steps necessary to deal with this situation and I should be back from Australia in time to discuss any proposal your consultants wish to present.

Kind Regards,

Monty Hedley

Managing Director – Roadmaster Ltd.

Case details given to role-play staff

The following extra case details are provided to staff involved in the role-plays. Students do not receive this information.

The Firm

Roadmaster Ltd. is a road construction contracting firm located in the central North Island of New Zealand. The company's work includes major one-off road construction projects on a quotation basis for local councils, and small track and drainage jobs for local farmers. With a staff of over 60 Roadmaster is a significant employer of local labor.

Roadmaster's fleet comprises over 120 vehicles, including a large number of earthmoving and construction machines. Some of these machines are only used for very specialized work, and are therefore idle for much of the time. Roadmaster must achieve a return on its considerable investment in equipment by competing successfully against other contractors for a wide variety of contracting work.

The company is split into three divisions, Contracts, Quarries and Fleet Service, and has a small administration department. The Contracts Division is responsible for major contract work for local councils, for minor quoted work for farm customers (including drainage, road and site opment) and for sundry jobs such as road gravel delivery.

The Quarries Division runs a centrally located quarry producing over 100,000 tons of gravel per year, most of which is used in the Contracts operations although some is sold directly to farm customers. The Fleet Services Division operates from the workshop at the company headquarters and maintains all vehicles, including trucks and utility vans and earth-working machinery such as graders, bulldozers, diggers and rollers.

The Information Systems

Historically, the Contracts Division's performance has been determined by analyzing the performance of the individual trucks and machines in the fleet. A Vehicle Ledger captures the costs incurred (including labor) and revenue earned by each vehicle. This information has been summarized for the profit and loss report for the Division. This primary analysis view by vehicle has evolved from Roadmaster's beginnings as a supplier of labor and machinery on hourly rates, when it was important to know whether a particular vehicle was paying its way.

More recently Roadmaster has diversified into undertaking larger contracts on a quotation basis, supplying all machinery and quarry materials to complete the whole job. This has created a contention

for information between the vehicle and the contract, with managers now needing information about individual contract performance as well as the performance of individual vehicles.

The current computing system, which batch processes payroll, vehicle, creditors' and debtors' transactions, is a standard accounting package that has been customized to meet the individual vehicle reporting requirements. Unfortunately, this computing system is an 'orphan'. The customizations have made the programs incompatible with new releases of the package so no upgrades have been performed for several years. The software is now substantially different from the latest standard version of the package and the supplier will no longer support it. Roadmaster's version is so different from the latest version that the only practical upgrade option is to abandon the existing package and install the new one. However while the new version of the package meets Roadmaster's new contract based reporting requirements, it does not retain the individual vehicle reporting options. Roadmaster's disenchantment with the supplier's 'take it or leave it' attitude has created an impasse. Roadmaster struggles on with the existing package and the administration staff rely on ad hoc spreadsheets and manual ledgers to prepare the contract analysis reports.

New Ventures

Roadmaster has now branched into a new area, with an ongoing 3-year road maintenance contract for a local town council, (Waitomo Town Council). This contract is an innovation for Roadmaster since it involves on-going maintenance of existing roads rather than one-off construction of new roads. The contract is much larger than anything Roadmaster has tackled in the past and has required substantial extra investment in plant and machinery. A maintenance contract also requires different management skills both in the areas of supervision of the field staff and in contract administration.

Roadmaster has realized there are three particular areas of concern for the new contract. Firstly, the day-to-day control of field staff is proving problematic. Traditionally, Roadmaster assigned the required staff and machines to a oneoff contract and kept them there until the job was finished. However with the maintenance contract, they receive a number of job requests each day for different types of work, in different geographic locations, and with different required response times. This requires new management skills in terms of planning and scheduling work to ensure the most efficient use of staff and machinery, while at the same time avoiding any penalties for failing to meet the required response times.

This scheduling problem is made worse by the way work is assigned and contract payments are approved. On one-off contracts all the work is assigned at the start and Roadmaster submits a monthly progress claim based on the percentage completion of the total contract. This claim is processed and approved by the client and Roadmaster receives monthly payments to offset costs incurred on the contract to date. On the new maintenance contract the Council assigns work on daily work orders each comprising one or more jobs. The Council will only accept monthly claims for fully completed work orders. Therefore Roadmaster has to plan and schedule work to avoid large numbers of inprogress jobs at the end of a month because Roadmaster must carry all costs incurred on incomplete work orders through the following month. The carry-over of in-progress jobs each month is causing severe pressure on Roadmaster's cash flow, which has already been put under stress by the start-up costs associated with the new maintenance contract.

The second area of concern is the monitoring of job performance. Roadmaster has found that the first few months of this contract have not been as profitable as expected. Currently, the administration staff uses ad hoc spreadsheets to report costs at the contract level only. Managers can only identify actual costs of

labor, machinery and materials on an individual job basis by manual review of the original job sheets. Thus, it is difficult for managers to identify exactly where higher than expected expenses are occurring. In particular, there is currently no method of accurately measuring the quantity of raw materials used for each job. Roadmaster knows the total amount of raw material used on the Waitomo Town Council contract but relies on the supervisor's visual estimates to ensure the correct amount is used for a particular job.

Finally, Waitomo Town Council requires Roadmaster to produce an itemized claim each month. This claim must provide, for each item on the contract, full details of all jobs within that item completed for the month. Once again the current system can only produce summary reports and this is insufficient for the Council's itemized claim process.

The People

As with most organizations, the problems within Roadmaster are not necessarily solved simply by the provision of better information systems. The various key people in the organization are also critical to the success or failure of any proposed intervention. The key players in this case are George Small, Contracts Division Manager, Ben Jackson, Waitomo Town Council Contract Supervisor, and Mary Goddard, Office Manager.

George Small. George has been with Roadmaster since Monty Hedley first started the firm thirty years ago. George's many years of practical experience with road construction are highly valued by Monty who has promoted him to his present position of Contracts Manager. However George is more at home out on the site than dealing with the paperwork. George's ability to quote accurately and competitively on the one-off roading contracts is legendary within the firm. Although no one else can understand how he reaches the final figures (he literally scribbles his calculations on the back of an envelope) his quotations are regularly successful, and his tight on-the job supervision of the ensuing contracts ensures a profitable outcome. He is able to monitor progress on these one-off contracts by comparing the monthly progress payments received against the total labor and machinery costs incurred to date.

George was closely involved in the original quotations for the Waitomo Town Council contract but he and Monty agreed that this contract was too large for George to manage alongside his other duties. So they appointed a full-time contract supervisor Ben Jackson to supervise the day-today work and to prepare the Council's detailed reporting requirements. Ben reports directly to George but George has a 'hands-off' approach to staff supervision and Ben has developed his own approach to the management of the contract.

Now problems with the Waitomo Town Council contract supervision are beginning to surface and Monty has asked George to focus entirely on this new contract and get it running smoothly. George recognizes there are problems with the on-site supervision and is trying to get Ben on track with that. However he has realized that one of the major problems with Ben's supervision is that he is simply not spending enough time on site. Ben argues that he has to spend a large part of his time dealing with routine administration of the contract, and George is out of his depth here. George has always left administration matters to Mary, the Office Manager. While there have been frequent battles between George and Mary over her insistence on the need for complete and accurate records, and his more laissezfaire approach, he does have respect for her ability to keep track of the business costs. However in a fit of pique at the start of the contract, George conducted a quiet campaign with Monty against the suggestion that Mary's hours

should be increased to enable her to handle the Waitomo Town Council work. George argued that if Ben was full-time on only one contract he should have more than enough time to handle all aspects of the work and so extending Mary's hours would be unnecessary. George now regrets that argument, but Monty is holding George to his claim that a full-time contract supervisor should be able to cover everything.

George has realized that keeping track of detailed costs for this contract is a major concern. The Council's payments are made per job on the daily work orders, while Mary's reports can only track the total labor and machinery costs over the whole contract. This means that George has no way of identifying which jobs are being done at a loss.

George is very concerned about his inability to understand the spreadsheet systems Ben has set up to track the jobs and produce the required reports for the Council. George's instinctive reaction is to get Mary to sort it out but given his earlier opposition to Mary's involvement he doesn't want to back down now. Neither does he want to lose face with Ben by admitting he doesn't understand what's going on.

Mary Goddard. Mary has been Office Manager at Roadmaster for over 12 years. She has seen the firm grow substantially in that time and takes pride in the systems she has set up. The computing system cannot provide the contract reporting required by Roadmaster so Mary spends much of her time accumulating figures in manual ledgers to keep track of costs on the various contracts. This is timeconsuming and Mary is often late with the reports.

