Multivariate Statistical Analysis in Missing Skills Identification

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Abstract: The human capital development programs, partly financed by the means of European Social Fund, result in activities with the goal to equip students with skills not offered in traditional education and training system. Especially unique, so called soft skills seems to be necessary in contemporary professional careers and thus on the labour market. Courses developing skills such as team work ability, leadership, creativity, independent thinking and innovative approach to problem solving will be financed. Here, the university graduates are of special interest. For that purpose, a thorough analysis of needs is necessary. Existing databases describing the quality of human capital should be analysed in order to identify those competencies that graduates of universities are missing. Rich arsenal of multivariate statistical tools may be applicable for analyses. The list covers a wide range of techniques, from the simplest methods of descriptive statistics to advanced multivariate statistical clustering methods. Authors of the study examined and obtained results in an attempt to identify the missing soft competences using available statistical data. The list of specific results of the analysis includes identification of desired (by employers) competence profile. It has been confronted with the declared (by potential employees) possession level of soft skills. The level of compliance (convergence) of declared needs for soft competences (demand, employers' declarations) with the declared possession of soft competences (supply, potential employees' declarations) has been made. The credibility of respondents' declarations was assessed. Additionally, the conclusion that priority setting whether demand or supply side determines the directions of trainings has been drawn. It appeared that there is substantial consent on both sides. Nevertheless, decomposition (identification of) convergent and divergent indications have been made. Along with merit goals, the technical analysis of applicability of selected multivariate statistical analysis tools and techniques for the purpose of soft skills analysis has been made.
The policy recommendation coming from results of this analysis may be formulated on two observations: The improvement of the competences: Performing calculations and Working with computers and using the Internet should be accomplished, regardless the job type. The specialized competences should be improved depending on job type. The inference from results leads to the conclusion, that also employees see clearly the distinction between general competences, useful (necessary) of any job, and specific competences, needed for individual job.

Keywords: human capital, missing skills, multivariate statistical analysis

1 Introduction

For the define definition of the education results, the terminology and definitions adopted in The European and National Qualification Frameworks are used. Key terms in education output description include knowledge, skills and personal attitudes. The analysis of the graduate description, although there is no direct indication on weights attributed to those three groups of teaching and learning results, leads to the conclusion, that one may expect some kind of equilibrium.

The analysis of the reality in the higher education, and analogously in other segments of education and training system, shows that effort and stress is attributed mainly to knowledge, in the second order to the skills, and in minimal degree, one cares for acquired personal attitudes, often referred to as soft skills.

On the labour market, the main player is employer. It is Obvious, that employers declare completely opposite hierarchy of expected employee characteristics. On the top of the hierarchy of expected employee characteristics soft skills are placed. On the second place are skills. The erudition, knowledge, although desirable, is considered by employer as additional, supplementary criterion.

In 2015 survey, 77% employers surveyed by CareerBuilder said they were seeking candidates with soft skills, and 16 percent of the respondents considered such qualities more crucial than hard skills[1].

Appreciating this discrepancy, the Polish Ministry of Science and Higher Education has launched in mid-2015, the Competency Development Programme in form of additional financial means for activities to equip students with soft skills necessary on the labour market and in scientific careers. Analogous measures are planned in Operative Program[2] *Knowledge Education Development 2014–2020* (PO WER) partly financed with mean of European Social Fund. The task is to develop skills such as team work ability, leadership, creativity, independent thinking and innovative approach to problem solving.

Although the general list of soft skills desired by employers covers universal skills, there is significant diversification of expectations across workplace types and across professions groups[3]. To guarantee, the measures to improve soft skills are a success, there is necessity for thorough analysis of needs. Deep and competent assessment of compliance (convergence) of declared level (self–assessment) of possessed soft skills with the declared employers' needs (demand – supply analysis) is necessary[4].

Interesting possibility aroused with development of databases describing the quality of human capital. The most widespread mode of assessment of the level of soft skills possession is subjective approach. In this technique, the respondent declares to

1 See for example The Ten Unique Soft Skills … (2015), Why Attitude is more Important (2015). Similar results for Polish employers have been found in Dziechciarz et. al (2006), Kurkliński and Maszybrocki (2008), Maszybrocki (2010). Extensive literature review on the topic may be found in Getting Youth (2013).

