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SURVEY QUESTIONNAIRE FOR THE STUDY ON OCCUPATIONAL SAFETY CULTURE IN A PRODUCTION PLANT. CONSTRUCTION AND STATISTICAL VERIFICATION OF DATA CORRECTNESS

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Abstract
The article presents the issue related with a proper preparation of a data sheet for the analysis, the way of verifying the correctness and reliability of input information, and proper data encoding. Improper input or coding of data can significantly influence the correctness of performed analyses or extend their time. This stage of an analysis is presented by an authorship questionnaire for the study on occupational safety culture in a manufacturing plant, using the Statistica software for analyses. There were used real data, obtained during the research on the issue of occupational safety and factors having the greatest influence on the state of occupational safety.

Keywords
Safety analysis, correlation coefficients, computer programs, software safety, process identification.

Introduction

According to the Journal of Laws 2016, item 380: "An enterprise is an organise set of non-material and material components, aimed at running a business activity". An enterprise (organisation) functions in certain environment and, according to the organisation model by Hatch [1], is composed of four elements" culture, social structure, physical structure, and technology. Accepting such organisation model (Fig. 1), we can assume that an occupational accident will cause a change of functioning of each module of an enterprise and will have an influence on it, as well as on the enterprise's environment. Regardless the accepted enterprise model (where elements overlap or there are strong dependences between them), if elements function properly, they can cause a synergy effect, or in case when they do not cooperate, we can face a defect of dissymmetry [2]. A proper level of occupational safety is the basis of a success of each company. This dependence was noticed in the works by Brown [3] and Zohar [4]. Occupational safety depends also on subjective feelings of employees, their views, beliefs, their attitude towards norms and procedures.

A similar approach can be found in works of Cooper [5], Neal et al. [6], and Silvia et al. [7]. However, practices of numerous enterprises, focusing more on efficiency than safety, reveals that there is still much to work on in the field of occupational safety.

Especially in the area of awareness that each accident (regardless of its level) cause financial losses of a company. According to data from Central Statistical Office – Statistical Yearbook of Industry – Poland [8–11] and data included in Accidents at work in 2007 [12] and Accidents at work in 2015 [13] in manufacturing plants active in Poland, the number of accidents at work is still decreasing (Fig. 2). However, the tendency is not constant. While the number of accidents at work in Polish industry in 2013 significantly decreased, the value for 2015 slightly increased when compared to 2014 and 2013.

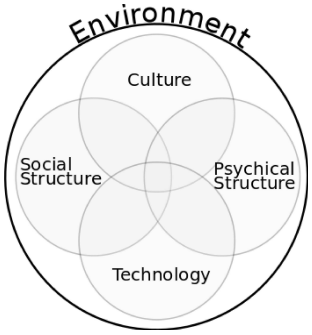


Fig. 1. Organisation model by M. Hatch.

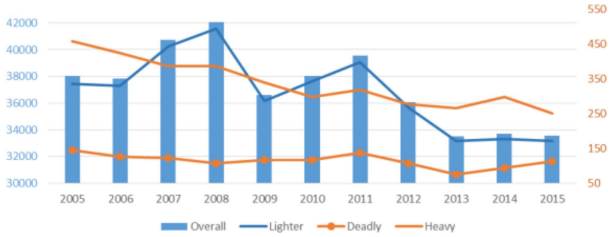


Fig. 2. Accidents at work in Polish industry in the years 2005–2015 (own elaboration on the basis of data of the Polish Central Statistical Office).

On the basis of data included in elaborations: Working conditions in 2015 [14], Accidents at work and work-related health problems) [12, 15], and Lubuskie Voivodeship. Subregions. Poviats. Gminas [16], the Fig. 3 was developed, presenting the number of employees working in the dangerous conditions in the industrial branch in Poland in the years 2005–2015. Király and Restás [17] also examined the working conditions in some special, dangerous circumstances. We can observe that Polish entrepreneurs care about the working conditions of their employees. The number of employees endangered by bad working conditions is constantly decreasing.

The aim was development of an original tool for measuring the level of occupational safety climate (a survey questionnaire, evaluation of reliability of developed tool).

