Scientific Visualization, 2022, volume 14, number 3, pages 29 - 46, DOI: 10.26583/sv.14.3.03

Visual Management as an Effective Organizational Technology

N.N. Krupina[1]

St. Petersburg State Agrarian University, St. Petersburg, Pushkin

[1] ORCID: 0000-0002-7983-845X, Krupina_n17@ mail.ru

Abstract

The article discusses the essence of the concept, characteristics, tasks and evolution of visual management (VM) from the standpoint of the analysis of the subject content of management and the features of organizational technology. The priority groups of production tasks that are successfully solved with the help of VM tools are identified - communications, safety and efficiency («lean production») of the production and technological cycle. Emphasis is placed on the ability of visualization techniques to present important operational information so that the employee «at a glance» can assess the current state of the working system and quickly eliminate detected deviations from the norm. Based on the principle of continuity of the organization's activities, a method for assessing the quality level of VM is proposed and illustrated on a conditional example. It is proposed to use the method of dynamic standards, which are taken as indicators of «labor productivity», «costs» and «net profit». A map of positioning options for the quality level of VM is given and alternative situations are characterized - productive, efficient, allowed and inefficient levels. In the context of the topic, the main aspects of the development of modern software are outlined.

Keywords: production, management tasks, information visualization, visual management (VM), organizational technology, VM tools, place of VM in the value chain, performance criteria, labor productivity, net profit, costs, dynamic standards method, VM quality level.

1. Introduction

Visual management (VM) is a relatively young field of knowledge and practical activity, formed during the evolution of information and socio–economic relations to facilitate the perception and comprehension of important and significant information. This is a complex and rapidly developing process since the 1960s, associated with the beginning of the global informatization of society, the active penetration of mathematical methods and IT-technologies into production management. As the business environment becomes more complex and the flow of information grows, the need for accumulation, generalization, codification and translation of useful experience and accumulated knowledge for solving practical problems is satisfied. Often the experience of VM becomes a competitive advantage and an impulse for the transition of management to a qualitatively new level of development. It simplifies and facilitates the work of performers, makes it more rational, safe, comfortable, scientifically sound and effective. However, the issues of evaluating the effectiveness and efficiency of visualization systems in management practice remain poorly understood.

Research hypothesis: *the growth of information saturation in a complex and ambiguous competitive environment actualizes the role of visual management as a successful independent professionally implemented organizational technology. Based on the principle of continuity of the organization's activities, it is advisable to evaluate the effectiveness of the corporate information visualization system using dynamic standards, which can be classical indicators - labor productivity, costs and net profit.*

The purpose of the study is to comprehend the VM system in terms of technology, to clarify the essence, directions of development and features of VM as an indispensable technology for managing limited resources and, on this basis, to think over the methodology for forming

the composition of key indicators and a method for evaluating efficiency based on the model of the reference dynamics of these indicators. General scientific research methods were used: search and study of scientific publications on the topic of research, analysis and synthesis, the relationship of historical and logical processes, the search for cause-and-effect relationships. A matrix approach is used to find a solution to a practical problem.

2. Visual management as a technology

We define the concept of «management» as the main one in the phrase VM, and, despite the versatility of the essence (science, practice, experience, art) and the numerous interpretations, we single out its attributive feature. Management is a set of scientific knowledge, principles, means and forms of effective management of production and production personnel in a competitive environment. In the context of the hypothesis, we will consider management as a technology for coordinating and combining the work activities of other people in such a way that it is effective and efficient [1].

Management technology allows you to decompose the production process into its constituent elements, which opens up the possibility of repeatedly increasing the efficiency of labor operations due to rationality, the exclusion of secondary work, the sophistication of organizational methods and techniques, the sustainability of obtaining results, impersonality and reduction in resource costs [2]. This fully corresponds to the essence of the VM and is confirmed by the interpretation of the concept:

• *the visual management system* is a set of tools that should constantly remind workers and managers of all the elements that ensure the success of the company's activities: from the presentation of a strategic goal to a list of employee proposals. This system responds promptly to changes, makes problems visible and obvious, relies on standards, focuses on achieving specific goals, solving the most important production tasks [3];

• *visualization of processes* - such placement of tools, parts, containers and other indicators of production, when an employee understands the state of the system at a glance - the norm or deviation [4];

• *visual project management* is a new concept of practice that combines visual thinking tools and data visualization methodologies with more traditional methods of communication, reporting and project facilitation; it is a revolutionary new approach to presenting data and information in visually rich designs that improve awareness and understanding of project critical points and key performance indicators [5];

• *visual control* is a system of visual elements (boards, diagrams, charts, signs, marking information on displays) that control people's actions; it is the practice of effectively conveying messages to workers or exchanging information between them. The content of these messages relates to modes and methods of work, organization of activities, procedures, instructions, as well as problems of the enterprise [6];

• *visual management* is the placement in an understandable form of all tools, parts, production activities, indicators of the production system so that the current state of the system can be understood at a glance to any person involved in the activity [7].

The presented views are united by the VM's focus on important operational information «at the first glance of the user» for diagnosing the current state of the production system and adequate impact when a deviation from the norm is detected. With the help of VM tools, transparency of organizational processes is achieved when solving numerous tactical and strategic tasks, which can be divided into three groups (fig. 1). At the level of executors' workplaces, priority remains for the operational solution of tasks aimed at achieving the efficiency and safety of production, the development of increased returns from external and internal corporate communications.

VM is a multilevel phenomenon: organization of workplaces, measurement and display of operational data, training, development of managerial decisions, control, diagnostics and analysis of performance results, public policy and feedback. A high-quality VM system is posi-

tively perceived by the performer, because it simplifies the extraction and synthesis of key information, reduces the time and stress of their comprehension [8]. The visibility of data has a motivating effect on almost all employees, reveals hidden mental schemes involved in the generation of various scenarios and team decisions [9]. So, for example, despite a long history, the most popular business applications based on OLAP-technologies remain indispensable for budgeting, analyzing the seasonal dynamics of cash flows, and predicting the results of a planned marketing mix in various territorial markets.

