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SUSTAINABLE SOFT COMPETENCES DEVELOPMENT OF SOFTWARE DEVELOPERS BY COMMUNICATION SKILLS TRAINING

Abstract. Soft competencies are of great importance for software developers like designers, programmers, testers, and maintainers. These competencies are also important for software companies in team work, interaction with stakeholders, etc. The main problem is to determine in which way soft competencies should be developed. In this paper a sustainable soft competences development of software developers is proposed. The relation between competences are important in the approach, hence influence diagrams between competences should be determined. Based on our research and literature analysis a competence model is proposed suitable for IT companies. These communication skills have the largest influence on other skills. A training cycle for software developers is proposed, to reach the goal of sustainable competency development. The training solution is reviewed and analyzed.

Keywords: soft competences, communication skills, software developers, HR sustainability

1. Introduction

Today, more and more companies understand that their success depends primarily on the potential of employed workers, which results not only in knowledge, but mostly in having and using proper skills. A common assumption is that a person in a managerial position in addition to his knowledge of project management should have appropriate social skills. However, the need of having staff with high soft skills in technical positions only reaches the awareness of stakeholders. Today's organizations working in the areas of IT are increasingly

aware that the professionals working for them should possess not only technical knowledge but also skills that will allow them to use this knowledge to a greater extent. Success in this business is directly related to the soft competencies of these employees. Here, a question arises, how to develop these skills and which skills should be developed in the first instance. An additional issue is how to develop employee competencies to the state desired by companies, teams and specific persons.

For the purposes of this article the following research problem can be formulated. Soft skills are necessary on software developer positions, because a large part of professional activities corresponding to this position is based on soft skills. It is important to develop soft skills in accordance to the needs of employers, teams and each individual in a sustainable way. Between soft competence there are different levels of dependence. The problem arises of how to develop a set of competencies to achieve sustainable goals. The research question considered here is, is it possible to develop soft skills through a dedicated training?

A hypothesis concerning the development of competencies can be formulated as follows. A dedicated training of software developers can increase the soft skills of the persons involved. The level of impact of some soft skills on the other can be determined. Communication competencies are characterized by a relatively high level of influence on other soft skills. Communication skills are key soft abilities, useful for other competencies (e.g. the ability to work in a team, negotiation abilities, etc.). It is advisable to start training on communication skills and determine their influence on other competencies. Sustainable growth of competencies should take into account the needs of employers, teams and the programmer itself.

Based on a literature review and the authors' experience, the following facts are identified. The development of soft skills of software developers affects the professional career. Strengthening their communication skills helps them in reaching personal goals at work (like raises, a promotion etc.). The software developer wishing to advance vertically must develop soft skills. The programmer willing to accept the functions of a team leader needs to have better-developed soft skills than other developers. Changing profession from software developer to project manager requires additional soft skills.

In order to verify to some extent the hypothesis, some training concerning soft competences were given to groups of graduate and postgraduate students. The analysis is based on observation and questionnaires completed before and after the training.

The proposed solution is based on the following findings. The relationship between competences can be described by influence graphs. A short training proposal aims to change attitudes of software developers to communication skills and increase awareness of the competence needs. Through a training workout, you can get an increase of competence in order to assess their level of growth.

The article defines the research problem and hypothesis concerning the development of soft competencies of software developers. The proposed solution will be validated to some

extend by carrying out cycle training course supporting the sustainable development of competencies.

2. Aspects of competence sustainability of software developers

At the beginning we should concentrate on what are software developers and why it is important to deal with that profession. At the beginning, a few definitions are proposed.

A software developer is a person taking part in a process of making software systems, concerned with activities like design, development, maintenance, testing, and evaluation. A Software engineer is a software developer applying software engineering methods. Usually, it is assumed that a software engineer is educated in a software engineering field. A programmer is a software developer; whose main task is writing software programs. In the paper we will use the term software developer and software engineer interchangeably.

Skills mean the ability to apply knowledge and use know-how to complete tasks and solve problems. Skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).

Competency is the ability to use knowledge and skills, and talents on personality, attitude, intelligence and motives to achieve some unspecified intentions. The concern is which person has the competency attributes and not where those competencies should be used. Competence means possessing the competencies needed to perform the work of a given position. The competence assessment will result from the occupation profile and competencies of the employee.

