

## Enablers of Optimal Work Systems in Industry

### Review, Framework and Likert-scale Survey for Improving Intra-Organisational Communication of Finnish Case Companies

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**Abstract**— The paper constructs a work systemic framework for more detailed communication analyses and developments. This aims to promote effectively desired and prevent undesired outcomes in companies. In the empirical part the paper piloted new measuring scales and presents their application in surveying the perceptions of the work systems of real industrial organisational cases (N=6). The tentative scales seemed to be consistent, reliable (Cronbach's Alpha) and able to show differences both between companies and groups of employees within companies. As far as both research and practice, finally, recommend new kind closer and synergic connections between issues of communication developments, quality management, productivity, well-being at work and human resources management. These would be useful as far as ICT-enabled collaboration is developed, too. The review section of this paper reveals that actually the author team has for 15 years implicitly emphasised human-centred communication as far as its studies are concerned. Participatory human-centred approach has been an essential feature of almost all Research and Development (R&D) related to achieving an optimal system for production, services, and products. Though R&D has been aiming to cover and analyse a wide variety of as well tangible and intangible work systems issues, opinion now is that the author team's should have been dealt more explicitly already earlier.

**Keywords**-human communication; human resources (HR); Likert-scale; perceptions of own work; quality management.

#### I. INTRODUCTION

A work system comprises a combination of people, technology, and tasks within a space and other work environment (tangible and intangible), and the interaction of these components within a managed goal-oriented organisation with its processes (Figure 1). Holistic ergonomics aims to optimise work systems, as far as performance and effectiveness, including in a key role people without detriment to their health, safety, or other factors of well-being at work. In other words of the work systems standard, optimisation may be evaluated based on measures of three categories (1) health and well-being, (2) safety, and (3) performance (the quantity and quality (Q) of production with minimal non-conformities) [1][2].

According to this holistic thinking, the factors of both well-being and productivity at work comprise a lot of synergy.

This paper is interested in the above interactive system and particularly in the creation of a contextual framework for communication needed to run the manufacturing and services of six Finnish industrial case companies, and generally later in other companies. Together with The Finnish Work Environment Fund, these companies are funding this study, which is being conducted at the University of Oulu.

We see Communication (C) as an essential factor of work system interaction that operates between and within system components (Figure 1). The following definition of communication guides the current study: “the act or process of using words, sounds, signs, or behaviours to express or exchange information or to express your ideas, thoughts, feelings, etc., to someone else”[3]. In general, in intra-organisational work systems, and even more so in cross- and inter-organisational contexts, the channels and flow of Information and Communication (IC) are essential for effective businesses and the individuals within them. Such communication is today more and more enabled, aided, mediated and supported by Technology (T). Though we focus predominantly on face-to-face communication, ICT should be more explicitly taken into account in the work systems. T has been considered to bring both pros and cons to communication. This study tries to promote the pros of T in terms of its potential to improve both the quality and quantity of communication. For instance, the Health, Safety and Environment ICT (HSE ICT) relates a lot to communication while fulfilling the tasks of reporting and the collection of data, data storage, information processing, and distribution of information to decision makers inside the organisation [4].

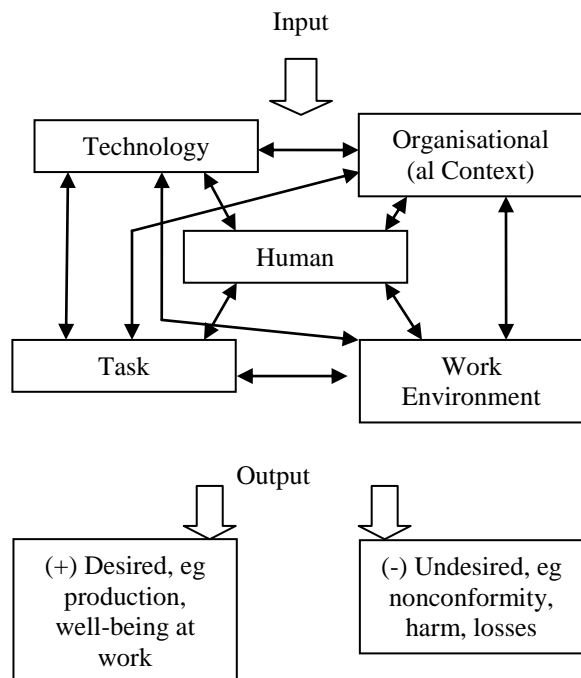


Figure 1. The balanced work system model [47], modified to represent the outcomes as well, i.e., desired and undesired results at work [2].