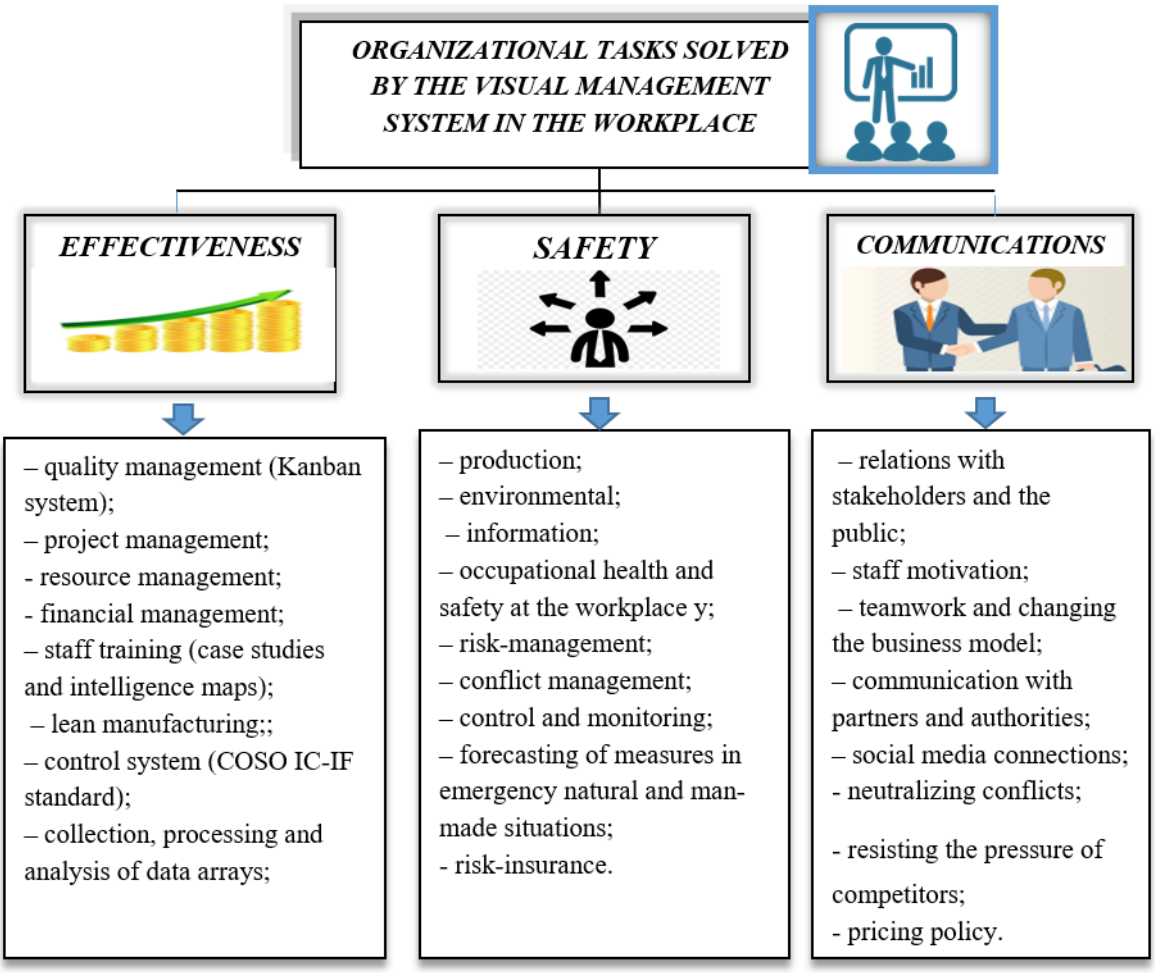

Fig. 1. Organizational tasks solved by the VM system in the workplace (compiled by the author)

The technological essence of the VM is confirmed by the presence of:

– signs characteristic of technologies, namely: a) the division of the labor process into phases and stages; b) the unambiguity of the procedures; c) the target orientation; d) the regulatory nature; e) the binding of procedures to certain calendar dates;

– three aspects explaining the nature of [10]: a) essential, reflecting the means of technology (instrument of influence, goal-setting activity, transformation process); b) epistemological, representing technology as systematized knowledge; c) managerial, considering technology as a set of knowledge and methods, a sequence of procedures and operations purposefully applied in various fields activities;

– basic structure-forming elements - principles, laws and patterns of organization and management; methods and means of collecting and processing information; methods of effective influence on employees; d) control systems [11];

– cognitive resource: VM techniques are based on the use of the biological nature and psychological and emotional patterns of functioning of the intellectual capital of the management object;

– mechanisms and tools for identifying, extracting and formalizing knowledge necessary to create the required socio-scientific strategy for mastering innovations to increase the effectiveness of group interaction, develop the creative potential of employees, overcome social and cognitive problems [12].

VMs have clear advantages:

– ease of extracting and synthesizing information, availability of software, the ability to solve technically complex tasks and effectively coordinate the actions of a large number of participants [13];

– involvement of visual memory and focusing the performer's attention on actions that mediate the achievement of the result;

– clarity, accuracy and unambiguity of the description of details and the algorithm of actions, which eliminates the erroneous choice of actions and reduces the risk of injury as much as possible;

– reduction of waste of time and resources without loss of quality of work;

– productive interaction in a team, exchange of knowledge, ideas, experience.

VM tools are dynamically developing, changing and expanding depending on the general concepts and scientific schools prevailing in the theory and practice of management. When substantiating the stages of VM development, the results of the authors' research were used [14-17] (fig. 2). In the course of its evolution, VM has gone from the simplest methods of observing, documenting, compressing information and statistical processing of structured data for their visual perception to the most complex highly intelligent methods of project management, identifying patterns and strategic planning of business processes, including the ability to integrate unstructured data.

Effective address primitive VM tools include the following methods of employee concentration:

– color marking of tools, parts, assemblies; «road signs» - signs, positions of placement of important work items; outlining places of permanent storage of devices or posting information;

- information boards of various shapes and sizes, divided into two fragments according to the principle «Before»-«Became» («Stop-«Go», «Before»-«After»);

– technical acoustic and visual warning or warning systems in the event of danger, problem or defect in operation («alarm lamps»).

PERIOD AND SCHOOL OF MANAGEMENT	**PRIORITY ASPECTS OF MANAGEMENT**	**DOMINANT TREND AND PRODUCTION PARADIGMS**	**PREVAILING VISUALIZATION TECHNIQUES AND TOOLS**
School of Scientific Management (1885–1920).	Operational methods of work, division and coordination of labor, specialization and assembly lines, technological discipline; accounting, control and document flow	*Craft Production* Production as a set of controlled sandtandardized repetitive operations	*Simple planning, accounting and workflow systems* Graphical methods of statistics, maps of work operations, Gantt chart and cockscomb chart
Administrative School (1920-1940)	Development of general organizational and administrative issues and universal principles of scientific management	*Mass Production* Operational activities with an emphasis on ensuring the quality of work and product. Process approach in management	*Total Quality Management* (System of Differentiation) Six Sigma, Shewhart charts, control charts, quality spiral, PDCA cycle,
School of human relations (1930-1950)	Planning, organization, management personnel, management, coordination, accounting, budgeting. Empirical (pragmatic) approach to management	*Mass Production* Management from the standpoint of psychology and human relations management from the standpoint of psychology and human relations. Systematic approach to management	*Birth of the Business Process Management Software Industry* Tableau De Bord model. Business Process Reengineering, information boards, accent visualization, scenario modeling, road maps
Entrepreneurship school and School of strategic	The Importance of the Entrepreneur's Personality. Resource saving.	*Flexible Production* The human factor as the basis of production and commercial success. Identi-	*Growth in the number of firms involved in software development* Integrated packages (workstation); maps

management (1960-1980)	Behavioral approach to management Situational approach to management The concept of management culture	fication of the individual with the organization. Business Management and Business-Process Reengineering	of business processes and financial flows; matrix analysis; Balanced Scorecard, transactions in the ERP system.
School of Systems Management (1990-2020)	Focus on innovation; project management; management by objectives and based on information technology; strengthening the role of intellectual capital	*Customization and personalization* Construction of networks and clusters. Integrated business-space based on global informatized networks	*Software as a Service* Graphical notations based on Business Process Model and Notation. Online Behavioural Advertising. Attribute Explorer. Single database; client-server, visual development tools, graphic editors.
«New school» present time	Innovative production as the basis of the knowledge economy.Introduction to management of the apparatus of exact sciences and computers. cognitive management Cognitive management	*Socially oriented industries* Achieving social priorities Management of non-standard solutions. Mathematical modeling, game theory, system analysis. Business value management	*Digital Business* Adaptive Case Management. Cognitive modeling . Network communications. Digital marketing. Description of multidimensional objects. Roadmaps supply and risk management, logistics routes . logical models and mental maps of business-processes. Low-Code Platform; Appian, PowerApps, Microsoft, Salesforce Lightning и Zoho Creator. Road Map
2030 year – forecast [14, c. 175]. The concept of management will be based on the use of human capital, which ensures intensive economic growth as part of the development of the sixth technological order after overcoming the global economic crisis of the 2020 years. Management based on the use of human capital: knowledge, skills, talents and abilities of employees			

Fig. 2. Development of VM tools in coordination with the evolution of management schools (developed by the author)

The VM techniques are successfully used in small business, when several areas of responsibility are delegated at the same time. For example, an administrator of the hotel is obliged to prepare a certificate of security systems at the facility weekly, controlling the manifestation of certain factors (fig. 3).