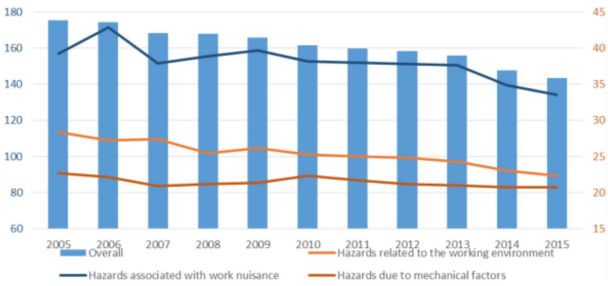


Fig. 3. Employees working in hazardous conditions in the industrial branch (per 1000 employees of analysed population) in Poland in the years 2005–2015 (own elaboration on the basis of data of the Polish Central Statistical Office).

Correlation between working conditions and the number of occupational accidents

As Pántya wrote, the dangerous working conditions are different than at the industrial area and needs high attention in some special workplace, for example at the emergency services [18]. In order to verify whether there is a relationship between working conditions and the number and severity of accidents, the correlation between these two factors was analysed. The correlation factor between these two variables is positive and equals to 0.706 (Table 1). This indicates a quite strong correlation. Thus, working conditions have an influence on the number and severity of occupational accidents.

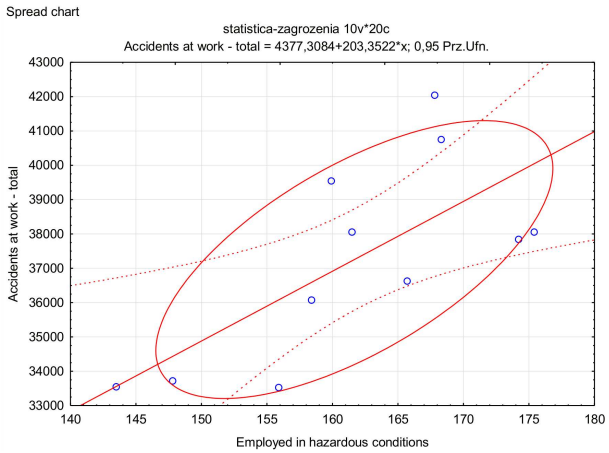


Fig. 4. Accidents at work and employment in hazardous conditions.

Table 1
Correlation factor between working conditions and the number of occupational accidents.

	Average	Standard deviation	Employed in hazardous conditions	Accidents at work in total
Employed in hazardous conditions	161.67	10.065	1	0.706104
Accidents at work in total	37253.82	2898.524	0.706104	1

The correlation factor at the level of 0.706 is an evidence of a quite strong dependence. However, it does not exceed 0.9. Thus, we can draw a conclusion that not only work conditions have an influence on occupational safety but also other factors. So called human factor may have a significant influence on occupational safety. It is confirmed by statistics of reasons of accidents at work (Polish Central Statistical Office, 2014), stating that:

- about 60% of accidents are due to human causes,
- about 30% of accidents are due to organisational causes,
- about 10% of accidents are due to technical causes.

Statistics concerning reasons of accidents at work confirm the thesis that it is necessary to build proper awareness of employees in order to provide a high level of occupational safety. In order to shape the employees' awareness and introduce interventional and countermeasure programs, it is essential to perform a diagnosis of the awareness of employees in the field of occupational safety. Such diagnosis is necessary that countermeasures were adjusted to the character of an existing problem and to a group of employees in accordance to the sociodemographic structure (different methods should be used in case of young employees and other for those with longer experience, etc.). When processing study results, it is often that one, consciously or unconsciously, is planning an experiment, choosing statistical tools of various types [19]. In such way, costs and duration time of an experiment are limited, by elimination of input values, as well as a decrease of the number of values of inputs [20, 21]. Statistical tools are used in numerous branches of science [19, 20, 22], what enables decreasing financial expenditures, necessary for conduction of an experiment, what in turn, results in decreased amount of time. Thus, a survey questionnaire for studying the level of occupational safety culture was used to determine the human factor. According to Hofmann & Stetzer [23] and Salminen [24], occupational safety culture is a measure of the level of implementation and considering as own guidelines concerning safety. Technical and organisational aspects related with occupational safety are legally regulated and are subject to controls and verification. It is relatively easy to identify them and to check the correctness of the technical state of machines, devices, and infrastructure of an enterprise. A problem appears at the moment of identifying proper use of technical safety measures, or if they are used at all. Having even the most modern technical safety measures or management systems does not guarantee a proper use of them. One can assume that the level of occupational safety culture is an objective indicator, specifying the level of occupational safety in a manufacturing plant and the level at which employees regard rules, norms, and guidelines concerning safe work conditions.