## II. BACKGROUND

Industrial expressions of the role of communication at work can be typically mentioned, eg., as follows:

First, according to Reason [5], communication problems fall into three categories:

- System failures, in which the necessary channels of communication do not exist, or are not functioning, or are not regularly used
- Message failures, in which channels exist, but necessary information is not transmitted
- Reception failures, in which channels exist, the right message is sent, but it is either misinterpreted by the recipient or arrives too late.

Second, Hugnes and Ferrett emphasise the role of communication to be as follows: "The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to and the style and proficiency of, an organisations health and safety management. Organisations with a positive safety culture are characterised by communications founded on a mutual understanding of the importance of safety and by confidence in the efficacy of preventive measures. [6]" Third, an increasing trend within current work organisations is moving jobs at multiple sites. It means that employees are mobile, visiting many distributed sites with face-to-face communication situations, while at the same time frequently using mobile ICT as an essential tool during their work

tasks and shifts. That these people predominantly work alone is generally understood to be a challenge to manage well. One such example of this business situation is short-haul truck driving. ICT innovation proposals related to improving communication within the supply chain partners of this mobile and distributed work system have been studied by Reiman, Pekkala and Väyrynen [7].

Fourth, it is worth to mention that Saari showed in his analysis that disturbances in the information processes of a work system and human communication comprise an important factor behind accidents at work [8].

Fifth, Glendon, Clarke and McKenna [9] concluded, that in highly demanding or busy work situations such as safety critical situations, communication factors typically include ones of language, hierarchy, authority, avoiding conflicts, fears, attitudes, behaviour styles, rigid role differentiation, the complexity of the tasks, the impersonality of the media, communication via IT or within team where each member can see and hear each other, among others. These factors have typically been studied in relation to aviation incidents or crashes, flight simulator training, and medical care.

Sixth, to guarantee an optimal communication in a work system, in addition to the intra- and intergroup interactions of employers, managers and supervisors, and employees, communication with external stakeholders is also important. Fluent and frequent contacts to and between internal and external stakeholders can be provided only by increasing the role of communication technology. Dul et al. show a lot of strategic and wise visions for ergonomics and human factors related, eg., to various stakeholders affecting and affected by modern businesses. They speak quite much about communication generally; but according to our opinion, not as such within work systems, as our study aims [10].

Figure 2 shows the key contextual issues of this study collected for the description, analysis and evaluation of the framework of communication in the companies. Eight cumulative issues are reviewed in more detailed way in Table 1. Related issues covered in the past papers by the authors of this study include the following:

- Implementation of telemedicine [11]
- Utilizing employee's knowledge in metal industry [12]
- Developing mobile communication services for the elderly [13]
- Case describing a collaboratively-developed software application for improving service quality [14]
- Increasing hospital staff participation into the development processes [15]
- Participatory design science approach on the optimum work system [16]
- Short haul drivers' two-way assessments of prerequisites and communications contributing employee and customer satisfaction [7]
- Regional workplace development in the context of sociotechnology and knowledge [17]

- Multifaceted analysis of truck transportation's work system by drivers and stakeholders [18]
- Microinnovations [19]
- Managing well-being at work [20]
- Concurrent engineering activities using videophone communication [21]
- User-centered development of video telephony for servicing [22]
- Video-based ergonomic development of work system cases [23]
- HSEQ integrated (asset) management in process industry network [24]
- Communication in high tech product development projects [25]