2 The program description may be found in (Szczegółowy 2015).

3 Dziechciarz (2012 and 2016a) gives extensive discussion on education results quality.

4 For discussion see for example Dziechciarz (2015a) and Dziechciarz Duda, Przybysz (2014).

which extend she/he is able to use individual soft skill. The possible, alternative, approach to assess the level of soft skills is to measure it in tests. The goal is to prove, that a person is able to use individual skill. Additionally one may classify, on which level she/he is able to use individual soft skill. Such objective measurement is extremely expensive, time consuming, and requires frequent updating of results. This is the reason, why it is used extremely seldom. Multivariate statistical analysis framework provides arsenal of tools for purpose of looking into large database of self-assessment statements[5]. The list starts with basic descriptive statistics, along with correlation and dependence measures, factor and correspondence analysis, up to classification techniques.

2 The objective of the analysis

The demand – supply analysis comparing employees' self-assessment side (supply) with employers' statements concerning importance of individual skill for particular workplace type (demand side) has a task to assess compliance (convergence) of declared self-assessment of possessed soft competences with the declared employers' needs[6]. The list of specific objectives of the analysis includes:

— Identifying desired (by employers) competence profile and its confrontation with the declared (by potential employees) possession level of soft skills.
— Assessment of compliance (convergence) of declared needs for soft competences (demand, employers' declarations) with the declared possession of soft competences (supply, potential employees' declarations).
— Credibility assessment of respondents' declarations.
And additionally:
— Priority setting whether demand or supply side determines the directions of trainings?
— Decomposition (identification of) convergent and divergent indications.
— Testing of applicability of selected multivariate statistical analysis tools and techniques for the purpose of soft skills analysis.

All databases on the topic, available in Poland should be analysed in order to identify those competencies that graduates of universities are missing. In the presented analysis, as main source of statistical data, the fifth edition of the Polish Study of Human Capital was chosen. The details of the study and the source data are availa-

5 Dziechciarz, Błaczkowska and Grześkowiak (2009) discuss applicability of econometric approach for evaluation of education systems this analysis is further deepened in the article by Dziechciarz Duda, Król (2012) and Dziechciarz, Dziechciarz Duda, Król and Targaszewska (2014).

6 Dziechciarz et al. (2012) give comprehensive analysis of erudite competences on the primary and secondary school level.

ble on the web page of the study (http://en.bkl.parp.gov.pl). The used database contains information coming from large number of respondents (*BKL2014* …, 2014). It covers over 64000 employers and 70890 of potential employees[7]. The database used for analysis in this article, was collected during the implementation of the 2014 edition of the Project *Study of Human Capital in Poland* (*Study of …* 2014). In further text, the database will be referred to as BKL2014.

3 Concepts, definitions and methods

3.1. The soft skills

The classification of soft competencies, developed for the purposes of the Study of Human Capital in Poland, consists of twelve groups, both for employees[8] and for employers (see table 1).

7 Unfortunately, database contains variable description only in Polish language.

8 The soft competencies for Employees are further classified into subcategories: C01_1: quick summarizing large amounts of text; C01_2: logical thinking, factual analysis; C01_3: continuous learning new things; C03_1: perform simple calculations; C03_2: perform advanced mathematical calculations; C04_1: basic command of MS Office; C04_2: knowledge of specialized programs, writing programs, web pages; C04_3: computer and internet literacy; C07_1: making independent decisions; C07_2: entrepreneurship and showing initiative; C07_3: creativity; C07_4: resilience to stress; C07_5: timely completion of planned activities; C08_1: group cooperation; C08_2: ease in establishing contacts ; C08_3: communicativeness; C08_4: solving conflicts between people; C10_1: assigning tasks to other employees; C10_2: coordinating the work of other staff; C10_3: disciplining other staff; C11_1: frequent trips; C11_2: flexible working hours flexible working time.