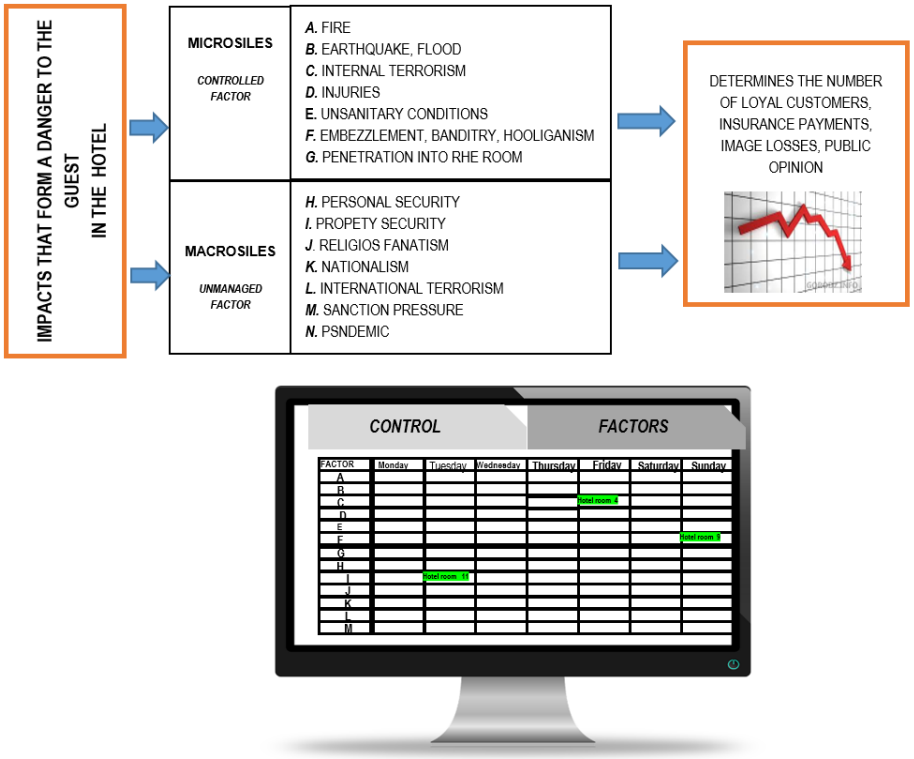

Fig. 3. Controlled factors in the hotel security system

More complex unique intelligent visualization systems based on the Work Explorer software and multimedia technologies «guided» the employee through all operational areas and

«critical points» of the technological cycle, indicating the process features as clearly as possible.

The transition from one operation to another is accompanied not only by an image, but also by a short text. The scenario of such a step-by-step instruction may vary depending on the complexity of the work and the qualifications of the performer. If necessary, the employee can independently open additional applications in the form of drawings, schemes, sketches, photographs, reference data and necessary explanations. The possibility of direct operational communication with the foreman or work manager is provided. Such «smart» workplaces minimize the number of violations and technological errors.

Leading specialists and top-managers actively use digital business modeling tools in the course of planning and analyzing financial flows, for example, developing appropriate mental maps. The mind map of the business process clearly and visually represents a set of elements and their relationships in the process of production and sale of the product, illustrates the procedure for «making money» [18]. The high effectiveness of the application of business models in managing knowledge and motivation of personnel has been repeatedly confirmed due to the fact that almost all parameters of the business process are compactly described and visualized [19]. For the presentation of complex and voluminous concepts, the world's leading corporations use mind maps developed with the help of special software editors that allow you to change fonts, color and size of elements, if necessary, integrate images to attract attention (Mind Jet, Map It, Imind, Freeplane) [20]. The return on VM costs is expanding (from 30 to 50%) - saving working time, mobilizing reserves, improving product quality, continuous improvement of business processes, reducing costs, increasing business reputation.

3. Visual management system software

The software of the VM system is diverse and allows you to quickly solve a wide range of applied management tasks. Reviews of the evolution, state, «bottlenecks» and problems of software development of management processes of organizations and enterprises are published regularly, for example, works [21-22]. The researchers point to the irreversibility of the processes of developing hybrid systems and the intellectualization of software products, which corresponds to the management's request for effective tools for complex analysis and planning of the sustainability of business processes under the impact of modern global and local challenges. In the context of the hypothesis under study, we note certain aspects.

✓ Management of a complex system of organizational, industrial, social, commercial and other relations is based on an accurate and complete formalized representation of business processes provided by SADT, IDEF, DFD methodologies. To maintain managerial routines (normal and predictable patterns of business behavior), computer modeling methodologies based on CASE technology are used. The most popular is the UFO triune construct – «Node – Function – Object» (UFO – toolkit), within which a formal semantic normative system is used. It can be assumed that a «node» («crossroads of the flow of connections») is a specific center of responsibility; a «function» (a means of balancing connections) is a set of carriers of working competencies; an «object» (a material embodiment of a function) is a space in which responsibility and competencies are distributed. In the notation of DFD- and IDTFO-diagrams, the resources of the responsibility center are usually represented by the competencies of the staff; in the notation of BPMN-diagrams, they are an abstract class of business relationships called an «Event» that enters the operational cycle or is generated by a business process. For example, for the purposes of project financing and budgeting, they get an adequate idea of the dynamics of cash flows, which eliminates any possibility of collisions, errors of interpretation and inaccurate interpretation. Unambiguity in the interpretation of notation signs «allows using it as a basis for creating a method of graph-analytical modeling of project financing systems, constructing analytical procedures and generating binary code of simulation models» [23].

✓ For the purposes of project management, developers of graphic editors of models of complex innovative business processes offer software tools for structural, simulation, analytical modeling. Experts recognize the IDEF standard (1981) and its later (2004) modification – BPMN notation (*The Business Process Modeling Notation)* with high language comfort and the ability to detail engineering tasks from the design stage to the implementation and control of the idea. The graphical space combines artifacts, areas of responsibility (*Swimlanes*), data, connecting elements (*Connecting Objects*) and flow elements (*Flow Objects*) with events, actions (*Activities*) and gateways built into the flow. For example, users of various templates and basic shapes-blanks of the *Microsoft Visio* graphic editor can successfully build an organizational diagram or a roadmap of the technological process, visually support new interpretations of competitive advantage, adapt service information for various responsibility centers, promptly make adjustments taking into account the constantly changing production or market situation. A very effective tool are the applications of the *ConceptDraw Office* package: problem-oriented templates, thematic libraries, a set of vector drawing tools, a built-in presentation mode reduce the time for solving complex professional and technical tasks, simplify the description of new processes, facilitate the installation of default properties for added objects, open the possibility for slide shows. Using the *Flow Breeze* module for *Microsoft Excel*, managers make flowcharts in automatic mode, pre-formatting the text, choosing the color of shapes, font, line style, type of text alignment, copying fragments of other documents [24]. To optimize business reporting and feedback from stakeholders, the built-in templates in the *Diagram Designer* systems [25-26], *Edraw Max* 6.5.0.2046 Portablet [27-28], PaceStar WizFlow *Professional* v6.0 [29] are used without causing difficulties. They allow you to visualize the structures of operational, labor, and financial processes and fill business plans, innovation and index cards, investment projects and programs with graphic content. Chart styles and templates can be changed by creating your own chart types, the functions of importing objects from other files and exporting ready-made flowcharts to files are supported, as well as saving them to separate files in EMF, WMF, BMP and JPG formats.