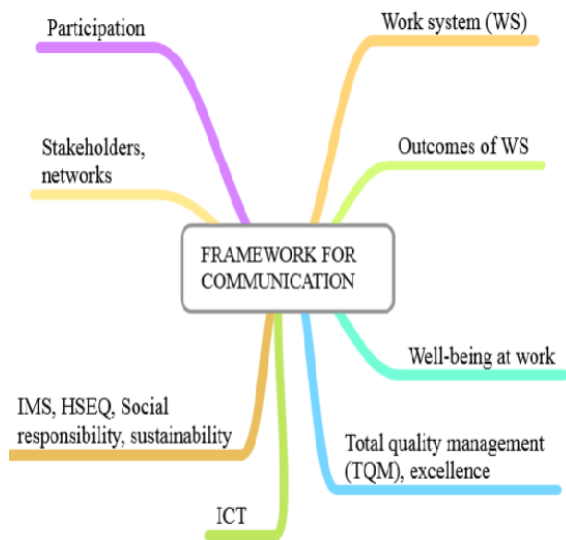


Figure 2. Key effective issues chosen for the description, analysis, and evaluation of a framework for communication.

Lessons learned from all the above, we define the scope of our whole study called Kitkaton Kommunikointi (KIKO), in English Frictionless Communication (FriCo), focusing explicitly consciously on communication possesses the potential to reveal many means of enhancing interaction within a work system, for the benefit of management, workforce, and stakeholders. According to the review above, our assumption is that too much of communication issues are thought to be implicit in our former studies. That is why we see that a lot of inductive study related work communication at the field is needed, too. This later part of our study relies on ethnography and user-study-style observational and other methods of contextual [61] data collection. More explicit picture of the practice and quality of communication and evidence of the importance of the quality of communication enables to understand, model, measure, promote, and manage generally better within the work system.

TABLE 1. A SHORT DESCRIPTION WITH REFERENCES TO KEY ISSUES CHOSEN FOR THE DESCRIPTION, ANALYSIS AND EVALUATION OF A FRAMEWORK FOR COMMUNICATION.

Most relevant general academic and practical backgrounds	Main points, messages, or results.	Reference(s)
Work system (WS)	People, technological tools tasks, work environment, and interaction of these components within an organisation.	[1][47]
Outcomes of WS in general	Work systems' optimization may be evaluated based on measures of categories (1) health and well-being, (2) safety, and (3) performance (the quantity and quality conformity).	[1][33][34][2][23]
Well-being at work	Means safe, healthy, and productive work in a well-led organisation by competent workers and work communities who see their job as meaningful and rewarding.	[48]
(Total) Quality Management (TQM), Excellence	<ul style="list-style-type: none"> <li>•Production process, products, services, system, continuous improvement</li> <li>•Safety and productivity as integral inherent parts of quality</li> <li>•Employee and supplier participation</li> </ul>	[49][50][43][42]
Participation	Involving people as employees, consumers and citizens, in development, individuals and organisations, driving forces of potential benefits comprise involvement in process, motivation, competence and confidence.	[51][22][55][56]
Stakeholders, networks	Especially employees, customers, owners, partners, business networks, community, citizens, regulating society, i.e. affecting, affected, involved organisations and individuals.	[52][17][53][57][58][59][60]
HSEQ, Social responsibility (SR), sustainability	Products and services satisfy requirements for quality and excellence, responsible organisations have also to be concerned about the well-being of their employees, their work environment, impact of operations on the local community, and long-term effects of their activities and products.	[35][54]
ICT	Developments in computer technology, telecommunication technology and media technology have given rise to new interactive activities such as social media, gaming, and to an explosion of information transfer. People's lives have become more and more dependent on ICT and virtual networks. ICT developments have brought about many changes in work organisation and organisational design, including more focus on teamwork, the rise of virtual organisations, remote work including working from home, fading borders between occupational and private life, and increased complexity of networks.	[10][47]

Lasswell, the US scientist, once described that every act of communication is ultimately an answer to one aspect of

the following question: Who (says) What (to) Whom (in) What Channel (with) What Effect [26]. We find this understanding of communication quite straightforward and rudimentary. While it may be useful in other cases, it appears less useful for the current study. The objectives of this study are of a much more multi-disciplinary and diverse nature than are encompassed in Lasswell's understanding about communication.

