LOOK ACADEMIC PUBLISHERS
OPEN ACCESS

INTERNATIONAL JOURNAL OF ENVIRONMENTAL & SCIENCE EDUCATION
2016, VOL.11, NO.18, 11819-11830

Mapping of Losses within Organization of Service Activity for Effective Use of Equipment

Anastasiya Egorova[a], Elena Yaschkova[a], Nadezhda Sineva[a], Anzhelika Schkunova[a], Sergey Semenov[b] and Yuliya Klyueva[b]

[a]Kozma Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, RUSSIA;
[b]Institute of Food Technology and Design, the branch of Nizhny Novgorod State University of Engineering and Economics, Nizhny Novgorod, RUSSIA

ABSTRACT

The main objective of the present research is the revealing of "theoretical bottlenecks" (TBN) at enterprises – the stage of production process, within which there is loss of time necessary for providing of product or service. The methodological basis of the research is represented with: - theoretical and methodological analysis and synthesis of available special national and foreign scientific and methodological literature, conceptual analysis of scientific articles and thematic publications; - research and generalization of both - national and foreign developments and implementation of projects on mapping of losses within organization of service activity at enterprise; - applying of generalization, comparison, forecasting methods. Mapping at enterprises should be performed for as long as a plant unit remains theoretical bottleneck, losses of production are not described to the full, products are not received or taken out, or while the reason for such losses is the absence of raw material necessary for starting of production process or impossibility of end product's shipment.

KEYWORDS
Mapping, products, equipment, enterprise, service activity

ARTICLE HISTORY
Received 22 September 2016
Revised 11 October 2016
Accepted 17 November 2016

Introduction

At the present time mapping of losses within organization of service activity aimed at effective use of equipment is stipulated with the necessity of finding of production volume growth potential. The main criteria of mapping are the following losses: products are not received from allied suppliers/products are not taken out by allied suppliers. The volume of production is characterized with products passed the full cycle of processing on the present unit, excluding partial or idle running within production.

Problem Statement

Mapping is performed during estimation of coefficient of effective use of shop's equipment or production chain, as far as the reasons for losses of the present type lie within the analyzed equipment complex. Consequently, there is

CORRESPONDENCE Anastasiya Egorova ✉nesti88@mail.ru

a necessity of reclassifying such downtimes from external losses to internal ones and defining type of loss in accordance with initial cause of its emerging (Vasiliev, 2013).

Mapping covers losses at neighboring shops that turned out to be a reason for emerging of such types of losses at "theoretical bottleneck", as:

- "the products are not received from allied suppliers";

- "the products are not taken out by allied suppliers".

Mapping at enterprises should be performed for as long as a plant unit remains theoretical bottleneck, losses of production are not described to the full, products are not received or taken out, or while the reason for such losses is the absence of raw material necessary for starting of production process or impossibility of end product's shipment.

Literature review

The matters of production organization and mapping of losses within organization of service activity are discussed in works of such scientists as V.N. Vasiliev (2013), I.A. Dubrovin (2008; 2016), A.G. Bratuhin & V.D. Kalachanov (1993). The problems of effective functioning of equipment are considered in works of: E.N. Kulichkov & I.V. Traynev (1994), M.V. Kobyak & M.Y. Laiko (2012), M.A. Limitovsky (2001), E.S. Minaeva & V.P. Panagushin (1998), S. Ilyina (2004), S.A. Sokolitsyn (1988) and other researchers.

Research objective

The main objective of the present research is the revealing of "theoretical bottlenecks" (TBN) at enterprises – the stage of production process, within which there is loss of time necessary for providing of product or service.

Methods of research

The methodological basis of the research is represented with:

- theoretical and methodological analysis and synthesis of available special national and foreign scientific and methodological literature, conceptual analysis of scientific articles and thematic publications;

- research and generalization of both - national and foreign developments and implementation of projects on mapping of losses within organization of service activity at enterprise;

- applying of generalization, comparison, forecasting methods.

Results and Discussion

Mapping is the definition of the degree of influence of allied units' losses at shop upon bottleneck defining.

