Article

Methodology and Statistical Modeling of Social Capital Influence on Employees' Individual Innovativeness in a Company

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Abstract: The research deals with the problem of identification and substantiation of mechanisms of social capital influence on individual innovativeness of employees, which increases the positive innovation effect in companies. The study proposes a new methodological approach and technology for assessing the social capital of employees, taking into account the factors of interpersonal and institutional trust, involvement in social networks, social norms, and its impact on the employee's innovativeness. The methodology uses methods of system analysis and synthesis, expert assessments, statistical modeling, and survey. Numerical experiments are carried out using collected data from special surveys of employees of a machine-building company. An assessment of social capital and its impact on the employee's innovativeness is determined and a statistically significant influence of the factors of "trust" and "social networks and connections" on social capital is set. It is revealed that the main determinant of innovativeness is the risk appetite. It is proved that the innovativeness model includes factors of "trust" and "social networks and connections". The cumulative effect of social capital on innovativeness is positive and statistically significant.

1. Introduction

Sustainable economic growth is a high-priority problem of modern economic policy. In solving these problems, the central idea is people and human capital development. However, in addition to knowledge and experience, it is necessary to take into account employees' ability to create social communities that are open to a variety of communication and trust infrastructures, where organizational social capital is formed, contributing to an added value increase.

In research of innovation, insufficient attention is paid to the study of the characteristics of innovation in relation to its ability to create and adapt new ideas, as well as to use it in practice and develop new products. The emergence and implementation of new ideas or technologies do not always go smoothly. In order to freely diffuse into society, the system of relations and social values must correspond to the innovation conditions. This implies the importance of research on social and cultural determinants of innovation and innovativeness.

Their own management decisions and reforms do not affect individual innovation; they have an effect when social capital is accumulated. This increases the likelihood that innovative processes will have an effect. However, so far, studies have not discussed in detail the foundation or economic and social mechanisms of social capital's influence on innovation in a company. Identification and justification of such mechanisms is the objective of this paper.

The objective of this study is to show whether social capital and its factors influence a person's decision to introduce innovations and change the probability of creative thinking and behavior, i.e., whether they intentionally influence innovation.

The article is organized as follows. Section 2 describes the features of the study of social capital and discusses its structure, factors, and levels. Furthermore, the existing methods and approaches to the study of innovation at different levels are discussed, and factors of personal innovativeness are shown. Section 3 describes the proposed methodology for social capital assessment and its impact on innovation. Section 4 is devoted to the analysis of numerical experiments that proved the efficiency of the developed methodology and discussion of study results.

2. Literature Review

2.1. Human Capital and Social Capital

The concept of physical capital embodied in machines, equipment, and tools can be expanded by including the concept of human capital [1]. Unlike physical capital, which is formed through the transformation of the material to produce goods, thereby modernizing production processes, human capital is created through the internal transformation of the individuals themselves as a result of their skills and abilities. The origin of social capital is associated with changes in relationships between individuals and facilitates their activities [2].

If physical capital is fully tangible and can be embodied in material objects, then human capital is less tangible. It manifests itself in the skills and knowledge acquired by the individual. Social capital is even less tangible since it is based on individual relationships. Along with physical and human capital, social capital facilitates human activity—labor, production, and innovation.

The function of social capital is to create a certain value from social structure and translate it into a resource to achieve individual or group purposes. A person's behavior is formed under the influence of not only rational personal interest but also irrational factors such as emotions, moral restrictions, social obligations and expectations, trust, and knowledge. In this context, the main condition for an effective organization is people's ability to interact with each other, the quality of teamwork, and the ability to trust colleagues and external counterparties.

The initial stage of conceptual studies devoted to social capital dates back to the 1970s and was associated with the relationship between social inequality and the education of economic actors. In accordance with Coleman's theory [2,3], social capital was presented as an "analytical construct", and the theory of social capital is terminological in nature, which organizes the concepts developed by previous research traditions into a single theory. Furthermore, since the 1990s, social capital has continued to be explored in the tradition of Coleman. The idea of the positive role of social capital in economic growth has been reflected in a number of publications [4,5]. The ideas of Coleman and Putnam are similar in that they represent social capital not as social relations, but as a thing. Social capital is presented differently in the theoretical and methodological works of Bourdieu [6,7]. Bourdieu's concept uses the economic foundations of the category of "capital", and social capital manifests itself in social relations, similar to Marx's capital concepts. The difference between these theories is the choice and analysis of research object. For Bourdieu, this is a capital relation, embodied in material forms, and the research subject of Coleman and Putnam is a social capital thing. Bourdieu defines social capital as "a certain amount of resources, actual and virtual, acquired by individuals or groups through the possession of more or less institutionalized relationships of mutual acquaintance and recognition" [6].

Furthermore, the issue of social capital is steadily becoming included in the research agenda not only in the field of sociology but also in the field of economics and related areas of scientific knowledge. This interest is explained by the fact that social capital holds a special place among other capital forms, since social relations form the substance of capital, and does not simply give certain resources. It is increasingly recognized that social capital

is one of the main factors influencing the economic development of enterprises, regions, and countries. Fukuyama [8] defines social capital as "confirmed informal norms that promote cooperation between two or more individuals".

2.2. Organizational Levels of Social Capital

A multilevel analysis of the social capital of an organization was first carried out by Turner [9], who defined social capital as "the forces that increase the potential for the economic development of a society by creating and maintaining social ties and models of social organizations". These forces act at the macro-level in the form of individual associations to solve fundamental issues related to the production, reproduction, regulation, and coordination of basic needs at the meso-level as corporate elements of human capital and categorical elements that generate social differences that affect the attitude in society, and at the micro-level as direct personal relationships within corporate and social units.

Solving the problem of social capital determination at a company (organization) level, it is important not only to identify the social capital of an individual but also to obtain, based on such assessments, the corporate social capital as a whole. At the same time, corporate social capital is formed through a synergistic synthesis of individuals' social capital. Corporate social capital should be considered at various interrelated and mutually conditioning levels: at the level of the individual employee, at the level of the organization as a whole, and at the level of inter-organizational networks.

The study of individual social capital involves an analysis of the readiness of the economic subject to maintain trusting relationships with their colleagues, as well as an assessment of the importance to develop social ties to improve their well-being or moral satisfaction. At the corporate level, studies analyze social structures forming and connections with other social structures, as well as the distribution of social interaction results. This takes into account the corporate culture characteristic. In an individualistic culture based on competition between employees, performance takes precedence over goodwill, and trust is built on calculation, which leads to a decrease in the willingness of employees to share experience and skills. In a collectivist culture, much more importance is attached to the commonality of values and goodwill, the receipt and dissemination of information, since they cover a much larger audience than formal ones. Informal channels are capable of transmitting and receiving information both horizontally and vertically.

2.3. Forms of Social Capital

In general, there are three forms of social capital: trust (interpersonal and institutional), social networks and connections, and social norms and values. Let us consider each of these forms in the context of social and economic effects at different levels.

2.3.1. Trust Norms between Individuals

Trust in the sphere of business relations [10,11] is characterized as "the optimistic expectation of a person, group or company that is in a situation of vulnerability and dependence on another person, another group or company in a situation of the joint activity or economic exchange in order to contribute, in ultimately, mutually beneficial cooperation between the parties". There are two components of trust—rational and emotional. The rational component determines the degree of an employee's confidence that a colleague, manager, or subordinate is able to fulfill their obligations. This component is based on the assessment of competence, labor productivity, and the consistency and predictability of actions. The second component—emotional—is based on an assessment of the common values and motives of employees: goodwill, openness, motivation to achieve a common goal, and decency. Trust, as the most important form of social capital, contributes to the creation of economic results through the mechanism of reducing transaction costs [8,12,13]. This is achieved by easier access to information and resources, reducing the cost of control functions.

2.3.2. Social Connections and Networks

"Social network is a pattern of social connections in a social group" [3]. The analysis of networks led to the emergence of the idea of types of social capital (bonding and bridging). The impact of social networks and connections on regional economic growth was first noted in [5]. Researchers showed that differentiation in economic development between regions depends on the presence of horizontal ties. This is explained by information networks. Olson in [14] argued that horizontal associations can act as special groups lobbying for preferential policies to the detriment of overall economic development, adhering to a different point of view on the horizontal tie's influence. Later, in empirical work, social groups that have the theoretical ability to positively or negatively influence economic development began to be called the Putnam and Olson groups, respectively.