Mary and George have a grudging respect for one another but that doesn't prevent them from continually sparring over the accuracy of the records. Mary is always arguing that George doesn't appreciate the importance of accurate record keeping on the job. George responds that Mary's reports are always too late to be of any use to him. Mary has been concerned from the start (rightly) that Ben didn't have enough knowledge and experience to set up the appropriate systems. She has tried surreptitiously to keep an eye on what he's done and is very concerned about the spreadsheets he has set up. She is upset that she wasn't involved in setting up these spreadsheets, but she only works 30 hours a week and Monty refused to extend her hours in order to set up systems for recording the Waitomo Town Council information. She's now very determined not to get involved until she wrings an admission from Monty and George that she's needed and that they're prepared to back that up with an increase in her hours and pay. Ben Jackson. Ben is young, ambitious, and very brash. He's climbed the ladder with some basic training from the Maniatoto District Council in the southern part of New Zealand and tends to be a 'hotshot' type. The Waitomo Town Council contract supervisor's job was a big jump for Ben and he's out of his depth. In his previous job he had worked under the close supervision of a senior engineer who had provided a lot of guidance, both in personnel management and in the development of suitable record keeping procedures. Ben exaggerated his ability and experience in both these areas at his job interview and is now struggling to meet the expectations he created.

Ben's knowledge of computers is largely self-taught so his spreadsheet methods are unorthodox. He is very defensive if Mary questions him about the spreadsheets he uses to track the Council jobs partly because he's afraid she'll discover something he's overlooked and partly because he fears he'll lose his job if Mary reports that his systems are inadequate. He never documents his spreadsheets so it's difficult for anyone else to see how they work, especially as he takes delight in setting up complex links and playing around with macros, etc. However most of the time what he actually does is cut and paste from one sheet to another. He has on occasion 'lost' data doing this and ended up redoing hours of work.

Ben is a little resentful that Monty has asked George to be more directly involved in the Council contract. He believes he has been doing a good job, so he isn't making much effort to assist George in sorting out the problems that are occurring. Ben sees the attitude of the Council staff as the major problem. He believes the Council staff is resentful and obstructive because the Council's own roading team was disbanded when the road maintenance contract was awarded to Roadmaster. There are some areas where the Council has been difficult, particularly in the way they allocate jobs over a wide geographic range every day and this is enough for Ben to use the Council as a scapegoat whenever something goes wrong.

Teaching Notes
Teaching Aims

It is commonly accepted that requirements analysis plays a critical role in determining the success of system implementation. Faulty requirements analysis has been identified by a number of authors as a leading cause of information system problems and failures (Brooks, 1987; Hoffer, George & Valacich, 1996; Laudon & Laudon, 1996). Yet, textbooks used in tertiary institutions to teach systems development methods tend to present information requirements analysis as a simple and straightforward process of interviewing users and specifying their needs (Hoffer, George & Valacich, 1996; Whitten, Bentley & Barlow, 1994). Interviewing and communication skills are presented as an essential part of an analyst's repertoire, but there is rarely much attention paid to the practical difficulties of initial investigation of problem situations. Two areas are of particular concern. First, it is important to develop in students an appreciation of the wider organizational issues that can impact on what appears on the surface to be a straightforward information system problem. Second, it is important that students learn practical skills to help in investigating the complex and confused problem situations they are likely to face in the 'real world'. Just lecturing about information systems in their organizational context, for example, or about interviewing and analysis skills does not of itself ensure that the students will appreciate the contextual issues in practice, or understand how to use appropriate interview techniques in real situations. Research in training methods (Burke & Day, 1986) suggests that skillsbased training is most effective if students have had an opportunity to apply the skills in a realistic situation and to receive feedback.

This case is one of a set of four cases intended to give students practical experience in the investigation of an initial problem situation. The teaching aims are to:

• give students the opportunity to practice and apply skills in investigating and developing initial systems requirements;

• develop an appreciation in students that information systems solutions must take into account the organizational and social context of the work environment in order to lead to successful system outcomes; and

• give students an insight into the special problems facing small firms regarding information management.

The cases follow lectures on information systems in their organizational context, information gathering and analysis skills, and aspects of systems development methodologies particularly relevant to the information gathering stages of system development. Students review different techniques for analyzing and evaluating information gained from interviews, including critical factor analysis, problem and opportunity analysis, traditional methodologies such as Information Engineering and SSADM, and Soft Systems Methodology, (see, for example, Avison & Fitzgerald, 1995, for coverage of these). The students are encouraged to explore the application of these techniques in the case studies.

Preparation

Students work in teams, playing the part of new employees of a software-consulting firm on their first major assignment. Each team is assigned to a different case and those not involved in a particular case observe the interviews and participate in the feedback sessions after the interviews. Students get only a memo from their boss and a letter from their client.

Students are expected to carry out their investigation with minimal guidance from the instructor. They are required to conduct the role-play interviews in a fully professional manner, to develop a report analyzing the situation for their boss, and to prepare a presentation for the clients. Student approaches to the exercise have varied considerably, but generally the more successful students make considerable effort to inform themselves about their clients' area of business, and to plan and prepare their interviews, and analyze and organize their findings.

I have found it helpful to have a meeting of the Roadmaster role-players before the interviews, so that we can go over the case and our characters and agree on our 'story'. The role-players are encouraged to develop 'difficult' aspects of their characters (for example, taciturnity, vagueness, being in a hurry, etc.) so that the students experience the challenge of handling different interview situations. The teaching colleagues who assist with the role-plays need to commit about two to three hours of their time – about an hour for preparation, half an hour for the interview, and an hour for the final presentation and debriefing session. In practice, the role-plays of the interviews have followed quite different tracks with different student groups depending on the students' focus. This has sometimes required the roleplayers to improvise if the students ask detailed questions about areas not fully elaborated in the notes. Sometimes confusing or contradictory answers have been given but this reflects what frequently happens in real life, particularly as different interviewees have different perspectives on the situation, and the answers tend to reflect the different priorities of each of the key players. Colleagues who have assisted with these role-plays have commented on how enjoyable they are, and so far have always been willing to return for a repeat performance.

It should be noted that this approach to case teaching requires considerable time commitment from teaching colleagues, and this is a limitation for larger class sizes. Currently, it has been used in a tutorial situation with class sizes of no more than twenty students, and a maximum of five students working on each case. Given that one of the aims of this approach is to develop students' practical skills in 'real-life' interview situations, participation in the roleplay interviews is an important component of students' overall skill development. It is possible with larger classes to have students observe volunteers do the interviewing and then develop their proposals in small groups. However this approach loses the actual practice element that is central to this skills-based training approach.

Debriefing

An initial debriefing of the interview takes place in the next class meeting. Students participate in a group discussion on the conduct of the interviews. As well as discussing how well student interviewers planned and structured their interviews, we also discuss how they handled the personalities and dealt with any sensitive issues and review various approaches for dealing with the interview situations they faced.

The final debriefing takes place once the students have made their presentation to the clients. The colleagues involved in the role-play are present and provide feedback to the student teams on how well their presentation addresses the client's concerns. At this session discussion focuses on the various issues that arose during the interviews, with particular emphasis on the wider problems that could impact any

proposed information system solution. Discussion of these issues (management, political, inter-personal) is encouraged in order to give the students a better appreciation and understanding of the need to consider the whole context of the organization in making their recommendations. We also review the techniques the students used to analyze and present their information (critical factor analysis, Soft Systems techniques, etc.) and discuss how useful these were in practice, and which were most appropriate for the situation. This review leads into discussion about the theory of methodologies in general and how practical their application is in real-life situations, particularly in the small business context.

Finally, in the debriefing session we discuss the specific issues and themes the students have discovered and what possible solutions might be explored.

Specific issues and themes

Information systems issues in this case fall into three main areas – control of daily job scheduling for the maintenance contract; dependence on spreadsheets for much of the major record-keeping, reporting and analysis of performance; and 'people' issues.

A very useful line of discussion can explore the most suitable information systems support that can be provided for the job scheduling issues. Students tend to want to rush in and 'build a system' and discussion can focus on whether this is indeed the best and most cost-effective solution in this situation. The firm actually opted for a manual and highly visual whiteboard system, plus some basic training for Ben, which resulted in a dramatic improvement in the control of daily job scheduling at very little cost. The reliance on poorly planned and documented spreadsheets is typical of many companies of this size (Cragg & King, 1993). Astute students will have discovered from their interviews the vulnerability of Roadmaster's critical management accounting information, which is contained in undocumented spreadsheets prepared and maintained by inexperienced or self-taught staff. They will also have uncovered that much of Mary's 30 hours per week is eaten up in 're-jigging' information already captured in the existing information system, in order to present the kind of information that management requires on the one-off contracts.