The SWEBOK (Software Engineering Book of Knowledge (Bourque, Fairley, & IEEE Computer Society, 2014)) requires that software engineers possess a proper set of knowledge, skills, training, and experience in professional practice. It defines knowledge areas (KA) concerned with the knowledge, skills, and attitudes that software engineers must possess to practice software engineering in a professional, responsible, and ethical manner. In SWEBOK software engineering professional practice areas are divided into subareas: professionalism, group dynamics and psychology, and communication skills. The study (Jamróz, Pitulej, & Werewka, 2014) shows a systematic approach to the development and assessment of competences that could be leveraged in software development companies. Another issue is the definition of the process of career path development, as well as the definition of the organizational structure supporting this process

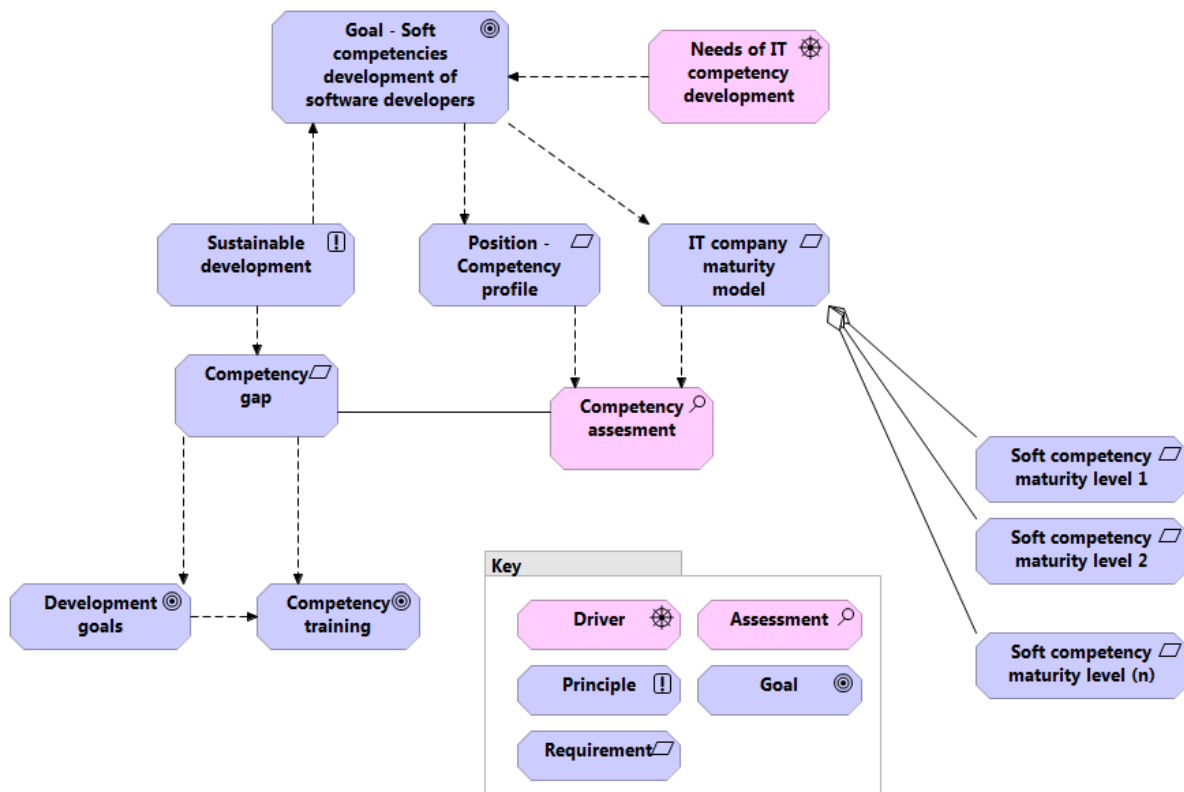


Fig. 1. Determining competence gaps and training goals

Generally sustainable development means a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Corporate sustainability (Dyllick & Hockerts, 2002) is defined as meeting the needs of stakeholders in the firm directly and indirectly (shareholders, employees, customers, pressure groups, communities and others), without affecting its ability to meet the needs of stakeholders in the future. In (YusKelana, Abu Mansor, & Ayyub Hassan, 2015) the key features of sustainability practices in human resources are reviewed and a number of terms that connects the relationship between sustainability and human resources. In (Gollan, 2000) HR sustainability is defined as an organization's ability to create value in an organization that is able to regenerate and renew wealth through human resource policies. The goals of Human Resource Management can be summarized as the 'Four Cs': commitment, competence, congruence and cost-effectiveness (Beer, Spector, Lawrence, Mills, & Walton, 1984). The four Cs are: Commitment that concerns employees' loyalty to the organization; Competence relates to employee's skills and abilities, training requirements and potential for higher-level work; Congruence means that management and workers share the same vision of the organizational goals and work together to attain them; Cost Effectiveness concerns operational efficiency.