Hypotheses about the influence of social groups on economic growth were tested in [12]. It was found that there is no statistically significant effect. At the same time, horizontal associations contributed to the public trust, as well as forms of civic engagement. In [15], the positive influence of the Putnam group, which was understood as the respondents' membership in charitable organizations, was found. In [16], the hypothesis of a positive impact of Putnam groups was also not rejected. In [17], the influence of the Putnam and Olson groups on socio-economic development was detected.

2.3.3. Social Norms and Values

Of particular interest to researchers are problems about the relationship of social norms and values with social behavior and social capital. However, the results obtained are quite heterogeneous and ambiguous. One of the reasons for the deviations in the significance and strength of the connection between values and activity found by researchers may be the methodological difficulties in indicator measuring, as well as the ambiguous nature of the relationship between value judgments and real behavior [18]. There is a point of view that the cultural (value) schemes that determine behavior are not fully accessible to people's minds and, accordingly, they are difficult to measure [19]. Discrepancies can also be caused by the confluence of third factors, such as cultural differences, and the success of the value scenarios implementation that distort the direct influence of the individual's values, social behavior, and social capital. To clarify the influence of the individual's values on their actions, it is necessary to limit the number of factors mediating the relationship.

The study [12] confirmed the influence of social norms and values on social capital. The degree of civil cooperation was measured. This approach is quite common in measuring social norms and is the result of a standard sociological survey "To justify or not to justify?" adapted for analysis. Substantially, the measure of civil cooperation norms reflects the willingness to cooperate expressed by the respondents when faced with the problems of collective action. To determine the social capital level, indicators of social norms are used, for example, the obedience of children to parents [13] and prosocial behavior [20]. It is argued that parents want to prevent possible deviant behavior by educating obedience in children.

2.4. Social Capital and Its Impact on Organizational Performance

The effects produced by social capital are diverse. A number of studies have shown that social capital determines crime [21], life quality satisfaction [22], efficiency of economic and political system, poverty [23], labor productivity [24], open innovation and firm performance [25–28], unemployment rates and other parameters of public well-being.

The relationship between a team's social network architecture and team innovation is discussed in [29]. The authors argue that team social capital, operationalized as bridging and bonding social capital, negatively influences team innovation via team proportional task conflict, which is the level of problems conflict teams experience proportional to the general level of team conflict. The results revealed that "teams with bonding and bridging social capital are less innovative because they experience less proportional task conflict" [29].

Understanding the role of social capital in a company's socio-economic efficiency goes back to the concept of capital and its economic significance and main property—to generate income. According to the authors [30], the "social capital of an organization is the realized economic potential of social networks that increases the added value of an organization". Corporate social capital is based on employees' social relations. The objective basis for social relations is the labor relations of employees. Cooperation in labor activity ensures social contact among employees.

2.5. Levels, Subjects, and Factors of Innovation

The production of innovations is becoming the most important condition for companies' development. A necessary property of innovation is openness to the external environment and new knowledge with the help of social networks and connections. Social capital through the social connections generates a resource through which an employee or group get access to network resources which allow them to achieve better results. It forms an employee's ability to develop human capital using the knowledge and experience of other employees.

Studies concerning the creation, implementation and diffusion of innovations examine the structures of social systems, group norms and decision-making patterns within these systems, as well as the organizational changes that appear in these social systems as a result of innovation implementation [31]. For a comprehensive analysis of innovation, it is necessary to study three main levels—organizational, group and personal.

At the organizational level there structural innovation aspects are studied. The psychological microclimate, traditions and corporate culture are investigated, which contribute to innovations. At the group level, socio-psychological processes in a team are investigated, which are related both to the individual innovativeness and innovative potential of a company. Analyzing the organizational factors of innovativeness, the socio-psychological aspects of innovativeness, personal characteristics such as creativity, critical thinking, risk appetite and other important factors are not taken into account [32].

Therefore, at the individual level, it is also necessary to study their personal characteristics, to analyze their cognitive, motivational and emotional spheres. Features of the formation, functioning, manifestation and development of personal innovation determine the behavioral patterns of the subject under constantly changing economic, technological, industrial, informational, political, and market conditions. Personal innovation is a factor that ensures the adaptation of an individual to a constantly changing world.

Innovativeness can be characterized as the most important factor that determines a person's ability for innovative thinking and their ability to produce new ideas and depends on personal characteristics, such as the desire for novelty, original ideas, creativity, critical thinking, risk appetite, independence of judgment, information awareness and readiness to deal with new information. A number of scientific papers on management, and organizational behavior, examine issues related to innovation and innovative thinking, the attitude of employees to organizational changes [33], the relationship between the innovativeness of employees of an organization and the density of their contacts with colleagues at the cognitive level [34], and the impact of managers' innovativeness on the organization's efficiency [30].

It is quite obvious that the factors of social capital have a purposeful influence on the decision to initiate innovative projects. Creativity in the form of cognitive and social processes forms the individual ability to produce new ideas and concepts in the field. Personal innovativeness characterizes the effectiveness of the production and implementation of new ideas, which includes the production and implementation of new products, services, technologies, markets, and organizational processes.

The relationship between the concepts of creativity and innovation is considered in a number of works as a particular and a whole, i.e., innovation implies the presence of creativity, but creativity alone is not enough for a sustainable ability to engage in innovative behavior [35,36]. A number of studies have shown the influence of sociocultural

characteristics on the creative behavior of an individual [18,37], and intercultural sensitivity (tolerance, care, attention to others) contributes to effective joint activities in a multicultural and multinational environment [38]. The impact of the components of intellectual capital on the types of innovative decisions made by its subjects is substantiated [39]; they single out social intelligence (as a skill of participating in social interactions, cooperation and productively building social ties, trusting relationships with colleagues, exchanging information and ideas) and consider it as a basis for leadership and behavioral efficiency (the ability to build relationships with counterparties in a particular situation) [40] and innovation development [41]. Emotional intelligence (the ability to recognize and manage one's emotions while moving towards a goal, based on internal beliefs and motivation), as part of social intelligence, is recognized as one of the key characteristics of a qualified employee [42].

2.6. Influence Social Capital on Innovation

Research [43] identifies personality traits significantly associated with successful free innovation in the household sector. The study uses the five-factor model of personality consisting of five underlying traits of personality that displays minimal overlap: openness, extraversion, conscientiousness, agreeableness, and neuroticism. The study suggests possible ways to increase the amount of successful free innovation. It can be said that the choice of components represents the spectrum of innovation activities from technological innovations to latent innovations and social innovations.

A fundamental connection between social capital and innovation is suggested by Putnam et al. [4] in the statement "trust lubricates cooperation", which clearly identifies the importance of trust as a factor of cooperation. Beugelsdijke and van Schaik [44] show that higher levels of trust usually lead to higher levels of cooperation. A possible relation is made by Rutten and Boekema [45] and Shan et al. [46] who support the view that cooperation is essential to the innovation process. They consider that social capital is extremely important in the effectiveness and efficiency of cooperation and collaboration. In agreement with this, Tsai and Ghoshal's [47] research reveals a significant positive link between the companies' social capital and their capability of making innovations. Dakhli [48] empirically confirms the important role of trust as a driver of innovation. By facilitating exchange and reducing the need for time-consuming and expensive monitoring, trust fosters more extensive and unconstrained cooperation and a freer exchange of information, which may ultimately lead to more R&D-related activities and inventions [49].

Landry et al. [50] also consider social capital to be an influential factor in the decision to innovate or not and subsequently the radical nature of the innovation. Moreover, social capital may be considered to be a crucial factor in an organization's bid to become more innovative [51]. Hence, trust through collaboration is also important for innovation. In addition, Landry et al. [49] show that social capital is "an essential ingredient for understanding innovation".

The concept of trust as important for innovation has been explored by Murphy [51]. As Putnam et al. [4] and Beugelsdijk and van Shaik [44] found, "collaboration breeds trust". If this statement is correct, then cooperation and trust by mutually supporting and fostering one another "may create a virtuous circle" [52]. This virtuous circle may increasingly produce high levels of trust and cooperation. Rutten in [45] supports this proposition, stating that firms are more likely to co-operate with each other if they are in a high trust relationship. The rationale for this statement is the expectation of organizations of the benefits of working together.

Social capital is positively related to the innovativeness of a company through the positive links of trust, corporate culture and managerial innovation [53,54]. Birudavolu and Nag consider that some of the key components of innovation in social capital are ambidextrous thinking and intrapreneurship [55,56].