Similarly, Ben re-enters and re-analyzes data to keep track of his daily work orders and to prepare the monthly claims for the Council. This is obviously an area with potential for computerized solutions. Once again, however, students tend to rush in with a proposal to build a database and it is useful to encourage them to fully investigate what 'buy' options exist. The firm's final choice was to purchase a packaged solution with some limited customization provided by the vendor.

The people issues are well worth following up in discussion. The role players are encouraged to highlight the tensions between Ben and Mary, and Mary and George during their interviews, and George shows considerable discomfort about anything related to "them computer thingies"! Students are able to identify that the lack of co-operation and communication between Mary and Ben, and George's computer phobia, are major hurdles to be overcome if any system implementation is to be successful. Some students will also recognize that little has been done to encourage a useful dialogue with the Waitomo Town Council and that some problems need to be resolved here too. In fact the most significant system improvements in the real situation came when George initiated better liaison with the Council over allocation of jobs and streamlining of reporting requirements. The company also ran team-building exercises for the main staff involved in the Council contract, and encouraged George to take some basic computer training so that he could appreciate what information he could get from the new system.

Conclusion

There are a number of practical results from using this case study. Students experience a real-life requirements analysis situation and have the opportunity to become more proficient in investigating and developing initial requirements in a 'safe' setting. Our experience has been that students develop a better understanding of the need to take into account the context of the organization and the interactions of the people in it when making recommendations to deal with problem situations identified. They also have the opportunity to develop teamwork skills and to practice professional presentation and report writing skills. However in addition to these very practical outcomes, the students gain a clearer understanding of the various systems development methodologies, tools and techniques that they have reviewed in theory, and their application and limitations in practice.

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New Trends in Multimedia Standards: MPEG4 and JPEG2000

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A B S T R A C T

The dramatic increase in both computational power, brought on by the introduction of increasingly powerful chips, and the communications bandwidth, unleashed by the introduction of cable modem and ADSL, lays a solid foundation for the take-off of multimedia applications. Standards always play an important role in multimedia applications due to the need for wide distribution of multimedia contents. Standards have long played pivotal roles in the development of multimedia equipment and contents. MPEG4 and JPEG2000 are two recent multimedia standards under development under the auspice of the International Standards Organization (ISO). These new standards introduce new technology and new features that will become enabling technology for many emerging applications. In this paper, we describe the new trends and new developments that shape these new standards, and illustrate the potential impact of these new standards on multimedia applications.

Keywords: image coding, video coding, MPEG4, JPEG2000, multimedia.

Introduction

Multimedia has long played an important role in the process of informing activities: learning, studying, researching, and communicating, which can be summed up in an old Chinese saying, "A picture is worth one thousand words". The ability to see, hear, and interact with the material that a client is interested in provides valuable additional dimension to a client's learning experience. With the introduction of personal computers in 1980s, CD-ROM based learning has long been an established part of the educational process and a fast developing market. However, with the fast adoption of the Internet and the continuous development in PC processor speed and capability, a promising new era in multimedia, both in informing and entertainment applications, is just beginning. With an alarming rate, much of the world's knowledge base is moving on-line. It is already a reality in many parts of the United States that school children can access a web site over a cable modem or ADSL modem at home, pulling off a detailed marketing report for his/her term paper. In the near future, he would also be able to listen to a live broadcast of a lecture on the same subject he is researching, interact with the materials through an animated graphical user interface, and watch a short clip of video on that subject, all through a single standardized file format and protocol.

Standards have long played pivotal roles in the development of multimedia equipment and contents. The need for standardization in multimedia applications is not a choice, but a necessity. To be able to widely distribute multimedia content to readers, we must be sure that the format of the files that contain the media content can be recognized and decoded correctly no matter what devices or platforms the users are using. On the other hand, standards have significantly facilitated the spread of multimedia contents. Just look at the impact of JPEG on the distribution of images, and MPEG1/MPEG2 on the distribution of video.

In recent years, responding to the development of many promising new technologies in the field of multimedia and the practical needs of many commercial applications, the Genevabased International Standards Organization (ISO) has undertaken two new projects in the last few years: MPEG4 and JPEG2000. MPEG4 is aimed at standardizing a framework for the representation and delivery of multimedia contents such as video, audio, text, and graphics in a unified framework, while JPEG2000 is focused on developing the next-generation image compression and representation standard. It is widely expected that the introduction of these two standards will become a significant catalyst driving the future growth of the multimedia industry, and will provide better tools for all participants in the informing science areas.

In the following, we introduce in more details the new technologies in the upcoming MPEG4 and JEPG2000 standards. Section 2 covers MPEG4, and JPEG2000 is covered in Section 3. We conclude by summarizing the new technology and features, and elaborate more on their implications for multimedia applications.

The MPEG4 Video and
Multimedia Standard
MPEG4 Overview
MPEG-4 is an ISO/IEC standard being developed by MPEG (Moving Pictures Experts Group). MPEG also developed the Emmy award winning standards MPEG-1 and MPEG-2. MPEG-1 was an audiovisual coding standard aimed at addressing the storage and retrieval of multimedia information on a CD-ROM [1]. MPEG-2 followed closely behind MPEG1 and was a standard that addressed the broadcast TV applications. MPEG-2 was a hugely successful standard with significant acceptance in the market place with a number of other applications in addition to broadcast TV [1]. Some of the prominent applications of MPEG-2 include Direct Broadcast Satellite (DBS), Digital Versatile Disk (DVD) and High Resolution Television (HDTV). Initially MPEG-3 was reserved for HDTV applications. However, later on MPEG-2 was found to be suitable for HDTV, and it was decided to include HDTV as a separate profile of MPEG-2 and discontinue the MPEG-3 work item.

Both MPEG-1 and MPEG-2 use block-based motion compensation for removing time-domain redundancy, and use DCTbased block coders for encoding the residue and Intra-coded frames. Intra-coded frames are the frames that are coded with no references to other frames, and the whole frame is coded as a still image. In video sequences, adjacent frames have much overlapped information and a lot of redundancy can be removed by using motion compensation. In MPEG, a macroblock (16x16) motion compensation method is adopted, in which a macro-block in the current frame is matched to a macro-block in the reference frame, and only residue signal needs to be coded. For residue coding, DCT transform is used to convert the signal to the frequency domain, which represents better form for compression. At the system level, the compressed video bitstream is mixed and synchronized with audio signal so that complete movie or TV content can be delivered.

MPEG-4 is the next audio-visual coding standard from ISO after MPEG-1 and MPEG-2. Unlike the previous two standards, which had one clear application in mind when they were developed, MPEG-4 is a much broader umbrella type standard that has a number of different technologies, which are targeted at different applications. Initially, MPEG-4 was aimed primarily at low bit rate video communications. However, its scope was later expanded for it to be much more of a multimedia coding standard. MPEG-4 is efficient across a wide variety of bitrates ranging from a few Kbits/sec to tens of Mbits/sec. In addition to providing improved coding efficiency, MPEG-4 also provides a number of functionality. These include, 1) the ability to efficiently encode mixed media data such as video, graphics, text, images, audio

and speech, (called as audio-visual objects AVOs), 2) the ability to create a compelling multi-media presentation by compositing these mixed media objects by a compositing script, 3) error resilience to enable robust transmission of compressed data over noisy communication channels, 4) the ability to encode arbitrary shaped video objects, 5) multiplex and synchronize the data associated with these objects, so that they can be transported over network channels providing a QoS appropriate for the nature of the specific objects and, 6) the ability to interact with the audio visual scene generated at the receiver end. These functionalities supported by the standard will enable many compelling applications ranging from wireless videophones, Internet multimedia presentations, broadcast TV and DVD. As can be imagined a standard that supports these diverse set of functionalities and associated applications is fairly complex. This paper focuses only on some major innovations of the MPEG4 video coder. The reader is directed to the wealth of information that is available on MPEG at the official MPEG web site http://www.cselt.it/mpeg and other recent MPEG4 publications [3,4,5,6,7,8].

MPEG-4 reached a Committee Draft (CD) standard status in November 1997. MPEG-4 was released in October 1998 as Draft International Standard (DIS), and will be an official International Standard (IS) in 1999. MPEG-4 Committee has also taken the approach of "versioning" to the standard formation process. MPEG-4 version 1 includes a number of useful tools and version 2 is expected to include some others that are being developed by the standards body [3]. It is expected that MPEG-4 version 2 will be backwards compatible with MPEG-4 version 1.