Sustainable developing of soft competences means adapting the development of soft skills to the occupied position (including adopting to hard competences), to the needs of the team and the development needs of the company and the employee himself. In addition, it is

assumed competence development in an economically efficient and smooth way. It is not expected to develop competence "in stock". Desired outcomes should be achieved at the minimal expense and the organization should be prepared for the opportunities and changes in the market environment.

3. Soft competency model

The concept of soft skills in the context of software engineers begins to appear in IT organizations. So far, software engineers had to possess technical knowledge combined with experience. However, continuous development and a growing demand for better and better specialists caused the need to identify extra requirements such as soft skills.

There are different classifications of soft skills. An example is a soft skill taxonomy for the construction graduate (Mahasneh & Thabet, 2016). In this paper soft skills are extracted, reduced, classified and organized into 12 clusters that constitute the taxonomy. The obtained results are used to evaluate and determine a theoretical framework to implement soft skills in construction education. To maintain a competency framework, it is important to cluster the competences. Clustering units of competency for learning and assessment can help to produce developing learning and assessment strategies as well as realize significant efficiency benefits for their organization ("Clustering units of competency," 2013).

Increasingly, we realize that possessing soft skills affects different possibilities for employees such as rapid development, adaptation to new conditions, taking risk decisions and others. Therefore, there is a need to create a specific soft competency model of software developers, which will not only become a reference base for the development of software developers, but will be also helpful in determining a profile of future workers. In the previous study developers' views on the competencies of project managers are presented (Werewka & Wietecha, 2016). The position of IT companies regarding soft skills of software developers and project managers is investigated based on published job offers.

The model presented in this paper was created based on an analysis of: published job offers for software developer positions, the literature and various descriptions of software developers' duties and responsibilities.