Symbol		Soft competency description
C01	Z01	Seeking and analysis of information, and drawing conclusions
C02	Z02	Technical imagination, handling and repairing technical devices
C03	Z03	Performing calculations
C04	Z04	Working with computers and using the Internet
C05	Z05	Artistic and creative skills
C06	Z06	Physical fitness
C07	Z07	Self-organisation of work and showing initiative
C08	Z08	Contacts with other people
C09	Z09	Organisation and conducting office works
C10	Z10	Managerial skills and organisation of work
C11	Z11	Availability
C12	Z12	Fluent use of Polish language (linguistic correctness, wide vocabulary, ease of speaking)

Table 1
The classification of soft competencies, developed for the purposes of the Study of Human Capital in Poland
Note: the symbols with description C and Z refers to Employees, and Employers, respectively.
Source. BKL http://bkl.parp.gov.pl.

The basic hypothesis concerning required skills is that along with universally expected skills, each branch of the economy and administration requires unique, specific skills. In most cases, those specific skills, and the differences in the level of competencies possession is sought as fundamental. Describing industry relevant competence level is crucial both for education system as well as for labour market institution and their training and retraining policy. The list of universally desired skills covers honesty, cooperation, concern for quality, commitment, communication. Employers consider that those characteristics are additional to professional (technical) competences, which are veto type presupposition. General position is that employers trust the formal diploma, believing that education system is effective in forming knowledge and specific hard skills, different for different industries. Universities as part of education system are doing a much better job in training of specialized technical competence than soft skills. Universities positively react towards business and administration expectation on general responsibility of higher education for shaping good professional specialist equipped with required (hard) skills. Greater discrepancy between education side and employers exists, when responsibility in development of soft skills is discussed. Employers expect that education system will equip potential job applicants[9]. The university system represents the opinion that the employee's horizontal and vertical mobility on labour market makes it impossible to fit into each possible requirement. It seems obvious, that in

9 Extensive discussion on the topic may be found in results of EURYDICE and MODERN projects; see Higher Education (2008) and De Boer and File (2009).

present time, the cooperation between business, administration and education is not working effectively. The governmental authorities encourage close cooperation with employers organisations and representatives, both in the construction and assessment of the teaching programs in order to optimise the use of education resources to improve graduate's labour market readiness. Companies that cooperate with universities declare greater ease in obtaining the competent employees. On the part of the deficits answer may be introducing elements of curriculum design and activities based on actual case studies, carried out in cooperation with business.

3.2. Descriptive analysis of competences

Simple plots have been used (box and whiskers) in order to demonstrate the basic characteristics of declared level of possessed soft competences.

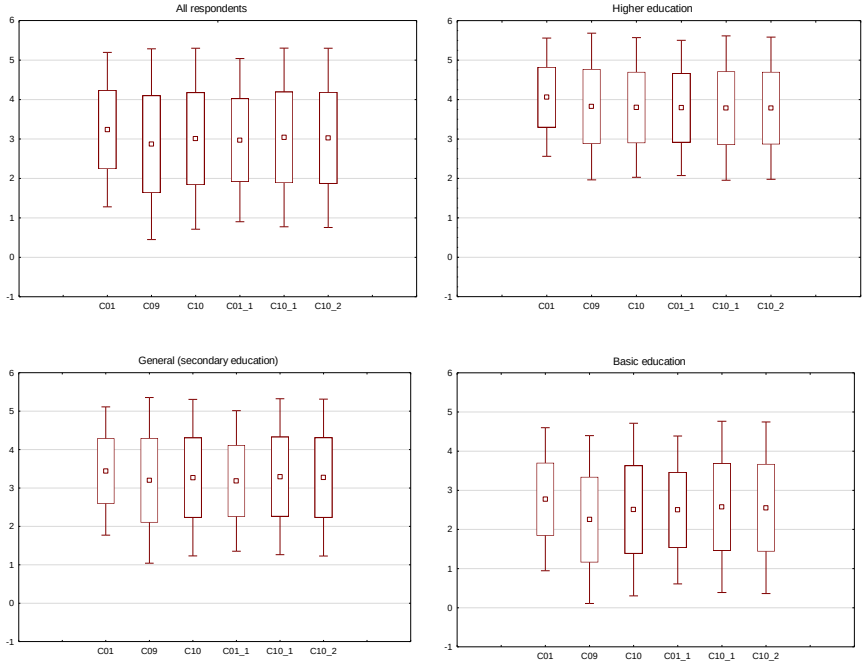

Figure 1
Box and whiskers plots, level of possessed soft competences, declaration of potential employees broken down by educational groups
Source: Own calculation on data from BKL2014.