Being a multimedia coding standard, MPEG-4 standardizes tools not only for video coding but also for coding audio, graphics and text. The standard also includes a systems part, which describes how the audio, video, text and graphics are synchronized and presented in a compelling manner for various applications. Next, we highlight some of the most novel parts in the emerging MPEG4 standards.

Figure 1. An MPEG4 scene with audio and video objects

Object-base Multimedia Composition and Interactivity

The basic building block of a multimedia presentation in MPEG4 is object. There are many basic object types supported in

MPEG4: video objects, audio objects, texts, graphics, 2-D meshes, 3-D meshes, HTML objects, etc. These objects are placed inside a scene with descriptors indicating its location, orientation, and other necessary properties. A scene in MPEG4 is described using Binary Format for Scenes (BIFS) – an efficient syntax for describing the compositions of a scene with binary data. An example of a MPEG4 scene is given in Figure 1. In this scene, we have a moving video object – the teacher. An audio object is also associated with the video object that stores the speeches spoken by the teacher.

We also have graphic objects such as the globe, the desk, and the white board. Simultaneously, a dynamic web page object is displayed on the white board – the presentation material for the course. Each object has a built-in timing attribute, which can be utilized to synchronize the presentation timing of different objects. For instance, the synchronization of the lip movement of the video object and the audio object, and the synchronization of the audio object and the page changes of the HTML object on the white board. The objects and the BIFS define the actual contents and the spatial and temporal relationship among the different objects
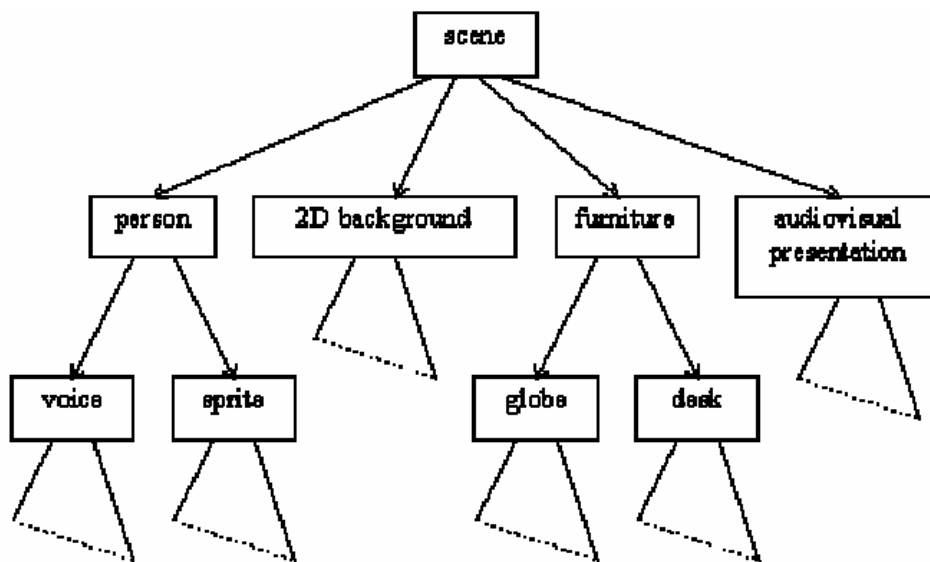

Figure 2. The Tree Structure of An MPEG4 Scene

inside a scene. An MPEG4 compositor performs the actual presentation of the scene. The role of a compositor is to take the decoder output of each object, look at the attribute fields of the object descriptor and the information contained in the BIFS stream, and generate an audio-video sequence that is actually presented to the end users.

BIFS describes an MPEG4 scene with a hierarchical structure, which can be represented with a tree (see Figure 2). Each node of the tree is an audio/video objects. In addition, the scene can be dynamic, that is, BIFS supports streaming delivery, so that the scene description can be updated dynamically. For instance, without changing the bitstream already delivered for the different objects in the above scene – the teacher, the globe, the desk, the white board, and the presentation web pages, we could change the spatial locations of the different objects, creating an animated classroom, with the direction and volume

of the speech from the teacher changing with each update of the scene description. This feature allows the creation of a very complicated and lively presentation with little overhead.

In addition, an MPEG4 player will also support user interactivity at the object level. The user can click on any of the object, or move mouse inside the perimeter of an object. This event will trigger an event signal sent back to the server/encoder side. The property or composition of the scene can be changed according to this event. This object-based interactivity is very valuable for multimedia learning applications, where users can explore on their own terms and the scene adapts according to the preference of the user.

Streaming and Scalable Media Capability

Multimedia delivery over the Internet is one of the focused applications for MPEG4. There are several features that are particularly important for multimedia on the Internet. (1) The media should be able to be streamed to the end user, which means that the receiver can render the content as it receives the data without waiting for the downloading of the whole file. The flurry of deals and mergers by the Internet streaming video companies demonstrates the importance of the streaming media. (Yahoo's acquisition of Broadcast.com for $5.7 billion is an example). Streaming will also enable the delivery of live events without delay. (2) The media should be scalable.

There are a variety of bandwidths available for different users accessing the same content. The servers and users should have the flexibility to tradeoff quality with downloading time and bandwidth requirement.

MPEG4 provides tools for addressing both of the above features. The scalability feature is supported in the still texture and video tools (scalability is a serious concern mostly only for video and image due to their large data amount). For video presentation, from the same bitstream, the user can extract a sub-bitstream that represents either a lower frame rate, or a lower resolution. This allows the users with lower bandwidth connections to trade-off either motion smoothness or video resolution for a lower bandwidth requirement. The still images coded with the MPEG4 still texture tools support both resolution and quality scalability with very fine granularity.

The combination of these tools makes MPEG4 suitable for scalable media delivery over the Internet. In addition, The MPEG4 file format is designed so that the media streams from different objects can be delivered in a streaming fashion. It also supports random access, fast editing and searching of the media stream.

The JPEG2000 Image Coding Standard

The original JPEG image coding standard developed by the ISO/IEC Joint Picture Expert Group (officially named ISOIEC/JTC1/SC29/Working Group (WG) 01) has been a big success in the market place. The JPEG image format was widely used for the Internet, digital photography, and multimedia desktop publishing along with numerous other applications. After the completion of DCT-based JPEG, many advances have been made in image coding such as wavelet and subband based technology, and many limitations and shortcomings of the JPEG standard were also discovered and widely recognized, such as severe blocking effects at low bitrate, insufficient support for scalability (both spatial and quality scalability), lack of object based and region based representation, lack of support for error resilience, etc. Recognizing these problems of the current JPEG standard and the promises of the new technologies, the ISOIEC/JTC1/SC29/WG01 committee decided that the timing for the development of a new image coding standard was ripe. The new work item for developing the next generation image coding standard

was approved by ISO/IEC SC29 subcommittee in late 1996, and a call for proposal was issued in March 1997.

The charter for the JPEG2000 standardization efforts is to develop an image coding algorithm that will meet the needs of its major application areas into the next millennium. High on the list are superior image quality at low bitrate, flexibility of the bitstream for supporting scalability, progressive transmission, robustness to channel errors, lossless coding, and region-of-interest coding (ROI), preferably all achieved with similar complexity as that of the current JPEG standard.

There are totally 24 full proposals and 7 partial submissions received by the JPEG committee, with most of the proposals based on wavelet methods, and a thorough subjective and objective testing was conducted at the JPEG Sydney meeting in November 1997. A baseline codec was formed (the Verification Model), which was the anchor point to which subsequent proposals were compared. Currently, intensive work is still on going in evaluating various proposals for error resilience, entropy coding, low-complexity transform, shape coding, and region-of-interest coding. According to the current schedule, the JPEG2000 standard will become Committee Draft (CD) in 1999, at which point the technical content of the standard will a woman was decomposed into edges and textures at different scales, and most of the coefficients after the transform become also zero (the white space).