✓ The main user of a management decision is always a person, therefore, a large burden in creating a unique, non-monotonous, attractive and memorable positive design of a visual product falls on color and animation creatives. All the proposed editors allow you to choose a font, images, color combinations, contrast, style and appropriate animation [30-31]. It is reported that users are less sympathetic to bright colors, but comfortably perceive the classic ones – «dark plum», «red», «dark blue», the color of «blue steel», as well as white and gray [32]. Dynamic text is actively used to position key production tasks for the purpose of occupational safety and health, teaching advanced work techniques, and solving problems of saving resources. Available interactive software products (*ActorScript, VBScript, PHP, ASP, Actionscript, Javascript*) use traditional coding methods, and allow you to write scripts, present complex situations in a playful way (two-dimensional animation sets an object in motion in four possible directions from the center, explaining what and why is happening in the workspace) [33]. A variety of HTML animations are created using the library D3.js . (*Data-Driven Documents*). It has been repeatedly proven that the modeling of industrial hazardous situations, the use of role-playing games, team problem solving in emergency situations is very effective when instructing personnel. The employee becomes the subject of interaction, actively participates in the learning process himself, following his individual route. The most popular are animated 3D videos showing typical accidents, consequences of erroneous actions and their causes. For example, the program «Fire extinguishing at electrical installations»: builds a sequence of multimedia plots depending on the correct or incorrect actions of the trainee [34].

✓ Intelligence maps are being actively introduced into calendar planning - simple, very convenient visual formats for organizing (highlighting, displaying, fixing and storing) the flow of information to popularize the most important ideas, concepts, and significant stages of production. For example, the scope of a shift assignment (job functions) is divided into inde-

pendent elements, each of which is then divided into specific installations, tasks, initiatives, indicating the methods of their solution. Computer software packages, including many templates, cliparts, and special modules, allow decomposition to be carried out in sufficient depth and detail. This is *ConceptDraw MINDMAP 7* as part of the *ConceptDraw Office package; Edraw Max v. 6* with an editor for drawing Gantt graphs and flowcharts); *XMind 3.2; MS Visio 2010; Mindjet:MindManager 2012 v. 9; MindMeister, XMind Zen; MindMup; Mind42; LOOPY* [35]. Creative visual techniques of integration of strategic and mental maps are successfully used by top management to solve non-standard tasks of optimization and restructuring of business processes or strategic consulting. Thus, in the course of innovative technological modernization of production, it is required to show a roadmap of movement from planned goals and objectives to specific indicators and achievements.

✓ VM is the first step towards multidimensional digitalization of production, as it relies on tools for converting analog organizational information into digital for automated processing of an array of management data [36]. Business modeling systems aimed at achieving operational and/or strategic goals provide significant improvement in indicators: improving labor productivity, customer service quality, optimizing operations, and forming a new business model. The VM system covers all levels of digitalization of the operational cycle in accordance with the typology of Strohmeier S. [37]. At level 1 (analog), «paper» reporting prevails, and the potential of digitalization does not cover either strategic or current activities. VM tools are used for the rational organization of workplaces: they clearly indicate the rules of the layout of the tool, the sequence of operations, scheduled shift tasks. At the second level (operational), digitalization covers only the management of operational processes, and VM tools help to improve the quality of work, reduce production costs, speed up paperwork, document flow and reporting. At the third level (strategic), digitalization covers all key business processes and business communications. To search for new commercial ideas, VM technologies are directly integrated into strategic planning and business analytics, activate feedback with customers and partners in the network space. At the fourth level (integration), the introduction of artificial intelligence makes it possible to digitalize management functions as much as possible, leaving specialists time for creative work and useful initiatives. This leads to high management efficiency, multiplicative effect of organizational changes and economic efficiency of activities [38]. At this level, VM practice is identified with the concept of «electronic human resource management» (electronic HRM or e-HRM), which is progressively transformed into the concept of digital management (digital HRM). It covers the whole range of applied tasks – quality of customer service, conditions, productivity, safety and remuneration, competence development, training, motivation and career growth [39]. At the same time, the VM system remains an effective tool for implementing corporate functions of target groups of linear and administrative employees to create value [40].

4. The Effectiveness of visualization systems

The commercial basis of any production process is the *customer value chain* in a sequence of interrelated operations for the development, production and sale of an economic good. The task of management is to ensure maximum value for the consumer and the lowest cost for the producer through the rational use of resources. M. Porter combined five elements in this value chain: managing the creation of resource reserves (incoming logistics), technological operations for converting raw materials into a product, delivering the product to the consumer (outgoing logistics), marketing and sales, and service (customer service) [41]. At the same time, at the stage of formation of information visualization, its «reference model» was proposed [42]. At the initial stage, chaotic information is converted into a table of meaningfully structured data and then into a visual structure, which is transformed into a specific graphical representation. These two models are well coordinated, which allows us to identify the role and place of the VM system in the customer value chain (fig. 4).

To confirm the hypothesis, we proceed from the fact that evaluating the effectiveness of organizational management technology is rather complex and multifaceted task. The current accounting system does not allow for reliable identification and allocation of costs and benefits created directly by the corporate VM system. The value of the VM is manifested in the intellectual support of production, therefore, efficiency should be expressed in terms of the ratio of benefits and costs received, which corresponds to the generally accepted approach [43].

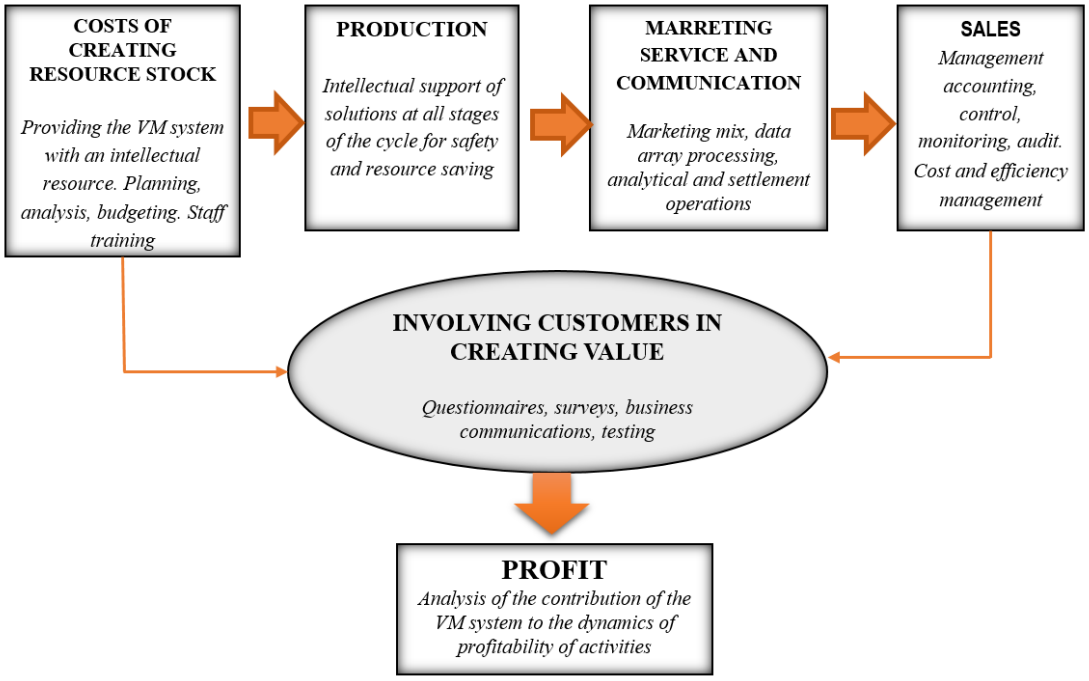

Fig. 4. The place of the VM system in the chain of creating consumer value of a commercial product (compiled by the author)

A method for evaluating the effectiveness of information visualization using the ratio «informativeness – efficiency» is proposed [44]. The informative value of visualization depends on the detail of the information flow, the composition of search tools and the type of models (graphs, maps, matrices, histograms). Increasing the information content of graphic models often negatively affects the efficiency of perception, so the concept of graphic design and the scenario for using the visualization system should take into account the capabilities and features of the human cognitive apparatus as much as possible. Another study reports on the «automation pyramid» as an exemplary Haldan MES business growth model, which collects data on the status and efficiency of equipment in real time and presents reports to the staff on the dashboard [45]. Collected data becomes valuable information for control, planning and allocation of resources. It is shown that the faster the information is processed at the lower workplace, the faster the response corrective action is implemented when the work cycle deviates from the standard task. Through the classification of operational data, processing and comparative analysis, the system displays key production performance indicators. Databases and advanced VM tools (Google Sheets, App Sheet, STC-LAM) are able to generate intelligent predictive information and thus increase productivity.

