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# Implementation of Crisis-Resource-Management-based Team Training in Lower Austria

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## Abstract

**Objective:** Sequelae of medical errors are a significant problem in acute care. Human-factor-based events are frequent but avoidable causes. Thus, non-technical skills are crucial. In 2008, crisis-resource-management (CRM)-based simulation training was established for the medical staff of the Lower Austria Regional Hospitals, one of the largest hospital operators in Europe.

**Methods:** Implementation and development of simulation training from 2008 until today are described, costs and performance data retrospectively analysed over a 10-year period. The applied methodology and organisational aspects of CRM training are highlighted. To complete the picture, activities triggered through CRM training throughout the hospitals with potential to further improve patient safety are shown.

**Results:** With an initial funding of €100,000 by the Landeskliniken Holding and course rates of €350 to €500, a simulation programme was established for approximately 1,900 co-workers in the acute care setting. In the past 10 years, more than 2,300 doctors and nurses took part in one of the courses, held by 14 qualified trainers. Training was held in the simulation centre as well as in hospitals. Over the time, simulation facilities have been expanded to 8 different manikins, high-fidelity ventilation and monitoring simulation. In addition, a variety of patient safety activities like implementation of critical incident reporting, OR checklists and anaesthesia briefing was accompanied by the trainer team. The total cost of the project was just under €20, 00,000.

**Conclusion:** Simulation-based CRM training was successfully introduced and sustainably institutionalised at the NOE LKH group of hospitals. The demand for and acceptance of the training were both excellent. The previous costs of training were relatively low; the organisational model of an independent, non-profit registered association allowed the training activities to be implemented without reducing the availability of the instructors in their clinical roles.

**Keywords:** Crisis resource management, human factor, medical simulation, non-technical skills, patient safety, team training

## Introduction

Undesirable effects of medical treatment are a pressing issue, especially in acute care. In a recent working paper on the economics of patient safety, the Organisation for Economic Cooperation and Development (OECD) (1) mentions errors in medical treatment as 1 of the 15 greatest threats to health. About 1 in 10 patients is harmed during healthcare, although many of these incidents could be prevented. The investigation of such events often reveals poor implementation of safety strategies that are well established in other 'high-reliability organisations' like aviation or the chemical industry. However, these techniques have to be learned; in aviation, role-specific crew resource management (CRM) training in the simulator is explicitly required before beginning real operational work. Improvement is urgent owing to the fact that costs of harm run into trillions of dollars annually (including flow-on economic consequences), and evidence that suggests that 15% of hospital expenditure and activity in OECD countries can be attributed to treating safety failures (1).



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To strengthen the competence in managing critical situations, the use of simulation training in healthcare is increasing (2-4). Non-technical skills (NTS) (5, 6), such as safe communication, teamwork, task-orientation and decision-making, are experienced as key elements of successful crisis management. Trainees are enabled to integrate new knowledge within their existing expertise by immediately applying it in active practice (7, 8). Notably, the qualifications of the instructors and a target-group specific design of the training scenarios are key to effective mediation of the CRM strategies (9-13). Simulation-based team training can be performed both in special facilities (simulation centres) and directly in workplaces (in-situ simulation). The latter may be particularly effective at identifying local organisational deficits and gaps in competence. Therefore, it can also serve as an internal safety audit.

To assure the quality of activities of medical simulation centres, the Austrian Society for Anaesthesiology, Reanimation, and Intensive Medicine (ÖGARI) published guidelines for certification in 2010. As the first of the German-speaking countries, Austria made CRM-based simulation training a compulsory element of training of specialists in anaesthesiology and intensive medicine in 2015. However, federal legal authorities have supplied no grants or funding to date.

## Methods

In 2008, CRM-based simulation team training was set up on a regular basis for the Lower Austrian Landeskliniken Holding (NOE LKH), one of the largest European hospital operators. In this article, we describe the implementation, training concepts and resources needed. Costs and performance data were retrospectively analysed over a 10-year period (2008–2017). Finally, we performed a web-based survey of all course participants in 2017. In this survey, we asked participants to rate the skills taught in the course according to their importance (scale from 1: extremely important to 7: very unimportant). The topics asked were individual CRM competencies, teamwork, CRM strategies to avoid problems. The latter data are presented as an electronic supplement (Table S1-S3).