Survey questionnaire

The study on the level of safety climate was conducted using an original survey questionnaire [25, 26]. The aim of the developed survey was to document opinions of employees concerning the level of occupational safety culture in a company. The concept of the questionnaire arouse after an analysis of existing questionnaires in this field. In practice, there are numerous tools for evaluating the level occupational safety culture. According to work "Occupational Safety and Health culture assessment – A review of main approaches and selected tools, European Agency for Safety and Health at Work", we can distinguish the following tools of not commercial character (commonly available and free) [27]:

- Score Your Safety Culture Checklist,
- Hearts & Minds programme – Understanding Your Culture Checklist,
- Safety Climate Assessment Toolkit and User Guide (LSCAT),
- Safety Health of Maintenance Engineering (SHoMe) Tool,
- Nordic Occupational Safety Climate Questionnaire (NOSACQ-50),
- IAEA Guidance for Use in the Enhancement of Safety Culture.

Among the above mentioned tools, there is no tool for measuring the level of occupational safety culture in Polish. These are not universal tools that could be used for any manufacturing plant. Each tool is dedicated to a certain branch of industry or business activity. As a result, there arouse the necessity to develop a tool that would meet needs of Po-

lish manufacturing companies (especially, considering micro, small and medium enterprises).

Questionnaire construction

The survey was verified in practice (pilot studies were conducted) [28]. The study aim was to check the level of safety culture observed in analysed companies. When developing the questionnaire, in order to eliminate the conflict between properties (declaration of respondents that they represent a high level of safety) and attitude (revealed in detailed questions), it was decided that attitudes would be a more significant and useful indicator that properties. Instead of asking respondents if they and a company present a high level of occupational safety culture, we ask them a series of questions concerning issues related with occupational safety and health, and related issues, which are a determinant of high occupational culture.

Due to that, it was necessary to determine which of dimensions of the notion of occupational safety culture are its essence and should undergone operationalisation. As a result, the following designates of high occupational safety culture were accepted, which, at the same time, became theme groups in the original survey questionnaire:

I. Knowledge about occupational safety – education and training of employees – what employees should know. Do employees have a possibility to acquire information (knowledge) about threats at a work post and in a company. At this point, it must be stressed that we study only possibilities employees have in a company, while the question if they use them or not is included in point XII. According to the rule that three conditions must be met: to be able to – to know – to use.

II. Views and beliefs - Prompt reacting to problems concerning safety. "A belief that safety is a value connected with each aim of an organization".

III. Communication in the field of occupational health and safety – Communication based on mutual trust.

IV. Attitude towards occupational safety crew – Stimulating engagement of employees with occupational health and safety aims, confidence in their validity and the necessity of realisation, and team work.

V. My influence on occupational safety – Developing care over safety of one self and co-workers.

VI. Attitude of superiors towards safety – Engagement of the management in safety and leadership issues; Determining a declaration of occupational health and safety policy and proper procedures and norms.

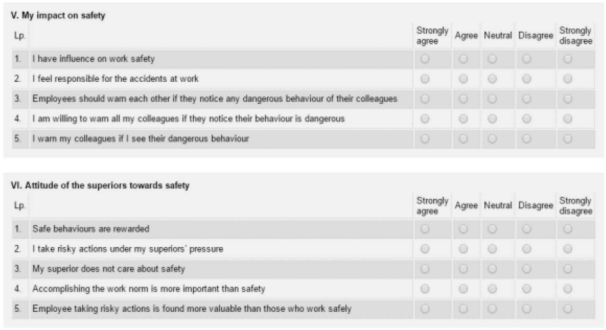
VII. Attitude towards occupational health and safety trainings – Education and training of employees.

VIII. Resistance to stress – Stimulating of engagement of employees with occupational health and safety aims, confidence in their validity and necessity of realisation, and team work.

