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TEAMBUILDING AS A TOOL FOR ACHIEVING SYNERGY IN BUSINESS MODEL MANAGEMENT IN THE CONTEXT OF DIGITALIZATION

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Abstract. New business conditions, technological devices 5.0, development of holacratic organizations and the search for innovative methods of synergy achieving in business model management have led to the necessity of teambuilding studying as tools for solving business development problems in new dynamic conditions. Therefore, current market trends underscore the relevance of the topic by the fact that teambuilding is one of the effective tools for the tasks facing today's business models: digitalization, development in conditions of uncertainty, and high rates of change. *The main objectives* of the article are teambuilding substantiating it as a tool to achieve the effect of synergic interaction between professionals and modeling the team structure, considering the conditions of digitalization and new social challenges of today. The article summarizes the scientific approaches to the mechanism of teambuilding in business and determines the signs of the teambuilding process from a systemic point of view. The tools, tendencies and problems of achieving the synergy effect of team interaction within the given business model are determined. The business models of the world's leading team-type companies are characterized and the practical tools, as well as main barriers of teambuilding tools implementation, are analyzed. A methodical approach to the team structure modeling in the conditions given by the business model is offered. It is substantiated that the application of the deterministic stochastic model is a more accurate reflection of real practice, as it takes into account the factors of the business model's influence on the team structure in accordance with the requirements of the task. *Research methods*. To substantiate the main purpose of the article, the postulates of the system approach to the teambuilding concept and the main features of the functioning of teams in business are used. Methods of economic and mathematical modeling are used to reflect the team structure optimization in order to achieve a synergy effect. The method of comparative analysis is the basis of the methodology for determining the teambuilding activities effect, and the functional-system method is used to determine the tools of teamwork synergy achieving. In the context of digitalization, the proposed synergy matrix (S) is enhanced by digital communication protocols. The transition to Industry 5.0 implies that the 'Analyst' and 'Hacker' roles are increasingly reliant on AI-driven data processing, which reduces the time for feedback loops (as noted in the studies of digitalization's impact on feedback). Thus, the synergy effect is not only a result of human interaction but also a derivative of the technological maturity of the business model's digital infrastructure. The model was validated through a comparative analysis of two food industry enterprises: Grandem PE (Halal certified) and Blizart Co. (ISO 22000/HACCP certified). *Results*. The results of numerical experiments confirmed the model's effectiveness, showing a significant increase in the synergy coefficient (A) from 1.18 to 1.45 for Grandem PE and from 1.24 to 1.38 for Blizart Co. The application of the stochastic model allowed for a reduction in communication losses by 26.3-28.8%, resulting in a net synergy

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growth of 11.3% and 22.9%, respectively. These findings prove that teambuilding acting as a stochastic system serves as a high-leverage tool for achieving non-linear business growth in the Industry 5.0 era.

Keywords: stochastic optimization, management, team interaction, holacracy, Industry 5.0, organizational efficiency, 3Rs model, communication losses.

JEL Classification: M11, M54, C61, L66

1. Introduction

In the conditions of entrepreneurial activity, when the business model must be flexible and management has to be effective in order not to lose market position and develop the business, effective tools for managing the potential of employees should be used. Additional barriers to business development are formed by the labor market, where the demand for talent exceeds supply, and the value of employees increases, and material incentives are not the main tool for employees' motivation. Such new social challenges testify to the urgency of scientific understanding and practical application of the team-building tool, in which employees feel initiative, purposefulness and synergistic interaction effect.

The need for digital solutions, uncertainty and the rapid change paces require the search for tools to achieve a synergy effect from the use of resources, including the most valuable – human. One of such tools is team synergy, which can be achieved through an effectively designed teambuilding mechanism.

The paper is organized as follows: Section 2 reviews the literature, Section 3 describes the methodology, Section 4 presents the model, and Section 5 discusses the results.

Analysis of sources and publications. The conceptual foundations of team dynamics and team models have been previously studied (A. Sandy Pentland, 2012), with key recommendations for success identified.

Plenty of scientists studied the problems of group activity management (Makovoz et al., 2020; Nikiforova & Bilokon, 2012; Spichkova et al., 2025), who were actively involved in the development of diverse models and methods aimed at the team efficiency improving.

The article (C. Valdes-Dapena, 2018) outlines the practical difference between the uses of teambuilding activities and substantiates the importance of teamwork for its members. The economic effect of applying the scientific foundations of teambuilding is studied using the case of the Mars Inc. In (J. Pollack and P. Matous, 2019) communication connections and their influence on work results are investigated. Scientists (Salas et al., 2008) study the effectiveness of teamwork and tools for achieving it, such as: cooperation, conflict management, coordination, communication, coaching and team consciousness. The characteristics of team synergy are studied by (Akgün & Keskin, 2021).