**Main Points:**

- CRM-based simulation training is a valuable tool in the education and training of personnel in an acute care setting and is a mandatory part of training for anaesthesia residents in Austria.
- This study describes a state-wide inter-professional simulation programme, established in 2008 in Lower Austria.
- Characteristics of course programmes, organisational as well as funding bases, are illustrated in detail on the basis of 10 years' experience.
- This study aimed to support other programmes in the sustainability of their establishment.

### Statistical analysis

All data were processed and analysed using the programme Excel©, Microsoft Corporation, Redmond, WA, USA, 98052-6399; the online survey was performed using Survey Monkey® (Palo Alto, CA 94301, USA).

## Results

### Setting

The NOE LKH operates all 27 public hospitals in the federal state of Lower Austria (Niederösterreich, NOE), an extensively settled region with an area of 19,186 km$^2$ and 16,53,419 inhabitants (2016 census). The hospital structure consists of 2 central general hospitals, 4 regional specialist hospitals and 21 district hospitals (Figure 1). This includes a total of more than 7,800 patient beds and approximately 21,500 employees, half of these in direct contact with patients. Approximately 1,900 physicians and nursing staff work in acute areas such as A&E, intensive care, monitoring wards, operating theatres of various specialties, and delivery rooms. Prompted by a growing awareness for improving patient safety, the concept for simulation-based CRM training of NOE LKH staff was developed in 2007 by the Karl Landsteiner Institute for Medical Simulation, Patient Safety, and Emergency Medicine. It consisted of setting up a designated simulation centre (the Lower Austria Centre for Medical Simulation and Patient Safety, 'SiZ'), providing CRM-based training courses for multi-professional teams of healthcare workers, as well as in-situ training and train-the-trainer courses.

### Finance

The initial concept of organisation and financing of the sim-


**Figure 1. Hospitals of the 'Landeskliniken Holding Niederösterreich/LKH NOE'**

**Table 1. Cost calculation of participation fees**

| Item | 1 day | 2 days | In-situ |
|---|---|---|---|
| Instructor fees | 1,920 | 2,840 | 5,760 |
| Consumables | 300 | 420 | 240 |
| Investment in equipment, etc. (depreciation) | 125 | 188 | 500 |
| Catering for participants and instructors | 72 | 144 | 420* |
| Room rental costs | 235 | 420 | n/a |
| Reserve funds, social insurance contributions etc. | 576 | 1,152 | 1,728 |
| Overnight and travel expenses for instructors | n/a | n/a | 1,680 |
| Total (based on 12/48 part) | 302 | 576 | 215 |

All amounts in €. *only for instructors

ulation project was basically designed for a sustainable project lifetime: a registered non-profit association (named 'Lower Austria Centre for Medical Simulation and Patient Safety') was founded as a legal basis. A total of 2 Laerdal™ human simulators, a SimMan 3G® and a SimBaby® and the AQAI audio and video system were bought with an initial grant of €100,000 endowed by the Lower Austrian health care and social fund (NOEGUS). The calculation of the course fees aimed at covering staff costs, equipment renewal, all course material costs, costs of renting the spaces, providing meals for the course participants and staff, social insurance contributions and a reserve fund (Table 1). Based on a course fee of €350 for 1-day courses and €500 for 2-day courses, NOE LKH agreed to provide finance for training around 300 employees per year. This proved to be a sufficient economic basis for operating a simulation centre.

**Training concept**

In the educational setup, the programme closely followed the CRM course model developed by Gaba (11). Competence in NTS is imparted by multi-professional teams of physicians and nurses, facing challenging treatment situations in an interactive operational environment. The content of the scenarios is designed around the specialist field of the individual participants, the scenario scripts are written in accordance with the model of Dieckmann and Rall (14). All fields of acute clinical practice are covered. Per training day, up to 6 scenarios are performed. An extensive debriefing, led by experienced instructors, follows each scenario. All the course formats start with a theoretical introduction in which specific medical topics of the training, CRM principles and NTS are addressed, taking into account the different competence levels, needs and previous simulator experience of the course participants. The scenarios also pay attention to the reality of an increasingly multicultural society, which may involve differences in medical attitudes as well as problems of language and perception. Training can be organised with teams from individual departments or also with a mix of participants from different hospitals. With the implementation of simulation-based team training in the curricula of anaesthetists and general practitioners, there was an increasing demand for qualified trainers. Accordingly, since 2010, the SiZ team has also been offering training courses for instructors following the InFacT® course model (15, 16), in cooperation with the InPaSS™ Institute, Reutlingen and the Medical University of Vienna. In 2015, an additional in-situ training programme was started, mainly to support clinics in the implementation of new equipment or methods (for example, anaesthesia machines, DaVinci surgical robots), the introduction of new care areas or major structural changes in the NOE LKH hospitals.