After the wavelet transform, entropy coding is used to compress the amount of data needed to represent the image. Currently, JPEG2000 uses a block based arithmetic coder with a context switching scheme[9]. The entropy coding encodes the value of the wavelet coefficients in a bitplane-by-bitplane fashion, which ensures the feature of fine granularity scalability. Other than scalability, the coder also provides excellent support for random access, region of interest coding, error
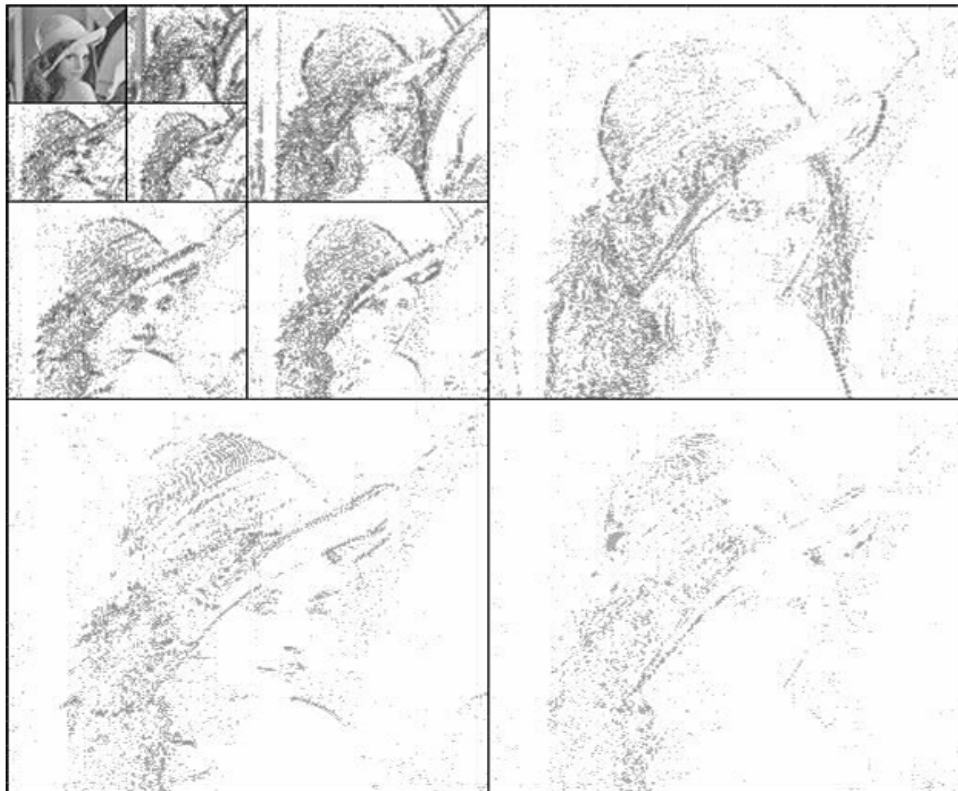
Figure 3. Wavelet Decomposition of A Picture

be stable. It will become Draft International standard (DIS) in 2000 and final International Standard (IS) in 2001. As it stands at this moment, the JPEG2000 standard is still subject to drastic changes given that almost all aspects of the current baseline algorithm are being evaluated and compared with competing proposals. However, the consensus seems to have emerged that the new JPEG standard will be based on wavelet technology (as opposed to Discrete Cosine Transform –DCT based technology in the current JPEG standard).

Wavelet transform is a mathematical tool for decomposing a signal (such as a picture) into a multi-resolution representation. It has many elegant mathematical properties so that after the transformation, the picture is much more compact in energy and much easier to compress. Figure 3 shows a wavelet transform of a picture. We can see that the original picture of resilience, and information embedding. It will also support streaming of the image data over networks. The readers are encouraged to stay tune and a lot of information can be found at the web site: http://www.jpeg.org .

Summary

Both MPEG4 and JPEG2000 promise to produce the next generation multimedia representation and delivery standards that will significantly enhance features and functionality. The application software and equipment that use these enabling technology is expected to come to the market in the next couple of years. They promise to bring much enhanced user experience to the Internet, to CD-ROM titles, and other interactive learning venues. These new application software and web sites will, in no doubt in my mind, significantly elevate the

importance of the role multimedia plays in the informing science areas.

To probe further, the readers are referred to the following web sites:
• The official MPEG web site:
http://www.cselt.it/mpeg
 • MPEG4 system:
http://garuda.imag.fr/MPEG4
 • MPEG4 video:
www.hhi.de/mpeg-video
 • MPEG4 Synthetic coding:
www.es.com/mpeg4-snhc
 • MPEG4 audio coding:
www.tnt.uni-hannover.de/project/mpeg/audio
 • JPEG2000:
www.jpeg.org

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KNOWLEDGE-ORIENTED LEADERSHIP, PSYCHOLOGICAL SAFETY, EMPLOYEE VOICE, AND INNOVATION

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A B S T R A C T

Aim/Purpose : *The truism is that leadership fosters or restricts innovation behaviours in organisations, but the extent to which it does depends on the leadership style in practice. This study focuses on one of the contemporary leadership styles, knowledge-oriented leadership [KOL], which has received scant attention in research. In doing so, the contextual factors of psychological safety [PS] and employee voice [EV] were applied to determine how KOL influences are channeled to innovation at the individual level.*

Methodology : *Data were collected from 347 academic staff in public universities in Southern Nigeria and subjected to a partial least square [PLS] analytical procedure for data treatment and hypotheses testing using the SmartPLS 3 software for variance-based structural equation modelling.*

Contribution : *The study formed an integrated research framework that links knowledgeoriented leadership and innovation by accounting for the contextual mechanisms of psychological safety and employee voice. .*

Findings : *The PLS results demonstrated that the knowledge-oriented leadership and innovation relationship was positive and significant, and this relationship was partially mediated by two variables, namely, PS and EV. Furthermore, the two mediating variables channeled KOL's influence on innovation in a sequence.*

Recommendations : *Organisations need to consider the practical application of KOL to improve innovation outcomes considerably. By this, leadership training programs should include modules, courses, or topics on KOL to engender the formation of requisite managerial skills. More so, they should consider the criterion of demon*

Knowledge-Oriented Leadership : *strable KOL abilities for leadership selection and recruitment. As a personal development initiative, managers can attend leadership development programmes as well as obtain certification in knowledge management to improve their KOL abilities. This initiative should be encouraged and supported by organisations. In all, the human resource management framework should be responsive to the dynamics of the knowledge economy regarding leadership. Given that PS and EV function as mediators, organisations should actively cultivate an environment enabling interpersonal risky behaviours founded on trust, respect, and cooperation and encourage/support employees who demonstrate such behaviour accordingly. In this line, they should create and sustain a supportive environment that positively reinforces voice decisions and behaviours.*

Future Research : The study only determined the links between KOL, PS, EV, and innovation in public universities in Southern Nigeria. Other studies may examine the linkages in other knowledge-intensive organisations as well as expand the geographic scope to make for better generality of findings. Future studies should look at other underlying mechanisms that can affect the KOL-innovation relationship, such as psychological capital, work engagement, work commitment, etc. The role of moderators can be identified and introduced to this integrative framework to demonstrate the conditions affecting the linkages.

***Keywords:** employee voice, knowledge-oriented leadership, knowledge sharing, innovation, psychological safety*

INTRODUCTION

The relationship between leadership and innovation (i.e., a collaborative behavioural process involving the transformation of ideas into practical solutions targeted at a specific problem or challenge) is not new to research. But what appears new is the distinct forms of leadership effectuating innovation among employees in an organisation. Studies have shown that certain positive forms of leadership (e.g., authentic leadership, transformational leadership, ethical leadership, empowering leadership, and supportive leadership) are needed to facilitate and reinforce innovation (Carmeli et al., 2013; X. Li et al., 2020; Liu et al., 2023; Ononye, 2023a, 2023b; Y. Wang et al., 2018). However, not enough studies have investigated the influence of knowledge-oriented leadership [KOL], which is one of the contemporary leadership behaviours that has begun to emerge in innovation studies (Naqshbandi & Jasimuddin, 2018). KOL develops knowledge management behaviours and practices for the effective and efficient utilisation of new and existing knowledge (Sahibzada et al., 2021). This leadership style is important in the knowledge economy because it is aligned with knowledge-intensive organisations, ensuring that the right leadership style is used to modulate and align knowledge exploration and exploitation capabilities according to changing task demands (Sahibzada et al., 2021). Besides, innovation is a knowledge-based activity, and one way to support it is by having leaders who understand the catalytic power of knowledge (Naqshbandi & Jasimuddin, 2018). Although the relationship between KOL and innovation has been studied, the contextual factors affecting this relationship are still limited. To extend this line of research, the study focuses on the mediating roles of psychological safety [PS] and employee voice [EV]. This is because both constructs are closely related to positive forms of leadership and innovation-related variables (Botha & Steyn, 2022; Carmeli et al., 2013; Javed et al., 2017; Sifatu et al., 2022; Y. Wang et al., 2018; Zakkariya & Aboobaker, 2020). PS is a mental state wherein an employee can relate with others without fear of negative consequences (e.g., punishment, rejection, resentment, embarrassment, threat, criticism, or other uncertain reception). EV is a discretionary behaviour involving the expression of information to management about work-related concerns with the intent to foster meaningful change or improvement to organisational processes, practices, and services (Botha & Steyn, 2022; Dedahanov et al., 2016).