Teambuilding is analyzed through various functional applications within business processes:

As a strategic tool for enhancing managerial decision-making and agility – explored by Ziebell et al. (2026) through the integration of mindfulness practices in Scrum teams.

As a core element of the HR-management system – aimed at achieving interaction synergy as discussed by Salas et al. (2007).

As a foundational component for business model development – analyzed by Shevchenko (2020) in the context of organizational structure.

Activating team intuition and creativity is the subject of increasing research quantity on new product development (NPD). In a qualitative study (Spichkova et al., 2025) it was argued that "team intuition has different aspects, namely: holistic, affective, conclusion, attitude, free, social and moral".

We also note the following research studies that have gained practical implementation: the Tuckman development team model (Kozlowski & Bell, 2001) and the study by Anvari et al. (2026), which emphasizes the role of emotionally intelligent leadership and team trust in enhancing knowledge-sharing behavior and project success. Additionally, Walton and Gilbert (2022) offer a methodical approach to feedback assessment with teams and individual employees in the context of digitalization and communications.

So, we believe that the justification of team synergy for the business models' practical implementation at modern enterprises and modeling teamwork methods taking into account the various complex business conditions caused by digitalization and growing competition should be developed and justified.

The main objectives of the article are teambuilding substantiating as a tool to achieve the effect of synergic interaction between professionals and modeling the team structure considering the conditions of digitalization and new social challenges of today.

2. System Approach to Teambuilding

Teambuilding is a set of principles, methods and tools for building an effective team. Teambuilding is typically understood as an event or exercise aimed at improving the socio-psychological climate in the team. Teambuilding is a strategic tool aimed at long-term goals. Teambuilding is a methodology, and teambuilding is a technical tool. On the one hand, teambuilding is

a strategic tool aimed at long-term goals, and on the other hand – it can be a technical tool for solving the current team problems. Teambuilding as a tool of synergy increases the existing labor potential. However, in general, the concept of the two terms is aimed at forming an effective relationship of interaction between professionals in order to achieve a certain result, which is a synergistic effect of cooperation.

The teambuilding concept is based on a systematic approach, the system elements of which are the professional qualities and qualifications of team members. However, only with effective interaction they can achieve a result that they would not have achieved without cooperation.

Teams, as a systemic entity, are characterized by such features as synergy, emergence and stability. These properties are based on the synergy law, which is formulated as follows: the set of parts that make up the system is organized in such a way that the total potential of the system is greater than the sum of the parts potentials included in it separately (Bertalanffy, 1962). Thus, the team synergy is determined by the effect of interaction in the team which exceeds the result of each team member individually.

In general, an emergence is the appearance of the whole properties, non-additive properties of the parts included in it, i.e. properties that do not follow from the properties of the parts (Geseleva & Zaritska, 2013). The team's emergence lies in their holistic focus on a common result, but by showing such professional and qualified employee characteristics that they cannot show alone.

Emergence demonstrates one of the facets of the concept of integrity. The system acts as a whole because it is the bearer of emergent properties: it will not be whole – and the property will disappear; this property is manifested – hence, the system is intact. The system properties such as "indivisibility of parts", "distinctness of parts" do not contradict each other. Distinguishing parts, but not breaking the ties between them, that is, not separating them; we do not destroy the system. If we need the system itself and not something else, then it cannot be divided into parts. When removing some part from the system, we get another system with the concept of system integrity, but with other characteristics (Geseleva & Zaritska, 2013).

In the system approach, such system characteristic as stability is distinguished. Greater stability of the system internal parts characterize this property compared to the external environment, which characterizes the prolongation of the system existence. The stability of a team system is determined by internal communication policies and organizational relationships.

Researchers identify the following tools for teambuilding, which can achieve the emergence and stability effect of team interaction (Kalinets, 2014; Makovoz et al., 2020): corporate culture, communication, code of values, qualification and functional distribution, organizational structure and motivation mechanism, conflicts and methods their solutions, roles system and positions, ethical norms and informal institutions of management (style, humor, interaction mental norms).

Teambuilding in business should be implemented in the following areas:

– improving the working time efficiency by improving the employee emotional characteristics of interaction;

– improving communication links in the team, which will lead to efficiency and project implementation effectiveness;

– relationships optimization between levels and structural units of the management organizational structure;

– procedural approach introduction through the forming of team's focus on the result – customer satisfaction;

– innovative team thinking development and management decision creativity, which can be a competitive advantage in a changing environment;

– increasing the management decision effectiveness through feedback from staff;

– reducing staff turnover by increasing the professional value sense of employees and responsibility for the common cause;

– increasing the employees' initiative level through the social motivation tools;

– professional and functional certainty of the employees role in the economic business unit development;

– communication digitalization and functional distribution.