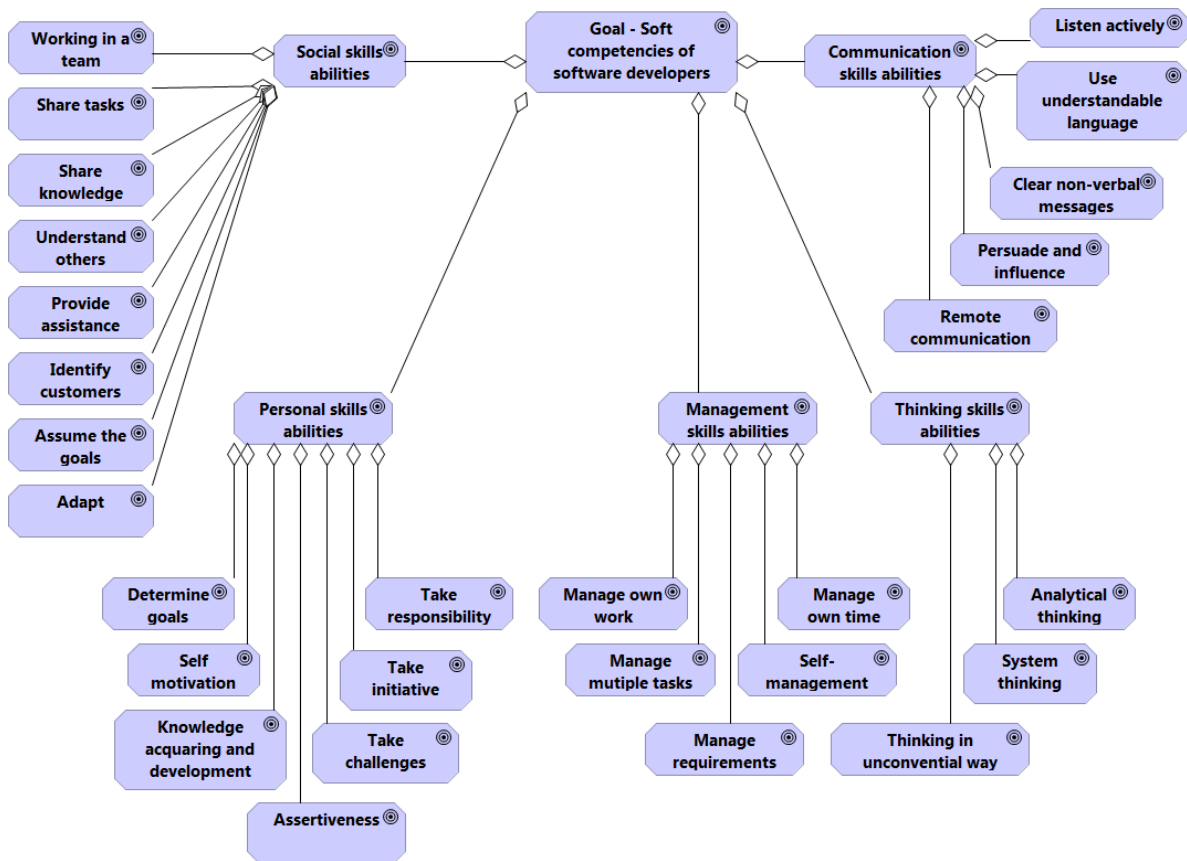


Fig. 2. Soft competency classification as a part of ArchiMate motivation model

The proposed soft competency model for software developers (Fig. 2) is based on competency clustering. This clustering method is based on the principle used in computer science to minimize coupling between groups and maximize cohesion (strong interrelation) within groups. Finally, the five competency clusters are distinguished:

1. **Social skills:** They relate directly to the behavior closely associated with interpersonal contacts at work. The main factor influencing to having the skills is aware-ness of the value of working with others and its impact on the efficiency of the individual and organization: Ability to work in a team, Ability to share tasks with others, Ability to share knowledge with others, Ability to understand other people, Ability to provide assistance, Ability to identify a customer's needs and respond to them, Ability to assume the goals and values of the organization, Ability to adapt the work to the standards dominating in the organization (e.g. SCRUM).
2. **Personal skills:** They are concentrated around self-development, self-motivation and focusing on personal goals: Ability to determine short- and long-term development goals, Ability to self-motivation, Ability to development and acquire knowledge, Ability to assertive approach, Ability to take on new challenges, Ability to take initiative, Ability to take responsibility.

3. Management skills: They focus mainly on own work. An employee who has the skills of this group is organized, operates according to a specific plan and fulfills own obligations on time: Ability to self-management, Ability to manage own time, Ability to manage own work, Ability to manage multiple tasks (multi-tasking), Ability to manage requirements.
4. Communication skills: They are undoubtedly the most important in a whole competency model. They determine the occurrence of most other competences, due to this, communication skills can be considered as the base for the development of soft competencies of software developers: Ability to listen actively and react to messages of others, Ability to use proper/understandable language, Ability to communicate clear and understandable non-verbal messages, Ability for remote communication, Ability to persuade and influence others through communication.
5. Thinking skills: They refer to the analysis, verification and assessment of the problem and the selection of the appropriate mindset to find the solution: Ability to analytical thinking, Ability to systems thinking, Ability to think in an unconventional way/out of the box.