The method of practical management effectiveness, including its graphical model, for obtaining estimates of current and forecast strategic management is discussed [46]. The main idea is to obtain an integral assessment of management effectiveness by two parameters – «effectiveness» and «cost-effectiveness». However, this rather time-consuming technique (as a variant of the earned value method) does not give an unambiguous and reliable idea of the return of resources and efforts put into the development of VM tools directly. It is possible to evaluate the effectiveness of the considered organizational technology as an element of gen-

eral management, based on the motivation for profitable activities, using a more accessible method.

Each organization formulates a mission, from which its intention about the continuity of economic activity in the foreseeable future follows, therefore, we propose to evaluate the effectiveness of VM based on the principle of continuity of implemented business-processes. In a competitive environment, the efficiency criterion is the volume of products sold, confirming its market demand. The intensity of resources used, in addition to the volume of output, characterizes the indicator «labor productivity». The expansion of business activity justifies the increase in operating costs, but it is important to maintain a certain rhythm of cash flows Higher growth rates of sales revenue indicate the effectiveness of investments, the opposite is an overspending of resources. The digital competencies of management, the skills of operational analysis using VM tools allow developing measures to support the required proportions and sustainability of the reproduction process. In this regard, the most effective solution to this problem will be the method of dynamic standards. The method corresponds to the principle of business continuity, is based on the formation and subsequent comparison of the actual dynamics (growth rates) of consciously chosen indicators with their reference order [47]. To assess the effectiveness of management of the organization's activities, the choice of criteria and assessment method is made accounting for generally accepted ideas, confirmed by successful practice. The following authoritative opinions have been taken into account:

– P. Drucker (1954) suggested that the mandatory factors that make an organization better and more efficient, include «employee performance and internal productivity»;

– Steers T. (1975) defined the organization's ability to adapt through cost management as a criterion of effectiveness;

– Peters T. and Waterman R. (1986) recommended to evaluate the «the productivity of each employee»;

– Sink S. (1989) pointed to «productivity and quality of working life».

As indicators of the effectiveness and efficiency of VM as an organizational management technology, we have selected labor productivity, net profit and VM maintenance costs (hereinafter referred to as costs). Labor productivity fully reflects the results of the impact of VM tools focused on the employee in terms of training competencies, labor protection and motivation for creative productive activities. An expert way can be used to evaluate the contribution of the VM to the overall result of the activity according to the scheme we propose (Fig. 5).

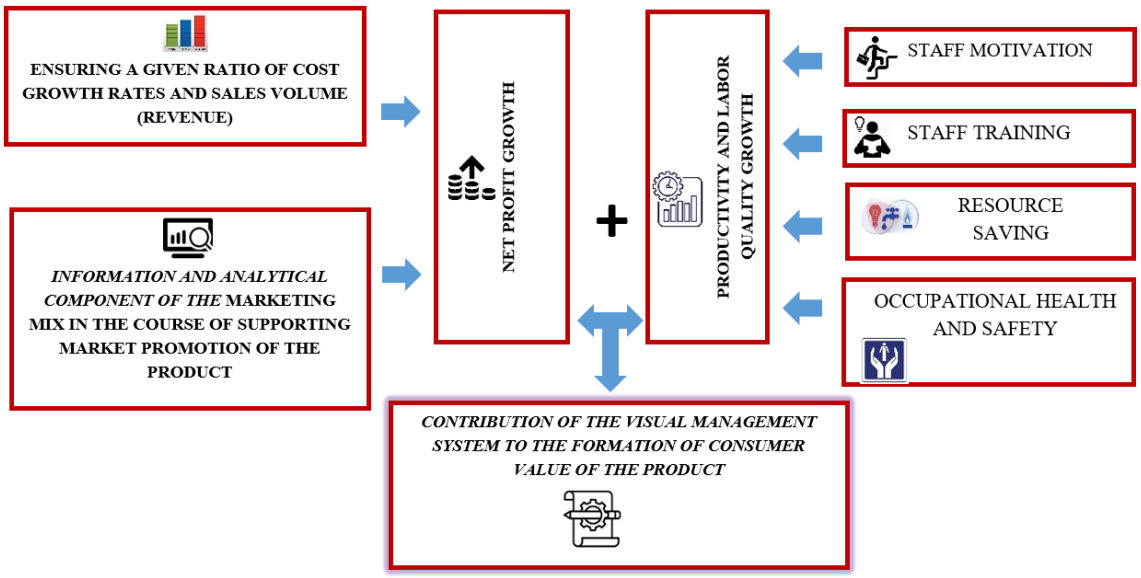

Fig. 5. Schematic diagram reflecting the contribution of the VM system to the formation of the total consumer value of the product (compiled by the author)

Let us consider the essence of the proposed criteria in more detail.

Costs, as a fundamental economic category, characterize the monetary value of consumed resources. Management efficiency lies in their reduction. In an unstable and risky external environment, the criterion of strategic effectiveness is the organization's ability to adapt through cost management.

Labor productivity is defined as the ratio of revenue to the average number of employees. It characterizes the efficiency of labor in an organization, primarily from the standpoint of the performance by employees of specified production operations at specific workplaces in accordance with certain instructions and regulations. At the same time, labor presupposes mental activity of a person, therefore, creative initiatives and rationalization proposals of employees are encouraged. The ratio of creative and routine components of labor depends on the applied management technologies, including VM tools. Therefore, the growth of the indicator indicates the sustainability of the activity, high profitability and efficiency of management technologies.

Net profit. The final and main financial result of economic activity, characterizing the increase in the organization's own capital. Almost all management decisions are focused on maximizing profits. If labor productivity is considered as evidence of the social and economic recognition of the created consumer value, and not only as a characteristic of the level of intensity of the use of personnel [48], then there is a direct relationship between net profit and output. These indicators are the most capable of integrating all the positive results and effects from the functioning of the WM system (production, economic, financial, labor, social, environmental, status, etc.). Evaluation of performance improvement of activity in space and time is carried out by incrementing the value of each indicator. The change in the dynamics of costs should correspond to the change in the dynamics of labor productivity and profit. The excess of the growth rate of results (production and profit) over the growth rate of costs means that the amount of income allows the organization to pay off the costs incurred in full and make a profit. Four options for the dynamics of indicators have been identified (Fig. 6).

Let's describe the possible options:

1. ***Productive VM.*** The growth rate of labor productivity outpaces the growth rate of costs, despite the fact that net profit growth, on the contrary, lags behind the growth rate of costs. This may indicate the availability of an accessible and effective hardware-information, professional, and educational environment. The workers are motivated, ready to expand their skills and abilities, comply with technological regulations, master the techniques of lean production, and prevent injuries and defects at work. Visualization techniques involve most of the sensual aspects of performers in the process of perception. It is possible that the target organizational technology SQDCME is being implemented, which allows overcoming the inconsistency in the goals of activity between management and employees, increasing labor productivity by 5-10%, and ensuring progressive economic growth [49]. Q – quality; D (Delivery) – order execution; C – costs; M (Morale) – corporate culture, E - environmental standards. At the same time, the lag in the growth of net profit may be due to the current high accounts payable or other mandatory payments attributed to profit. Such a short-term situation is acceptable when expanding the business activity of an organization that invests in expanding the production base or in creating its own distribution network in the face of growing market demand.