3. Teambuilding as a Business Model

Modern business practice and technological structure 5.0 have led to the predominance of sociocratic management and the development of sustainable business models, namely the emergence of teal organizations (Laloux, 2014), project-based structures, and holacracy. These models shift the paradigm from traditional 'command and control' to self-management and evolutionary purpose. The competition paradigm in the professional development field ("win-lose concept") is changing to the synergy interaction concept ("win-win"). Such business models of the team type are more adapted to the application of emergent management decisions, which in uncertainty conditions is crucial for maintaining market positions and economic development.

Let's consider examples of companies that have chosen teambuilding as a business model and the organizational structure forming principle.

Buurtzorg (n.d.) is an innovative healthcare organization founded in 2006 with a comprehensive care model led by a nurse who revolutionized public care in the Netherlands. The business model of this organization is formed based on teambuilding and team cooperation not only within the country but also abroad. As the model is developing, a global learning network is formed around Buurtzorg to share experiences and knowledge.

Valve Corporation (2012) (an IT company in the USA) is based on the business model of teambuilding, which is based on the equal cooperation model "Boss free". This model is characterized by the talent development and the synergistic effect achievement – leadership in the gaming business market due to leadership lack and guidance. According to the authors of the so-called "flat model" (Valve Corporation, 2012), it is the cooperation "without instructions" that motivates the employee initiative and creativity. Guidelines destroy 99% of the talent value.

The holocratic business model 'No boss' is also used by the leading European training platform for organizations Springest (n.d.), and the pioneering Swiss software company Liip (n.d.), which is widely recognized for its successful implementation of self-management. Successful Ukrainian companies such as IPLAND and Uptech also define basic teambuilding principles within their business models, drawing on the official frameworks of self-organizing systems (HolacracyOne, 2024). Companies such as Zappos (n.d.), GrantTree (n.d.), Sylius (n.d.), Precision Nutrition (n.d.), Voys (n.d.) and others define holacratic management structures in their business models.

As the Ukrainian banking institutions, in particular FUIB (n.d.) and Privatbank (n.d.), digitalization transformation practice has shown, teambuilding in modern conditions is an effective tool for implementing digital solutions.

From the analysis of leading companies' business models, we can identify the main trends in teambuilding in the new uncertainty conditions and dynamic changes caused by quarantine restrictions include:

1) the trend of globalization, which allows to form multinational teams and implement the world market leaders best practices in the business model;
2) the trend of caring for the worker health and their families, which became especially relevant during the COVID-19 pandemic;
3) the Hi-tech trend in HR-management;
4) the gender equality trend and taking into account women's quotas in the team formation;
5) teambuilding measures application with an emphasis on eco-tourism and new experience;
6) the trend of growing value of the individual and his professional qualities;
7) the trend of emotional intelligence development of both the individual and the team;
8) project approach to team building.

The main barriers to implementing the teambuilding tools at business model are: opportunism to changes related to reducing the bureaucratization level and increasing the employee autonomy equation; insufficiently developed information base on the effectiveness of implementing teambuilding principles; lack of adaptive methodology for consistent teambuilding principles implementation in the business model; the complexity of calculating the economic effect of investment in teambuilding activities.

4. Practical Tools for Synergy Achieving Through Teambuilding

Teambuilding should be preceded by a conceptual approach to diagnosing problems, analyzing the structure and goals of the team. The results of this diagnosis should be the basis for the methods formation of teambuilding for the project – economic and social development of the enterprise. One of the practical tools for implementing changes in the business model that has proven its effectiveness is the Grid approach. It is an effective strategic tool that has proven its effectiveness in research for 40 years. Using this systematic approach and time-tested methodology, the organization can successfully identify and achieve standards of excellence.

The Grid methodology provides a structured system for assessing an organization's intangible assets such as human behavior and teamwork. Each stage of the team's activity is measured, so participants can objectively compare the goals with the results and thus improve the process of interaction.

Grid International was founded in 1961 by two scientists-innovators in the training and development organization field – Blake and Mouton (1964). Their company was created to form a work environment in which employees felt sincere initiative and interest in achieving common goals.

The Leadership Grid methodology has gained global recognition and has been translated into numerous languages, confirming its universal applicability, and the approach itself has proven effective regardless of industry, country or culture. Today, the network has approximately 40 associate offices around the world that implement and disseminate the Grid methodology to organizations working in a variety of industries. Blake and Mouton's fundamental principles have stood the test of time and proved their practical value today, in a competitive work environment where communication and commitment to the organization are vital to the entire company's success.