**Simulation centre facilities**

The simulation centre was set up in the NOE LKH hospital Hochegg in the south of Lower Austria, where it was possible to rent suitable facilities. For simulation-based human factor training, a good level of environmental fidelity is important. The SiZ areas at Hochegg can be configured individually-as intensive-care unit, recovery room, normal ward, delivery unit, emergency room or operating theatre. This includes appropriate control rooms, a debriefing and lecture room and utility rooms. The equipment currently includes 8 Laerdal™ patient simulators. The lung simulator *TestChest®* and enhanced hemodynamic monitoring simulation software (*PiCCO®*) enables to perform even complex intensive-medicine scenarios on the SimMan 3G simulator.

**Staffing**

A total of 2 instructors and 2 facilitators accompany every team-training course. The 14-person team of instructors, who are doctors and nurses, was trained in accordance with the InFacT® concept at simulation centres in Germany (Tübingen, Mainz, Berlin, Germany). All team members of SiZ instruct on at least 2 days per month. They carry out this work alongside their full-time hospital jobs in their various fields and get paid at similar rates to their usual salaries in the hospital. This means about €65 to € 80 per hour for doctors and €34 to €40 for nursing staff. This results in approx. €1,980 to €2,400 faculty cost per training day. The simulation centre is active for 5–7 days per month; the cumulative work volume of the instructors currently equates to 2 full-time equivalents (including course preparation and other activities). The ongoing development of the team is assured by peer coaching (17) as well as by participation in debriefing workshops and specialist conferences. A part-time employee does the course administration.

**Course activities**

From 2008 to 2017, a total of 230 courses for 2,327 participants and 9 InFacT© instructor courses for 97 participants were held; of which, 70.4% were NTS-focused, multi-profes-

**Table 2. Full costs**

| Course model | One day | Two days | In-situ |
|---|---|---|---|
| Participation fees | 3.745 | 5.885 | 10.700 |
| Work hours of participants | 4.194 | 8.388 | 22.438 |
| Total | 7.939 | 14.273 | 33.138 |
| Per participant | 742 | 1.334 | 774 |

All figures in € per training course, calculated with the mean number of participants of 10.7 (simulation centre) or 42 (in-situ training) and the average composition of groups from nursing staff, junior doctors and specialists in the ratio 5.1:2.4:3.2

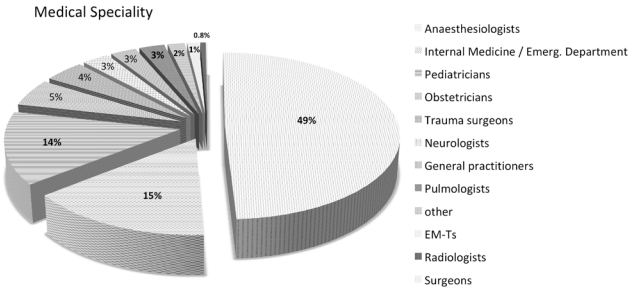


**Figure 2. Medical specialties of participants**

sional CRM courses for different specialties (Figure 2). The proportion of more skills-oriented courses was 23.5%. A total of 75.1% of the participants in simulation training came from the Lower Austria hospitals, 9% from Vienna, 3.5% from Burgenland, 3% from Styria, and 2% from Upper Austria. Participants from other regions of Austria, Germany and Switzerland each made up less than 1% of the total; 62.1% of participants were women. In the InFacT® courses, 33% of the participants were women. Doctors made up 54.5% of the participants, nursing staff 43.5% and other staff (paramedics, psychologists) 2%. The mean length of professional experience was 13.5±3.2 years, and 16% of the participants had experience of medical simulation prior to their first course at the SiZ. The training penetration rate (number of simulation-training courses completed per full-time equivalents of the respective specialty) over the entire study period was 1.7 for anaesthetists from Lower Austria (specialist nurses 0.5), paediatricians 0.8 (specialist nurses 0.4), internists specialising in intensive and emergency medicine and pulmonologists also 0.8 (nurses 0.2 or 0.3) and in other specialties less than 0.1 (that is, less than 10% of the full-time equivalents).