Thus, the analysis of the literature in the field of social capital associated with innovation and innovative activity of a company allows us to make an assumption that the factors

of social capital—*trust, social networks and connections, social norms and values*—determine the nature of a person's attitude to innovation [3,18,19,21,24,25]. An analysis of the qualities of innovators makes it possible to characterize the attitude towards innovations and, more broadly, the innovativeness of an individual with such components as *creativity and risk appetite* in the development and implementation of innovative solutions, and *strategicness* as the ability of an individual to focus their behavior on long-term goals; here, we follow studies [35–42].

3. Methodology

We propose the methodological approach in the form of information technology, based on step-by-step information processing and modeling to assess the impact of social capital on the individual innovativeness, and is used to support decision-making in the field of a company's innovation policy aimed at increasing R&D. A conceptual diagram of the technology is shown in Figure 1.
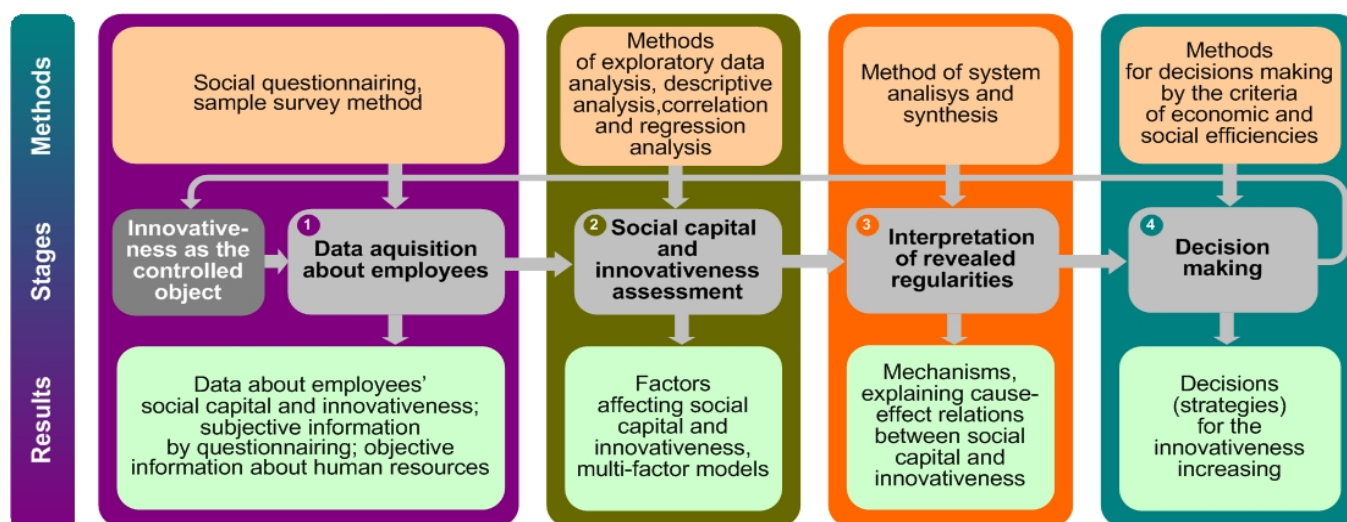

Figure 1. Conceptual scheme of the technology to assess the impact of social capital on employee innovativeness.

The technology consists of four stages and uses methods of system analysis, statistical data processing, sociological monitoring and economic analysis, and foresight modeling. Let us consider in more detail the stages, methods and results of each stage.

Stage 1. Preparation and survey of the company's employees. Here, we use sample surveys, sociological surveys and economic analysis.

1.1. The development of indicators for assessing the social capital and individual innovativeness factors. For social capital, these are factors of trust, social values and norms, social networks and connections. For innovation, these are factors of creativity, risk appetite and strategicness. The result of the procedure is the substantiation of indicators that evaluate social capital and individual innovativeness.

1.2. Questionnaire design for conducting an employee survey. The result of the procedure is a questionnaire consisting of eight groups of questions for each factor of social capital and innovativeness, as well as socio-economic and demographic factors.

1.3. Questioning of employees in a company. The result of the procedure is a sample survey questionnaire.

Stage 2. Assessment of social capital and innovativeness, identification of their relationship. Methods of exploratory data analysis, descriptive analysis of sample data, methods of correlation and regression analysis are used.

2.1. Exploratory analysis of survey data, descriptive analysis. The result of the procedure is a qualitative analysis of the survey data and statistical indicators that calculate the sample means, standard deviations and frequencies tables for qualitative variables.

2.2. Evaluation of indices for social capital and innovativeness. The result of the procedure is calculated values of partial indices of social capital and innovativeness

2.3. Calculation of the integral index of social capital and innovativeness for each employee. The result of the procedure is a quantitative assessment of the social capital and innovativeness of an employee.

2.4. Modeling and evaluation of the impact of social capital on innovativeness. The results of the stage are correlation matrices and regression models that reflect the relationship between factors.

Stage 3. Interpretation of the revealed regularities. At this stage, the methods of system analysis and synthesis are applied to describe the regularities of the influence of social capital factors on innovation revealed in the previous stage. The mechanisms of causal relationships of factors are revealed and substantiated.

3.1. Generalization of the modeling results, description of the revealed patterns and their meaningful interpretation. The result of the procedure is the mechanisms of the influence of social capital factors on innovation, and the rationale for cause-and-effect relationships.

Stage 4. Development of management decisions. To develop solutions, foresight modeling methods are used, and the criteria for the effectiveness of decisions are economic indicators (increase in labor productivity, costs, profits) and social indicators (quality of human potential).

The proposed methodology differs from existing ones in that, firstly, it is based on statistical data processing about employees' objective and subjective factors, secondly, it provides the analysis of cause-and-effect relationships of the influence of social capital factors on the factors of personal innovation and subsequently to manage the company's innovative processes based on the impact on human and social resources.

Based on the methodology, the following problems are implemented:

1. Assessment of employees' social capital using factors of interpersonal and institutional trust, involvement in social networks and labor values.
2. Assessment of employees' innovativeness using factors of individual risk, goal setting and individual values and attitudes.
3. Conducting a comparative analysis of employees' social capital and innovativeness.
4. Assessment of the impact of an employee's social capital on their innovativeness, which provides a comprehensive analysis of cause-and-effect relationships and further divides factors into "controlled" and "uncontrolled" with the further possibility of management by the company.

3.1. Stage 1—Preparation and Conduct of a Survey of Employees of the Enterprise, Collection of Objective Information

To ensure the process of data collecting, it is necessary to develop a system of indicators to assess the factors of social capital and innovativeness. The theoretically substantiated factors described in Section 2 were selected as such indicators. For social capital, there are trust, social values and norms, social networks and connections. Innovativeness is determined by factors of creativity, risk appetite and strategicness.

To collect data about factors of social capital and innovativeness, we use an approach based on psychodiagnostic tools [57–60] for test development, which includes the following stages: (1) goal statement and definition of the initial theoretical concept; (2) test specification and task development; (3) pilot study for empirical testing; (4) test reliability analysis; (5) test validity analysis; (6) analysis of test discrimination; (7) test standardization.

The purpose of the diagnostic study is to assess the social capital and innovativeness of the individual in a labor process. The theoretical basis for the developed approach is the social capital concept, described in Section 2. Since social capital is a systemic phenomenon that integrates trust, social networks and connections, and social norms and

values, the methodology is based on ideas about social capital structure including these three components. The innovativeness of a personality is a construct that includes creativity, risk appetite and strategicness, therefore innovativeness is diagnosed using three blocks of questions.

In the next stage, we specify the test and development tasks. Here, the content of each component is selected and fixed. A list of properties reflecting social capital and innovativeness content is created, on the basis of which questions are formulated. The questions are a set of statements presented to respondents with two or three scaling levels. The statements were created taking into account typical situations: interaction with colleagues, interaction with managers and contractors, relationships with colleagues and managers, purposefulness, and desire to take risks to achieve the goal.

After task development, we create a trial version of the questionnaire. We conduct a pilot study to empirically test the methodology, analyze the suitability of the developed questions, and check the internal consistency of the test. In total, 30 employees took part in the empirical testing. To assess the internal consistency of test items, the one-dimensional reliability Cronbach's α coefficient is used:

$$\alpha = \left(\frac{p}{p-1} \right) \left(1 - \frac{\sum\limits_{p} \sigma_{fp}^2}{\sigma_f^2} \right), \tag{1}$$

where p is the number of test tasks; f is the number of respondents; σ_f^2 is the dispersion of scores for each test item among all respondents; $\sum\limits_{p} \sigma_{fp}^2$ is the sum of the variances of estimates for each test item among all respondents for all test items.