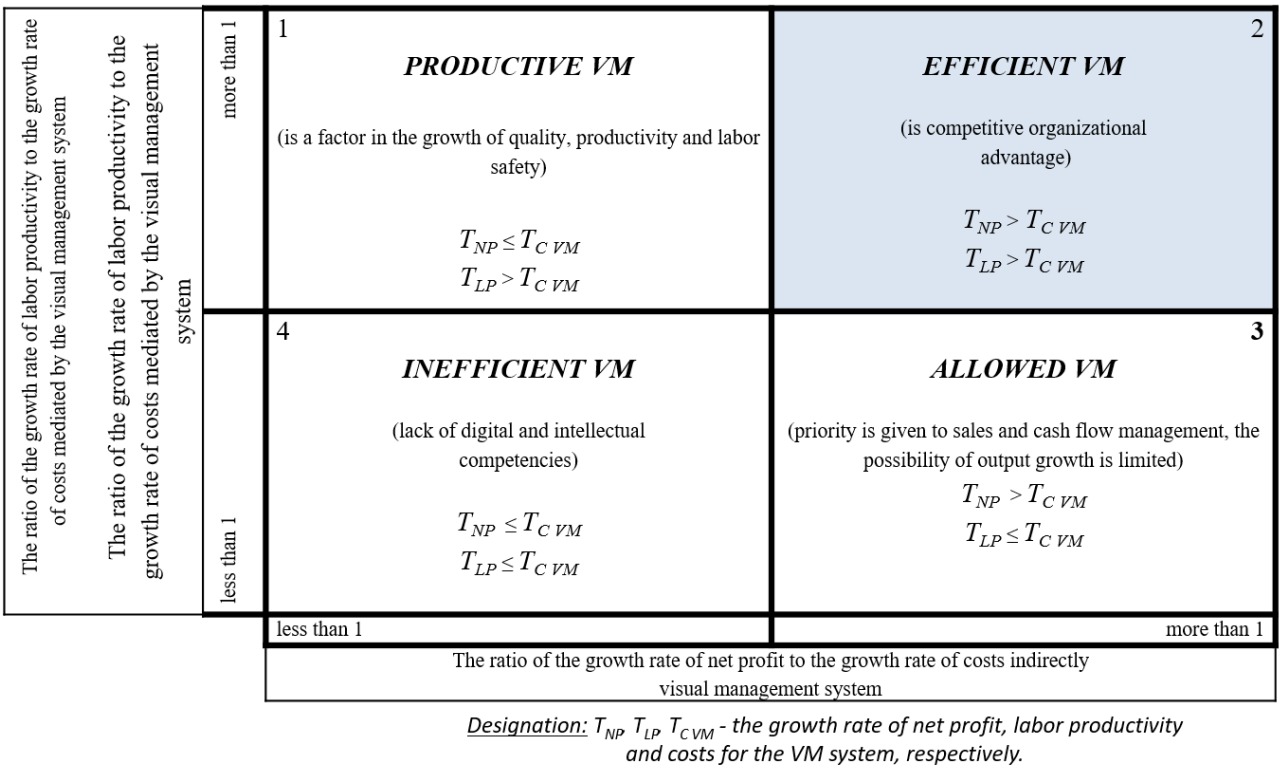

Fig. 6. Variants of the quality level of VM depending on the dynamics of performance indicators (compiled by the author)

2. ***Efficient VM.*** The best possible pair dynamics of indicators is achieved: the growth rates of labor productivity and net profit outstrip the growth rate of costs. At the same time, the best (ideal) ratio is observed when the growth rate of net profit outstrips the growth rate of labor productivity. An example is the practice of machine–building enterprises using powerful tools of intelligent production control - Augmented Reality technologies. An employee from the available software support at the right time independently selects the necessary text or graphic image. Virtual reality provides the manager with complete visual analytics to support decision-making to improve the quality and competitiveness of the product at every stage of the technological cycle. The essence of accent visualization consists in fixing attention exclusively on the details of the task performed by him and adjusting the active elements of the interface displayed on the interactive information panel (dashboard). The employee integrates into the cycle («human-in-the-loop»): he uses reference information, regulations, regulates the level of data detail, and a computer algorithm helps him to keep attention on important aspects of work [50].

3. ***Allowed VM.*** The growth rate of net profit exceeds the growth rate of costs, but the costs themselves grow faster than labor productivity. The situation is typical for organizations for which the growth of production volume is limited or is not a strategic goal. Commercial success is determined by the level of complexity and quality of work, ensuring production safety (including environmental), effective marketing policy, activity in the development of innovations. These can be construction or service organizations (health, culture, education), waste processing enterprises, treatment facilities, transport companies. Almost all business entities operating during an economic downturn or external restrictions (for example, during the COVID-19 period) are in a situation where it is important to maintain the profitability of production and effectively manage cash flows. Flexibility, ability to adapt to a dynamic environment and, if necessary, rebuild business-processes often becomes a strategic goal of management. The skills of building and detailed description of the market map, logistics of commodity flows, analysis of customer needs, diagnostics of the product portfolio, identification of factors determining the market capacity lead to success. In this case, the effect of the VM

system implementation is achieved by a reliable risk analysis and is expressed as a difference in the values of the same indicators in «as is» and «as will be» situations [51]. Digital systems are used: operational analytics (SAP HANA, Lumira, Predictive Analytics), organizational and financial management support (Enterprise Resource Planning System), production and product lifecycle management (MES, PLM, SCADA, SAP Cloud ALM, Solution Manager). Domestic universities, expanding the use of computer analytical services in management and focusing on the openness of information for stakeholders, constantly evaluate development trends to improve the quality of human resources [52].

4. ***Inefficient VM.*** The growth rates of net profit and productivity lag behind the growth rate of costs. The organization misses opportunities to increase its competitiveness associated with the VM system.

Let us illustrate the proposed approach with a hypothetical example. A medium-sized agricultural firm with a land area of 32,000 hectares has been operating since year 2008. The enterprise produces and sells vegetables, the revenue from which is 90% of the total income. Organizational management was based on electronic document management based on a traditional platform. From years 2017 to 2019, the management of the enterprise faced a set of problems - an increase in industrial injuries and staff turnover, an increase in non-production losses of resources and a decrease in sales. It was decided to organize a new responsibility center for the phased introduction of lean manufacturing techniques based on the «5S» technology (Fig. 7).

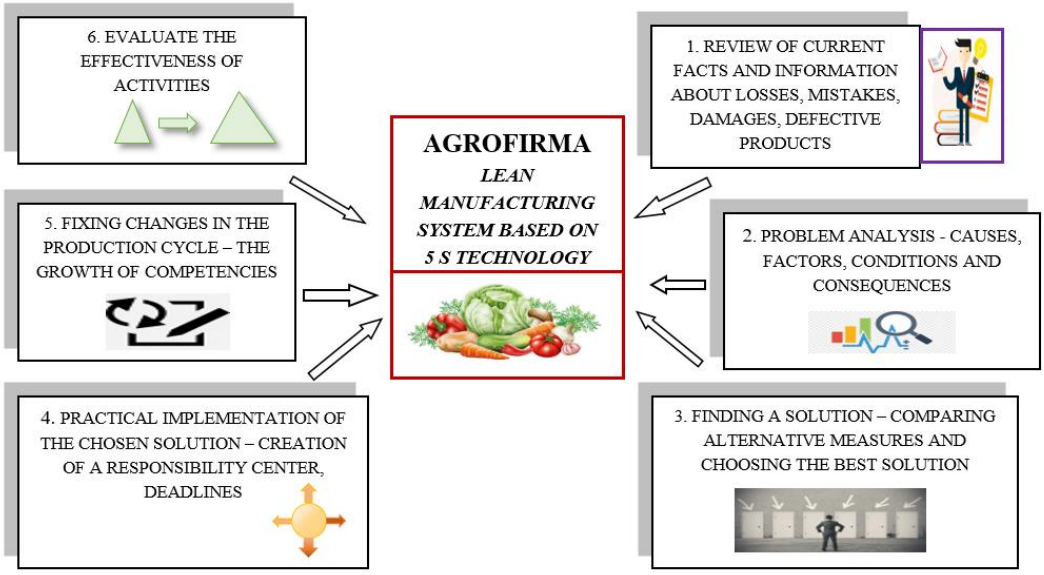

Fig. 7. Stages of implementation of lean production technology at the facilities of the agricultural company

The main performance indicators of the agricultural firm before and after organizational changes and the introduction of lean manufacturing technology into the workspace are presented in Table 1.