The objectives of the KIKO study are as follows:

- To develop the interaction skills of the supervisors and employees of the case companies.
- To study the case companies' communication and find those factors which contribute to or detract from purposeful interaction and operation.
- To identify interaction challenges in the case companies to create new solutions and operation models, and to try to formulate an approach to an innovative procedure for enhancing individual and organisational communication being applicable in other companies ("KIKO R&D service package" as a recommendation of a good practice).

As a part of the preliminary actions of the whole KIKO study, a literature review and a field survey of employees' and supervisors' opinions and perceptions was required. The literature review is presented in the introduction and background. That is why the following additionally objective for starting the KIKO needed to be fulfilled: describing and measuring the starting points generally, and especially clarifying the perceived situation and conditions of the case companies by a questionnaire directed to the supervisors and employees.

### III. MATERIALS AND METHODS

The current study is comprised of activities divided into three work packages (WPs):

- WP1: Training and evaluating communication skills in a special laboratory using the consultative approach.
- WP2: Observing and developing the communication practices and culture between employees and supervisors within the case companies (e.g., in workshops, manufacturing lines, sites, offices, R&D spaces, etc.)
- WP3: Identifying and analysing the communication pros, cons and challenges of each case company based on WPs 1 and 2. Based on the results and conclusions of the WPs1 above, the case companies are arranging collaborative workshops with researchers, and thereby creating new solutions, operation models, and management practices to improve the current practises (see design science, [16][27]).

The current KIKO study utilises the consultative psychological approach, and relevant methods of ergonomics, quality management, and organisational

development (mainly in the fields of ethnography and participatory development, and design).

The study will be carried out with six companies or company units that represent significant Finnish companies in the fields of technology [28] and energy (electric power distribution). KIKO was and is being conducted during 2013 and 2014. Not only is the Federation of Finnish technology industries interested in research on optimal work system in companies [29], so are the European metal, engineering and technology industries [30].

In the initial phase of the study before the WPs, an examination of the literature and a survey on the perceptions of the features of the work systems were carried out. The former is briefly presented in the introduction and in the discussion chapter of this paper. The latter, a field questionnaire, was comprised, of background information questions and allowed free space for writing respondent's own views and opinions. In the main part of the questionnaire, the satisfaction part of the questionnaire, a 5-point Likert scale was used. Each respondent was asked to give his or her opinion (i.e., "how much do they agree" with the presented opinion or work system conditions description) on the statements presented (see Appendix). The potential choices consisted of "1 equals strongly disagree" to "5 equals strongly agree". The employees (blue-collar workers and clerical employees) and supervisors (managerial staff and experts) were asked to fill in the number 1, 2, 3, 4 or 5 according to how they felt about their work system and communication within it.

The questionnaire was directed at the entire staff (employees and supervisors) of all the participating case units. The questionnaire was introduced by first stating that it would take less than 10 minutes to complete.

The field survey was predominantly conducted utilising a web-based questionnaire, but some of the respondents who did not have access to web were given a paper questionnaire. The questionnaires were distributed to the employees and supervisors of the participating companies. Of the distributed questionnaires, a total of 448 was delivered back to the researchers, as follows:

- Case I, bigger company, total response rate 77%, employees (N=220) and supervisors (N=21)
- Case II, bigger company, total response rate 55%, employees (N=15) and supervisors (N=9)
- Case III, smaller company, total response rate 100%, employees (N=8) and supervisors (N=2)
- Case IV, smaller company, total response rate 61%, employees (N=48) and supervisors (N=10)
- Case V, smaller company, total response rate 51%, employees (N=32) and supervisors (N=7)
- Case VI, bigger company, total response rate 49%, employees (N=41) and supervisors (N=18)

The statistics software package (SPSS 22.0) was utilised both for a wide variety of basic descriptive purposes and in trials to predict developed dependent variables using various independent variables.