IX. Motivation to safe behaviour – Expressing appreciation to group and individual achievements.

The scope of the survey covers all determinants of high safety culture, its questions are of simple language in order to be understood by every employee – from the management to unqualified workers. An often mistake when preparing surveys is using too professional, difficult language. This may cause difficulties for respondents in understanding questions, what causes discouraging of employees.

The questionnaire, includes five detailed questions in each theme group (Fig. 5). The survey is completed by demographic and social features of respondents such asage, sex, education, seniority.



V. My impact on safety

Lp.		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.	I have influence on work safety	○	○	○	○	○
2.	I feel responsible for the accidents at work	○	○	○	○	○
3.	Employees should warn each other if they notice any dangerous behaviour of their colleagues	○	○	○	○	○
4.	I am willing to warn all my colleagues if they notice their behaviour is dangerous	○	○	○	○	○
5.	I warn my colleagues if I see their dangerous behaviour	○	○	○	○	○

VI. Attitude of the superiors towards safety

Lp.		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.	Safe behaviours are rewarded	○	○	○	○	○
2.	I take risky actions under my superiors' pressure	○	○	○	○	○
3.	My superior does not care about safety	○	○	○	○	○
4.	Accomplishing the work norm is more important than safety	○	○	○	○	○
5.	Employee taking risky actions is found more valuable than those who work safely	○	○	○	○	○

Fig. 5. A part of the survey for study on the level of safety climate [28].

Individual results show the way in which particular employees perceive occupational safety culture of his/her company. The overall result of all employees is the indicator of occupational safety culture of a company, which can be compared to results obtained at other enterprises. Evaluation of safety culture enables identification of areas that require changes or empowerment. It may be used in the course of creating prevention programs and evaluating the efficiency of such programs. The survey questionnaire used in the study has the Cronbach's alpha factor equal to 0,949, what indicate a high level of the reliability of a study tool.

Measurement scale

The survey used disjunctive closed questions (allowing a choice of only one answer). Five-grade Likert scale was used for evaluation of questions. This

scale was chosen as it allows not only to know opinions of respondents, but also to evaluate their determination in a certain issue. Likert scale has the character of a formal level. The category of those who are not able to determine their views, is a neutral opinion, situated in the half of the scale. There are five possible answers: definitely yes, rather yes, I don't know, rather not, definitely not. Answers in each category can obtain a specific number of points (from 0 to 4). The sum of points for all answers gives us the index of occupational culture level in a company. In order to eliminate "mechanical" completion of the survey, there were used questions with an opposite scoring for particular answers (Table 2).

Table 2
An example of questions with opposite scoring [4].

	Definitely yes	Rather yes	I don't know	Rather not	Definitely not
I take risky actions under my superiors' pressure	0	1	2	3	4
Safe behaviours are rewarded	4	3	2	1	0

The survey is composed of 45 questions (5 questions per each designate of high occupational safety culture). The result of 180 points (45 questions * 4 points) indicates a high culture of occupational safety of a respondent. Persons presenting extremely low culture of occupational safety obtained 0 points, while 90 points is the level of not decided respondents (45 questions * 2 points).

Selection of study sample – acquisition of data

The study was conducted in September and October 2016 in manufacturing companies in Poland, in the area of Krosno poviat in Lubuskie voivodeship (Fig. 6).

In order to realise assumed aims, 745 surveys were conducted in manufacturing plants located in Krosno poviat. An important factor when selecting companies was the will of managements to cooperate, as well as the availability of data. The following criteria were used for selection of companies:

- analysis of companies located in Krosno poviat (the scope of studies close to the place of living, the possibility to conduct studies in person),
- legal and organisational form was not considered,
- branch – manufacturing,
- ownership form – immaterial.

Fig. 6. Location of Krosno poviat on the map of Poland.

In order to verify whether the sample amount is sufficient, the strength of test was calculated using Statistica software. The strength in the analysed example was 1. Thus, the sample number is sufficient in order to regard study results as reliable.

Table 3
Test strength results.