The respondents (employees) with higher education diploma (least numerous group) manifest relatively high self-assessment with low variability. Respondents with basic education show much lower level of soft competences, accompanied with much higher variability (figure 1). The respondents with secondary education, in

accordance with expectation, show more optimistic picture of their soft competences than people with basic education and less favourable in comparison with those with higher education. Such statements give moderate, cautious ground to assess, that respondents carefully formulate their self-assessment, at least in accordance with the level of their education. It gives some reasoning for the use of subjective statements as a base of analysis. In our analysis, these are potential employers who represent the opposite (demand) side. They consider quite optimistic soft skills and the level of its possession by potential employees. The difference between the answers: *fully satisfactory* and *unsatisfactory, employees require additional training)* differs only slightly. The message coming from the figure 2, may be understood as the situation, where employers accept, to large extent, that employees are lacking certain skills, but this may be improved by additional training. Over thousand respondents (1051, i.e. 25.0%) and almost three thousand respondents (2961, i.e. 70.4%) said that potential employee possess, respectively *fully satisfactory* and *satisfactory, but the employees need some additional training*. Only 196 respondents (4.7%) declare, the competences are *unsatisfactory, employees require training*. The worst assessment concerns competences Z2, Z5, Z9 and Z10.

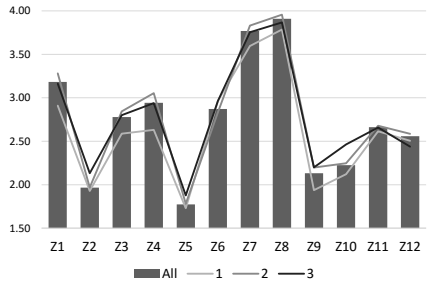

Figure 2
Employers' assessment of soft competences of potential employees

Note: the employers' assessment of soft competences are broken down by the level of satisfaction with the skills of potential employees:
1 – fully satisfactory,
2 – satisfactory, but the employees need some additional training,
3 – unsatisfactory, employees require training).

Source: Own calculation on data from BKL2014.

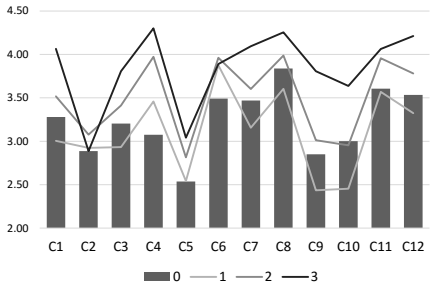

Figure 3.
Employees' assessment of soft competences;

Note: the employees' assessment of soft competences are broken down by the level of education:
1 – basic education graduates,
2 – general (secondary) education graduates,
3 – higher education graduates,
0 – the rest of respondents.

Source: Own calculation on data from BKL2014.

Figure 3 demonstrates interesting phenomenon. Solid histograms show self assessment for respondents who finished education six or more years ago. The lines show

graduates[10] of certain level. It is striking, that in general, graduates overestimate their competences in comparison with more experienced employees. Especially those with higher education seems to be over optimistic in their opinions. Analogous with employers, the C5, C9 and C10 are seen as most problematic. General inference for whole sample of respondents may be used for general purposes only. Among the five most sought after professions in Poland in 2014 were, respectively, a truck driver, a sales representative, salesman, cook and accountant[11]. This substantiate the choice of sales representative and accountant as test cases for closer insight. An attempt to compare expectations on the employers' side with the employees' judgement gives interesting insight into differences on required skills. It is not surprising, that for employer, the ability of effective work goes first. Employee is seeking good working atmosphere. The striking difference may be seen in high importance of *working with computers and using the Internet* competence, in employers' hierarchy, and low in employee hierarchy. Analogously, the competence: *contacts with other people, either with colleagues or customers* is very high in employees' hierarchy, and low in employers.

3.3. Analysis for selected job type. Sales representative and Accountant

The specific job type requires specific skills in general, and in particular, specific soft skills. In this particular situation, demand and supply of competencies necessary for accountancy job is analysed. Taking into consideration the knowledge on the differences between the nature of sales representative and accountant jobs[12], it is not surprising, that appropriate differences are manifested in employers' declarations (figure 4). Analysis of similarities and differences in self-assessment of competencies for individual job gives insight into the way, employee consider ability to take responsibility to work on particular post.