### Cost analysis

Employees of NOE LKH take the training on educational leave at full pay. This leads to calculated mean total costs per course participant of €742 for a 1-day and €1,284 for a 2-day training course (Table 2) for NÖ LKH. The calculation is based on personnel costs for consultants, residents and nursing staff at currently €69.60, €41.40 and € 39.60 per hour, respectively. The mean number of participants per course (10.7) and the mean ratio of the aforementioned categories of staff of 3.2:2.4:5.1 were applied. The costs of an in-situ training course are marginally higher at €774 per participant because the technical effort is greater. On average, in-situ training courses have 42 participants in the course of 3 consecutive training days. The required adjustments of the calculated course costs over a period of 10 years were around 1% per year.

### Side effects

The activities of the Centre for Medical Simulation and Patient Safety triggered additional measures, suitable to enhance safety culture in the NOE LKH. SiZ was invited to give teaching courses or lectures on patient safety and medical simulation training for the Medical University, Vienna and the Danube University, Krems and numerous nursing schools in Lower Austria. As there is an increasing interest in the different care areas concerning the influence and importance of human factors and NTS, not at least acquired during the CRM training, the awareness for patient safety seems to develop a new dimension. For example, the simulation-based scenario training is routinely used for emergency physician basic education as well as for recurrent training in Lower Austria since late 2008; training modules for prehospital anaesthesia, airway management and paediatric emergencies were developed. In these modules, paramedics also take part to assure a scenario configuration as realistic as possible. In 2013, the NOE LKH decided to implement systemic Critical Incident Reporting (CIRS) in 8 pilot clinics based on a more open dealing with medical error. Staff of SiZ was invited to accompany this project, which covered the evaluation, selection and presentation of the CIRS software as well as training of personnel. In 2014, after a pilot phase in the hospital of Wiener Neustadt, the emergency checklists of the European Society of Anaesthesia (ESA) were implemented throughout all NOE LKH hospitals. Since then, they are regularly trained in every OR simulation in Hochegg or in the respective in-situ training hospital. With the implementation of the new training regulations for physicians in 2015, compulsory simulation-based courses for basic emergency management (BEM) were established for all newly employed physicians in Lower Austria. Besides training in medical skills for acute in-hospital emergencies, a strong focus is laid on NTS. All trainers were qualified by CRM training themselves, and the course directors had to pass an InFacT® course prior to establishing BEM training in their institution. From October 2015 to June 2018, 28 of these courses for 479 physicians were held.

## Discussion

For effective management of critical situations, successful strategies from other high-risk fields of work, such as avia-

tion, can be adopted to medicine. This is especially true for CRM-based team training on a simulator (18, 19). As called for by David Gaba (20-22), medical simulation has become a regular part of training, especially in anaesthesiology: in Austria, simulation-based training has been mandatory since 2015. Despite this, so far, only a few of the bodies that operate healthcare institutions have responded and established obligatory simulation training for their staff. The only information available across all the German-speaking countries is in the form of project outlines or personal communications; results on implementation of this type of training have not been published yet. The programme of one of the largest European hospital operators described here was begun on the initiative of anaesthesiologists, who have a well-known affinity to initiatives aimed at improving patient safety (23). The developed course models are in line with international practice, the participants come from the whole spectrum of acute care professionals: as a unique feature, all team-training sessions are conducted in multi-professional groups. With a strong focus on NTS (non-medical), such as safe communication, teamwork, task-orientation, decision-making and situational awareness (24-26), the medical simulation concept described is very similar to those in aviation.