The Leadership Grid methodology makes it possible to quantify such an aspect of the human factor as teamwork to achieve effective results. To understand how individual behavior affects the whole team

achievement, we have to understand the teamwork dynamics. Each teamwork involves the three main components interaction (Figure 1):

R1 Resources – human resources (education, training, experience, skills, enthusiasm and self-confidence), as well as material resources (budget, time, capital, production capacity and equipment).

R2 Relationships – how effectively people work together as one team to use the resources identified in R1.

R3 Results – results of activities, which might be seen, or felt, or measured. Includes many different indicators, such as profit, staff turnover, increase or decrease in capital, etc.

The most critical factor in the collaboration process is stage R2, during which team members convert resources into tangible results. And it is the Grid methodology that explores ways of working together at this stage, which is crucial for effective results, regardless of the quality and resources quantity at the beginning of stage R1.

Just as the mathematics principles help to measure resources in stage R1 and results in stage R3, Grid provides a toolkit for understanding and measuring interactions and behaviors in stage R2 (Chernyavska & Glyva, 2011).

The multiplier effect is a concept that defines that investing in teambuilding (for example, in teambuilding events or attracting professionals) leads to a larger than expected effect on performance. The synergistic teambuilding effect can be explained by the multiplier effect: to do this, we adapt the Cobb-Douglas production function to the current stage of economic business relations development, when communication is important.

$$Q = A * L^{a} * K^{1-a}, \quad (1)$$

where Q is the calculated or expected index of the task achieving or the business value increasing for some characteristic time interval;

L is index of staff participation in the team;

K is fixed capital index;

A, α is a positive constant number that characterizes the communication links in the business model.

The mechanism of teambuilding multiplicative effect is as follows:

1. There is an investment in teambuilding. For example, the manager decides to increase the cost of teambuilding events.
2. Investment leads to the improvement of several performance indicators, such as reduced staff turnover, increased productivity, increased task and function efficiency.
3. This allows the company to load production facilities more fully to get the scale effect.
4. This leads to an increase in innovation and creativity in doing business and the emergence of the new product and their customers as well. There is business diversification and scaling.
5. Aggregate demand for products is getting up, income and profitability are growing.

The result of the teambuilding implementation in the business model will be the synergy achievement, diffusion and multiplier effects in business.

The effectiveness of teambuilding can be assessed by the following components:

1. The emotional component characterizes the improvement of the relationship in the team and, thus, the team's emotional intelligence. This indicator can be measured through indicators of the emotional team state, through the assessment of their mood and job satisfaction degree before and after teambuilding activities.
2. The economic component characterizes the profitability growth and thee enterprise productivity before and after the teambuilding activities, as well as through the profitability of the teambuilding process, which is calculated as the ratio of net profit from sales to costs incurred for teambuilding activities. An increase in investment and business value can also

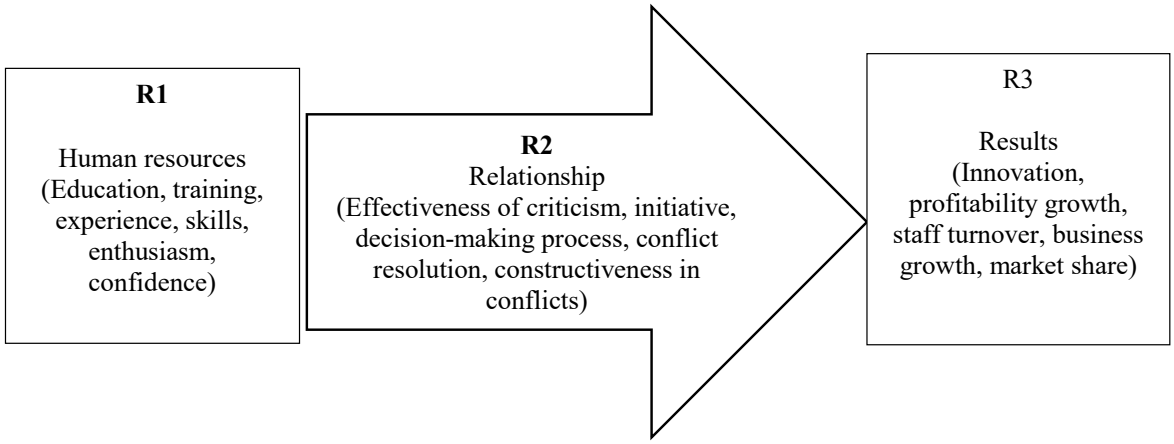

Figure 1. Teamwork Dynamics: 3Rs

Source: (Chernyavska and Glyva, 2011)

be an indicator of an improvement in the economic component.

3. The social component characterizes the growth of product sales level or the customer numbers before and after the teambuilding activities used. This also includes reducing staff turnover. This component also involves calculating profitability by comparing the increase in sales revenue and the cost of building a team.