The proposed model should be effective and useful for IT companies. In companies there is a need for a comparison of competences and positions. Therefore, a systematic approach should be used to develop and maintain employee competency descriptions. The approach is based on the following principles: (1) One set of position competencies should be adopted covering the needs of an entire company; (2) This set should be as small as possible to be easy to maintain; (3) Each competence should be expressed by the level of its achievements; (4) For each position a profile is determined, which defines competence levels necessary for this position; (5) An employee occupying a particular position, is evaluated in terms of their competence; (6) A competency gap is determined based on employee competencies shortages or excess; (7) Based on the information gathered, the employee may be assigned appropriate tasks, and a suitable career path can be proposed.

The principles are universal and can be adapted almost to each profession. Due to the nature of the IT sector, solutions should be adaptable in accordance with the needs of the industry. The proposed model (Fig. 2) has been adapted to the needs of software engineers' competency development. This model is a tradeoff of not being too general or too detailed.

4. Sustainable competency development

In sustainable competency development relations between competences is of great importance.

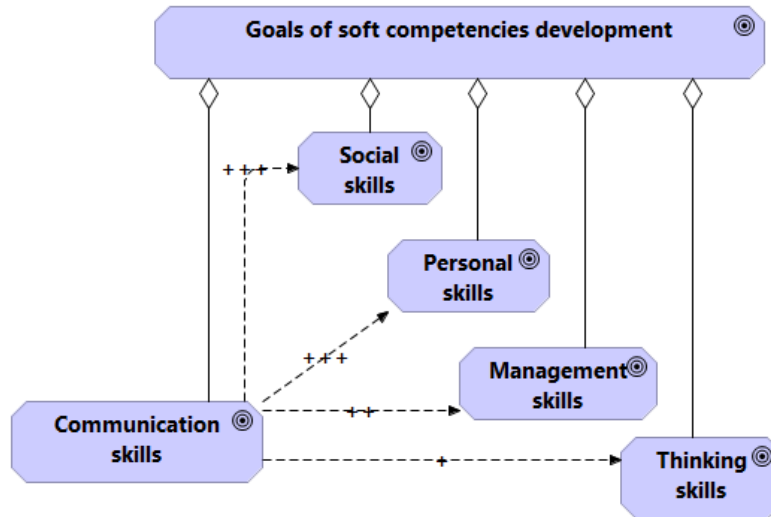


Fig. 3. Competency influence relations modeled in ArchiMate

The following formal model is introduced for a single person. A person has a set of n competences values: $C = \{c_1, c_2, \dots, c_n\}$. For each competency a competency required level can be defined as follow: $C^R = \{c^R_1, c^R_2, \dots, c^R_n\}$. The quality function Q should be based on two quality factors Q_1 and Q_2 as follow:

$$Q_1 = \sum_{i=1}^n (c_i - c_i^R), \text{ for } (c_i - c_i^R) \leq 0 \quad (1)$$

$$Q_2 = \sum_{i=1}^n (c_i - c_i^R), \text{ for } (c_i - c_i^R) > 0 \quad (2)$$

Sustainable competency development means to maximize the quality factor Q with minimal effort. The coefficients should be cautiously selected. E.g. $(\alpha = 1.0, \beta = 0.0)$ means that the competency above the required level has no value, or $(\alpha = 1.0, \beta = 0.3)$ means that competency above the required level has some value, but triple less.

Let us consider some training proposals: $TP = \{C^0, \Delta C_{\text{training}}, \text{eff}\}$. The proposal assumes that the person has already some initial competency level $TP = \{C^0, \Delta C_{\text{training}}, \text{eff}\}$. Additionally, the training should be directly concentrated on some increments of competency $\Delta C_{\text{training}} = \{\Delta c_1, \Delta c_2, \dots, \Delta c_n\}$. Increments of competency can cause indirect increment of competences. E.g. training on communication can increase directly

communication competency c_i , but indirectly other competences (c_j competency here): $c_j = c_j^0 + f_{ij}(c_i^0, \Delta c_i)$. The function f_{ij} – describes some influence relation between competences.

Another problem is to determine effort needed to increase some competence. In that case the cost of the training (effort) can be determined using the learning curve approach. One of the formulas is based on the logarithmic method allowing for the determination of training effort needed to reach n competency units: $eff_N = eff_1(N^b)$, where eff_N = time (effort) needed for the N th unit, eff_1 = hours to produce the first unit, $b = (\log \text{ of the learning rate}) / (\log 2) =$ slope of the learning curve. Based on the presented formula we can determine the effort needed to reach competence increase Δc_i starting from c_i^0 .