Average of null hypothesis (Mi0)	0.0000
Average in population (Mi)	3.3900
Standard deviation in population (Sigma)	0.7800
Standardized effect (Es)	4.3462
Sample number (N)	745.0000
First order error probability (Alfa)	0.0500
Critical value t	1.9632
Strength	1.0000

Data input

Data from surveys are directly input into databases by respondents (in case of electronic version) or indirectly by the survey administrator (in case of paper survey). The database, based on MySQL, stores results of surveys and it is managed by the phpMyAdmin tool.

This software enables: creating/deleting of databases, adding/deleting of relations, editions of structures and content, as well as export of data between them to a spreadsheet [29]. Statistica software has inbuilt tools for importing files, thanks to which one can load and transform data files from various applications using tools for file importing (which is launched using Open option from the File menu and selecting an imported file). Statistica software can load e.g. Excel sheets and text files. Figure 7 presents the scheme of survey data flow to the database used in the study.

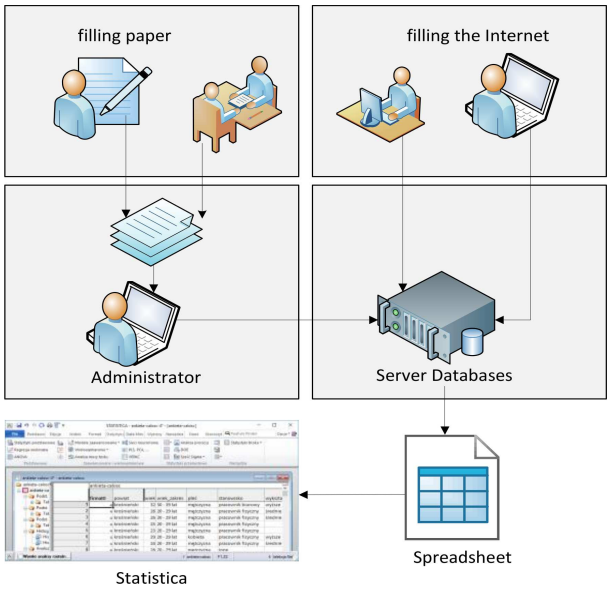


Fig. 7. Scheme of survey data flow to the database.

Data cleaning

Statistica supports a process of data cleaning using a series of modules designed for preparation of data that, for example, enable verification of data correctness, a change of data coding, management of data lacks and handling protruding cases, what allows a significant decrease of necessary verifications of source surveys.

Identification of protruding data or a lack of data

The spread chart is a very helpful form of diagnosing protruding cases. Figure 8 presents the chart of "age" variable spread, according to which we can observe that there are 16 lacks in this variable (this means that 16 persons did not provide their age in the survey).

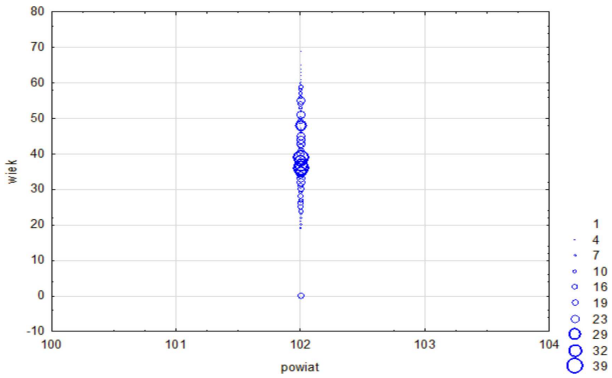


Fig. 8. "Age" variable spread chart – protruding observations.

Completing lacking data

Lacks in age variable were supplemented by the average. For this aim, a new variable (column) was created, with a formula that will verify if there is value of 0 in age variable. If such condition is met, instead of 0, there will be input the average value (in this case, the age average was equal to 38). Figure 9 presents the following fields: 1 – name of new variable, 2 – content of verifying formula [=*if(age = 0 and age <18; VARMEAN(age); age)*], 3 – final effect of change of 0 value to average.

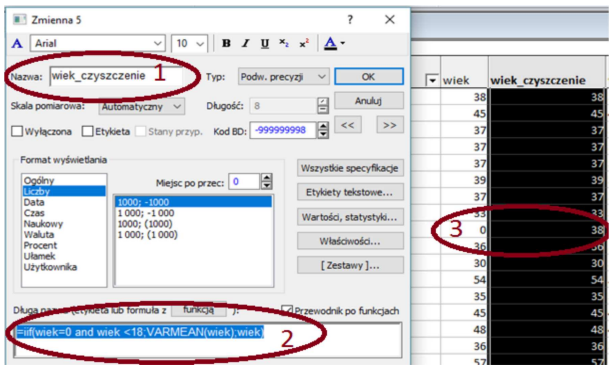


Fig. 9. Complementing of lacking data – age.