10 Graduates are defined as those, who finished education within last five years.

11 Dziechciarz (2015b and 2016b) extensively discusses the effectiveness and efficiency of training. On nonmonetary results see Dziechciarz Duda and Król (2013). Different point of view may be found in a book Górniak ed. (2015).

12 The number of respondents in the database consists of 164 for accountant jobs, and 420 for sales representative.

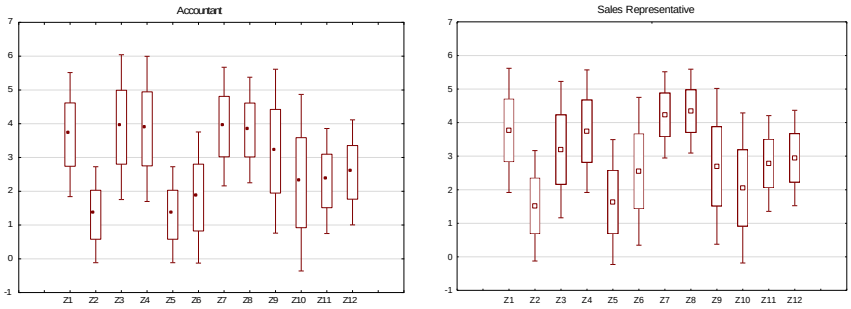

Figure 4
Box and whiskers plots, employers' assessment of soft competences
Source: Own calculation on data from BKL2014.

One may easily see groups of jobs with set of soft competencies. To large extend, sets shown are the same (similar), but some differences might be seen in assessment of job requirements with respect to soft skills.

For in depth insight, analytical technique of factor analysis[13] has been applied. For our purpose, one of the most popular variants of factor analysis, the main component method has been used. The technique variant with Equamax normalized rotation has been used. The method have been used for an attempt of the identification of main components in the employees declarations concerning importance of individual skills. The results are shown in the tables 2 and 3. An interesting insight may be drawn when comparing results contained in the table 2, where the results of an attempt of the identification of main components in the employers' declarations concerning importance of individual skills are shown with the table 3, where results of an attempt of the identification of main components in the employees' declarations concerning importance of individual skills are shown. Obtained results give indication for possible training effort direction and the most effective, or desirable education or training programs. In any case skills Z3 and Z4 (*Performing calculations* and *Working with computers and using the Internet***)** should be included in all variants of training. Otherwise, the composition of factors differ for both jobs types (Accountant and Sales Representative).

13 The technicalities may be found, among others, in Garson (2013) and Osborne (2015).

Factors / Competence	All jobs types		Accountant		Sales Representative	
	I	II	I	II	I	II
1	2	3	4	5	6	7
Z1	0.790		–	–		
Z2		0.832	–	–	–	–
Z3	0.717		0.803			0.738
Z4	0.824		0.795			
Z6		0.723	–0.780		–	–
Z7	–	–	–	–	0.818	
Z8	–	–		0.790	0.749	
Z9	0.768		–	–		0.803
Z10	–	–	–	–		0.817
Z11	–	–		0.718		
Z12	–	–		0.825		
% of variance	42.821	20.880	38.894	26.324	39.61	16.60

Table 2

Results of factor analysis. Employers' assessment of skills importance, in general and for selected jobs

Note: in the table, factor loadings >0.700 are included. Empty cells contain (hidden) factor loadings that have values lower than 0.700. Symbol "–" denotes competence omitted in presented version of analysis.

Source. Own calculation with the help of STATISTICA and SPSS packages on data from BKL2014 database http://bkl.parp.gov.pl.

The policy recommendation coming from results of this analysis may be formulated on two observations:

— The improvement of the competences: *Performing calculations* and *Working with computers and using the Internet* should be accomplished, regardless the job type.
— The specialized competences should be improved depending on job type.

The inference from results shown in the table 3 leads to the conclusion, that also employees see clearly the distinction between general competences, useful (necessary) of any job, and specific competences, needed for individual job. The deeper division of competences types is necessary to identify commonalities. The description of employee's declaration on competences importance is more complex, and for individual job, three factors were necessary. The composition of individual factors is even more distinct for the job of Accountant and Sales representative. This statement, gives ground for optimism. Namely, it means that potential employees, analogously to the employers, manifest reasoned, intelligent assessment of needed

competences along with realistic statements describing the level, they possess competences in question. To some extend it is a surprising result. The common opinion is, that employees overestimate own abilities, and employers underestimate them. The careful analysis of data in BKL2014 database overthrows this opinion. Unlike the results of demand side (employers), and supply side for all employees, where two main components were identified. For specific jobs selected for in depth analysis, three main components were identified.