Mapping of losses upon organization of service activity for effective use of equipment provides solution of the following tasks (Egorova, 2014):

— provision of transparency of theoretical and actual power indicators for each production and territorial object;

— allows exact planning of actions aimed at increase of efficiency and probable consolidation of powers;

— allows conducting comparative analysis for revealing of advanced working methods.

Correct mapping of allied units' losses as on a bottleneck requires advanced defining of minimum time of production flow from unit to unit and from shop to shop (Popov, 2012).

Definition of time point, from which the search for downtimes being initial cause for losses of "the products are not received from allied suppliers" and "the products are not taken out by allied suppliers" types is started at preceding unit, is represented in figure 1

$$T_{begin.\ of\ search} = T_{end} - T_{tech\ m\text{-}n} \quad (1)$$

where,

T^{end} - the time of end of downtime at bottleneck;

$T_{tech\ m\text{-}n}$ - duration of product's passing from shop m to shop n.

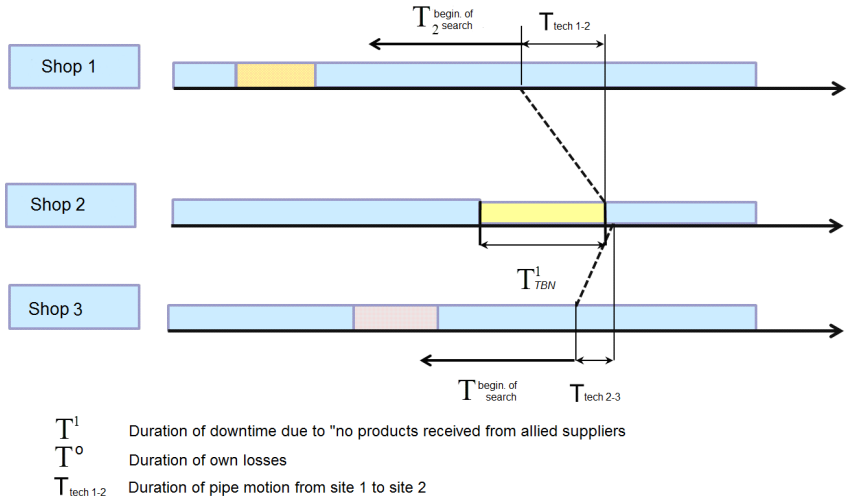

Figure 1. Description of downtime searching procedure for mapping of losses.

Mapping of losses of "the products are not received from allied suppliers" type

Initial cause for losses of "the products are not received from allied suppliers" type lies in downtimes of units/shops of preceding TBN (figure 2).

One performs countdown from the time point Tbegin. of search to the nearest downtime at preceding unit. In case of revealing downtime there is a necessity of estimating the cause for its emerging and the degree of its influence on bottleneck's downtimes.

There can be three sources for emerging of downtimes (Sineva, 2015):

- Preceding unit – the downtime of "the products are not received from allied suppliers" type;

- Following unit – the downtime of "the products are not taken out by allied suppliers" type;

- Own downtimes.