4. The organizational component involves the reduction of hierarchical levels of organizational management structures or the transition to holacratic management structures, redistribution and optimization of functions and responsibility areas.

The organizational component can also include a reduction in administrative costs and costs associated with changing environmental conditions and increasing the number of implemented projects.

Thus, we can form an effective indicator system of teambuilding efficiency (the template proposed in the Table 1).

5. Modeling Team Synergy

To achieve a multiplier effect from teambuilding activities, it is necessary to optimize the team structure and determine its optimal size in accordance with the task.

Many scientific approaches to modeling and substantiating the size and composition of the team are known. Among the most recognized frameworks in modern business practice are McClure's team formation method (2005) and the integration of AI-driven predictive analytics into Agile methodologies for enhanced sprint planning and decision-making (Ismail, 2026). Kozlowski and Bell (2001) substantiate the optimal team size, taking into account the peculiarities of the situation and the organization environment, the nature of team tasks and requirements, availability of time resources, money, motivational component and more. We offer the stochastic model of team structure optimization and its functional distribution in the context of new social challenges and digitalization in order to achieve team synergy.

The stochastic problem of optimizing the team structure is based on its deterministic model:

$$Z = \sum_{j=1}^{n} c_j x_j \to \max \quad (2)$$

under conditions

$$\sum_{j=1}^{n} a_{ij} x_j \le b_i \, (i \in I_1) \quad (3)$$

$$\sum_{j=1}^{n} V_{ij} x_j \ge Q_i \, (i \in I_2) \quad (4)$$

$$x_j \ge 0 (j \in J), \quad (5)$$

where

x_j – team size $(j \in J)$;

c_j – effect per 1 member of the j-function team;

a_{ij} – costs i-type of resource to ensure the implementation of j-function;

V_{ij} – the result of i-resource provided by the implementation of the j-function;

b_i – the amount of available resource i-species;

Q_i – the amount of tasks i-type that must be provided by this team;

I_1 – a totality, the elements of which are the restriction numbers on the use of resources and tasks;

I_2 – a totality, whose elements are numbers of requirements and criteria for tasks performing.

One of the ways to solve the optimization model is to determine the optimal team structure in the face of social challenges and digitalization. The stochastic analogue of the considered deterministic problem with random parameters is constructed according to the chosen problem statement. The optimality criterion is the maximization of the mathematical expectation of the objective function (2), which will reflect the synergistic effect. Conditions (3) – (5) should be replaced by probability constraints that require the fulfillment of the corresponding inequalities

Table 1
Teambuilding efficiency indicators

№	Indicator	Value before teambuilding events	Value after teambuilding events	The teambuilding effect
1	Staff turnover			Growth of discipline
2	Increasing the job satisfaction level			The effectiveness of work motivation
3	Profitability increasing			Economic effect
4	Reduction of administrative costs and labor costs			Cost optimization
5	Increasing productivity and reducing the complexity of tasks and functions			The level of efficiency of tasks
6	Growth of innovative developments and inventions at the enterprise, units for one worker			Growth of innovation level
7	Increasing customers and business product consumers or services			Increasing competitiveness
8	Rising business value			Economic effect

Source: Developed by the authors as a conceptual framework for performance evaluation

with a probability not less than a predetermined one.

The probability value is determined by the method of expert estimates or logical considerations related to the reserves availability, structural relationships, and the ability to maneuver them.

Therefore, it is necessary to solve the following stochastic problem:

$$Z = M(\sum_{j=J} e_j z_j) \to \max \quad (6)$$

$$P(\sum_{j\in J} a_{ij} z_j \le b_i) \ge p_i \ \ (i \in I_1) \quad (7)$$

$$P(\sum_{j\in J} V_{ij} z_j \ge Q_i) \ge p_i \ \ (i \in I_2) \quad (8)$$

$$z_j \ge 0 \ (j \in J), \quad (9)$$

where

M is a mathematical expectation sign.

Problem (6) – (9) of team structure optimization is a problem of stochastic programming with probability constraints (p) and management decision – a determined vector.

This model allows taking into account the growing requirements for team structure, determined by operation random factors and the digital transformation impact, on the one hand, and business models, on the other, which allows to make a more realistic reflection of modern business conditions.

The team structure optimization model with functional distribution and tasks optimization is taken as the basic economic-mathematical model. This is especially relevant in the context of problems and imbalances in the labor market in Ukraine.

Let us define a stochastic economic-mathematical model of a problem with probabilistic constraints that may be set by the business model conditions.