Given that EV is a discretionary behaviour, employees may show restraint in speaking up about organisational problems and probable solutions, especially if the right relational context is lacking (Nazir et al., 2020; Ononye, 2023a, 2023b; Ouyang et al., 2022). In such a situation, valuable knowledge remains hidden in the minds of employees, and the promises of EV to the furtherance of innovation

processes may not be fully realised. In the knowledge society, knowledge must be created and shared in disparate forms for value creation (Hosseini et al., 2022), and EV represents a knowledge-sharing [KS] approach leveraged by a knowledge-intensive organisation to gain important knowledge (Basheer et al., 2021). KOL's specific purpose is to develop knowledge work by fostering participation in knowledge-related activities, such as knowledge creation and KS (Zahur et al., 2022). Employees' participation in such activities benefits voice decisions because they are able to share important information in a way that triggers creative process engagements (Chan, 2014). By this, KOL promotes a KS culture, which could serve as a catalyst for exploiting EV (Chughtai & Khan, 2023). However, the exercise of expressive opportunities by employees cannot happen in isolation of PS. PS reduces the risks and uncertainties associated with the demonstration of certain work behaviours, like EV (Subhakaran et al., 2020). The behavioural modelling of KOL in a dyadic interaction may cultivate a psychologically safe climate where the voicing of opinions via KS mechanisms is encouraged and supported. Thus, PS is a hallmark for effective employee functioning in KS activities (Abi-Esber et al., 2022). Drawing from the proactive motivation model of Parker et al. (2010), which argues that certain contextual factors, like a leader's behaviour, impact proactive motivational states (i.e., PS), thereby enhancing or negating employees' proactive behaviour (e.g., EV and innovation) in the workplace. This argument is reinforced by the finding of a recent study (Abi-Esber et al., 2022) that PS intervenes in a leader's behaviour linked with discretionary employee behaviours. Furthermore, constructed upon the social exchange theory (SET), when leaders demonstrate supportive behaviours in the development of dyadic relationships with employees, they create the psychological conditions that allow employees to intentionally engage in specific extra-role behaviour: EV and innovation. The goal is to ensure important work-related ideas, opinions, or comments are utilised in the most efficient and effective manner for innovative work. Given the above, it is highly probable that KOL has the potential to exercise the utility of EV among the employees. How this is achieved is yet to be confirmed in any empirical study. Nonetheless, to the best of the researcher's knowledge, no single study has investigated the simple and sequential mediation of PS and EV in the KOL-innovation link. Therefore, the study attempts to examine the mediating roles of PS and EV in the KOL-innovation relationship.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT KOL AND INNOVATION

KOL employs aspects of transformational leadership (i.e., focused on inspiring, motivating, and coaching employees to ensure experimentation, flexibility, and risk-taking) and transactional leadership (i.e., focused on the exchange of rewards or benefits to ensure consistency, stability, and control) and is characterised by an enhanced focus on communication and motivation (Donate & Sánchez de Pablo, 2014; Naqshbandi & Jasimuddin, 2018), all of which are used to create a positive context for the optimal flow and utility of knowledge to further learning and innovation activities (Donate et al., 2022). By combining both leadership styles, KOL exhibits flexibility to adapt behaviours to the contextual demands of knowledge work (Zia, 2020). Botha and Steyn (2022) state that employee engagement in innovation activities is highly discretionary, which suggests that there are certain contextual factors, like leadership, that support it.

KOL exploits knowledge-related opportunities by providing a compelling vision and direction for knowledge management activities (Latif et al., 2021) and motivational resources to institutionalise learning through the creation, sharing, and application of new knowledge (Ononye & Igwe, 2019), all of which are fundamental to the operationalisation of innovation in organisations (Donate et al.,2022). Because KOL tends to be tolerant of interpersonally risky behaviours, they often develop and maintain an enabling environment for constructive communications and supportive relationships. The emotional and cognitive changes determine the motivational force for engaging in knowledge related activities for

innovation purposes (Ononye, 2023a). Donate and Sánchez de Pablo (2014) argue that the link between KOL and innovation is indirect through knowledge management processes. This argument has found support in several empirical studies (Chughtai & Khan, 2023; Naqshbandi & Jasimuddin, 2018; Sadeghi & Rad, 2018). While these studies suggest an indirect using team or organisation-level analysis, this research draws on the social exchange theory to determine the main effect of KOL on innovation using individual-level analysis. The theory argues that employees' attitudes and behaviours are consequences of the exchange processes or relations between them and organisational leadership. KOL leverages different leadership styles to ensure the right motivational elements impacting employees' personal resources are applied to sustain innovation efforts. In view of this, KOL can influence innovation among employees. Thus:

H1: The relationship between KOL and innovation is significant and positive.

KOL AND INNOVATION: THE MEDIATION OF PS

PS connotes employees' belief or perception about the consequences of demonstrating interpersonally risky behaviours (e.g., seeking feedback, asking for help, asking a challenging question, proposing a new idea, reporting a mistake, or admitting an error) in their work environment (Kark & Carmeli, 2009; Liu et al., 2023). This suggests that PS is context-specific and is most relevant in contexts where employees' engagement in certain work behaviours puts their personal interest or identity at risk (Zhang et al., 2010), even when doing so would afford benefits to the organisation (Edmondson, 1999). Binyamin et al. (2018) state that demonstrating innovative behaviours requires employees to engage in acts that are interpersonal in nature; hence, employees' perception of safety in interactions is highly important. KOL builds the trust and comfort levels of employees to leverage the motivational forces of self-expression in their working with each other (Zhang et al., 2010). They understand the power of knowledge and strive to leverage the knowledge of employees by creating a safe space for learning and knowledge exchange (Shariq et al., 2018). The elimination of fear in engagements in open discussions triggers the creative tension and trade-offs of ideas from conversations, leading to the demonstration of innovation (Edmondson, 2003). KOL's emphasis on open communication and motivation makes them highly receptive to innovative ideas from employees, which have implications for different aspects of organisational work (Donate et al., 2022; Donate & Sánchez de Pablo, 2014). The transformational qualities of KOL are closely related to PS and innovation behaviour (Carmeli et al., 2013). For instance, KOL's intellectual stimulation of employees encourages them to take risks by challenging the norm to address problems in a novel manner. Moreover, the role clarity, performance expectations, initiating knowledge management structure, and contingent reward provided by their transactional qualities are foundational to PS facilitation of work engagement (Kahn, 1990). Arguably, PS mediates the KOL-innovation link. Thus:

H2: PS enhances the relationship between KOL and innovation.

KOL AND INNOVATION: THE MEDIATION OF EV

Selvaraj and Joseph (2020) contend that it is no longer tenable to solve complex problems by relying chiefly on a leader's knowledge because it may not always provide a holistic understanding of the intricate nature of a problem. The power of EV lies in the detection of organisational problems/weaknesses as well as the mistakes made by management (Sifatu et al., 2022). This makes it necessary to unlock the hidden information embedded in the minds of individuals by encouraging EV. In doing so, employees demonstrate their participation and involvement in cooperative and constructive

discussions about organisational problems or challenges (Basheer et al., 2021), which is essential for improving the quality of decision making. Studies (e.g., Detert & Burris, 2007; Edmondson, 2003; Kim et al., 2023) highlighted leaders' support and openness to information sharing as conditions necessary for EV. Because managers exhibiting KOL behaviour tend to be tolerant of risky behaviours, they often create a trusting environment supportive of open and constructive relationships. The formation of positive relationships fosters creative conversations to expand employees' cognitive capac
ity for problem-solving (Ononye, 2023a).

Innovation is usually a direct outcome of the optimal utilisation of critical knowledge resources in organisations. As such, innovation is the transformation of EV, constituting discovery and creativity into practical solutions or change (Ononye, 2021). Given that KOL develops and applies knowledge productively for the attainment of competitive advantage, they could consider the wider utility and value of EV for the facilitation of knowledge work, like innovation. This argument is predicated on the knowledge-based theory. The study also argues that leadership styles viewed as positive can have a cascading influence on innovation by EV given their close relationship to both constructs (Bai et al., 2019; Basheer et al., 2021; Botha & Steyn, 2022; Nazir et al., 2020; Qi & Liu, 2017; Sifatu et al., 2022; Z. Wang et al., 2019; Yan & Xiao, 2016). KOL can demonstrate positive behaviours because they develop and sustain processes intended to foster KS and learning in organisations (Donate et al., 2022; Shariq et al., 2018). They enable employees to acquire, develop, and share critical knowledge necessary to enact changes and to be more involved in decisions and actions affecting work productivity and performance (Ononye, 2022). Given the above, the study contends that the encouragement of EV can mediate the relationship between KOL and innovation. Thus:

H3: EV enhances the relationship between KOL and innovation.