For training to be effective, it must achieve a high penetration rate of the target group. Savoldelli et al. (27) showed that the shortage of free time and worry about financial losses are leading reasons why staff decide not to take part in simulation training. Apart from the quality of the training, beneficial effects of simulation training strongly depend on the ability to finance the participation of as many workers as possible. As a matter of course, training must take place in work hours, and the costs must be borne by the employer. In aviation, this is the norm: at the large European airlines, about 3% of flying time is invested in simulator training, of this at least 6 hours per year with focus on crew resource management (personal communication from Cpt. Hans Härting, head of the department Human Factors Training in flight operations of Austrian Airlines). The guidelines of the European Aviation Safety Agency set the minimum volume of crew resource management training as an initial training of 12 h and recurrent training of 6 h every 3 years (GM3 ORO.FC.115). If commercial aircraft operators fail to meet these requirements, their operating licences lapse. Similar regulations for the healthcare sector could specify, for example, a further training programme defined either by the hospital operator or by law including an initial 2-day simulation training, possibly as part of the training as a specialist doctor or nurse, followed by a 1-day training at least every 3 years. In our opinion, however, the complexity of challenges in acute care settings would justify even a higher volume of training. Furthermore, it should be noted that simulator training lifts learning curves and, thus, has a cost-limiting effect (3) in general.

With regard to financing, the total costs of the first 10 years of simulation-based team training for NÖ LKH were just below €2,000,000. This corresponds to about 0.12% of the payroll costs of the staff in the acute departments, far below the expenditures accepted for CRM training in aviation. Of course, the described programme did not reach all the staff; the training penetration rate was quite low, at least apart from the anaesthesiology departments. However, a start has been made, and the methodology has been established and is well accepted: almost all of the participants experienced the training scenarios as realistic and relevant, similar to the results reported by Calamassi et al (28). Details of a participant's survey performed in 2017 are given in the supplementary materials. More than 80% of the people who completed a simulation-training course call for it to be made a statutory requirement. In response to this wish, NOE LKH concluded a contractual arrangement with SiZ in autumn 2017 to secure 10 more years of regular simulator training. To reach the intensity of aviation training as mentioned above (1 day of training per year for every member of staff in the acute departments), the volume of training would have to be increased by a factor of 5. The resulting costs of around €1,000,000 per year would still be under 1% of personnel costs obviously justified in terms of the reduction in harm to patients. The aforementioned report of the OECD (1) on '*The economics of patient safety*' quantifies the costs to the healthcare sector because of safety failures at 15% of the total costs. This would be approximately €12.6 billion for Austria for the in-patient sector alone. By this estimate, the costs of safety failures in Lower Austria must exceed some millions of euros per year.

For the team of instructors, the proposed expansion would mean an increase from the current 2 to at least 12 full-time equivalents. This would be an ambitious but feasible step. In recent years, 97 instructors have been trained at the SiZ. In comparison, the Centre for Medical Simulation (Boston, USA) provides around 330 training courses per year in various formats with an instructor staff of 12 full-time equivalents. Another interesting approach could be the intensifying of team-training activities carried out in Lower Austrian hospitals by local staff qualified by the 'train-the-trainer' concept following the InFacT® model.

The positive effects of team training on the safety culture in hospitals are described in numerous publications. There are clear signs of a shift in culture emerging in Lower Austria per the findings of the participants' report of courses and the findings of SiZ instructors during in-situ trainings in the hospitals. Acute departments of the hospitals (A&E, outpatient clinics, intensive-care units and operating theatres) are increasingly equipped with checklists and institutional algorithms, equipment has become more standardised, and increased attention is paid to the NTS of local staff. On the initiative of course par-

ticipants, team-training sessions (ALS, basic and specific emergency management) are carried out by the local staff themselves. The correct use of state-wide implemented checklists is trained on the simulator, as are the WHO-safe surgery checklist, anaesthesia briefing and the ESA emergency checklists. CRM-based team training, thus, appears to create awareness of the typical and frequent errors mentioned in the OECD report (1), their causes and consequences.

### Study limitations

Simulation models can be used to demonstrate the (potential) reduction of harm to patients, primarily through better performance in the NTS (29). In the reality of clinical patient care, it is much more difficult to clarify that simulation-based CRM training is able to reduce the probability of errors. This applies equally to our work. The records of the Lower Austria patient advocacy and also the data of the insurer of NOE LKH did not yield any actionable information in this sense on inquiry. However, newer publications do indicate positive effects (30). Moreover, numerous case reports describe immediate effects of competences acquired in training on patients. Finally, it is compellingly logical to train handling of critical situations in a virtual environment and in the team to manage them better. This must without doubt also be beneficial for the patients concerned.