Based on the results of primary calculations, test questions that reduce reliability are identified and eliminated. The univariate reliability factor is acceptable and the corresponding question is reliable if it is greater than 0.7. Questions with a one-dimensional reliability coefficient less than 0.7 are excluded from the test.

On the material of the study, factor analysis is carried out in order to check whether the blocks included in the test can be combined into separate factors. For this, the Kaiser–Meyer–Olkin (KMO test) selective adequacy criteria are used:

$$\text{KMO} = \frac{\sum\limits_{j \neq k} \sum r_{jk}^2}{\sum\limits_{j \neq k} \sum r_{jk}^2 + \sum\limits_{j \neq k} \sum p_{jk}^2}, \tag{2}$$

where r_{jk} and p_{jk} are pairwise and partial correlation between indicators, respectively.

KMO test values from 0.8 to 1 indicate the adequacy of a sample. KMO values less than 0.6 indicate the inadequacy of a sample and the need to correct test indicators.

In the next stage, the test reliability analysis is implemented based on the half-splitting of the test for each evaluation block. Splitting is carried out randomly, and the Pearson correlation coefficient of the test parts is used as a reliability indicator. The higher this indicator, the more reliable the test is.

In the next stage, we assess the test validity. Validity confirms that the test measures exactly what it is intended for. One of the main types of validity, which characterizes the representation of studied social capital and the innovativeness construct in test results, is the construct validity. Solving the question of the construct validity of a test as a complex characteristic of the adequacy is a search for an answer to two questions: (1) does a certain property really exist; (2) whether this test reliably measures individual differences in this property. In essence, construct validity allows us to confirm the set of theoretically expected relationships between the factors of social capital and innovativeness.

Construct validity includes many approaches such as content validity and purpose validity. Content validity characterizes the degree the test items correspond to the real

activity in which the measured property is manifested, and is based on a detailed study of the content of the test items. Content validity assessment is based on the expert method.

Factor analysis is used for statistical analysis of the structure of links between the indicators in order to obtain a simple factorial structure in which the maximum number of points will receive significant loads for only one factor. In addition to factor analysis, cluster analysis is used for these purposes. The hierarchical clustering algorithm allows a group of individual questions into homogeneous groups, corresponding, as a rule, to the factors obtained after the Varimax rotation of the principal components method.

An important aspect of construct validity is internal consistency, which reflects how certain test questions are subordinated to the main direction of the test as a whole, focused on the study of the same constructs. An essential feature of this method is the use of the total indicator of the test itself as a validation criterion. Internal consistency analysis is carried out by evaluating the correlation of responses to each item with the overall test result. For this, the Spearman and Kendall rank correlation coefficients are used. As a result, only those tasks are saved for which the correlation coefficient with the test as a whole is at least 0.25. Items with a low correlation with the overall test result are redesigned or excluded.

In the next stage, the test discrimination analysis is accomplished. A test is reliable and discriminatory if it has a large variance in scores for each test item and measures what it is supposed to measure. To assess the discrimination of tasks, the Spearman rank correlation coefficient of each task with the total score of the whole test is used. The higher the correlation coefficient, the more discriminant the task, and the more accurately the task reflects the purpose of the survey.

Test standardization ensures the comparability of indicators of different respondents and is intended for adequate interpretation of test results. The test standardization procedure is presented in Formula (3).

So, for data collection, a psychometric test (questionnaire) is designed, which has the properties of reliability, validity, and discrimination. The reliability of the test as a complex characteristic shows the accuracy of measurements and the stability of the test results to the action of random factors. The validity of the test as a characteristic of the adequacy of the interpretation of the measurement results evaluates its effectiveness and practical usefulness. Discrimination, the ability of a test to differentiate respondents by the level of task performance, is also an indicator of test effectiveness. Standardization of the test ensures comparability of the indicators obtained by one respondent compared with the indicators of other respondents in the individual groups. When forming a sample of standardization, its representativeness is taken into account. Stratification of standardization groups is carried out in relation to indicators of age, gender, and marital status.

The test (questionnaire) includes 27 statements in six blocks corresponding to social capital and innovation and seven questions reflecting the demographic and socio-economic characteristics of the respondent and is aimed at diagnosing the general level of social capital and innovativeness and identifying their content component by component. The questionnaire includes questions divided into separate blocks: 1—trust; 2—social networks and connections, 3—social norms and values; 4—creativity; 5—risk appetite; 6—strategicness. Questions (tasks) in the questionnaire are dichotomous and trichotomous. Employees are required to express their own attitude to each question on a scale from 1 to 2 or from 1 to 3. The characteristics of the survey questions with their symbols and the range of values are presented in Table 1.

Table 1. Characteristics of questions in the survey.

Indicator Number	Indicator	Variable	Range of Value or Binary
	Block 1 "Trust"		
1	Knowledge of the strategic goals and objectives of the company	T1	1 … 3
2	Teamwork	T2	1 … 3
3	Satisfaction with the team and colleagues, the degree of team cooperation	T3	1 … 2
4	Desire to help colleagues, upon request	T4	1 … 3
5	Desire to share experience and knowledge with colleagues	T5	1 … 3
6	Frequency of the manager's request to improve the characteristics of the product/service	T6	1 … 3
7	Frequency of contacting management for help	T7	1 … 3
	Block 2 "Social networks and connections"		
8	View social networks of colleagues	SC1	1 … 3
9	Use of social networks for business purposes	SC2	1 … 3
10	Automation of routine processes related to the interaction of employees in projects	SC3	1 … 3
11	Opportunity to contact a colleague during non-working hours	SC4	1 … 3
12	Maintain contact with co-workers outside of working hours	SC5	1 … 3
	Block 3 "Social norms and values"		
13	The importance of corporate culture	N1	1 … 3
14	Willingness to help colleagues	N2	1 … 3
15	Willingness of colleagues to help	N3	1 … 3
16	Attitude to mistakes and mistakes of colleagues	N4	1 … 3
17	Attitude towards innovation	N5	1 … 3
	Block 4 "Creativity"		
18	Participation in innovative projects on their different life cycle	Cr1	1 … 3
19	Participation in training programs and seminars	Cr2	1 … 3
20	Participation in R&D	Cr3	1 … 3
21	Willingness to take the initiative	Cr4	1 … 2
	Block 5 "Risk Appetite"		
22	Willingness to implement a new promising but risky project	RA1	1 … 3
23	The choice between two projects—risky, but more effective and reliable, but less effective	RA1	1 … 2
	Block 6 "Strategicness"		
24	The choice between a job with a guaranteed, but lower income, and more labor-intensive, but more promising from a career intention	Srt1	1 … 2
25	Exploration of new market segments	Srt2	1 … 3
26	Desire and inclination to change the auxiliary business processes of the company	Srt3	1 … 3
27	Desire and inclination to change the main business processes of the company	Srt4	1 … 3
	Block 7 "Demographic characteristics"		
28	Family status	D1	single (0), married (1)
29	Children	D2	0,1,2 …
30	Gender	D3	female (1), male (0)
	Block 8 "Socio-economic characteristics"		
31	Income level	E1	1 … 3
32	Education level	E2	Secondary (1), specialized (2), higher (3)
33	Work experience	E3	1 … 3

Most indicators are qualitative and are measured using an ordinal scale, some are binary, having two levels—0 or 1—such as gender and marital status; the indicator "children" is quantitative. At the same time, the value of a trait measured using an ordinal scale increases as its qualitative characteristics intensify.

3.2. Stage 2—Assessment of Social Capital and Innovativeness and Identification of Their Connection

In the second stage, the indices of social capital and innovativeness are evaluated. First, the survey data are normalized. For this, the procedure of linear scaling of the initial data by the interval [0; 1] according to the minimax principle is used:

$$z = \frac{x - x_{\min}}{x_{\max} - x_{\min}}, \tag{3}$$

where z is the normalized value of feature x; $x_{\min}$, $x_{\max}$ are the minimum and minimum values of feature x.

Each component is evaluated as an index based on the summation of normalized and weighted private indicators describing the components of social capital. As a result, private indicators of the social capital components are obtained:

$$I_{SC_i}^k = \sum_{j=1}^{n_l} z_{ij}^k w_j^k, \tag{4}$$

where k is the identifier of the assessment unit (the k-th assessment unit) of the i-th employee; n_l—the number of elements (tasks) in the block l; w_j^k—weight coefficients of estimated indicators z_{ij}^k.