KOL AND INNOVATION: THE SERIAL MEDIATION OF PS AND EV

KOL expects employees to demonstrate commitment to and involvement/participation in knowledge-related activities. The employee may reciprocate by voice in response to KOL activation of KS components (i.e., knowledge donation and knowledge collection) to enhance organisational knowledge. The social exchange theory argues that "leaders not only create opportunities for voice behavior by providing formal and informal voice mechanisms but also shape the cognitive factors that drive the decision to speak up" (Y. Li & Sun, 2015, p. 174). This notion has been validated in prior empirical studies (Abi-Esber et al., 2022; Detert & Burris, 2007; Yan & Xiao, 2016) that PS often determines leaders' contextual influence on EV, which is also viewed as a predictor and an intervening variable of innovation (Basheer et al., 2021; Nazir et al., 2020;). So, it is logical to assume that PS serves as a mediatory pathway through which leadership exercises EV with the aim of promoting innovation. In the context of KOL, this could be achieved by pointing out the contributions of knowledge management practices to the development of organisational knowledge and the furtherance of organisational change. The championing of such practices engenders employee involvement and participation. Besides, Mehmood et al. (2022) argued that PS, though related, is not enough for innovation; there are other intervening knowledge-related variables that also matter. They further found that PS and KS mediated the link between entrepreneurial leadership and employees' creativity. The serial mediation argument is that EV and PS form the contextual influences of leadership on innovation. Thus:

H4: The serial mediation of PS and EV enhances the relationship between KOL and innovation.
The hypotheses stated above are summarised in Figure 1 to show the pathways through which KOL influences innovation among employees.
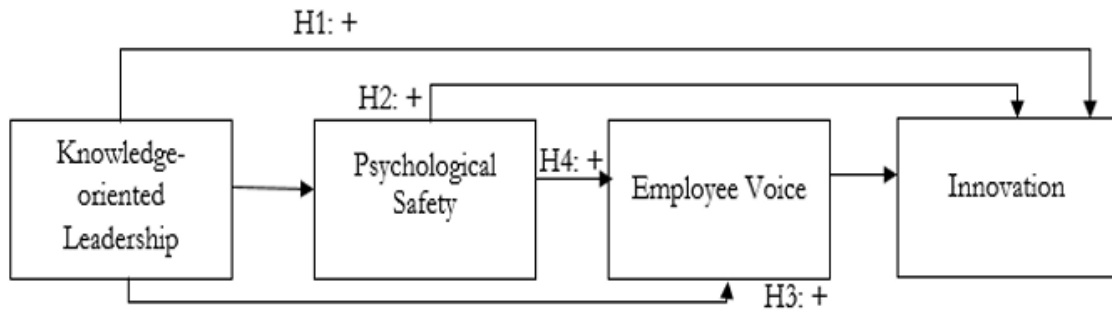
Figure 1. The research framework

METHOD

The study followed a cross-sectional approach to survey academic staff randomly selected from public universities operating in Southern Nigeria. The survey was performed for two months, from February 2023 to March 2023. The sample was selected because academic staff actively participate in knowledge-related activities in their work with students, colleagues, businesses, and other critical stakeholders to enhance teaching, research, and consultancy. Moreover, they often face an evolving environment in which innovative approaches are required to effectively and efficiently navigate different challenges impacting teaching, learning, and research outcomes. Donate and Sánchez de Pablo (2014) mention that organisations that are knowledge-intensive, like universities, require a different management style from those that are less or not knowledge-intensive and that the role of leadership should be distinctive and supportive of knowledge management practices. Given the relevance of knowledge and innovation in such organisations, the study assumes that the constructs under investigation would be demonstrated to a degree in their activities to test the probable links. This sample has been utilised in Sahibzada et al. (2021) to demonstrate the direct and indirect connections between KOL and organisational performance. After administering a survey on 391 academic staff in person, 353 responses were collected. A letter that explicitly captured the research topic, the research aims, and a statement of anonymity of responses accompanied the questionnaire. Informed consent for voluntary participation was obtained prior to the full application of the questionnaire. The respondents were followed up via text messages and/or calls, as indicated in their preferred communication mode, to improve the response rate, and the reminders were transmitted on three occasions during the survey period.

The academic staff who voluntarily participated were instructed to fill out a coded questionnaire on KOL and PS and were asked to present a similarly coded questionnaire to their immediate unit heads to assess their EV and innovation behaviour. Both questionnaires were completed and returned in an envelope provided by the researcher. Six of the 353 questionnaires were removed due to incomplete responses, resulting in 347 valid observations, i.e., an 88.7% response rate. The valid responses exceeded the minimum observations required to attain stable estimations in structural equation modelling, as Hair et al. (2017) indicated. The demographic characteristics of the respondents showed that male respondents (n = 189, 54.5%) were more than females (n = 158, 45.5%). The average age and tenure of the respondents were 46.7 years and 16.9 years, respectively. The majority of respondents had obtained a doctorate (n = 293, 84.4%), and 54 (15.6%) hold a master's degree. Of the 347 respondents, 131 were engaged in administration and academic work, and 216 were mainly engaged in academic work.

The questionnaire comprised validated scales from existing literature and was anchored on a 5-point Likert scale from strongly disagree (1) to strongly agree (5). The six-question items of KOL were adopted from Donate and Sánchez de Pablo (2014). A sample item includes "managers reward employees who share and apply their knowledge." The use of this scale has been found to be reliable in prior studies (Chughtai & Khan, 2023; Naqshbandi & Jasimuddin, 2018). Reinforcing this statement, Cronbach's alpha, α = 0.805, for this scale demonstrated high reliability. Six question items were taken from Edmondson (1999) to measure the extent to which employees feel safe engaging in open discussions with others in an organisation; that is, PS. Sample item includes "members of this organisation are able to bring up problems and tough issues." The PS scale achieved an acceptable Cronbach's alpha of 0.767. EV was assessed with the 6-question item scale in LePine and Van Dyne (1998). A sample includes "This employee develops and makes recommendations concerning issues that his/her work." The Cronbach's alpha, α = 0.836 for this scale, was high. Four items were taken from Ononye (2021) to assess the extent to which employees demonstrate innovative behaviour at work. Sample items include: "This employee defines problems to be solved at work" and "This employee is usually involved in the implementation of new ideas." The Cronbach's alpha, α = 0.780, for this scale was high.

The data collected were analysed with the partial least square structural equation modelling (PLSSEM) technique using the SmartPLS 3 software. The PLS is a variance-based analytical approach that combines factor analysis and regression. This approach is appropriate when mediation variables are studied with a small sample size. Following the 2-step analytical procedures in Anderson and Gerbing (1988), the study analysed the measurement model (i.e., verifying the validity and reliability of the constructs) and structural model (i.e., estimating the model parameters to determine the hypothesised relationships) sequentially. In doing so, the rule of thumb in Hair et al. (2017) was applied for the interpretation of the PLS results. The mediational approach recommended by Baron and Kenny (1986) was adopted for hypothesis testing. The bootstrap method using 5000 iterations was utilised in the structural model analysis.

RESULTS

A preliminary test was conducted to confirm the appropriateness of factor analysis for the dataset before performing the 2-step analytical procedure for structural equation modelling (SEM). The Kaiser–Meyer–Olkin measure of sampling adequacy showed that the resulting values were greater than the minimum acceptable value of 0.60 (KOL = 0.778, PS = 0.741, EV = 0.802, innovation = 0.739), and Bartlett's test for sphericity was significant for all the latent constructs at $p < 0.05$. These preliminary tests were performed with SPSS 20.0. Having confirmed the factorability of the dataset, the study proceeded to determine the validity and reliability of the measurement model. In Table 1, construct validity was assessed using the average variance extracted (convergent validity) and the FornellLarcker criterion (discriminant validity). The reliability was assessed with factor loading (item reliability) and composite reliability (construct reliability). Following the rule of thumb in Hair et al. (2017), the results indicate that construct validity was achieved because the average variance extracted (AVE) value of each construct was higher than the minimum point of 0.50, and the correlation of each construct was higher than the inter-construct correlations. Thus, acceptable convergent validity and discriminant validity were demonstrated. Furthermore, satisfactory reliability was confirmed because the factor loading (FL) of each item underlying a construct exceeded the minimum acceptable value of 0.707, and the composite reliability (CR) of each construct was above the limit of 0.70. Thus, adequate item and construct reliability were established.