As follows from the presented data, the introduction of VM tools in the «5S» part of the technology allowed to reduce the loss of resources in all problematic positions by half for two years. Despite the fact that the planned performance indicators were not achieved, the actual results increased slightly and the growth rate of net profit exceeded the growth rate of costs by 2.64%. The growth rate of costs exceeded the growth rate of productivity by 1.1%. The level of VM development is Allowed. With a favorable market situation and an increase in consumer demand, the agricultural firm has the opportunity to use the experience gained to increase sales.

Table 1. Main performance indicators of the agricultural firm (year 2021)

Performance indicators	Center of the VM				Growth rate, fact, %
	before the creation of the center		after the creation of the center		
	Plan	Fact	Plan	Fact	
1. Revenue from sale, rub./hectare	300000	265000	3000000	287000	108,30
2. Net profit, rub./ rub.//hectare	960	720	960	788	109,44
3. Costs, rub./hectare	257	250	257	267	106,80
4. Loss of profit, rub./hectare:					
4.1. Industrial injuries	-	0,150	-	0,032	21,33
4.2. Product loss	0,050	0,087	0,050	0,037	42,53
4.3. Loss of resources	-	0,050	-	0,008	16,00
4.4. «Human factor» (losses)	-	0,035	-	0,012	34,28
4.5. Irrational logistics	-	0,043	-	0,018	41,90
Total loss	-	0,230	-	0,107	46,52
5. Labor productivity, mill.. rub./human	4,57	4,04	4,57	4,83	105,7
6. The ratio of growth rates of net profit and costs	109,44 > 106,8				
7. The ratio of growth rates of labor productivity and costs	105,7 < 106,80				
The Level Assessment of VM	*Allowed VM*				

Conclusion

From the short review presented, it follows that the history of VM is inseparable from the history of management itself. In the course of the evolution of management theory and practice, information visualization tools have gone from the simplest document management techniques and visual agitation to a reliable and efficient technology of organizational management and strategic planning (SM). Digital visual systems for supporting the production process ensure safety, rhythm, rational distribution of resources and development of human resources in any area of economic activity. A distinctive feature of VM is the focus on achieving transparency for the contractor of all components of the organizational and technological processes of a particular production. First of all, with its help, any important operational information is perceived «at a glance by the user», which allows you to fix emerging violations and problems. The performers work clearly according to a well-established algorithm, technological discipline and responsibility for the results of work are increasing. Successful experience can become a competitive advantage and put management on a higher quality level. Its capabilities:

– positively influence the conscious individual development of employees' competencies and elements of corporate culture through targeted digitalization of work operations;

– to motivate specialists and managers in solving the most important tasks to actively master new information technologies (control, business intelligence, multimedia, information retrieval mechanisms);

– quickly change and adjust the toolkit for specific applied production situations, which ensures the adoption of more accurate, timely and efficient management decisions;

– to overcome the language barrier and misunderstanding in employee communications and feedback from the external environment by maximizing the visibility, clarity and comprehensibility of information, primarily for the purposes of security, resource saving and increasing return on costs at each workplace.

In a complex and unstable business environment, the development of VM becomes more adequate to the features of modern management tasks - interdisciplinarity, multifactoriality, dynamism, riskiness, uniqueness, and the demand for team efforts. Investments in the development of VM tools should pay off, and efficiency should be determined by the ratio of the results achieved and the costs incurred to ensure them. Despite the complex of produced effects (industrial, economic, social, environmental), it is advisable to include labor productivity and net profit among the key results of VM. Reliably assessing the pair dynamics of these

indicators in comparison with the change in costs is not difficult. In this case, it becomes possible to compare alternative options for the level of development of VM as a unique organizational technology - effective, efficient, acceptable and ineffective. This approach greatly simplifies and concretizes the assessment, makes it adequate, accessible and understandable not only for decision makers, but also for all participants in the activity. The applied value lies in the possibility of supporting the most important management decisions in the field of organization and motivation of labor, budgeting, mobilization of resource reserves, early warning of production risks, and activation of the intellectual potential of the organization.

Gratitude

The author expresses gratitude to Evgeny Viktorovich Mordasov, Chief IT-Specialist of the Stavropol Regional branch of the Social Insurance Fund of the Russian Federation for consulting support in the preparation of illustration.

References

1. Robbins S.P., Coulter M. Management: textbook / trans. from English - 8th ed. - M.: «Williams», 2006. - 1056 p.

2. Mandel A., Sizykh D. Multi-Factor Models in Express Analysis of Company Attraction as Investment /IFAC 18-th World Congress. Milan, Italy, 2011.

3. Semibratsky M.V. Visual management system in organization: principles of construction and practical instruments of implementation //Vestnik of Astrakhan State Technical University. Series: Economics, 2020; №3, p p. 19-26. DOI: 10.24143/2073-5537-2020-3-19-26.

4. Frolova I.I. The use of visual management in practice //Visual communication in sociocultural dynamics. Collection of articles of the international scientific and practical conference, 2015, p. 533-537.

5. Afanasiev A.A. Data visualization technology as a tool for improving the decision support process ///Engineering Bulletin of the Don, 2014, №. 4-1 (31), pp. 1-14.

6. Denisova V.G. Visual management as a management tool ///Standards and quality, 2019, № 9, pp. 70-74.

7. Marchwinski Ch., Shoo J. Lean Lexicon. A graphical glossary for Lean Thinkers. Forth Edition. Cambridge, Lean Enterprise Institute, 2009, - 112 p.

8. Maksimov N.V., Golitsina O.L, Monankov K.V., Gavrilkina A.S. Methods of visual graph-analytical presentation and retrieval of scientific and technical texts //Scientific Visualization, 2021, V. 13, № 1, pp. 138-161, DOI: 10.26583/sv.13.1.10

9. Marchwinski Ch., Shoo J. Lean Lexicon. A graphical glossary for Lean Thinkers. Forth Edition. Cambridge, Lean Enterprise Institute, 2009, 112 p.

10. Popovic A., Hackney R., Coelho P.S., Jaklic J. Towards business intelligence systems success: Effects of maturity and culture on analytical decision making //Decision Support Systems, 2012, V. 54, № 1, pp. 729-739. DOI: 10.1016/j.dss.2012.08.017.

11. Gareev T. R., Belsky V.V. Matrixes of strategic groupings: from «old» criticism to new dimensions //Innovation, 2015. - № 2 (196). - pp. 50-57.

12. Milner B.Z. Knowledge Management //Russian Journal of Management. – 2004, V.2, № 2, pp.. 167-172.

13. Ivanov D.S., Kuzyk M.G., Simachev Yu.V. Stimulating innovative activity of Russian manufacturing companies: opportunities and limitations //Foresight, 2012, Vol. 6, № 2, pp. 18-42.