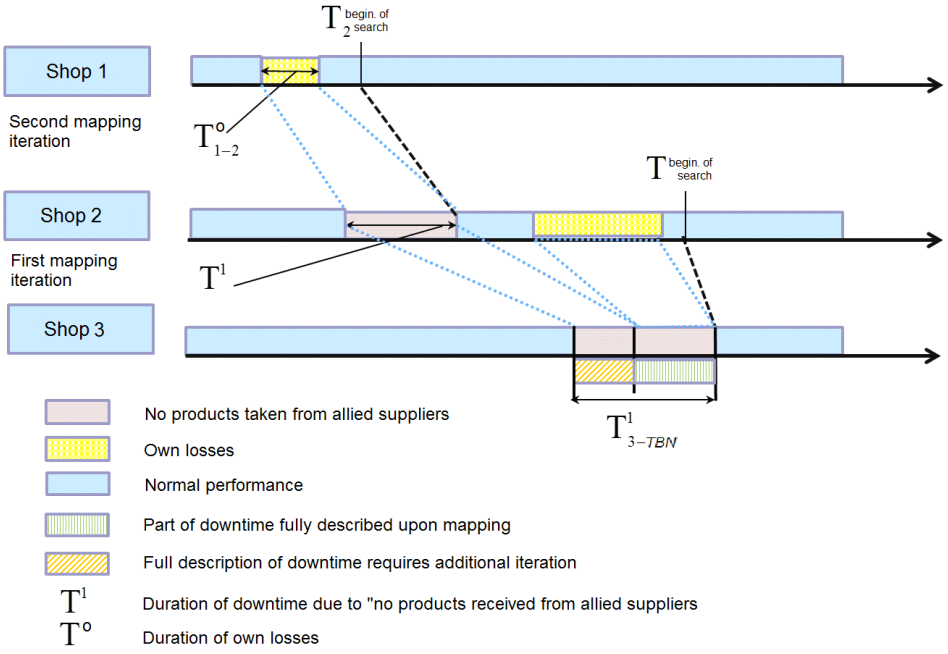

Figure 2. The procedure for mapping of downtimes of "the products are not received from allied suppliers" type

The following downtimes should be mapped on bottleneck:

- Preceding unit – the downtime of "the products are not received from allied suppliers" type;

- Own downtimes.

The downtimes of "the products are not taken out by allied suppliers" type are not used in mapping, as far as the cause for their emerging is the very bottleneck.

The degree of influence of preceding unit's downtimes on bottleneck's downtimes is defined by the formula:

$$DC^{1}_{TBN} = \frac{D^{1}_{TBN}}{D^{o}_{TBN-1}} \qquad (2)$$

$$D^{1}_{TBN} = \frac{T^{1}_{TBN}}{FC_{TBN}}$$

where, - the losses at bottleneck characterized as "no products from allied suppliers"

$$D^{o}_{TBN-1} = \frac{T^{of\ downtime}_{TBN-1}}{FC_{TBN-1}}$$

- the losses registered at unit/shop preceding to TBN.

One defines influence of just own losses and losses due to "no products are received from allied suppliers" in unit/shop being previous to TBN.

Having defined the influence of the nearest downtime of neighboring unit on downtime of bottleneck, we should proceed to the next downtime at preceding unit and define the degree of its influence on downtime of theoretical bottleneck. The procedure should be repeated till the full description of bottleneck downtime (Sineva & Yashkova, 2015).

However, the initial cause for TBN downtime not always lies in preceding unit/shop. In such a case one should perform the mapping procedure by means of several iterations gradually moving to the beginning of production chain. We should also notice that one describes downtimes emerged due to "no products received from allied suppliers" factor at unit preceding bottleneck, however the reason for their emerging is carried to bottleneck in accordance with the degree of their influence defined by first iteration of downtimes' mapping (Lobanova & Limitovsky, 2001).

Mapping of losses of "the products are not taken out by allied suppliers" type

Initial cause for losses of "the products are not taken out by allied suppliers" type lies in downtimes of units/shops following TBN (figure 3).

One performs countdown from the time point Tbegin of search to the nearest downtime at preceding unit. In case of revealing downtime there is a necessity of estimating the cause for its emerging and the degree of its influence on bottleneck's downtimes.

There can be three sources for emerging of downtimes (Semenov, 2015):

- Preceding unit – the downtime of "the products are not received from allied suppliers" type;

- Following unit – the downtime of "the products are not taken out by allied suppliers" type;

- Own downtimes.

The following downtimes should be mapped on bottleneck:

- Preceding unit – the downtime of "the products are not received from allied suppliers" type;

- Own downtimes.

The downtimes of "the products are not taken out by allied suppliers" type are not used in mapping, as far as the cause for their emerging is the very bottleneck.

The degree of influence of preceding unit's downtimes on bottleneck's downtimes is defined by the formula:

$$DC^{2}_{TBN} = \frac{D^{2}_{TBN}}{D^{o}_{TBN+1}} \qquad (3)$$

where, $DC^{2}_{TBN} = \frac{T^{2}_{TBN}}{FC_{TBN}}$ - the losses at bottleneck characterized as "no products from allied suppliers";

$$D_{TBN+1} = \frac{T^{of\ downtime}_{TBN+1}}{FC_{TBN+1}}$$ - the losses registered at unit/shop following TBN.