The presented model is based on many assumptions. To validate some of the assumptions a practical investigation should be presented. In this case a training proposal is given and the results of this training are investigated.

5. Training proposal assumptions

Humans learn, (gaining knowledge and experience) how to react properly, through specific situations. There are different ways to learn soft skills. The process of learning is influenced by culture, the environment we live in and our predispositions. From earliest age values and principles are inculcated in us. We follow them in later life and they determine our skills. Soft competencies can be taught on your own, by a deliberate desire to acquire specific experiences.

Learning soft competencies is time consuming. In this process we must pay attention to three factors (Morreale, Spitzberg, & Barge, 2006): knowledge (it consists of content, that is what should be done and procedures, that is how it should be done), experience (repetitive, deliberate, not accidental, goal-oriented behavior) and motivation (that makes a person tend to competent behavior in a particular situation). Training for soft skills should take into account all three factors.

Kechiagias K. (ed.): Teaching and Assessing Soft Skills, 2011 was written as a practical guide to practitioners who want to get involved in the teaching of soft skills to disadvantaged groups of young people, and elaborates the methodology used and results obtained from the assessment efforts of the partners.

Soft skills training should be a part of sustainable development. This will bring the best results by taking into account such factors as the nature of the occupation, the hard skills required, the development needs of organization, team and employee seniority and experience. Soft competences should be developed to respond to current needs so it is very important to prepare training for specific people.

In preparing content for training software engineers, it is necessary to pay special attention to the professional situation with which employees have to face every day. Providing knowledge based on examples causes that it will be better absorbed. Focusing participants on the concrete possibilities of the use of soft skills, creates a greater likelihood that they will use these skills in the future. An awareness that the use of certain soft competencies causes particular effects, is not enough. There is a high probability that the software engineers will consider these skills of little use, if we do not indicate where the competencies could be used. Participants will interpret the contents more personally, if they partially become creators of this training and they can share their own knowledge and experience with others. Active involvement of participants in the training process opens up new possibilities for the use of these competencies in various contexts. Participation can be enhanced by asking questions during training about their experiences or about the possibility of using the discussed issues in their daily work. The training should encourage participants to look for opportunities in their professional life, where the skills can be made use of.

Another important element of the soft competencies training is to motivate the participants to use the acquired skills in the future. This motivation can be created by defining a particular career goal by the participant, and determining which soft skills will be important to reach the goal. The use of coaching tools (e.g. The first step, Begin with the vision of the end (Wilczyńska, 2013) can help them with determining the goal. Motivation will be stronger if a participant shares his goal with others. This commitment affects goal achievement because every man strives to maintain an image of a consequent person in other people eyes. This consequence is highly valued in our culture, it is associated with strong personality, stability and integrity. That is why one tends to be evaluated by others as consequent in words, convictions and actions. Evidence of this is the rule of engagement and consequence of Robert Cialdini (Cialdini, 2008).

People learn soft skills through concrete experiences, so the training itself is only the beginning of the process of learning. Therefore, it is appropriate to include coaching sessions in the training cycle of the particular cluster. This will support participants after the training, maintain their motivation and help them develop skills gained during the training. Depending on the desired level of soft skill development, assuming the training applies only to one cluster, the training course should last 4-6 hours and sessions seem to be the most effective if they take place from 1 to 3 months after the training with the frequency adapted to the participants' needs (1-4 times a month). Such frequency seems to be optimal to achieving visible effects.

6. Validation of training results and motivation attitude

The impact of training on the development of soft skills was tested during communication skills training. Participants were asked to complete questionnaires before and after the training.

In a training set participated two groups of 46 postgraduate students on IT Project Management on the Faculty of Electrical Engineering, Automatics, Computer Science and Biomedical Engineering and two groups of 40 Computer Science graduate students of the same Faculty. Most of the postgraduate students hold software developer or other technical positions.

