DOI: 10.2507/28th.daaam.proceedings.151

PERFORMANCE INDICATORS OF PRODUCTION PROCESSES

Ajdin Vatres*, Izet Bijelonja, Mugdim Pasic

This Publication has to be referred as: Vatres, A[jdin]; Bijelonja, I[zet] & Pasic, M[ugdim] (2017). Performance Indicators of Production Processes, Proceedings of the 28th DAAAM International Symposium, pp.1090-1095, B. Katalinic (Ed.), Published by DAAAM International, ISBN 978-3-902734-11-2, ISSN 1726-9679, Vienna, Austria
DOI: 10.2507/28th.daaam.proceedings.151

Abstract

In this paper results of the research of the application of methods for designing and managing production processes as well as the presence of different process performance indicators in companies in Bosnia Herzegovina are presented. A survey questionnaire was designed to obtain required data for the analysis. The questionnaire consisted of two parts. The first part of the questionnaire contained questions about general characteristics of the companies, while the other part was related to the applied methods and tools for production process design and methods of evaluating the performance of the process. According to the analysis it can be concluded that 56,3 % of companies use production management software solutions like Pantheon, F 300, MIS, SAP. At the same time 37,5 % of the analysed companies use software packages to design their production process. In 62,5 % of the cases the companies analyse the performance indicators of the production process on a monthly basis.

Keywords: business process; performance indicators measurement; process modelling tools; production procedures

1. Introduction

Performance can be viewed simply as a company's ability to consistently achieve its goals. However, if measurement is carried out too often, it uses more resources and becomes counterproductive. Therefore, every organization should focus on the critical areas of its processes in tailormade fashion [1].

Depending on the company's priorities, key performance indicators (KPI) can be financial and non-financial measures that organizations use to determine how successful they are in accomplishing long lasting goals [2]. Performance indicators can be implemented within one manufacturing company, a network of manufacturing companies, a complete supply chain, as well as the complete distribution channel of a product. Through the development and implementation of key performance indicators, the company aims to monitor product performance, supplier selection, distribution channel management, sales and production planning. This requires significant financial resources [3]. In the paper [4] an integrated approach is proposed in order to prioritize key performance indicators. It is noted that, for instance, the size and complexity of organizations can affect the type and number of selected KPIs. Therefore it is imperative to select and utilize the most appropriate indicators.

Research paper [5] shows that traditional performance measures have many limitations. They are based on outdated traditional cost management systems, lagging metrics, not related to corporate strategy, inflexible, expensive and contradict continuous improvement. The limitations of traditional performance measures resulted in research that confirmed the necessity of introducing a new set of operational efficiency measures that should provide the necessary and timely information for day-to-day decision making. These measures should be flexible, primarily non-financial and can be changed as needed. One of the possible alternatives is time-based performance measurement, with its main drawback in overstating the role of time and neglecting the impact of other performance performance measures. Another way to respond to traditional problems is the development of integrated performance measurement systems, which also have their own limitations.

In [6] process modeling techniques are classified as diagrammatic models, formal/ mathematical models, business process languages programming languages. When speaking of graphing techniques, it is pointed out that the unavoidable advantage of the graphical approach is its simplicity and ease of creation, as well as the fact that no technical expertise is required for its analysis, which is why it still has a wide application in business practice. However, modeling based on pure graphic notation lacks formal semantics and quantitative information which results in its inconsistency and inadvertence. Furthermore, every analysis based on graphical model types often comes down to a visual overview of a chart that depends on the skills of an analyst, and is highly subjective.

The need for formal semantics in business modeling has led to the development of the second generation of models. Analyzing formal modeling techniques, in [6] it is emphasized that formal processes model concepts are defined rigorously and precisely, enabling them to mathematically analyze the consistency of the process and its other characteristics. On the other hand, the lack of formal methods to support process design is that the elements and constraints of business processes are mostly of a qualitative nature and are difficult to characterize in a formal way that can be matched by mathematical analysis methods. In [6] it is presented that mathematical representation of the process does not allow to describe the complexity of the actual environment (decision making, feedback loop, parallel or hierarchical flow). Also, complex mathematical notations are required for maintenance, which acts discouraging at business analysts.

Programming languages as the third and the latest generation of business process modeling techniques are the result of the need to solve problems arising from the complexity of formal techniques, which would preserve the consistency and potential of formal analysis. Languages for process modeling include elements and formal modeling and visualization of the business process in terms of building standardized and repeatable models [6].