Table 1. Measurement model results

	Construct	FL Range > .707	CR > .70	AVE > .50	VIF	Fornell-Larcker criterion			
						1	2	3	4
1	KOL	0.771 - 0.840	0.798	0.740	1.097	**0.860**			
2	EV	0.725 - 0.873	0.754	0.566	1.160	0.136	**0.752**		
3	PS	0.794 - 0.816	0.862	0.658	1.185	0.097	0.205	**0.811**	
4	Innovation	0.844 - 0.888	0.803	0.621		0.102	0.271	0.084	**0.788**

The multicollinearity test was performed using the variance inflation factor (VIF) to establish whether the self-reported scale is free of common method bias (Hosseini & Ferreira, 2023). This is critical in ensuring that latent constructs are perfectly correlated and that reliable inferences can be drawn from the measurement model (Ononye & Igwe, 2019). Following the recommendation in Kock (2015) that a model has no problem with common method bias (CMB) if all VIF values are ≤3.3, the resulting values demonstrated that CMB does not pose a challenge in this model. Given these satisfactory results, the study advanced to the second step of SEM, which is the estimation of the structural model. Regarding the R^2 value (0.575), the rule of thumb in Hair et al. (2017) states that values less than 0.75 and greater than 0.50 are considered moderate. Thus, the link between KOL, PS, and EV has moderate predictive power on innovation. The standardised root mean square residual (SMSR) and normed fit index (NFI) were within the recommended range/point. SMSR (0.074) was below 0.08, and NFI (0.904) was close to 1; all suggest a good model fit (Kline, 2014).

In Table 2, the structural model was assessed with the path coefficients (β), p-value, and coefficient of determination (R^2). The β indicated the nature of the relationship, the p-value demonstrated the significance of the relationship, and the R^2 showed the strength or intensity of the relationships given the dependent latent construct. H1 proposed that the relationship between KOL and innovation is significant and positive, and the PLS-SEM result ($\beta = 0.133$, $p = 0.000$) found that this proposition holds true. Thus, H1 was accepted. H2 predicted that PS enhances the KOL-innovation relationship, and the PLS-SEM result ($\beta = 0.099$, $p = 0.027$) proved this prediction to be true. Thus, H2 was accepted. The introduction of the mediational factor of PS made the correlation of the KOLinnovation link to reduce slightly ($\beta = 0.128$, $p = 0.000$), however, there was no change in its significance. The mediation effect was deemed to be partial. H3 argued that EV enhances the KOLinnovation relationship, and the PLS-SEM result ($\beta = 0.130$, $p = 0.000$) provided evidence to support this argument. Thus, the argument in H3 was confirmed. The introduction of the mediational factor of PS made the correlation of the KOL-innovation link reduce slightly ($\beta = 0.128$, $p = 0.000$); however, there was no change in its significance. The mediation effect was considered partial, which suggests there are other important contextual factors not included in this model. H4 stated that the serial mediation of PS and EV enhances the KOL-innovation relationship, and the PLS-SEM result ($\beta = 0.159$, $p = 0.000$) proved this statement to be valid. Thus, H4 was supported.

Table 2. Structural model estimation

H	Paths	β	p value	Remark
1	KOL → Innovation	0.133	0.000	Significant
2	KOL → PS	0.225	0.000	Significant
	PS → Innovation	0.192	0.000	Significant
	KOL → Innovation	0.131	0.000	Significant
	KOL → PS → Innovation	0.099	0.027	Significant
3	KOL → EV	0.383	0.000	Significant
	EV → Innovation	0.347	0.000	Significant
	KOL → Innovation	0.128	0.000	Significant
	KOL → EV → Innovation	0.130	0.000	Significant
4	PS → EV	0.288	0.000	Significant
	KOL → PS → EV → Innovation	0.159	0.000	Significant

Note: $P < 0.05$ $R^2 = 0.575$, SRMR = 0.074, NFI = 0.904, β = beta values

DISCUSSION

The study found a positive and significant relationship between KOL and innovation. Although previous studies (e.g., Chughtai & Khan, 2023; Donate et al., 2022; Naqshbandi & Jasimuddin, 2018; Sadeghi & Rad, 2018) showed that KOL effect on innovation is indirect, this finding demonstrated that it could also be direct. The relevance of KOL lies in providing employees with a shared frame of reference to engender commitment to the utility of knowledge in furthering innovation processes. Importantly, employees do not operate in a vacuum; the permission of leaders is critical for the implementation of employees' ideas, and as such, a salient aspect of employee innovation is the communication of ideas to leaders to elicit feedback (Lukes & Stephan, 2017).

The study found that PS enhances the KOL-innovation relationship. KOL leads through the knowledge lens by generating psychological conditions to stimulate proactive behaviours among employees regarding the use of KS practices for problem solving (Donate et al., 2022). Arguably, PS, characterised by mutual trust and respect, is a social lubricant that strengthens the connection, communication, and collaboration between KOL and employees, thereby improving KOL effectiveness in an innovation context.

THEORETICAL AND PRACTICAL IMPLICATIONS

This study advances both theory and practice regarding the relationships among the constructs. First, theoretically, the study examined the direct and indirect effects of KOL on innovation at the individual level, whereas prior research works contributed to the elucidation of the aforementioned relationship at the team and organisational level (Chughtai & Khan, 2023; Donate et al., 2022; Donate & Sánchez de Pablo, 2014; Naqshbandi & Jasimuddin, 2018; Sadeghi & Rad, 2018). Second, the aforementioned studies mentioned that KOL is necessary but not adequate for the effectuation of innovation, suggesting an indirect effect. However, this study noted that the KOL effect can be both direct and indirect at the individual level. However, in comparison to the direct effect, this leadership style can indirectly achieve more influence on innovation. Hence, the relevance of underlying factors in maximising its effectiveness in a specified context. Third, this study indicated the pathways (PS and EV) in which knowledge-oriented leadership explicates influence on innovation, whereas other related studies used PS and KS as contextual variables for other positive leadership behaviours (e.g., humble leadership and entrepreneurial leadership) in a creativity context (Mehmood et al., 2022; Y. Wang et al., 2018). Thus, this study demonstrated the centrality of the sequential link between PS and EV in fostering innovation based on a knowledge-oriented approach to leadership. The relational dynamics among the constructs

deepen our understanding from the social exchange perspective. Fourth, KOL is still in a nascent state of development (Latif et al., 2021); thus, this study added to the literature on the construct, initially developed by Donate and Sánchez de Pablo (2014), at the individual level and in an African country context, Nigeria in particular. The study presented other individual-level consequences of KOL not documented in previous studies (Chughtai & Khan, 2023; Donate et al., 2022; Donate & Sánchez de Pablo, 2014; Naqshbandi & Jasimuddin, 2018; Sadeghi & Rad, 2018; Sahibzada et al., 2021).

Importantly, organisations need to consider the practical application of KOL to improve innovation outcomes considerably. To achieve this, leadership training programs should include modules, courses, or topics on KOL to engender the formation of the requisite managerial skills. More so, they should consider the criterion of demonstrable KOL abilities for leadership selection and recruitment.

As a personal development initiative, managers can attend leadership development programmes as well as obtain certification in knowledge management to improve their KOL abilities. This initiative should be encouraged and supported by organisations. In all, the human resource management framework should be responsive to the dynamics of the knowledge economy regarding leadership. Given that PS and EV function as mediators, organisations should actively cultivate an environment enabling interpersonal risky behaviours founded on trust, respect, and cooperation and encourage/support employees who demonstrate such behaviour accordingly. In this line, they should create and sustain a supportive and deliberative environment that reinforces voice decisions and behaviours.

LIMITATIONS AND FUTURE RESEARCH

The research had its limitations. First, the study only determined the links between KOL, PS, EV, and innovation in public universities in Southern Nigeria. Other studies may examine the linkages in other knowledge-intensive organisations as well as expand the geographic scope to make for better generality of findings. Second, future studies should look at other underlying mechanisms that can affect the KOL-innovation relationship, such as psychological capital, work engagement, work commitment, etc. Third, the role of moderators can be identified and introduced to this integrative framework to demonstrate the conditions affecting the linkages. Fourth, the study made use of selfreported data from a single source, which may be prone to bias. Although the time-lagged data collection was adopted, future research can employ a longitudinal dataset for more concrete causal inferences.

CONCLUSION

The PLS analytical method was applied to investigate the relationship between KOL and innovation by accounting for PS and EV as mediators. Data were obtained from 347 academic staff operating in public universities in Southern Nigeria. From the PLS-SEM results, the study demonstrated that the KOL and innovation relationship was positive and significant, and this relationship was partially mediated by two variables, namely, PS and EV. Furthermore, the two mediating variables channeled KOL's influence on innovation in a sequence. Therefore, it was concluded that the KOL-innovation relationship can be explained by the mediational dynamics of PS and EV.

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