The dependent variables of the study were as follows:

- (i) Perceived holistic well-being, (ii) Perceived satisfaction

with communication, and (iii) Perceived satisfaction with IT-mediated communication. The sums of the variables comprised: (i) statements 1,2,6,7,12,14,15,16, 17,18,20,21; (ii) statements 3,4,5,10,11,13,19; (iii) statements 8,9,22 (see Appendix). The modelled and piloted tentative sum indexes (i.e., the corresponding averages of the sums) for i, ii, iii were calculated separately for the employees and supervisors, the different case companies, and then analysed and checked in terms of their reliability using Cronbach's Alpha (i.e., the consistency or repeatability of the measures collected from the questionnaires). The Cronbach's Alpha for every statement sub-group on the questionnaire was estimated and compared with the recommended limits of statistical significance in the literature [31][32]. In addition, we put into trial whether indexes (i), (ii), and (iii) showed differences as far as case companies (i.e., case I-VI, bigger or smaller) and staff categories (employee, supervisor).

#### IV. RESULTS

First of all, a general view on the distribution of opinions about the perceived work system and own role and contribution there were revealed, i.e, ratings generally and as far as all interesting sub-groups.

The appendix shows all questions about the level of accomplishment and choices assigned toward each subject matter in question (averaged opinions on statement / ratings on 5-point Likert scale,  $\bar{x} \pm$  standard deviation (sd)), by employee and supervisor, and total average opinion based on agreement levels given to all the 22 statements in all case companies.

The values of the piloted sum indexes varied in the way presented in the Table 2.

TABLE 2. THE THREE SUM INDEXES (i) PERCEIVED HOLISTIC WELL-BEING (ii) PERCEIVED SATISFACTION WITH COMMUNICATION AND (iii) PERCEIVED SATISFACTION WITH IT-MEDIATED COMMUNICATION. THESE INDEXES WERE CALCULATED SEPARATELY FOR THE EMPLOYEES AND SUPERVISORS, THE DIFFERENT CASE COMPANIES.

Case	i	ii	iii	total
Case I	3.5	3.6	3.3	3.5
Case II	3.8	3.9	3.5	3.8
Case III	3.7	3.7	3.8	3.7
Case IV	3.3	3.4	2.8	3.2
Case V	3.5	3.8	3.4	3.5
Case VI	3.6	3.7	3.2	3.6
Supervisors	3.8	3.9	3.6	3.8
Employees	3.4	3.6	3.2	3.4
Bigger comp.	3.6	3.7	3.3	3.6
Smaller comp.	3.5	3.7	3.3	3.5

Figure 3 shows averaged scores by staff category and case company. Cronbach's Alpha for every chosen statement sub-group of the questions, i.e., tentative measuring scales, was estimated and compared with the recommended limits in the literature:

Alpha for i= 0.87 (Good), Alpha for ii=0.72 (Good), Alpha for iii=0.62 (Acceptable)

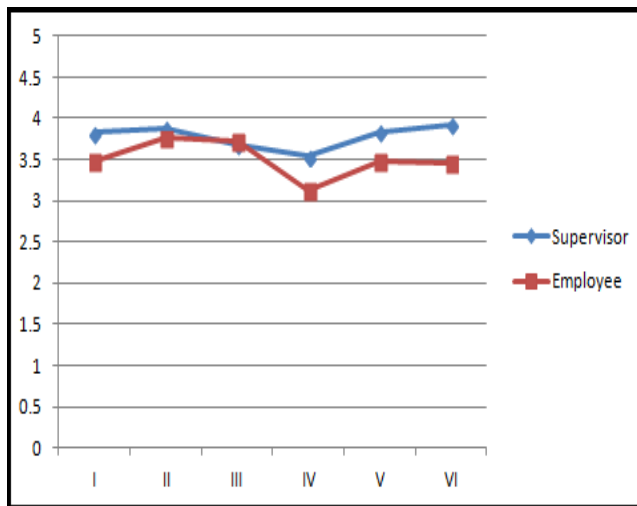


Figure 3. Average Likert-scores for employees and supervisors in case companies.

#### V. DISCUSSION

Our results of the current pilot empirical study indicate that choosing communication as a study issue, and the probable one in need for enhancement, seems to be right. Effective communication needs to be recognised as an integral capability in every organisation. Methods for the measuring, managing, and developing in a participatory, and business-tailored way should be further developed. The literature review shows Health and Safety (HS) communication to be frequently emphasised in an important British textbook on management and workforce [6]. In Finland, this emphasis would be important, and not only HS, but also Environment and Quality (EQ), and other outcomes, and enabling work system features as well. According to our opinion, KIKO-related multi-disciplinary R&D studies seem to have their relevant place.