As indicated in the research paper [7] during the late nineties it became imperative for successful organization of a production company to do process oriented reorganization of all business flows, and it was a regular practice for large companies. Today that is true for small and medium sized companies too. That is why the paper [7] gives a concept of introducing information systems while using the moment of the information system implementation to change and improve business processes and to continuously improve processes. This implementation concept allows parallel improvement of the business processes of the companies and business process automation. It allows for transparent measurement of improvement of business process efficiency.

Article [8] presents a set of criteria and proposes guidelines for the selection of the most beneficial business process management system. The proposal has been developed on the basis of literature overview and the feedback from practical experience. The research done in this paper supports the use of a complex set of criteria which is intentionally quite narrow and general, so that it can be applied to different organizations from different industries. However, specific criteria must be added in order to assure the applicability of guidelines in specific cases.

Paper [9] presents the results of empirical research conducted in Croatian and Slovenian companies. The main objective of our research was to determine whether a higher level of business process orientation resulted in better organizational performance in companies in transitional economies. The analyzed data supported this claim.

Research [10] extends on the research carried out by Skrinjar and associates (2008). The findings show that managers should not focus on financial indicators alone. Monitoring of various nonfinancial performance indicators significantly contributes to making good decisions in real time.

In this paper methods of designing and managing production processes as well as the presence of different process indicators are examined in companies in Bosnia and Herzegovina.

2. Research methodology

For the purpose of research of the methods of designing and managing production processes as well as the presence of different process indicators in companies in Bosnia and Herzegovina a survey questionnaire was designed. The survey questionnaire was sent electronically to 100 companies. The company list was created from the data obtained from the Chamber of Commerce of the Federation of Bosnia and Herzegovina. The response rate was 16 %.

Regarding the type of work performed by the surveyed companies, it should be noted that this is a broad spectrum of manufacturing activities: production of chemicals; ammunition production; production of primary aluminum and aluminum alloys; metal machining, fabrication and machining of metal structures; manufacture of electrical equipment for motor vehicles; cement production; production of air and liquid filters; production of boilers and biomass boilers; production of PVC and ALU carpentry, thermal insulation glass, metal plasticizing; production of plastic packaging; manufacture of furniture; production of textile for the auto industry.

The questionnaire contained 26 questions with pre-offered answer options. It was designed to provide an objective view of the respondents' condition by trying to remove all possible preferences according to the alternatives offered and gain an objective insight into the way production process management was performed. To avoid further clarification, the questions were intentionally simple. With the intent that companies of different production orientations could be involved in the research, the offered answers were of a typical character. The first part of the questionnaire contained questions about the basic characteristics of the investigated companies, while the second part related to companies applying methods and tools for process design and ways of evaluating the performance of the process.

3. Data analysis

Table 1 shows the basic characteristics of the surveyed companies (average number of employees, utilization of business capacity, production orientation and number of clients for which the company produces). The size of the company was determined according to the number of employees and from table 1 it can be seen that 50 % of the surveyed companies employ between 50 and 249 employees. Of the companies that participated in the survey, 87,4 % of companies have a production capacity utilization of more than 70 %. Furthermore, none of the companies are oriented exclusively to the domestic market, and 31,3 % of the companies are selling their products exclusively on the foreign market. Also, 93,7 % of analyzed companies have a wide range of clients.

Average number of employees	**%**
Up to 50	6,3
50 - 249	50,0
250 - 499	18,7
More than 500	25,0
Utilization of production capacities	**%**
85 - 100%	50,0
70 - 85%	37,4
55 - 70%	6,3
Less than 50%	6,3
Orientation of production	**%**
Domestic market	0
Foreign market	31,3
Domestic and foreign market	68,7
Number of clients	**%**
One	0
2 - 5	6,3
More than 5	93,7

Table 1. Overview of the general characteristics of the surveyed companies

When asked about the use of software for production management, 43,7 % of surveyed companies gave a negative response. In contrast, 56,3 % of companies use production management software, some of which are Pantheon, F 300, MIS, SAP.

Table 2 gives information on the use of manufacturing process design tools per company. In the sample, 12,5 % of companies do not use tools. By contrast, in designing and defining their processes, in most cases, companies use traditional graphical flow chart and process map type methods: 37,5 % of companies use flowcharts and 18,7 % process maps. Of the analyzed companies, 37,5 % use software packages such as CORPUS, F300, MIS, CIMDB and APIS.