The calculation of the integral index of social capital is carried out using an unweighted summation of partial indices of social capital components. As a result, a quantitative assessment of the employee's social capital is found:

$$I_{SC_i} = \sum_{k=1}^{m} I_{SC_i}^k, \tag{5}$$

where m is the number of social capital assessment blocks.

Private indices (4) and general index (5) of the employee's innovativeness are determined in the same way:

$$I_{INN_i}^s = \sum_{j=1}^{r_l} u_{ij}^k p_j^k, \tag{6}$$

where s is the identifier of the assessment block (s-th block of innovativeness assessment) of the i-th employee; r_l—the number of elements in the block l; p_j^k—weight coefficients of estimated indicators u_{ij}^k.

$$I_{INN_i} = \sum_{s=1}^{v} I_{INN_i}^s, \tag{7}$$

where v is the number of innovativeness assessment blocks.

3.3. Stage 3—Interpretation of the Revealed Patterns

The problem of managing the social capital of a company is poorly structured since the object of management is characterized by many qualitative factors and dependencies. One of the common methods of decision making, modeling possible situations and scenarios of such tasks, is the method of cognitive structuring [61–64]. The stages of cognitive structuring include:

- Create a conceptual scheme of the problem situation.
- Conduct a SWOT analysis of the problem situation.
- Develop a cognitive model (map) of the problem situation.

The main problem of cognitive structuring of the problem and the construction of a cognitive map is the refinement of knowledge about the subject area due to the localization of important factors and other characteristics of the problem situation. A weakly formalized cognitive map is a structure of causal influences of a weakly structured situation under study.

The factors in the contour of the problem of social capital management are studied. The following groups of factors have been identified: behavioral factors associated with trust; behavioral factors associated with networks and communications; factors of values (principles of activity); factors of resource productivity and economic efficiency.

A cognitive diagram has been designed to visualize the cause-and-effect relationships of the factors that determine the influence of social capital on innovation, on the one hand, and the influence of social capital and innovation factors on the efficiency of the company as a whole and its particular performance indicators, on the other (Figure 2).
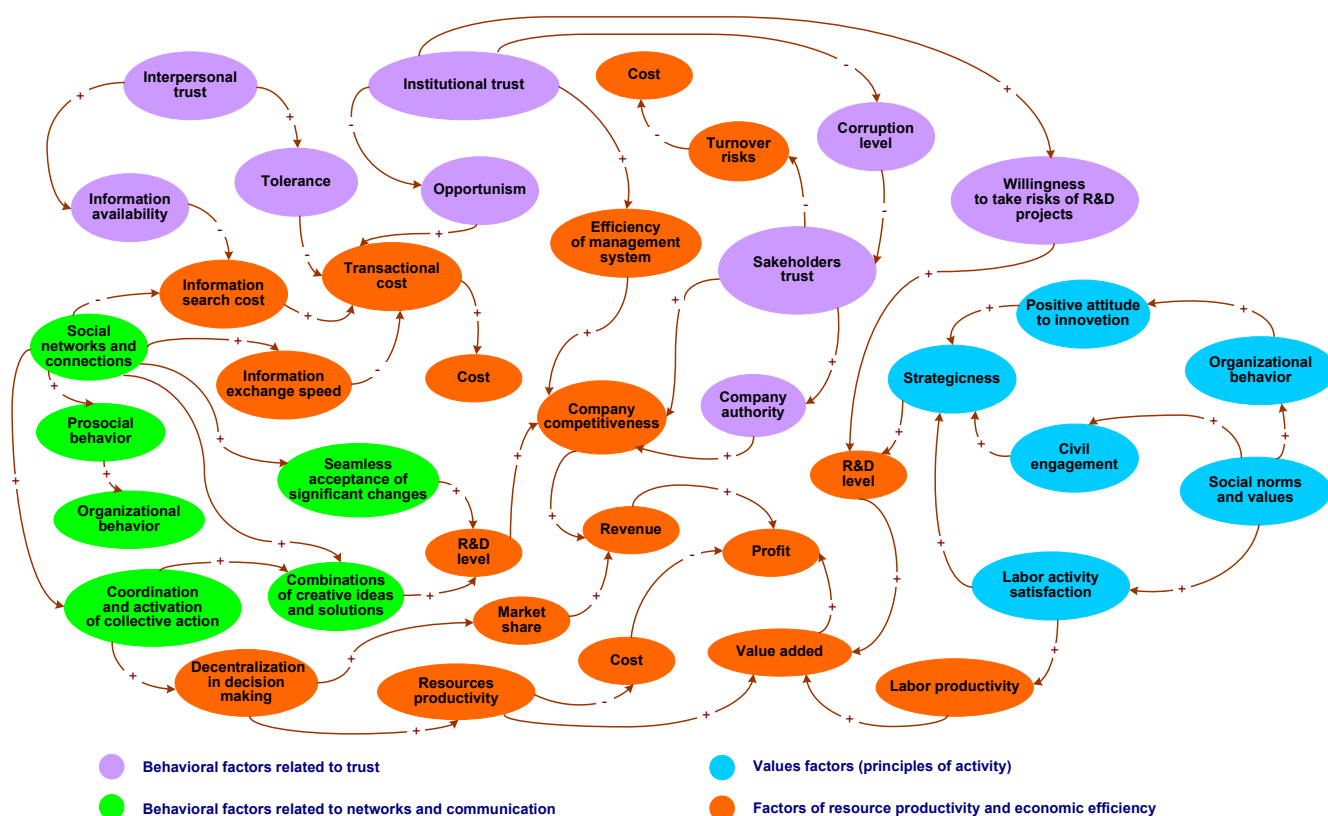
Figure 2. Cognitive map of the influence of social capital factors on a company's efficiency.

A detailed presentation of the problem will allow, on the basis of a cognitive diagram, to identify groups of target and control factors and conduct further detailed structural analysis and scenario modeling for various situations.

The economic mechanisms of the impact of social capital on a company's performance are determined by the following factors:

- Reduction of transaction costs.
- Strengthening of prosocial behavior.
- Decreasing of opportunism.
- Increasing job satisfaction.
- Growth of labor productivity.

The social capital of a company is the realized economic potential of social communications, conditioned by social networks and connections, which allow increasing the added value of the organization. The social capital of an organization affects the growth of an economic activity efficiency by reducing transaction costs that arise in the process of information searching, negotiating and labor contracts, monitoring and preventing opportunism, specifying and protecting property rights, complying with contractual obligations, and following the general rules of conduct for all stakeholders. Social capital is a mechanism for effective coordination of the employees' labor productivity, causing an effective solution for the implementation of organizational goals, and ensuring the efficiency of information exchange.

4. Empirical Results and Discussion

The design of the experiment includes the following steps: conducting a survey of employees in a company, preprocessing the results of the survey, economic and statistical analysis and interpretation of results. The experiment was held at a large industrial enterprise in Russia. A representative sample was compiled, which included 100 employees

from the design department, financial department, planning and economic department and sales department. Each respondent was asked to answer the questionnaire.