It is necessary to find the variable values.

$$z_s (s \in S), z_h (h \in H), z_j (j \in J), \overline{y} \text{ and } y$$

which allows you to maximize the function in:

$$\overline{y} = \overline{Z} - \underline{Z} \to \max$$

under the following conditions set by the business model:

1. Deterministic restrictions:

1.1) specified team composition:

$$Z_h = E_h \ (h \in H) \quad (10)$$

1.2) limitation of functional tasks:

$$\underline{n}_r \sum_{s\in S} z_s \overline{n}_r, \ r \in R \quad (11)$$

1.3) restrictions on the management organizational structure according to the company size and the market share that it occupies:

$$\sum_{m\in M} \phi_m \ge Z \quad (12)$$

1.4) limitation of working hours and communication time:

$$D_j \left(\sum_{s\in S} \bar{e}_q \bar{v}_{qs} z_s + \sum_{h\in H} e_h v_{qh} z_h \right) \le Y \text{ , j=1,2} \quad (13)$$

2. Probabilistic constraints:

2.1) formation of the financial investment amount of the project implemented by the team:

$$\mathrm{P}(-\underline{Z} + \sum_{s\in S} f_{1s} z_s + \sum_{h\in H} f_{1h} z_h = 0) \ge P_1 \quad (14)$$

2.2) formation of the income amount from the team result implementation:

$$\mathrm{P}(-\underline{Z} + \sum_{s\in S} \overline{E}_q \bar{v}_{qs} z_s + \sum_{h\in H} E_h v_{qh} z_h = 0) \ge P_e \quad (15)$$

2.3) limited resources:

$$\mathrm{P}(\sum_{s\in S} f_{ls} z_s + \sum_{h\in H} f_{lh} z_h \le F_l) \ge P_l \ \ (l \in L) \quad (16)$$

2.4) use of outsourcing services for project implementation:

$$\mathrm{P}(\sum_{s\in S} \bar{P}_{js} z_s - z_j \ge 0) \ge P_j \ (j \in J) \quad (17)$$

2.5) the cost of the team project is not less than the number of previous agreements:

$$P\left(\sum\nolimits_{s\in S} \overline{v_{qs}} z_s \ge V_q\right) \ge P_q (q \in Q_1, Q_1 \in Q) \quad (18)$$

2.6) optimization of the management organizational structure, including:

a) management functions balancing:

$$P(\sum_{s\in S_k} a_{is} \bar{p}_s z_s + \sum_{j\in J} a_{ij} z_j \ge \sum_{h\in H} b_{ih} z_h) \ge P_i, \ (i \in I) \quad (19)$$

б) by hierarchical structure:

$$P(\sum_{s\in S_k} a_{is} \bar{p}_s z_s + \sum_{j\in J} a_{ij} z_j \le \sum_{h\in H} d_{kh}^{\max} z_h) \ge P_k \text{ , } (k \in K) \quad (20)$$

$$P(\sum_{s\in S_k} a_{is} \bar{p}_s z_s + \sum_{j\in J} a_{ij} z_j \ge \sum_{h\in H} d_{kh}^{\min} z_h) \ge P_k \text{ , } (k \in K) \quad (21)$$

3. Integrity of variables:

$z_s \ge 0, (s \in S), z_h \ge 0, (h \in H), z_j > 0, (j \in J),$

$\underline{Z} > 0, \overline{Z} > 0,$ (22)

where

P_l, P_σ, P_ν, P_j, P_q, P_κ – the probability levels of the relevant requirements meeting.

The deterministic analogue determines the synergetic effect achievement, the model deterministic constraints without change and the probabilistic constraints, which are transformed into identical determinants with the help of the economic-mathematical apparatus.

4. Deterministic analogue of probabilistic constraints (2.1) on the team project cost formation:

$$\sum_{s\in S}\bar{f}_{1s}z_s + t_{p1l}\sqrt{\sum_{s\in S}\sigma^2_{\upsilon c}z_s^2} + \sum_{h\in H}E_h v_{qh}z_h - \bar{Z} = 0 \qquad (23)$$

5. Deterministic analogue of probabilistic constraints (2.2) on the income formation after the team project implementation:

$$\sum_{s\in S}\bar{e}_q\bar{v}_{qs}z_s - t_{p_c}\sqrt{\sum_{s\in S}\sigma^2_{\upsilon e}z_s^2} + \sum_{h\in H}e_h v_{qh}z_h - \bar{Z} = 0 \qquad (24)$$

6. Deterministic analogue of probability constraints (2.3) on the resource provision using:

$$\sum_{s\in S}\bar{f}_{1s}z_s + t_{pl}\sqrt{\sum_{s\in S}\sigma^2_{fls}z_s^2} + \\ + \sum_{h\in H}\bar{f}_{lh}\,zh\overline{F_l}, (l\in L) \qquad (25)$$

7. Deterministic analogue of probability constraints (2.4) on the outsourcing services using:

$$\sum_{s\in S}\bar{p}_{js}z_s - t_{pl}\sqrt{\sum_{s\in S}\sigma^2_{pj}z_s^2} - z_j \geq 0, (j\in J) \qquad (26)$$