## Conclusion

Over a period of 10 years, simulation-based CRM training was introduced and institutionalised at the NOE LKH group of hospitals, not least triggered by an increasing discussion on errors in healthcare by the public. The demand and acceptance for the training are both excellent, and hence, NOE LKH has decided to continue the programme for another 10 years. The previous costs of training were relatively low; the organisational model of an independent, non-profit registered association allowed the training activities to be implemented without reducing the availability of the instructors in their clinical roles. Notable by-products include the introduction of a CIRS, enhanced use of safety checklists and other measures to improve patient safety, all on the initiative of the course participants. These developments suggest that a new safety culture may be emerging. However, the rate of participation of staff in CRM-based team training must be increased substantially to ensure that the training is effective in daily practice. To reach all the healthcare staff in Lower Austria, the financing needs would be estimated at approximately €1,000,000 per year.

**Ethics Committee Approval:** Ethics committee agreement was received for this study from the ethics committee of Lower Austria. Due to the retrospective research character without any direct reference to patients, a formal approval was not deemed to be required.

**Informed Consent:** Written informed consent was obtained from all participants of simulation trainings as well as from simulation course instructors.

**Peer-review:** Externally peer-reviewed.

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**Table 1S. Training on the simulator: skills to be improved**

| Competence Rating by importance[1] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | ∑[2] |
|---|---|---|---|---|---|---|---|---|
| Ability to practice specific situations/problems | 22 | 16 | 20 | 10 | 9 | 20 | 18 | 115 |
| Better teamwork and definition of roles | 25 | 23 | 28 | 13 | 10 | 11 | 2 | 112 |
| Better situational control, less inhibition to speak up | 14 | 15 | 20 | 16 | 22 | 21 | 12 | 120 |
| Communication in the team works better | 8 | 34 | 15 | 31 | 17 | 13 | 6 | 124 |
| Ability to 'step back', to reevaluate the situation | 11 | 17 | 22 | 19 | 19 | 18 | 19 | 125 |
| Higher readiness to ask for help | 13 | 15 | 11 | 17 | 18 | 20 | 39 | 133 |
| Better knowledge of one's own behaviour in critical situations | 60 | 24 | 16 | 12 | 15 | 10 | 16 | 153 |
| Number of mentions | 153 | 144 | 132 | 118 | 110 | 113 | 112 | |

[1]Individual rating by participants, asked to score all the points according to priority
[2]Number of actual scores given

**Table 2S: Non-technical skills: team competence**

| Non-technical Skills Rating by importance[1] | 1 | 2 | 3 | 4 | 5 | 6 | ∑[2] |
|---|---|---|---|---|---|---|---|
| Team formation | 11 | 9 | 18 | 17 | 23 | 35 | 113 |
| Leadership by a team leader | 40 | 22 | 13 | 17 | 17 | 6 | 115 |
| Efficient and safe communication | 36 | 32 | 24 | 14 | 3 | 4 | 113 |
| Division of roles and prioritization | 8 | 33 | 34 | 24 | 12 | 4 | 115 |
| Decision-making | 8 | 16 | 13 | 26 | 31 | 22 | 116 |
| Situational awareness | 30 | 12 | 13 | 13 | 23 | 37 | 128 |
| Number of mentions | 133 | 124 | 115 | 111 | 109 | 108 | |

[1]Individual rating by participants, asked to score all the points according to priority
[2]Number of actual scores given

**Table 3S: CRM strategies to avoid problems**

| Individual strategy Rating by importance[1] | 1 | 2 | 3 | 4 | 5 | 6 | ∑[2] |
|---|---|---|---|---|---|---|---|
| Regularly reevaluate the situation in order to avoid errors | 41 | 18 | 12 | 17 | 15 | 8 | 111 |
| Assume nothing, question everything | 23 | 20 | 15 | 15 | 13 | 31 | 117 |
| Always speak up when there is a problem | 11 | 21 | 24 | 17 | 24 | 16 | 113 |
| Share problems with the team | 11 | 15 | 35 | 30 | 17 | 10 | 118 |
| Global view/evaluation of a situation | 18 | 27 | 15 | 13 | 21 | 20 | 114 |
| Systematic approach to problems | 29 | 24 | 14 | 18 | 18 | 25 | 128 |
| Number of mentions | 133 | 125 | 115 | 110 | 108 | 110 | |

[1]Individual rating by participants, asked to score all the points according to priority
[2]Number of actual scores given