Then, a detailed analysis of the indicators distributions was realized for the studied employees' sample. The distribution of employees by factors of social capital is shown in Figure 3, and by factors of innovativeness in Figure 4.
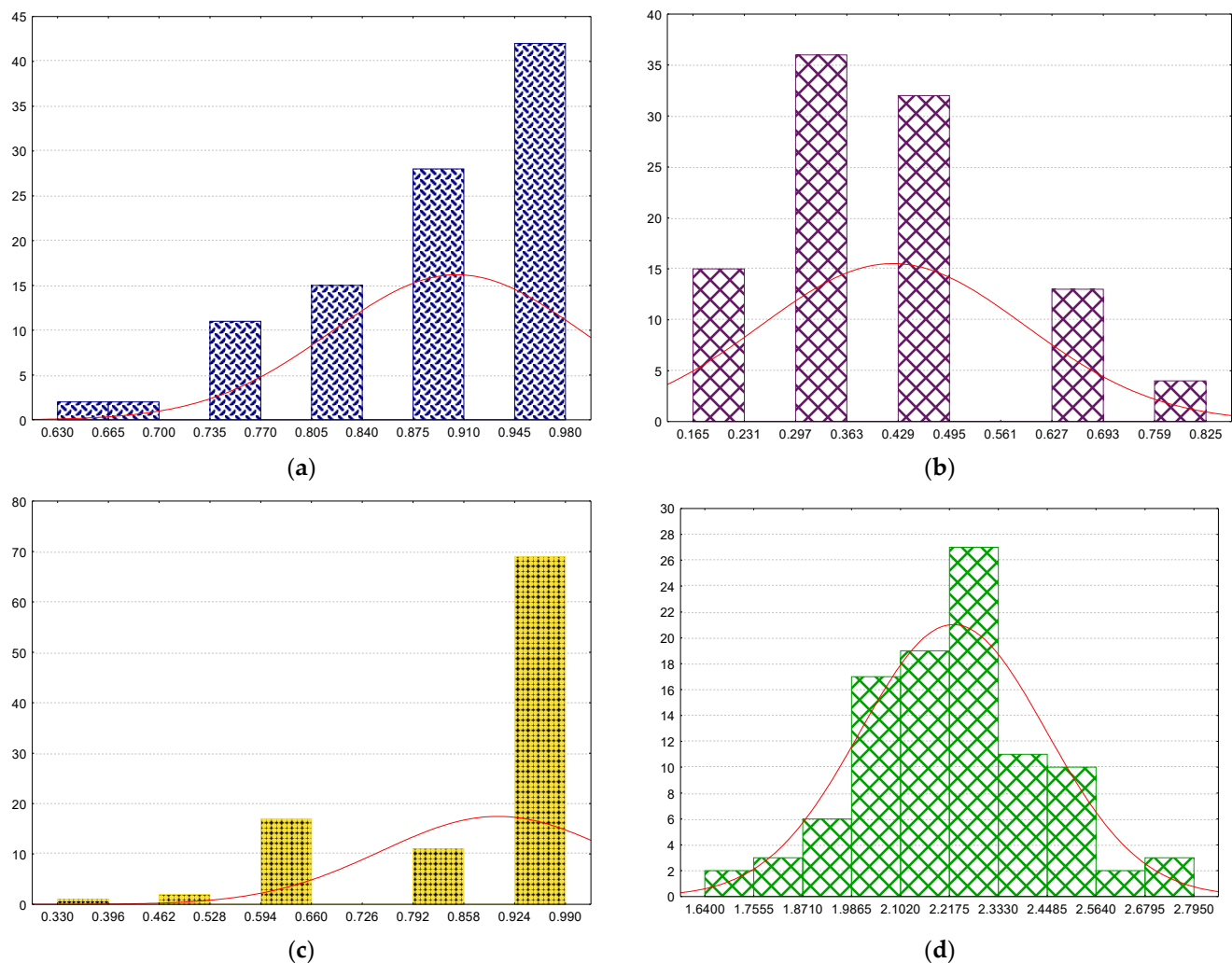
(a)

(b)

(c)

(d)

Figure 3. Employees distribution by levels of social capital indicators: (**a**) trust, $\overline{x} = 0.9037$; $\sigma = 0.0862$; (**b**) social networks and connections, $\overline{x} = 0.4207$; $\sigma = 0.1697$; (**c**) social norms and values, $\overline{x} = 0.8992$; $\sigma = 0.1509$; (**d**) social capital, $\overline{x} = 2.2237$; $\sigma = 0.2191$.

An analysis of the employees' distribution by levels of social capital factors shows that employees with high values of trust indices and social norms and values prevail—about 85% of employees in the sample have values of the trust index close to 1 and 69% of employees have an index of 0.8 or more up to 1. This characterizes a high level of trust of employees and a high commitment to compliance with established norms and rules. However, according to the index of social communications in the sample, about 68% of employees turned out to have a value of 0.3 to 0.5. In general, in terms of the level of social capital, the sample can be characterized as a normally distributed population, with a high level of the social capital index from 1.8 to 2.6 (with a maximum value of 3), which is more than 90% of employees.
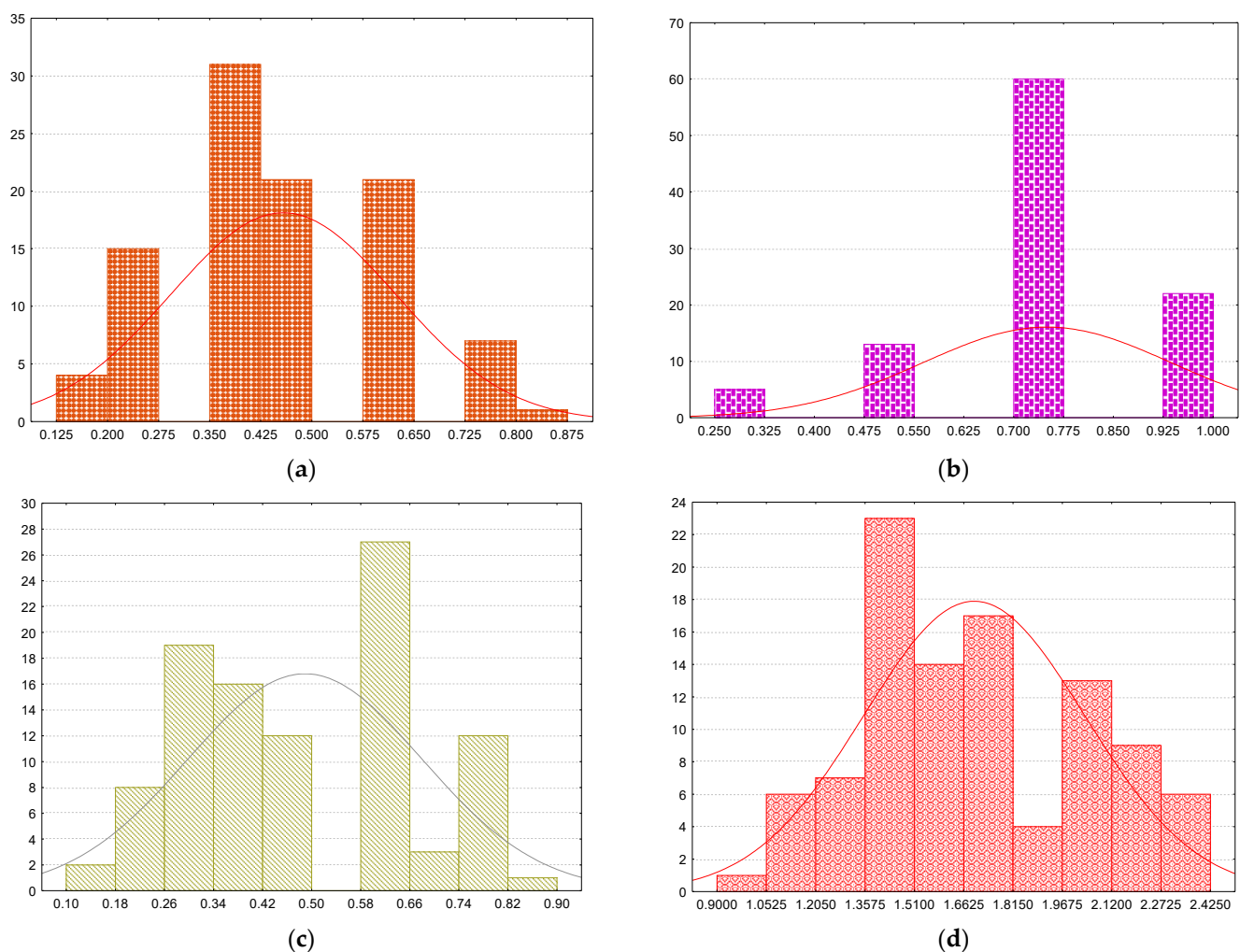
Figure 4. Employees distribution (in percentages) by levels of innovativeness indicators: (**a**) creativity, $\bar{x} = 0.4562; \sigma = 0.1651$; (**b**) risk apetite, $\bar{x} = 0.7475; \sigma = 0.1863$; (**c**) strategicness, $\bar{x} = 0.487; \sigma = 0.19$; (**d**) innovativeness, $\bar{x} = 1.6908; \sigma = 0.34$.

In terms of creativity, employees prevail (more than 50%) with an average level of creativity index from 0.25 to 0.5. The same structure is in terms of strategy, employees with a level of strategy from 0.37 to 0.6 predominate. At the same time, the structure of employees according to the level of the risk appetite index is different, in which, in general, employees have a high-risk appetite—from 0.6 to 0.88. In general, judging by the innovativeness indicator, most of the employees have large innovation indices—more than half of the employees have an index that exceeds 1.66 out of the maximum value of 2.68. The low level of the innovation index belongs to only 10% of employees—up to 0.23.

Detailed descriptive statistics are presented in Table 2.

The distribution of levels of social capital and innovation indices depending on the factors "gender" and "children", as well as "family status" is shown in Figure 5. Figure 5a shows that the indices of social capital and innovation are higher for men than for women, i.e., the majority of male employees have higher values for both indicators, but there are female employees in the sample that have extremely low or extremely high values. However, for male employees, it is much lower. This can be explained by the fact that the number of women who are not inclined to innovate is higher than the number of men. It should also be noted that the levels of social capital for women are more stable and vary around the median value, while for men the spread is much wider. This indicates a higher potential for social relationships between men.