The first questionnaire (filled before the training) gives information about the state of knowledge about the communication skills of the participants and previous experiences with the use of communication skills in the workplace. The second questionnaire (filled after the training), based on questions verifying knowledge and motivation, enables the estimation of increased knowledge and motivation in using communication skills in the near future.

Before the training, the participants showed very little general knowledge about communication skills. Answers on the first questionnaire were very similar concerning all training groups. When asked for examples of situations in everyday work, in which communication skills are useful, respondents most frequently cited business meetings, communication in a team, communication with customers and presenting their work results. When asked about situations where an awareness of non-verbal communication leads to results, responses were very general. The most common were presentations, negotiations, meetings. Some of the respondents were aware of non-verbal messages impacting on their image and clout. Before the training, respondents were also asked to list the ways they created a professional image at work. Replies indicated that software developers usually build they images through their own work, honest performance of their duties and acquiring education. They also willingly share their knowledge and support others, they try to minimize the number of mistakes and always be prepared to work.

The second questionnaire, filled after the training, contained more precise answers. Definitely the training content impact could be seen on both the knowledge and motivation of the participants. The students declared their willingness to use gained skills in specific professional situations such as voicing their own ideas or negotiating con-tracts.

It is noteworthy that the answers to the questions in Questionnaire 2 shows that the majority of the participants treat the information gained during the training very personally, because it is concerned with their professional life. Research showed willingness to work on themselves through the way they dress, working on the tone of their voice, and providing concise and specific answers to questions. Such responses may indicate that the participants

realized specific things they should work on to have a better impact on their professional image.

The participants were asked to determine the importance of communication skills on technical positions in IT (Fig. 4). In most cases, it was assessed at high level (third in the four-level scale) in the first questionnaire and assessments did not change significantly after the training. IT specialists are aware that communication skills are important in their work, which was also reflected in the active involvement part of the course of training.

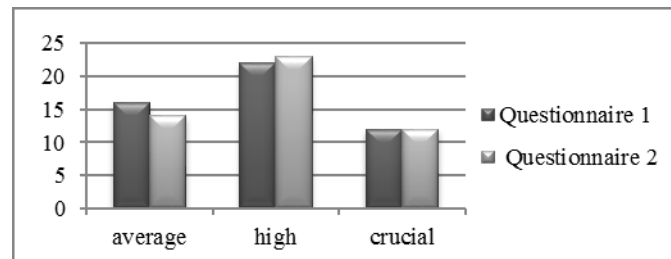


Fig. 4. The importance of communication skills on technical positions in IT

There was also a question about the importance of non-verbal communication on technical positions in IT (Fig. 5). The respondents assessed this communication at high level (third in the four-level scale) and in a lot of cases in both questionnaires. Those who before the training found the importance of non-verbal communication on low or medium level, after the training determined the importance on a higher level.

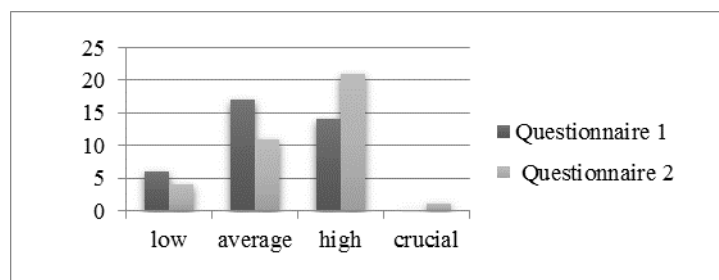


Fig. 5. The importance of non-verbal communication skills on technical positions in IT

This form of training seems to generate the intended effects. It does not only transmit knowledge but gives motivation to work on oneself by developing soft skills and shows concrete solutions for needs disclosed in the training course. A strong focus on participants' motivation to develop communication skills and reference training directly to the situation of professional life of participants gives the good chance that the knowledge gained during the training will become soft skills in a short period of time.

7. Conclusions

Software developers should have soft skills according to their position and development needs. Many applied trainings do not bring the desired effects and are burdened with high costs. The aim of the article was to develop a model of competence and development with emphasis on the relations between them. In order to validate solutions at this stage the paper focused on communication competences important for people who develop software. The results will be used to develop a complete model of competence development in accordance with the principle of sustainable development.

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