14. Tebekin A.V. To a question of formation of the concept of management of the 2030-th years //Vestnik of Moscow financial and legal university, 2019, № 2, - pp. 168-176.

15. Ganzalez E.J.A., Castro C.B., Bueno J.C.C., Ganzalez J.L.G.G. Dominant Approaches in the Field of Management //The International Journal of Organization Analysis, 2001, vol. 9, no 4, pp. 327-353.

16. Aleksandrova T.V. Digitalization as a Modern Trend of Development of Management of Industrial Organizations. *Bulletin of the South Ural State University. Ser. Economics and Management*, 2019, vol. 13, no. 3, pp. 137–144 (in Russ.). DOI: 10.14529/em190313.

17. Bratchenko S.A. Generation of Bedrocks Management Concepts in the Period of Establishment of Capitalism (a Brief Review of Scientific Papers). Upravlencheskie nauki = Management Sciences, 2018, vol. 8, no. 1, pp. 110–118. (In Russ.).

18. Osterwalder A., Pigneur Y., Tucci C.L. Clarifying Business Models: Origins, Present, and Future of the Concept // Communications of the Association for Information Systems (AIS), 2005, V. 16, № 1. pp. 1–25.

19. Sabir M.S., Hameed R.M., Rehman K., Rehman I. Teoretical Foundation of Business Model and Teir Building Blocks //Journal of Management Research, 2012, V. 4, № 4, - pp. 160–179.

20. Gavrilova T., Alsuf'ev A., Yanson A.-S. Modern notations of business models: a visual trend //Foresight, 2014, V. 8, № 2, pp. 56-70.

21. Buresh O.V. Management Process Software //Bulletin of the Oryol State University, 2005, no 8, pp. 59-64.

22. Mitrovic S. Information Support of Economic Analysis in Russia: Lines of and Prospects for Development //Economic Analysis: Theory and Practice, 2016, no 9, pp. 100-112.

23. Tuboltseva O.M., Matorin S.I., Graphical Notation for a Formalized Description of Project Financing Systems //Scientific Bulletin. Economics series. Computer science, 2018, vol. 45, no. 2. p p. 333-342. DOI: 10.18413/2411-3808-2018-45-2-333-342

24. Value Stream Mapping Tools. http://www.breezetree.com

25. Diagram Designer http://zoomexe.net/ofis/drug_of/2634-diagramdesigner.html

26. Diagram Designer http://meesoft.logicnet.dk/DiagramDesigner

27. Edraw Max http://en.wikipedia.org/wiki/Edraw_Max

28. Visualize innovate and collaborate with EdrawMax http://www.edrawsoft.com/EDrawMax.php

29. PaceStar WizFlow Professional v6.0.rar http://www.pacestar.com/wizflow/desc.htm

30. Reindel B. Web Designer·s Success Guide. Airgid Media Inc., 2006, pp. 11-80.

31. Itten I. The Art of Color. Moscow: Publisher Dmitry Aronov, 2007. pp. 20-91.

32. Murashchenkov S.V., Labzina I.A., Troshina S.G. Visual Component of Internet Editions as a Factor in their Positioning and Promotion //Society of Russia: educational space, psychological structures and social values, 2017, v. 8, no 3, pp. 111-124. DOI: 10.12731/2218-7405-2017-3-111-124

33. Sariev R.B. Animation and Interactive Programming: a Practical Approach //A Young Scientist, 2019, no. 19 (267), pp. 17-19.

34. Voroshilov S.P., Sedelnikov G.Ye. Interactive Labour Protection Training Programs, 2009, no 1, pp. 85-87.

35. Optimization Tools: Map of the Process //Sergey Kalinin's blog s-kalinin blogspot.com 01.08.2012

36. Amelin S.V., Shchetinina I.V. Production organization in conditions of digital economy //Organizator proizvodstva = Organizer of Production, 2018, no 26(4), pp. 7-18. DOI: 10.25987/VSTU.2018.50.18.001

37. Strohmeier S. Digital Human Resource Management: A Conceptual clarification //German Journal of Human Resource Management: Zeitschrift fur Personalforschung, 2020, no 34 (3), pp. 345-365.

38. Maslennikov V.V., Lyandau Y.V., Kalinina I.A. Developing the System of Digital Management of Organization //Vestnik of the Plekhanov Russian University of Economics,2019, no 6 (108), pp. 116-123. DOI: http://dx.doi.org/10.21686/2413-2829-2019-6-116-123.

39. Reis J., Amorim M., Melão N., Matos P. Digital Transformation: A Literature Review and Guidelines for Future Research //Springer International Publishing AG, part of Springer

Nature 2018 Á. Rocha et al. (Eds.): WorldCIST'18 2018, AISC 745, pp. 411–421, 2018. https://doi.org/10.1007/978-3-319-77703-0_41/

40. Jeschke S., Brecher C., Song H., Rawat D.B. Industrial Internet of Things: Cybermanufacturing Systems. – Switzerland: Springer International Publishing, 2017, – 715 p.

41. Porter M. Competitive strategy: A methodology for analyzing industries and competitors. / Per. from English. – M.: Alpina Business Books, 2005. – 454 p.

42. Stuart T. Kard, Jock D. Mackinlay, Ben Scheiderman. Readings in information visualization: using vision to think – Morgan Kaufmann Publishers, 1999. – 686 p.

https://www.researchgate.net/publication/220691172

43. Miles R.E. Theories of Management: Implications for Organizational Behavior and Development. N.Y.: McGrawHill, 1975, - 240: p.

44. Kolomeets M.V., Chechulin A.A., Kotenko I.V. Technique of computer network typology for monitoring of information security // News of higher educational institutions. Instrumentation, 2016, V. 59, № 10, pp.807-812. DOI: 10.17586/0021-3454-2016-59-10-807-812.

45. Steenkampa L.P., Hagedorn-Hansenb D., Oosthuizen G.A. Visual management system to manage manufacturing resources. 14th Global Conference on Sustainable Manufacturing, GCSM 3-5 October 2016, Stellenbosch, South Africa //Procedia Manufacturing, 2017, V. 8, pp. 455-462. DOI: 10.1016 j.promfg. 2017.02.058.

46. Zuev M.B., Zuev B.P., Bulgakova I.N. (2020) The formation and development of the performance assessment method in the conception of operational management. Business-Informatics, v. 14, № 1, pp. 75–84. DOI: 10.17323/2587-814X.2020.1.75.84

47. Krasnov V.D., Kozmenkova S.V. Going Concern Principle: The Essence and Economic Conditionality. International Accounting, 2017, vol. 20, iss. 19, pp. 1147–1162. https://doi.org/10.24891/ia.20.19.1147.

48. Zhernosek K.A. The study of scientific approaches to the definition of the concept of «labor productivity» // Actual issues of economic sciences, 2010, № 12-1,.- pp. 231 - 236.

49. Lapaev P.Y. The use of key performance indicators in management by goals // Actual directions of scientific research: from theory to practice, 2015, № 1 (3), pp. 318-319.

50. Holzinger A. Interactive machine learning for health informatics: when do we need the human-in-the-loop? //Brain Informatics 2016, v. 3, № 2, pp. 119–131. DOI: 10.1007/s40708-016-0042-6.

51. Isaev E.A., Pervukhin D.V., Rytikov G.O., Filyugina E.K., Airapetyan D.A. Evaluation of the effectiveness of information systems taking into account risks // Business Informatics. - 2021. - T. 15. - No. 1. - S. 19–29. DOI: 10.17323/2587-814X.2021.1.19.29/

52. Kolychev V.D., Budanov N.A. Visualization of the Processes of Performance Management and Evaluation of the Personnel Potential of the University // Scientific Visualization, 2021, V. 13, № 5, pp. 35-51. DOI: 10.26583/sv.13.5.04.