Table 2. Descriptive statistics of social capital and innovativeness indices.

| Variable	Mean	Standard Deviation	Variation	Mode	Frequency	25% Quartile	50% Quartile	75% Quartile	Asymmetry	Kurtosis
Trust	0.9037	0.0862	0.095386	0.9800	42	0.8400	0.9100	0.9800	−1.116	0.763
Social networks and connections	0.4207	0.1697	0.403375	0.3300	36	0.3300	0.3300	0.4950	0.374	−0.286
Social norms and values	0.8992	0.1509	0.167816	0.9900	69	0.8250	0.9900	0.9900	−1.508	1.448
Social capital	2.2237	0.2191	0.098529	2.1350	15	2.0900	2.2300	2.3950	0.120	0.316
Creativity	0.4562	0.1651	0.361903	0.3750	31	0.3750	0.4375	0.6250	0.137	−0.543
Risk apetite	0.7475	0.1863	0.249231	0.7500	60	0.7500	0.7500	0.7500	−0.731	0.865
Strategicness	0.4870	0.1900	0.390144	0.6000	27	0.3000	0.5000	0.6000	0.100	−0.802
Innovativeness	1.6908	0.3400	0.201088	Multiple	6	1.4500	1.6000	1.9750	0.337	−0.634
Family status	1.9400	0.2387	0.123041	2.0000	94	2.0000	2.0000	2.0000	−3.762	12.401
Children	0.9100	0.8177	0.898571	1.0000	45	0.0000	1.0000	1.0000	0.621	−0.125
Gender	1.6800	0.4688	0.279048	2.0000	68	1.0000	2.0000	2.0000	−0.784	−1.415

(**a**)

(**b**)

(**c**)
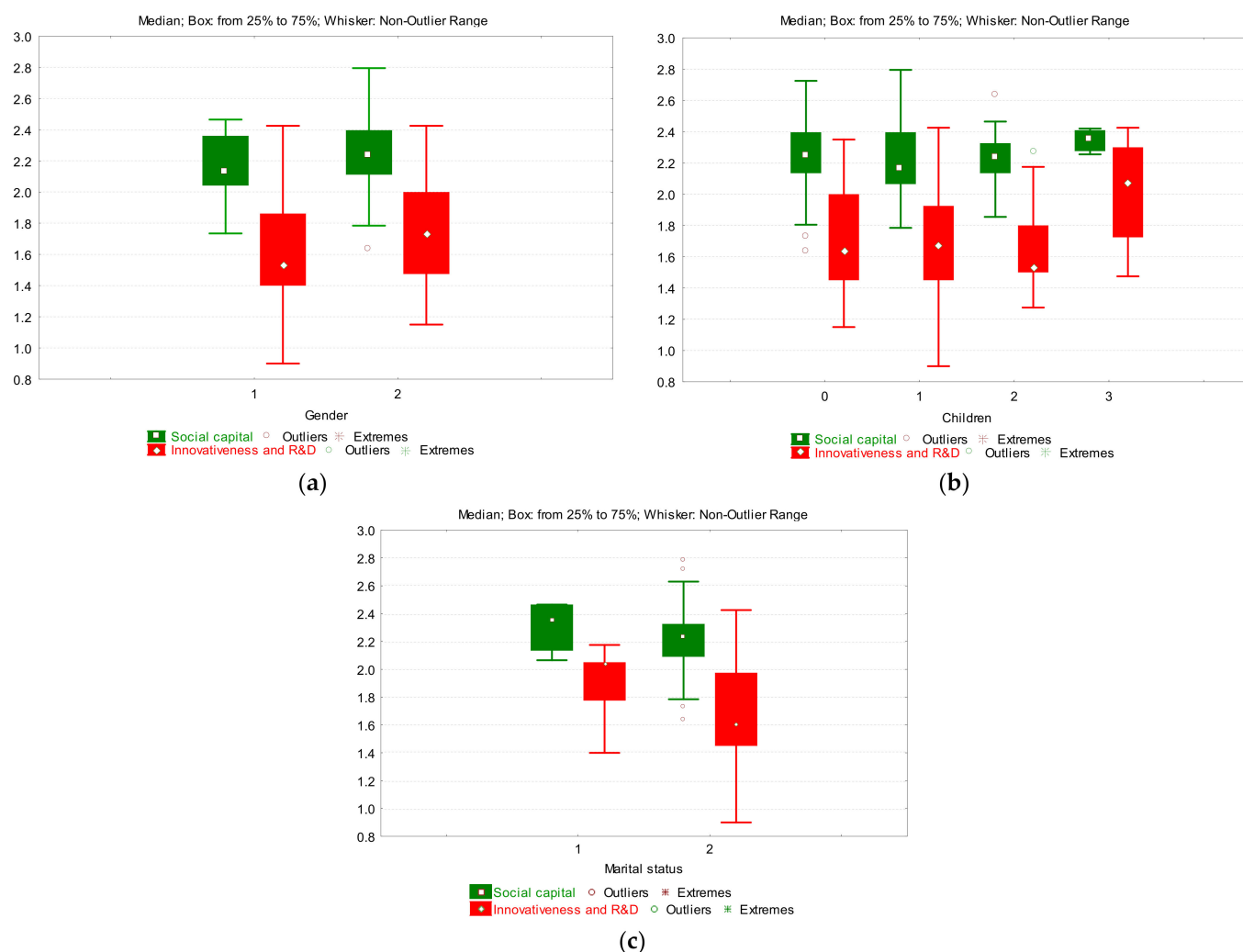
Figure 5. Distribution of employees by social capital levels and innovation indices depending on the grouping factor: (**a**) gender; (**b**) children; (**c**) family status.

Figure 5c clearly reflects higher values of social capital indicators, as well as higher values of innovativeness of employees who are not married which may be due to the fact that this group of employees is career-oriented. At the same time, employees with three or more children (Figure 5b) have a more stable level of social capital than others; in addition, this group for the most part also has higher innovativeness values. This may be due to the need for a more stable and higher income, which pushes employees to generate new ideas and new knowledge.

The factors of trust and social communications have a statistically significant impact on social capital, with the factor of social communications being the most influential (correlation coefficient is 0.663). At the same time, it is shown that the factor of social norms and values has a direct but weak impact on social capital. All the constituent factors that determine innovativeness—risk appetite, strategicness and creativity—turned out to be statistically significant, while the risk appetite factor has the maximum impact on innovation (the correlation coefficient is 0.661). It should be noted that, in general, social capital as a single factor weakly correlates with innovativeness, which confirms using constituent factors of social capital when modeling innovativeness.

To initialize modeling the influence of social capital and its factors on innovativeness, exploratory analysis is carried out and 3d maps are built, reflecting the paired influence of factors on the resulting indicator (Figure 6). The 3d maps visualize that a high level of creativity can be seen in employees with high communication skills and a low level of trust (Figure 6a). High risk appetites can be seen in employees with a low and medium level of communication and at the same time with a very low and very high level of trust in their environment (Figure 6b). The focus of employees on strategic results does not depend on trust but depends on communication (Figure 6c). In general, employees who simultaneously have a high level of communication and medium levels of trust, or a high level of trust and the average level of communication, or high indices of social norms and values with simultaneously high trust and low levels of communication, show a higher level of innovativeness (Figure 6d–f).

Modeling of the influence of social capital factors on innovativeness is carried out on the basis of regressions (general linear model, GLM regression). An ensemble of models with different specifications is built. Modeling of the influence of individual factors of social capital on innovativeness, as well as the influence of social capital factors on separate factors of innovativeness, is carried out in Table 3.

Table 3. Regression models for innovativeness and its factors (GLM regression).

Determinants of Innovativeness	Model 1 (Dependent Variable– Creativity)	Model 2 (Dependent Variable– Risk Appetite)	Model 3 (Dependent Variable– Strategicness)	Model 4 (Dependent Variable– Innovativeness)	Model 5 (Dependent Variable– Innovativeness)
Trust	0.12	0.42 *	0.28	0.46 *	
Social networks and connections	−0.13	−0.09	−0.1	−0.17 *	
Social norms and values	−0.32	−0.16	0.16	−0.14	
Social capital					0.06 *
Adjusted R^2	0.12	0.13	0.18	0.27	0.24

* significant parameter for $p < 0.05$.