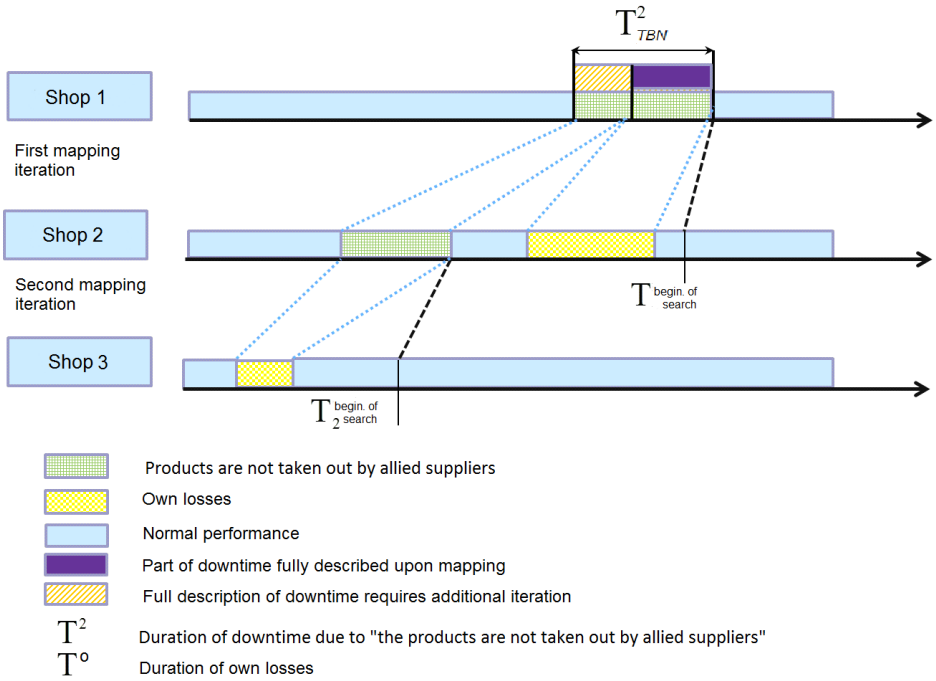

Figure 3. Procedure for mapping of downtimes of the products are not taken out by allied suppliers" type

One defines influence of just own losses and losses due to "no products are received from allied suppliers" in unit/shop preceding TBN.

Having defined the influence of the nearest downtime of neighboring unit on downtime of bottleneck, we should proceed to the next downtime at preceding unit and define the degree of its influence on downtime of theoretical bottleneck. The procedure should be repeated till the full description of bottleneck downtime (Yashkova et al., 2016).

However, the initial cause for TBN downtime not always lies in preceding unit/shop. In such a case one should perform the mapping procedure by means of several iterations gradually moving to the beginning of production chain. We should also notice that one describes downtimes emerged due to "no products received from allied suppliers" factor at unit preceding bottleneck, however the reason for their emerging is carried to bottleneck in accordance with the degree of their influence defined by first iteration of downtimes' mapping (Semenov & Tkachenko, 2014).

In cases when personnel describing downtime possess opportunity of defining the initial cause all by themselves the introduction of such information to description of downtime is permitted. Regardless of description introduced by personnel there is a necessity of conducting automated mapping for the purpose

of validation of conclusions made upon describing of downtime (Minasyan & Limitovsky, 2009).

In case of simultaneous registration at neighboring shops of losses of "the products are not taken out by allied suppliers" and "the products are not received from allied suppliers" types the initial cause for downtime is the transportation system.

