The European Proceedings of
Social & Behavioural Sciences
EpSBS

Future Academy

ISSN: 2357-1330

https://dx.doi.org/10.15405/epsbs.2019.03.46

GCPMED 2018
International Scientific Conference "Global Challenges and Prospects of the Modern Economic Development"

BIG DATA ANALYSIS FOR HR MANAGEMENT AT PRODUCTION ENTERPRISES

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Abstract

This paper presents a solution for HR management at a modern production enterprise based on Big Data analysis. It is proposed to capture the information of personnel productivity in the form of events and process it in real time using the technologies of parallel computing. As a result of such analysis, critical parameters and indicators of personnel activity can be calculated and compared to the known patterns of HR efficiency. Based on the results of personnel productivity identification and analysis there are provided adaptive strategies for HR development. To support such a feature there was developed a knowledge base implemented in the form of Ontology. This paper describes a model and architecture of Big Data analysis proposed for implementation at modern production enterprises. The approach allows identification of the patterns of the ideal "competency performance" of leaders and formation of the necessary qualities. These patterns are used to single out the two main groups of qualitative characteristics of the workforce: performing and innovative, which cause different approaches to their formation and forecasting. The results were probated as a part of a number of educational programs of advanced training and skills improvement in Samara, which allowed formulating the concepts in the education system at all levels, including additional and corporate education, the system of adaptation, the development of mentoring, project teams, research teams, personnel assessment and in many other areas requiring leadership skills and the implementation of innovative breakthrough solutions.

Keywords: Big Data, HR Management, Digital Economics, Production Enterprises.

https://dx.doi.org/10.15405/epsbs.2019.03.46
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Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

1. Introduction

Modern trends of human resources management at production enterprises are concerned with implementation of customized educational technologies capable of adaptation of standard procedures to personified conditions. Due to a high potential of innovations as a part of contemporary economics, most enterprises count and rely on motivated professionals competent to solve complex problems with a wide range of skills. Such requirements become valid not only for management or research fellows, almost all the staff of a typical production enterprise deals with challenging tasks that should be solved using modern technologies and/or equipment.

At the same time most widely spread managements systems are based on implementation of universal procedures of tasks scheduling, tracking, and monitoring. Due to the lack of information about workforce utilization real performance and efficiency the strategies of monitoring and control concentrate of business processes formalization, which makes it impossible to involve proactive personnel into the process of decision making in case of unpredicted situations or events. To cover this gap in this paper there is proposed a new approach based on an implementation of modern technologies of Big Data analysis.

2. Problem Statement

The problems of human factor influence over the project management technologies are studied by the Agile paradigm that requires organizing the process of adaptive allocation of project tasks in a highly flexible and interactive manner. Due to the high variability of business processes, complexity, and uncertainty of project tasks, and strong request for project team members' pro-activity and motivation the role of tasks performers becomes critical at all stages of project scheduling and execution management. This requires new approaches for project tasks allocation and scheduling software solutions using modern algorithms and systems of decision-making support, multi-agent technologies and knowledge bases (Kadushin, 2012; Mouromtsev et al., 2015).

To provide such a solution there can be proposed to implement a P2P outsourcing model (Ivaschenko, Martyshkin, Fedotov, Sitnikov, & Surnin, 2015), where at the stage of preliminary scheduling the tasks are distributed between the most accountable staff and on the operating level they are decomposed and partially shared. So, the current task owner can have little expertise about the outsourced work and needs an efficient tool for decision making support. Considering the high motivation of staff it can be inferred to solve this problem by auctioning. The ideas of indirect and conditional project management generating soft influence over highly motivated autonomous actors are being successfully implemented in Internet communities and social networks (Balakrishnan & Deo, 2006).

One of the solutions can be close to subject-oriented approach for business processes management (S-BPM), according to which the process of collaboration of several subjects is organized via structured communication (Fleischmann, Schmidt, & Stary, 2015). There can be proposed a model for the interaction of actors (subjects) in integrated information space, which can be implemented using the multi-agent software.

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The process of interaction of users in integrated information space at modern manufacturing enterprises and supply chains generates a sequence of events of the exchange of documents, messages and other information objects. The number of the events is big (large physical data volume); they vary and require high-speed processing. In this regard, the task of managing the collection and processing of information data in the system of acquisition and processing system with a stratified architecture may be referred to the Big Data problem (Baesens, 2014; Bessis & Dobre, 2014).

Possible ways of application of Big Data technologies in enterprise HR management are widely discussed in recent literature (Fairhurst, 2014; Zang & Ye, 2015; Acharekar & Palghadmal, 2016; Ivaschenko, Lednev, Diyazitdinova, & Sitnikov, 2016; Ivaschenko, Sitnikov, & Tanonykhina, 2017). The challenge refers to the use of multiple data sources to improve practices in training, recruitment, performance analysis and motivation. An overview of Big Data implementation in HR management is presented in (Barman & Ahmed, 2015). Big Data in HR sets to evaluate and improve practices including talent acquisition, development, retention, and overall organizational performance. The problems of talents identification and learning in this area are outlined as being most important.