8. Deterministic analogue of probabilistic requirements (2.5) to the design task:

$$\sum_{s\in S}\bar{v}_{js}z_s - t_{pl}\sqrt{\sum_{s\in S}\sigma^2_{pj}z_s^2} \geq V_q, (q\in Q_1, Q_1\in Q) \qquad (27)$$

9. Deterministic analogue of probabilistic constraints that provide communication links in the business model, including:

a) balancing the functional structure:

$$\sum_{s\in S_k}a_{is}\bar{p}_s z_s - t_{ps}\sqrt{\sum_{s\in S_k}\sigma^2_{ps}z_s^2} + \sum_{j\in J}a_{ij}z_j - \\ - \sum_{h\in H}b_{ih}z_h \geq 0, (i\in I); \qquad (28)$$

b) according to the management organizational structure:

$$\sum_{s\in S_k}a_{is}\bar{p}_s z_s - t_{ps}\sqrt{\sum_{s\in S_k}\sigma^2_{ps}z_s^2} + \sum_{j\in J}a_{ij}z_j - \\ - \sum_{h\in H}d^{\max}_{kh}z_h \leq 0, (k\in K); \qquad (29)$$

$$\sum_{s\in S_k}a_{is}\bar{p}_s z_s - t_{ps}\sqrt{\sum_{s\in S_k}\sigma^2_{ps}z_s^2} + \sum_{j\in J}a_{ij}\mathrm{x}_j - \\ - \sum_{h\in H}d^{\min}_{kh}\mathrm{x}_h \geq 0, (k\in K); \qquad (30)$$

where

$t_p = \Phi^{-1}(\mathrm{P_i})$.

The main difference between the deterministic analogue of the stochastic model and the corresponding linear model is that it takes into account the size of objective fluctuations of random variables – model parameters. So, it is a more accurate reflection of real practice, as it takes into account the factors influencing the team structure in accordance with the requirements of the task. That is, this model is the integration of teambuilding and resource capabilities into a single process – achieving the goal.

The optimization model contains possible teamwork limitations – those that are difficult to predict, and deterministic – those that are predictable and those that are set to perform the task. Thus, in addition to economic, organizational, technological and communication factors, the factors of a given project play an important role, which are mostly determined.

In our opinion, the proposed teambuilding structure more complete takes into account the peculiarities of team cooperation and socio-communication factors. It also meets the modern conditions of digital communication, where many parameters are set, and some are uncertain. The implementation of such a team structure formation model in practice will make the team function more efficiently, and the cooperation of members will be sustainable and contribute to the multiplier effect growth.

6. Results and Discussion

6.1. Model Validation through Comparative Case Study Analysis

To verify the adequacy of the developed deterministic-stochastic model, a study of two enterprises in the Ukrainian food industry was conducted. The selected objects represent typical SMEs with different team scales: Grandem PE (21 employees) and Blizart Co. (12 employees). This difference allows the model to be tested on both a compact, highly integrated team and a larger, more complex organizational structure, thereby validating the model's scalability.

Case A: Grandem PE. This enterprise specializes in the production of breadsticks (food straws) and successfully exports its products under the Halal quality certificate. Its team model is based on a cultural and ethical code where synergy is achieved through high loyalty and ideological cohesion.

Case B: Blizart Co. This firm is a manufacturer of premium craft ice cream operating under the international safety standard ISO 22000 and the HACCP (Hazard Analysis and Critical Control Points) system. The management model is transforming towards holacratic approaches where synergy is generated through the digitalization of safety control processes.

The qualitative parameters of the 3Rs model presented above served as the basis for the numerical experiments. To evaluate the practical effectiveness of the developed deterministic stochastic model, a comparative calculation of performance indicators was performed (Table 3).

The results (Table 3) verify that the transition from a qualitative 3Rs description to a stochastic

Table 2

Synergy efficiency parameters based on the 3Rs model (Resources, Relationships, Results)

Analysis Indicator	Grandem PE (Food Straws, Halal)	Blizart Co. (Ice Cream, ISO/HACCP)	Scientific Interpretation
Resource Basis (R_1)	Ethical standardization	Technological regulation	Transition from material to regulatory resources
Team Focus (R_2)	Shared identity	Digital transparency (HACCP)	Communication as a multiplier
«Baseline Synergy (A)	1.18	1.24	Level of non-linear efficiency growth
Results (R_3)	Market stability and export growth	Innovative flexibility and product safety	Emergent system output

Source: compiled and calculated by the authors based on the 3Rs model application and empirical data from the studied enterprises

optimization model allows for a significant increase in the emergent properties of the business unit.