To provide the necessary accuracy of calculation of effective work of equipment one should (Egorova, Vershinina & Zokirova, 2015):

— revise performance norms in connection with modernization of equipment or change of technological process, as well as upon excess of applicable performance norms by actual output;

— fix the reasons for performance change in supplement to approved performance norms, fix results of performance measurements in units' cyclograms;

— calculate performance of newly introduced or modernized equipment in accordance to regulations and state it not lower than it is prescribed by contractual values;

— provide units' performance upon manufacturing of new types of products in accordance with regulations;

— perform assessment of influence of technical condition of each unit on performance of line;

— renew information about probable routs of products' flow within processing between sites of shop minimum once a year;

— register change of performance by each of possible technological routes. Check correspondence of applicable performance of TBN to performance of the rest units within the route.

Detailed analysis requires classification of loss that is performed in correspondence to downtime classifier presented in this methodology (Shkunova & Koloda, 2014):

1. General fields of classifier for all the productions are:

— "Factor of losses";

— "Type of losses".

2. The field of "Type of loss/downtime" should be unified to the maximum. Introduction of additional types of losses is permitted only in case of total absence of possibility of classifying the loss by means of available types.

3. The fields of "node point/downtime group" and "description of downtime" are being unique for each unit.

Classification process:

1. The process of classification requires filling of all the fields by means of choosing values from fields of classifier for such fields as "type of loss/downtime", "node point/workpiece" (filled by operator), in case of emergency downtime the fields of "downtime description", "initial cause" are subsequently filled by foremen of maintenance personnel;

2. Downtimes detected by operators of units and having impact on TBN are described by senior foreman;

3. The field of "comment" is not obligatory for filling in case of filling of all other fields, however it is obligatory for filling in case one or more fields remain unfilled;

4. Operators performing introduction of information about downtimes to corporate information systems are admitted to exercising the present function only after passing corresponding training and certification.

Introduction of losses' classifier is performed (Shkunova, 2007):

— in case there are doubts or absence in applicable classifier of record corresponding to description of downtime for the field of "comment" operator, who classifies the downtime, fills special fields with new values - i.e. forms new values;

— suggested new values are considered by authorized representative of production manager (senior dispatcher) are approved, corrected or interchanged in existing classifier.

Automation of process of collection and classification of information about losses:

1. For the purpose of increase of efficiency of formation of information about losses, transparency of process and exclusion of "human factor" the process of introduction of data about losses to corporate information systems, including the data about downtimes, is subject to automation;

2. Automation of the process of collection of information about losses implies the data about events linked to beginning and end of operations performed by unit are introduced to information system in automatic mode, compared to the data about norms of the present operations' duration, and upon excess of the norms are fixed by the system as the fact, the duration of downtime for definite operation is also should be recorded. The node point/downtime groups are fixed automatically for frequently repeated events. The category of downtime is defined by unit's operator, while the description of downtime is performed by common operator.

3. The initiators of suggestions on change of classifier of losses, adding of new classification features, as well as deleting and changing of existing features can be represented by production departments. The decision on change and other decisions on matters of introduction of Classifier of downtimes are adopted by production Directorate.

The mapping of losses upon organization of service activity for effective use of equipment is performed on the basis of defining coefficient of effective use of equipment with its subsequent subdivision into two groups of coefficients (Sokolitsyn & Kuzin, 2015):

1. Coefficient of effective use of equipment No. 1:

— the fullest indicator of equipment efficiency

— analyzes efficiency of work with account of influence of planned and external downtimes.

The area of application of coefficient of effective use of equipment No. 1:

— for adoption of management decisions by middle and senior management (for example, the shop foreman and higher);

— typical considered period – week and more.

1. Coefficient of effective use of equipment No. 2 analyzes efficiency of work without account of impact of planned and external downtimes.

The area of application of coefficient of effective use of equipment No. 2:

— for adoption of management decisions at the level from shift to middle management (for example, the shop foreman);

— typical considered period – shift/day.

The analyzed time period of work of chosen technological chain (shop/department) should be subdivided into periods (Semenov & Tkachenko, 2014):

— available time with an indication of share of machine and effective time;

— downtimes in breaking up by categories.

Upon breaking up to periods one should rely on the following principles:

– available time of technological chain (shop/department) should be taken equal to available time - the theoretical bottleneck;

– machine time of technological chain (shop/department) should be taken equal to machine time - the theoretical bottleneck;

– upon calculation of effective time of work of technological chain (shop/department) one should take into account unique actual output at theoretical bottleneck;

– losses/downtimes at theoretical bottleneck should be considered losses of the whole technological chain (shop/department).