Change of coding (data aggregation)

Figure 10 presents the way of re-coding of age variable into ranges. It is possible to use the re-coding tool in any time from the data sheet. For this aim, use "Re-code" option from "Data" menu. There will be displayed "Re-code"" window for the variable, allowing defining new values if conditions set by us are met. In Fig. 9, the following fields are marked by numbers: 1 – re-code button, 2 – example condition, 3 – final effect of creating ranges for "age" variable.

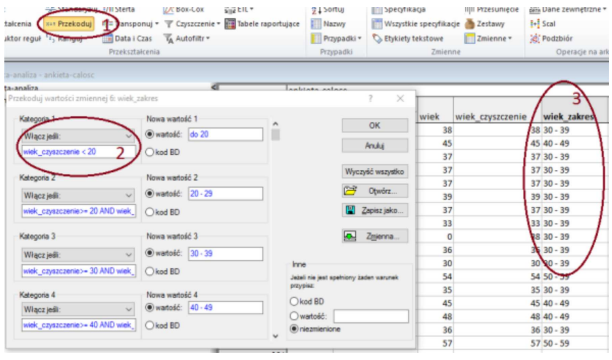


Fig. 10. Change of data coding – ranges for age variable.

Graphical presentation of results

Statistica includes a rich set of charts, enabling data visualisation. Data can be presented using sim-

ple pie charts, or histograms (Figs 11 and 12). The graphical way of presenting the empirical distribution enables interpretation of obtained study results, as well as makes presentation of data more attractive.

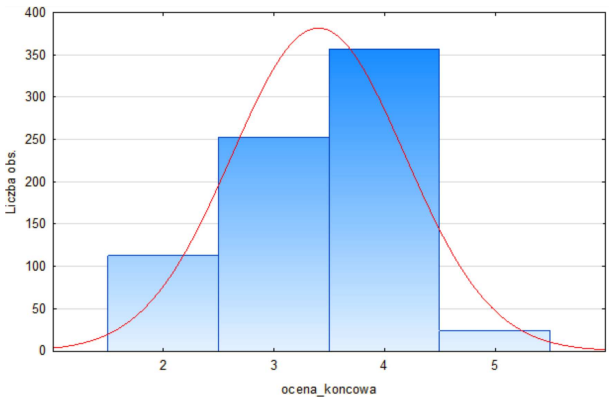


Fig. 11. Histogram of the frequency of final evaluation of safety culture level.

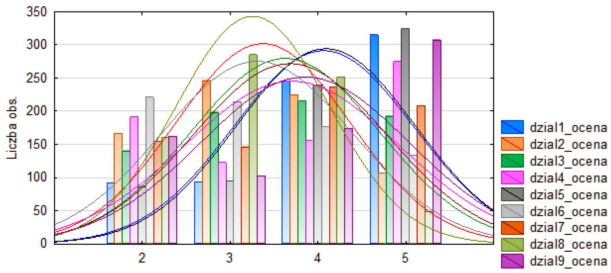


Fig. 12. Histogram of the distribution of the frequency of final evaluation of safety culture level, broken down by divisions corresponding to particular designated determining the level of occupational safety culture.

Summary

Survey studies are a complex process, requiring the knowledge of methods of concluding research, as well as having proper analytic tools, supporting researchers at each stage of processing results. Advanced tools supporting the process of survey data analysis, system enabling inputting survey data, proper processing of results. Collection of data is a long-lasting and arduous activity. However, more difficult is proper data analysis, including e.g. graphical presentation of obtained data. Proper analysis of data allows one to draw valuable conclusions. In that way, it is an efficient tool supporting companies' activity, increasing the efficiency of their activities. Thanks to using data analysis, we are able to discover knowledge enabling perfection of activities and supporting decisive processes in a company. Statistica facilitates the process of data analysis, and in case of databases composed of large amount of data, Statistica (or similar software) make analyses possible at all.

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