HR management plays general role in modern supply chains. At the same time, it remains problem domain specific, and no universal procedures can be implemented in different situations. Each employee should be considered a part of the whole organizational structure interlinked with others by formal and informal cases of interaction and subordination. From project and organization management perspective each resource remains under the influence of internal and external environment that can be described by several factors. Some of these problems are explored in Eremicheva et al. (2016) and Simonova, Ilyukhina, Bogatyreva, Vagin, & Nikolaeva (2016). Development of an effective organizational structure includes the following stages: identification of the organizational structure type (subordination, matrix, etc.), decomposition of structure to subdivisions (administration, projects, programmes, individuals, etc.), and formalization of responsibilities and authority levels (governance patters, decentralization issues, coordination and tracking procedures, activities' regulation technologies, etc.).

3. Research Questions

Decision-making is concerned with "production of ideas" and therefore depends on competence and individual qualities of motivated personnel leading collectives of like-minded people. Formation and forecasting of the emergence of leaders with the ability to innovate becomes a significant scientific problem. The solution is based on a comprehensive study of the laws of the formation of a set of qualities and competencies that determine the innovative nature of action. This solution is especially required in high-tech breakthrough industries. A new understanding of the role of a person in production process brings to the force such personality qualities that contribute to the generation of new knowledge, information and transformation of them into qualitatively new goods.

The proposed innovative approach is based on the definition of the ideal "competency performance" of leaders and approaches to the formation of the necessary qualities, for which it is necessary to single out the two main groups of qualitative characteristics of the workforce: performing and innovative, which cause different approaches to their formation and forecasting. Determination of the ideal "portrait" of the qualities of the leader requires a large-scale analysis of a large number of poorly

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structured data, which can be realized on the basis of the use of intelligent information systems, using modern information technologies, methods and algorithms for semantic analysis, clustering and classification of data.

As a basis of a formal model, employees are presented as actors being armed with certain skills and competencies. This fact of an employee getting the certain skull is described by a Boolean variable:

$$h_{i,m} = h\left(u_i, s_m\right) = \{0,1\}. \quad (1)$$

Organizational structure of an enterprise that defines possible ways of communication according to business processes can be described by relations:

$$c_{i,j} = c\left(u_i, u_j\right) = \{0,1\}. \quad (2)$$

The process of interaction between u_i and u_j according to these relations is described in the form of the events:

$$e_{i,j,k} = e\left(u_i, u_j, v_k, t_k\right) = \{0,1\}. \quad (3)$$

where v_k – represents the message (communication case), and t_k – event moment.

This event flow forms Big Data that change in time and describes the employees' activity. In order to provide analytical functionality, it is proposed to calculate cross-correlation indicators comparing these data flows with typical patterns of positive and negative behavior of employees reacting to incoming tasks.

Such a pattern of interaction is presented in the form of a sequence of actions at expected intervals $\left(t_{l,n}, t'_{l,n}\right)$:

$$G_l = \left\{ g_{l,n}\left(c_{i,j}, t_{l,n}, t'_{l,n}\right)\right\}. \quad (4)$$

Successful cases of interaction can be captured in knowledge base in the form of positive patterns, negative patterns can be used to identify weak reaction caused by the behavior treated as not effective..

4. Purpose of the Study

There are fundamental problems of direct and reverse relations between professional, business and personal qualities of leaders and the effectiveness of their decisions. The problem is in the absence of reliable information about the most effective combinations of qualitative characteristics of leaders that can provide the desired results. This problem leads to the absence of a systemic form of the necessary qualities at all levels of training. There should be explored the state of qualifications of acting specialists, the principles of the emergence and formation of talents and leaders, which set in motion the entire technological and economic chain, that ultimately leads to an increase in the welfare of people.

Leadership of the talented people allows natural abilities to be realized and to perceive the formative impact of education, culture, and moral values. However, identification of the conditions for the formation of such characteristics is associated with processing, analysis, and systematization of large arrays of semi-structured data. Such data can be found in free and incorporates access, which in many respects should be similar for all activities. That is why it is necessary to implement software tools for

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analyzing the dynamics of the development of professional and personal qualities of each person by comparing data from corporate portals and information that is available in the public domain.

This analysis can be implemented as an open software service integrated with corporate information systems, workflow systems and other components of enterprise integrated information space to track professional activity, as well as with social networks and other sources on the Internet for in-depth and system analysis of personality development. On the basis of semantic and statistical analysis of the dynamics of personal development, possible problems should be identified and recommendations for professional or personal development should be developed using available educational technologies. Also, within the framework of this service, an analysis of career prospects will be carried out and decision-making support will be provided on raising qualifications in the right direction.