As well as in periods when:

— the same nomenclature is produced at all the points of chain;

— different nomenclature is produced at the points of chain.

For each chain, within which "theoretical bottleneck" is the same shop, the breaking up of considered period of time aligns with breaking up of "theoretical bottleneck". Here we should notice there is a majority of such situations (Egorova, Vershinina, & Zokirova, 2015).

Situation 1. Every shop takes its priority of significance depending on importance, added value/marginal profit produced by shop. Therefore, the approximation of priority can be represented with assessment of relative value of equipment.

Situation 2. When at the same time several nomenclatures of product are manufactured at different units/shops in the framework of one manufacturing chain and there are several bottlenecks (the bottleneck for each nomenclature is represented with its unit/shop), the bottleneck of the whole work shop is the shop with higher priority.

Situation 3. When shops produce several nomenclatures of product, but are not being bottleneck within the production process, the bottleneck is the shop possessing bigger priority.

Conclusion

Summarizing the conducted research we should make the following conclusions:

To reach the depth of the analysis we should provide the possibility of grouping of considered time losses by the following features (Egorova & Kuznetsov, 2016):

1. Factor defining efficiency:

— losses of accessibility (planned and external equipment downtimes);

— losses of availability (equipment downtimes);

— capacity losses (losses of speed);

— quality losses ("Recalls", "Defect", "Shift to down grade").

2. Type of losses defining belonging of loss/downtime:

— external downtimes;

— planned shutdown;

— scheduled maintenance of equipment;

— emergency downtimes;

— change-over;

— unscheduled breaks;

— losses of speed;

— reprocessing (REPAIRS);

— reprocessing (RECALLS);

— shift to down grade;

— defect-utilization.

To analyze the coefficient of effective use of equipment during collecting initial data one should log the following information (Sovetov & Tsekhanovsky, 2014):

– date;

– production period (morning, day, night shift);

– shop;

– plant unit;

– processing routing (previous processing (shop/unit), from which product is taken, and the subsequent processing, to which product is delivered);

– nomenclature (assortment) of processed products;

– performance of specified unit and nomenclature;

– beginning of nominal time fund;

– end of nominal time fund;

– actual production output;

– actual output of unique products;

– actual output of unique products accepted upon first presentation;

– losses of time upon production with an indication of downtime category, description of downtime, node point and workpiece in case of emergency downtimes.

Since the calculation of coefficient of effective use of equipment is conducted with account of "theoretical bottleneck", the data about volume of manufactured products should be taken maximum approximated to theoretical bottleneck from

examination platform located in the same production chain. If quality control procedure is performed just at bottleneck, the information about volumes should be taken from the bottleneck. Upon quality control for calculation of effective use of equipment the key indicator is the number of processing times at theoretical bottleneck. The source of defect possesses no impact on the calculation, and the accounting of defects is performed for the purpose of elimination of causes for their emerging.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Anastasiya Egorova, PhD, assistant professor of business economics department, Kozma Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russıa.

Elena Yaschkova, PhD, assistant professor of innovation management department, Kozma Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russıa.

Nadezhda Sineva, PhD, assistant professor of innovation management department, Kozma Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russıa.

Anzhelika Schkunova, PhD, assistant professor of innovation management Kozma Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, Russıa.

Sergey Semenov, PhD, Associate Professor of the service and the service sector of the economy, Institute of Food Technology and Design, the branch of Nizhny Novgorod State University of Engineering and Economics, Nizhny Novgorod, Russıa.

Yuliya Klyueva, PhD, associate professor of the department of service and the service sector of the economy, Institute of Food Technology and Design, the branch of Nizhny Novgorod State University of Engineering and Economics, Nizhny Novgorod, Russıa.

References

Bratuhin, A.G. & Kalachanov, V.D. (1993). *Knowledge-based aviation products: organizational and economic problems of development*. Moscow: Mechanical engineering.

Dubrovin, I.A. (2016). *Economy and production organization*. Moscow: Dashkov and Co'.