Modeling results indicate that the trust index has a statistically significant impact on the propensity of an employee to take risks associated with the implementation of new projects (model 2). This proves that the growth of interpersonal and institutional trust between employees increases their ability to take responsibility for the implementation of projects with high uncertainty, and the tendency to take risks for the execution of a project and achievement of results grows. The results also showed that the construction of individual indicators of innovativeness depending on the factors of social capital is not fully justified (models 1, 3) and makes sense only with the combination of all factors (model 4) or when modeling the aggregate index of social capital and innovativeness (model 5).

In all models, the variable "social networks and connections" shows an inverse effect on innovativeness, while in model 4 the regression coefficient for this variable is statistically significant. This indicates the negative nature of the impact of strengthening social interactions on the stimulation of innovation, which may indirectly indicate the individualistic nature of innovation. Model 4 reflects a statistically significant positive effect of trust on innovation, which can be explained as a positive effect of institutional trust in innovation. Model 5 also shows the statistically significant and positive impact of social capital and generally confirms the expected nature of its impact on innovativeness.
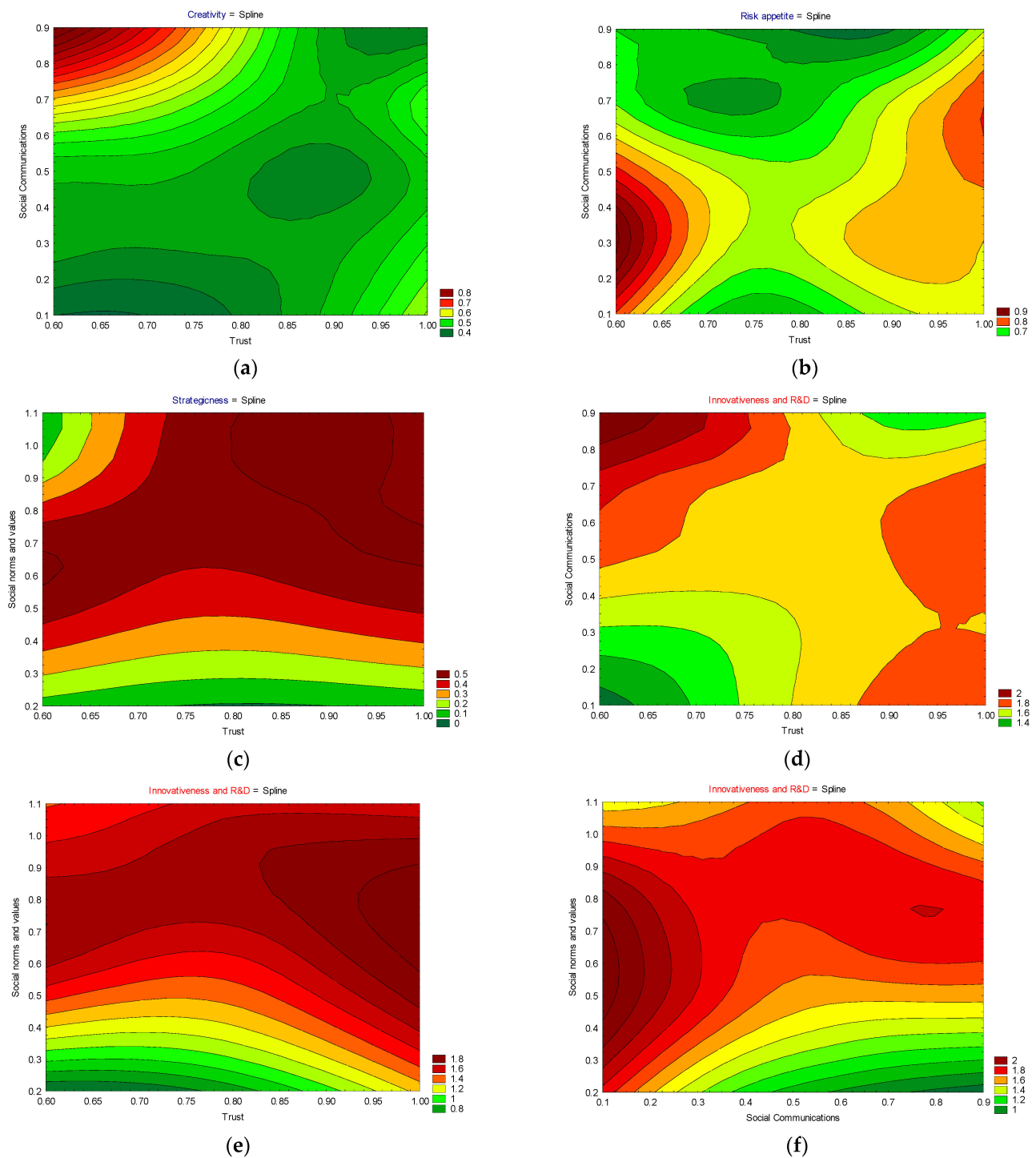
Figure 6. 3d-maps for influence assessment of factors on resulting indicator: (**a**) trust and social networks and connections on creativity; (**b**) trust and social networks and connections on risk appetite; (**c**) trust and social networks and connections on strategicness; (**d**) trust and social networks and connections on innovativeness; (**e**) trust and social norms and values on innovativeness; (**f**) social networks and connections and social norms and values on innovativeness.

5. Conclusions

In this study, we gave a systematic description of the social capital and innovativeness of the individual under the implementation of labor activity. Specifically, this study examined whether social capital and its factors influence a person's decision to introduce

innovations and change the probability of creative thinking and behavior and intentionally influence innovation.

We systematically analyzed the literature devoted to human and social capital, social capital level of organization, a form of social capital, social capital and its impact on organizational performance, innovation level, subject and factors, and the influence of social capital and innovation. We highlighted that the system under investigation is weakly structured, includes a set of heterogeneous elements and identifies their relationships, more often described by subjective information and subject to manipulation by the subject (employee).

The theoretical implications of the research are defined by the following points.

1. The new methodology is based on statistical data processing about employees' objective and subjective information and aims: firstly, to assess an employee's social capital using factors of interpersonal and institutional trust, involvement in social networks and labor values; secondly, to assess an employees' innovativeness using factors individual risk, goal setting and individual values and attitudes; thirdly, to conduct a comparative analysis of employee's social capital and innovativeness; fourthly, to assess the impact of an employee's social capital on their innovativeness, which provides a comprehensive analysis of cause-and-effect relationships and further divides factors into "controlled" and "uncontrolled" with the further possibility of management by the company.

2. We proposed indicators to assess the social capital and innovativeness of an individual (employee of a company), which ensures the questionnaire design for sociological surveys. The indicator system includes three groups for assessing social capital—"trust", "social networks and communication" and "social norms and values"—and three groups of indicators for assessing innovativeness—"creativity", "risk appetite " and "strategicness".

3. The cognitive map was constructed, which is a weakly formalized model for representing knowledge about the mutual influence of social capital factors on innovativeness in the form of cause-and-effect relationships between heterogeneous factors of social capital, innovativeness and company performance. The cognitive map is intended for a comprehensive analysis taking into account various factors, clarifying knowledge about a problem situation by localizing important factors, followed by a qualitative analysis of the most significant factors.

The practical implications of the study are as follows. We conducted a comprehensive empirical data analysis about company employees using an employees' survey in a large machine-building company. The results of this study verify the positive, stimulating effect of social capital on employee innovativeness. The statistically significant influence of the factors "trust" and "social networks and connections" on the social capital is proved. In the innovativeness model, the factors of "trust" and "social networks and connections" are statistically significant, while the cumulative effect of social capital on innovativeness is positive and statistically significant. Another major finding is that the main determinant of innovativeness is risk appetite. The reliability and validity of the obtained results are determined by the adequacy of the selected mathematical tools and confirmed on actual data.

The findings contribute to the understanding of how to mobilize human resources and activate innovation in a company. The significance of the research is in the implementation of the obtained results which would promote company performance and its sustainable development.

The proposed methodology is universal and can be used by companies of different types of economic activity. However, this research has some limitations associated with the availability of spatial and temporal data. In addition, experimental studies of the impact of social capital on innovativeness for enterprises of different sizes (small, medium and large) could be implemented, taking into account the corporate culture, traditions and rules for conducting R&D projects.

A further direction of research is the development of managerial decisions aimed at stimulating the innovative activity of employees by influencing social capital. For a deeper understanding of innovativeness appearing as creativity, risk appetite and strategicness should be studied in the context of the interaction of individual, behavioral and sociocultural variables.

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