Factors / Variable	All job types		Accountant			Sales Representative		
	I	II	I	II	III	I	II	III
1	2	3	4	5	6	7	8	9
C01		0.790		–	–	0.723	–	–
C01_1		0.810	–	–	–	–	–	–
C01_3		0.700	–	–	–	–	–	–
C03					0.854	–	–	–
C03_1	–	–			0.839	–	–	–
C04		0.729				0.872		
C04_2		0.755		–	–	–	–	–
C07			0.797					
C07_1	0.702							
C07_2			0.810				0.815	
C07_3			–	–	–		0.790	
C07_5	0.747							
C08	0.837			0.842		0.799		
C08_2	0.846			0.798		–	–	–
C08_3	0.818					–	–	–
C10	–	–	–	–	–		0.871	
C11	–	–	–	–	–			0.847
C11_1	–	–	–	–	–			0.883
C11_2	–	–	–	–	–			0.757
C12						0.811		
% variation	34.05	32.12	44.42	13.43	9.14	42.70	15.33	9.69

Table 3

Results of factor analysis, principal component variant, with Equamax normalized rotation. Employees' assessment of skills importance, in general and for selected jobs

Notes: In the table, factor loadings >0.700 are included. Empty cells contain (hidden) factor loadings that have values lower than 0.700. Symbol "–" denotes competence omitted in presented version of analysis.

The list of soft competencies for Employees are given in table 1.

Source. Own calculation with the help of STATISTICA and SPSS packages on data from BKL2014 database http://bkl.parp.gov.pl.

Conclusions

Results of analysis of the reality in the higher education, and analogously in other segments of education and training system, shows that effort and stress is attributed mainly to knowledge, in the second order to the skills, and in minimal degree, teachers and education organisers care for personal attitudes, often referred to as soft skills acquired by students and trainee's. Obvious observation, that each job requires specific competences, may be quantified with the help of simple and more advanced statistical tool. The *sine qua non* condition is reliable data on what employers need, and what employee are capable to manage on individual, specific job type. Both educators and governmental agencies seem to appreciate the need to improve soft skills. Assuming, the erudition (knowledge), will be provided in formal education system, the Government effort goes in direction of improving skills and soft skills. As an example may serve Competency Development Programme launched by Ministry of Science and Higher Education and Operative Program *Knowledge Education Development 2014–2020* (PO WER) partly financed with mean of European Social Fund. The task is to develop skills such as *team work ability, leadership, creativity, independent thinking* and *innovative approach to problem solving*. Although the general list of soft skills desired by employers covers universal skills, there is significant diversification of expectations across workplace types and across professions groups. Comprehensive analysis of needs, deep and competent assessment of compliance (convergence) of declared level (self–assessment) of possessed skills with the declared employers' needs (demand – supply analysis) is necessary, to guarantee that the measures to improve soft skills are effective.

The confrontation of desired (by employers) competence profile with the declared (by potential employees) possession level of soft skills gave the measurement result for the level of compliance. It seems that the convergence of declared needs for soft competences (demand, employers' declarations) with the declared possession of soft competences (supply, potential employees' declarations) gives a possibility to rationalize the training plans. Important result is confirmation of the credibility of respondents' declarations, both on employers and employee side. It appeared that there is substantial consent on both sides. The latter leads to recommendations that it does not matter, whether demand or supply side determines the directions of trainings. On the other side, along with common skills, there are specific needs.

The policy recommendation coming from results of this analysis may be formulated on two observations: The improvement of the competences: *Performing calculations* and *Working with computers and using the Internet* should be accomplished, regardless the job type. The specialized competences should be improved depending on job type. The inference from results leads to the conclusion, that also employees see clearly the distinction between general competences, useful (necessary) of any job, and specific competences, needed for individual job.

Along with merit goals of the analysis, the applicability of selected multivariate statistical analysis tools and techniques for the purpose of soft skills analysis has been confirmed.

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