An optimal work system approach has a lot of similarities with quality prize models(excellence models) like European or US ones [33][34], as far as taking care of the both enablers and results of the good practises of work and inc business. Communication might not only be in relation with more or less directly measureable issues – it is a value as such, a part of human and social assets.

Our past emphasis on the concept of participation is quite near, we think, to the concept of collaboration. Both concepts are probably highly correlated with communication. In a tentative modelling of communication at work, we try to present key issues, at least as thinking about our emphasis on this paper. The issues relate closely to the work system, management, quality assurance,

integrated management [35] and finally, “well-being in work system”. This probably quite new term sounds to be feasible. We think we can continue, with our field company partners, using this preliminary choice. To be more comprehensive, we think some elements have to be added to our questionnaire to cover full enough the work systems in companies such as collaborators of this study.

To sum up thoughts we found in international literature, our future steps should especially include more issues linked with the modelling of well-being in the work system, or Quality of Work(ing) Life (QWL) [20][36][37][38], lean management [39][40][41], and emerging views of ICT (the variety of communication channels, ambient, mobile technology, moving multi-site jobs, remote work, embedded, Enterprise resource planning (ERP) systems, “social media”, video). QWL (Quality of Work(ing) Life) is, in addition to Quality of Products and Services and Quality of Work Force, defined together to form Quality [42]. This conclusion by Dzissah et al. correlates positively quite much with our study’s prerequisites and models through the work system and communication are not emphasized by them. The later actual work packages of the KIKO study will most probably further contribute as far as many issues and results, and conclusions, of the current questionnaire part, first phase of the whole study.

As far as the work system is concerned, our assumption is that qualitatively (and quantitatively) enhanced communication has power to increase desired and correspondently decrease the undesired outcomes of the work system. We hope to get more evidence of this. In any case, we suggest that more means to improve communication like ones to improve quality are to be developed and implemented. In our introduction, we did not consider much able to be learned from Lasswell’s older questions (i.e., Who (says) What (to) Whom (in) What Channel (with) What Effect [26]). Instead, we felt that answering the set of questions why, who, when, where, what, and further how (i.e., so-called the five Ws and one H, see Hutchison [43]) might be more useful. That is why the latter questions are often seen the important first steps towards quality developments, excellence and integrated management, and now being well-being in the work system included.

Glendon, Clarke and McKenna [9], suggest looking at even more and specific topics within industrial organisations, such as the hierarchy, team structure, team performance, centralisation degree of the teams and networks, attitudes, and the quality of communication. The latter strongly relates to the roles and systems of ICT in company and individual levels, too. More precisely, Glendon, Clarke and McKenna encourage us to study the aspects in the following way: with adequate dissemination of top-down communications..., but also bottom-up communications... ease worker relations... reduced status distinctions operate through encouraging communication, sharing ideas, and promoting greater concern and trust among workers [9].

Referring to the literature, we conclude that our current review and questionnaire support, generally, our own past

socio-technical holistic emphasis: as far communication developments, we recommend synergic design, development and implementation approach [44][45][46] [10]. Further, our past and current concepts, give an approach to apply the contextual design [61] for developing ICT systems useable for supporting collaboration within companies.

This paper focuses on general and Human Resource (HR) management, assessment and developments of well-being at work (system), total quality and further productivity and safety issues, i.e., to achieve more desired and less undesired outcomes within work system contexts. Other later coming papers based on the same KIKO study will provide broader views on these multi-professional and – disciplinary research and development issues of communication in companies.

As far as our pilot questionnaire, generally, and new Likert-style scales constructed specially, we found them useful as a starting point for enhancing communication R&D, e.g., in later sections of the KIKO project. Tentative three scales based of the chosen sub-sets of statements proved to be consistent and reliable measuring scales and applicable to surveying real industrial case organisations. Of course, the pilot scales need further trials with more case organisations, and careful evaluation.

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Appendix. Statements amounted 22, and basic descriptive statistics for each one. Distribution of the ratings in percentages on 5-point Likert scale are colour-coded (see right side of the figure).