Since such a service becomes available in real time for a large number of users, its implementation requires the use of modern technologies of parallel computing and big data analysis. For this, the semantic and statistical analysis will be implemented on the Big Data processing platform. Within this framework, new architectural and technical solutions were developed on the basis of existing technologies of semantic and statistical analysis. It allows realizing the analysis of big data taking into account the specific character of the subject area.

As a result of the development of the obtained software solution, a service is implemented in forms of an individual set of possible trajectories for the formation of innovative qualities. These innovative qualities determine the effective professional activity of leaders, that is important, especially in high-tech industries. The basis for the development of such a mechanism should be a universal system for monitoring, collecting and analyzing the quality characteristics of leaders formed on the basis of large-scale intelligent analysis of a large array of semi-structured data.

The use of the latest intellectual information systems in the development of a monitoring system, methods of predictive analytics and work with Big Data, neural network technologies and artificial intelligence determine the interdisciplinary nature of the research results. The object of the research is a statistical sample of professional and personal competencies and qualifications of the workforce in relation to the results of the innovation and economic activities of enterprises and organizations. The subject of the research is social and labor relations arising in the process of interaction between various government, social and public, legal and economic structures involved in the formation of innovative qualities of the leaders of the digital economy.

The results of the research are needed to formulate concepts and approaches in the education system at all levels, including additional and corporate education, the system of adaptation, the development of mentoring, project teams, research teams, personnel assessment and in many other areas requiring leadership skills and the implementation of innovative breakthrough solutions.

5. Research Methods

The proposed solution vision is presented in Fig. 01. Both IT infrastructure and enterprise corporate organization remain in correspondence and determine the processes of enterprise functioning, project planning and control, performance monitoring and analysis and product lifecycle management.

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Activity network represent matrix organizational structure of management and executive's interaction processes. The logic of their negotiation is generally determined by project plans.

Events of actors' interaction, project tasks progress and fulfilment as well as possible deviations from the initial project plan are captured by interaction dynamics analysis module and forwarded for analysis and decision-making support. In this subsystem real events are correlated with the expected milestones of project plan, which results in various control measures. Its is proposed here to extend and enrich the analysis procedure by the results of tracking of organizational activity indicators. This can help identification of interaction gaps in advance and predict possible problems determined by the influence of a combination of human and time factors.

Possible management measures include strategic goals coordination (strategic visioning), operational scheduling and management, motivating employees by e.g. a combination of bonuses and penalties, changing the organizational structure by fixing the examples of positive interaction and reducing negative patterns and interaction management, which remains free and self-organized.

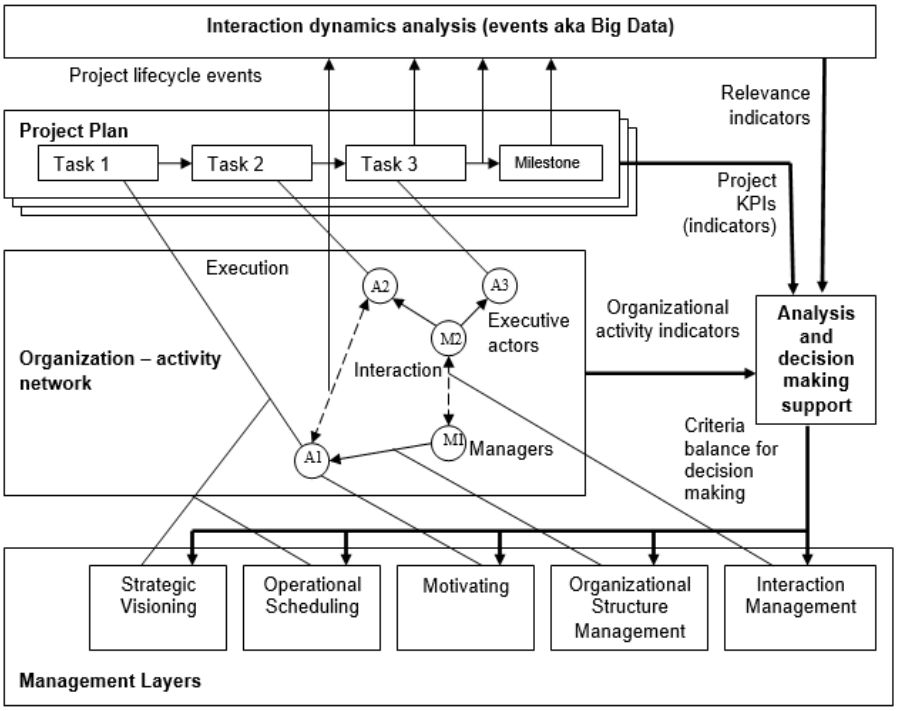

Figure 01. Solution Vision Architecture

Such an approach allows simulating real relations between the employees that is specific for modern enterprises. High qualification, narrow area of expertise and focused specialization makes it impossible to organize whole interaction in the form of a top-down commands and reports. So, employees start building horizontal links of interaction which becomes a new area of study and management. Under these circumstances project plan becomes an important tool of efforts coordination and consolidation. This is exactly what is expressed in the form of an oriented activity network with nodes representing the employees and links depicting the relations between them.