The mathematical justification for the observed 22.9% synergy growth in Grandem PE lies in the transition from rigid functional distribution to a flexible stochastic structure. By applying the deterministic analogue (Eq. 23-30) with a confidence level of P=0.95, the model effectively minimized the variance of digital communication gaps and resource volatility.

Unlike the deterministic approach, the stochastic model maximizes the mathematical expectation of the synergy effect M(Q) by optimizing the team size x_j according to the probabilistic constraints of the business environment. For Blizart Co., the model's application resulted in a 26% reduction in communication time, proving its effectiveness in highly regulated digitalized workflows. These results confirm that teambuilding, when modeled as a stochastic system, acts as a high-leverage tool for achieving non-linear business growth.

6.2. Discussion – The Synergy of Standards and Digital Tools

The analysis confirms the hypothesis that quality standards serve as an "organizational foundation" for teambuilding. In the case of Grandem PE, Halal certification acts as a social regulator that reduces transaction costs within the team. This allows for the mathematical modeling of stable stochastic processes, as staff behavior remains predictable and determined by shared values.

At the same time, the Blizart case demonstrates a higher level of synergy (1.24) due to the implementation of the HACCP system. We argue that the digitalization of critical control points automatically creates a low-opportunism environment. In this context, employees do not merely follow instructions; instead, they become participants in a "digital responsibility network" characteristic of holacratic management models.

It has been proven that in the context of Industry 5.0, teambuilding in small and medium-sized enterprises (SMEs) of the food industry should be based on a combination of "hard" standards (ISO/Halal) and "soft" synergy methods. This creates a multiplicative effect where personnel involvement (L) and capital (K) interact through the coefficient A, which significantly exceeds the simple sum of individual factors.

7. Conclusions

The research provides a comprehensive analysis of the empirical and economic-mathematical aspects of teambuilding as a strategic tool for achieving synergy within business model management. The implementation of a systems approach to HR management has identified teambuilding as a fundamental mechanism for generating emergent effects.

The study of progressive business models and the comparative analysis of two food industry enterprises – Grandem PE (Halal certified) and Blizart Co. (ISO 22000/HACCP certified) – lead to several critical conclusions.

First, it is established that team-based business models are significantly better adapted to uncertainty.

Table 3

Efficiency of team synergy achieving based on the 3Rs model

Enterprise	Scenario / Approach	Synergy Coeff. (A or Q)	Comm. loss reduction	Synergy growth (ΔS)
Grandem PE	Baseline (Traditional)	1.18	–	–
	Stochastic Model	1.45	-28.8%	+22.9% *
Blizart Co.	Baseline (Traditional)	1.24	–	–
	Stochastic Model	1.38	-26.3%	+11.3% *

*Statistical significance of the synergy growth confirmed at a confidence level of $P = 0.95$ through the application of the deterministic-stochastic optimization model.

Source: developed and calculated by the authors based on numerical experiments and the deterministic-stochastic optimization model

In small and medium-sized enterprises (SMEs), team building acts as a "multiplier" of resources. The practical application of the 3Rs model (Resources, Relationships, Results) proved that qualitative improvements in team dynamics (Relationships) can compensate for limited material assets (Resources), leading to non-linear growth in productivity.

Second, the proposed deterministic-stochastic model was successfully validated. By incorporating stochastic factors, the model offers a more realistic reflection of business processes than traditional linear approaches. The case studies demonstrated that the model remains effective for teams of different scales (from 12 to 21 members), confirming its versatility for various SME types. The synergy coefficient (A) reached values of 1.38 to 1.45, proving that the integration of teambuilding into a single resource-management process creates a measurable multiplicative effect.

Third, the research highlights that international quality standards (Halal, HACCP) serve as an organizational catalyst for teambuilding. These standards reduce internal transaction costs and "opportunism to change," providing a stable foundation for digital transformation.

In summary, the transition to Industry 5.0 requires businesses to shift from hierarchical structures to "digital responsibility networks". The tools proposed in this study, including the Grid methodology and stochastic modeling, provide a methodological basis for managers to transform team interaction into a sustainable competitive advantage.

The scientific novelty of the results lies in the formalization of the teambuilding process as a deterministic system within the Lean Canvas and Holacracy frameworks. Unlike traditional approaches, the proposed model accounts for the specific role-based distribution of tasks in high-tech environments, providing a tool for calculating the potential synergy of business units before their actual formation.

Author Contributions

Viktoriia Kyfyak: Conceptualization, Methodology, Formal analysis, Investigation, Writing – Original Draft, Project administration.

Volodymyr Zapuhkliak: Software, Validation, Data Curation, Writing – Review & Editing, Visualization.

Oleksandr Kyfyak: Resources, Supervision, Methodology, Formal analysis (statistical validation), Writing – Review & Editing.

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