Dubrovin, I.A. (2008). *Organization and planning of production in enterprises*. Moscow: Colossus.

Egorova, A.O. (2014). Competitive advantages of enterprise as the basis for formation of competitive strategy. In digest: Industrial; development of Russia: problems, prospects. *Works of 7th International scientific and practical conference of teachers, scientists, specialists, candidates,* student in 3 volumes. Enterprise economy department, 42-48.

Egorova, A.O. & Kuznetsov, V.P. (2016). Classification of competitive strategies of industrial enterprises. News of higher educational institutions. *Food technology, 2-3(350-351),* 10-13.

Egorova, A.O., Vershinina, M.V. & Zokirova, N.K. (2015). Experience of strategic development of atomic and energetic mechanical engineering (by the example of "ATOMENERGOMASH" JSC). *Herald of Minin University, 3(11),* 2-17.

Ilyina, S. (2004). *Crisis management*. Rostov-on-Don: Publishing house "Phoenix".

Kobyak, M.V. & Layko, M.Y. (2012). Technological progress as a factor of innovation in the hotel industry. *Russian Entrepreneurship, 18(240),* 126-132.

Kulichkov, E.N. & Traynev, I.V. (1994). *Marketing Systems and information process in the activity of the manager*. Moscow: AST.

Limitovsky, M.A. (2001). *Basis of measurement. The financial and investment decisions*. Moscow: DeCa.

Lobanova, E.N. & Limitovsky, M.A. (2001). *Financial Manager*. Moscow: DeCa.

Minaeva, E.S. & Panagushin, V.P. (1998). *Crisis management*. Moscow: Publishing house PRIOR.

Minasyan, V.B. & Limitovsky, M.A. (2009). *CAPM and Diversifi cation of the Investment Portfolio under Heterogeneous Volatility*. SSRN Working Paper.

Popov, V.N. (2012). *Production organization and enterprise management: the textbook for students of higher educational institutions studying at technical departments*. Moscow: INFRA-M.

Semenov, S.V. (2015). Applying of innovative services in crediting at consumer market. *Herald of State Engineering and Economic Institute of Nizhniy Novgorod, 5(48),* 86-91.

Semenov, S.V. & Tkachenko, S.S. (2014). Creation of tariffless personnel remuneration system at modern mechanical engineering enterprises. *Herald of Minin University, 4(8),* 20-37.

Shkunova, A.A. (2007). *Organization management: organizational behaviour*. Nizhniy Novgorod: Minin Nizhny Novgorod State Pedagogical University.

Shkunova, A.A. & Koloda, S.A. (2014). Levels of relationships in corporate management culture. *Gerald of Minin University, 4(8),* 24-36.

Sineva, N.L. (2015). Innovational cycle in organization innovative activity. *In digest: Innovative management technologies, the collection of articles on materials of 2nd all-Russian scientific and practical conference*. Nizhny Novgorod: Minin Nizhny Novgorod State Pedagogical University, 47-50.

Sineva, N.L. & Yashkov, E.V. (2015). Modern organization personnel's intellectual and creative activity development management. *Online magazine "Naukovedenie", 5(30),* 90.

Sokolitsyn, S.A. (1988). *The organization and operational management of machine-building production*. Moscow: Mechanical Engineering.

Sokolitsyn, S.A. & Kuzin B.I. (2015). *Organization and operating management of mechanical engineering enterprise.* Leningrad: Mechanical engineering, Leningrad department.

Sovetov, B.Y. & Tsekhanovsky, V.V. (2014). *Automated management of modern production*. Leningrad: Mechanic engineering, Leningrad department.

Vasiliev, V.N. (2013). *Organization of production under market conditions: textbook for students of mechanical engineering higher educational institutions*. Moscow: Mechanical engineering.

Yashkova, E.V., Sineva, N.L., Shkunova, A.A., Bystrova, N.V., Smirnova, Z.V. & Kolosova, T.V. (2016). Development of Innovative Business Model of Modern Manager's Qualities. *International Journal of Environmental and Science Education, 11(1),* 4650-4659.