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6. Findings

Considering the modern trends in enterprise project management and the nature of event flows that describe the process of employees' interaction the main target of Big Data analysis application appears to become HR policy development and coordination. Large volumes of data that describe various cases of human negotiation at different project phases can give a significant material to produce efficient motivation technologies and apply them in practice.

Under the proposed architecture the HR policy plays the general role in labor potential formation on the basis of personal technologies used in organizations to ensure the quality of employment, quality of working life, development of labor potential, both for domestic needs and for the regional labor market. To formalize the monitoring results, it was proposed to identify a reasonable system of data on the characteristics of personnel work in organizations in its relationship with the organization's strategy.

Therefore, the interrelation between corporate personnel management systems and the development of regional personnel potential is justified. Since the most effective resource is concentrated on the formation and development of personal potential, it allows us to quickly respond to a dynamically changing economic, technological and political external situation. The levers of influence on the career and development of a specialist in the current situation are rather within the competence of the company's personnel services, then in the educational system. Educational organizations become a tool for staff development since they do not manage the career of the labors, serve as built-in elements both in a person's personal career and in the corporate personnel management system.

The study proposed to focus on improving the quality of work of personnel management services to solve the problem of interaction between the education system and employers. For this, it is necessary to develop a strategy for managing the labor potential of the region with a priority direction in the field of corporate personnel management. An integrated approach to the management system and the functioning of the labor potential of the region on the basis of forecasting staffing needs have been developed. The principles, objectives of the development of monitoring the quality of the workforce at the regional level, the object, and the subject of research are determined.

The practical significance of the research results lies in the possibility of using materials in the development of a personnel forecast, a regional program of personnel management, in institutions of higher and vocational education for the targeted formation of competencies and qualifications of graduates. One of the important structural elements of the monitoring of competencies and qualifications is the recognition of a survey of graduates of the system of professional, higher and additional education. The development of a monitoring program is a logical continuation of the research begun.

Some other methodologies have been developed in order to create a personnel evaluation system, such as:

- methodology for assessing the attitude of the employee to work: assessing the impact of real and potential orientations of employees on the efficiency of work;
- methodology for assessing competencies: a factor-criterion model of labor potential;
- methodology for assessing the motivational background;
- methodology for assessing the motivational saturation of staff;
- method of building a role model of behavior;

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- methodology for assessing the complexity of work (in the BSC system);
- methodology for assessing the quality of the workforce through the calculation of integral indicators of personnel activities;
- methodology for optimizing the structure of personnel through the effectiveness of training: at the individual level and at the enterprise level;
- methodology for assessing the results of labor (by levels: individual, collective, organizational).

Methods of personnel assessment, practical recommendations for changing the structure of personnel based on competence, systemic and functional approaches, as well as methods for evaluating the results of labor are introduced into the personnel management system of a number of enterprises in Samara region.

7. Conclusion

Being implemented as a part of project management software Big Data analysis algorithms can be used for monitoring of employees' activity and HR management decision making support. This approach allows solving the problem of the formation and evaluating of leaders in the information economy at the micro and macro levels. Based on the analysis of a large array of semi-structured data of enterprises and organizations of high-tech industries it is proposed to develop a monitoring structure for evaluating the quality characteristics of leaders and create a pattern of an ideal "competence portrait" of a leader in high-tech industries based on a grouping of qualitative characteristics of performance and innovative qualities. In each group of qualitative characteristics there is developed a system of indicators and working mechanisms for estimating the competencies and qualifications of leaders.

Next steps include forecasting of innovative potential qualities among the leaders of enterprises and high-tech industries. The forecast should include the concept of the formation of the competence of a leader in the process of professional development. The concept should be applicable at all levels of vocational and further education. Guidelines for the formation and development of innovative qualities of enterprise leaders in the main areas of both the education system and personnel policy of enterprises should also be part of the forecast. The results of the research are needed to formulate concepts and approaches in the education system at all levels, including additional and corporate education, the system of adaptation, the development of mentoring, project teams, research teams, personnel assessment and in many other areas requiring leadership skills and the implementation of innovative breakthrough solutions.

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