Company	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Flow Charts			x					x	x		x			x		x
Process Charts			x										x			x
Software packages		x		x			x			x		x				x
Other tools	x														x	x
No use of tools					x	x										

Table 2. Use of tools for production process design

When it comes to the way companies make a daily production plan, it can be concluded from the data that 31,2 % of companies use only experience, 56,3 % of companies use software, 12,5 % of companies based on work order and 6,3 % of companies based on aggregate production plan.

Table 3 shows the ways in which the surveyed companies measure the production cycle time and set working standards. The most commonly used method of determining the production cycle is the time required for each operation, represented by 81,2 % of the company. When determining work standards, 37,5 % of the companies combines multiple methods for estimating the work time, 31,2 % of companies measure the work time of a prototype sample, 18,7 % of the companies determine working standard by experience, and 12,6 % of companies apply different standards.

The manner in which surveyed companies determine the working standards	**%**
By experience	18,7
Measuring the work on the prototype sample	31,2
MTM-, MOST-, MODAPTS-standard	6,3
REFA-standard	6,3
Combining multiple methods for estimating work time	37,5
The way the surveyed companies measure the time cycle	**%**
Measuring total production time	0
By measuring the time of each operation and collecting these times	81,2
Combination of total time measurement and time measurement obtained by the time of each operation	12,5
Unknown	6,3

Table 3. Determination of the working standards and measurement of the time cycle

In 93,7 % of cases, companies have prescribed procedures for transferring information in the production process. When manufacturing processes are performed, the most commonly used method of defining work tasks is in the written form (68,8 %). Also, companies do so via the information system (50 %).

The next set of questions related to the use of certain types of production planning files by companies. Table 4 is a representation of the utilization of work center master files, item master files and routing files. In the case of 62,5 % of companies, all three types of files are represented. In contrast, 18,6 % of companies record only information about each component that the company produces (item master file), while 6,3 % of companies have only written procedures for item delivery (routing file). When it comes to the control file, 50 % of companies track current progress for each order by software, 31,3 % of the companies do it through checklists, while 18,7 % of the companies decided to combine both methods.

Company	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Work center master files	x	x	x	x			x	x	x	x	x		x			x
Item master files	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Routing files		x	x	x			x	x	x	x	x	x	x	x		x

Table 4. Types of design files and their representation

In order to transport semi-finished goods companies use different equipment: cranes (50 %), lifters (37,5 %), conveyors (62,5 %), forklifts (25 %), pushcarts (6,3 %), pipelines (6,3 %), or do it manually (12,5 %).

For 62,5 % of the companies, control of the product in the production process implies control of the finished product and the control of the semi-finished products at each workplace after the completion of the operation. At the same time, 31,5 % of companies control only semi-products, while 6.3% of companies use other forms of control. In the event of a defective product, 62,5 % of companies have a written procedure for the product rework, while 6,3 % of companies rely only on oral communication or on the information system only. In 12,5 % cases it is a combination of oral and written method of defining the rework, in 6,3 % of cases this combination refers to written procedures and an information system or a combination of oral and defining procedures through an information system. Regarding the number of products returned for rework, 93,7 % of companies track (document) their number.

It was found that 75 % of respondents measure the utilization of specific resources (workforce, machines, etc.). Also, when it comes to downtime causes, which are shown in the table 5, the most common cause of downtime is a failure in 75 % of cases. For 56,2 % of companies downtime was caused by switching to a new product, scheduled maintenance was noted in 25 % cases and the human factor in 18,8 % of cases. Furthermore, downtime as a result of a bottleneck occurs in 12,5 % of cases and the lack of financial resources is listed in 6,3 % of companies. A resource which would represent a bottleneck, for 62,5 % of companies is changing depending on the current production program.

Company	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Malfunction	x	x	x	x	x		x		x	x	x			x	x	x
Planned maintenance							x				x	x			x	
Moving to new product	x		x	x		x			x		x		x	x		x
Bottleneck						x								x		
Human factor											x			x		x
Insolvency								x								

Table 5. Causes for downtime

Table 6 represents the time frames for reviewing the performance indicators of a manufacturing process by companies. Analysis of the performance indicators of a company's manufacturing process most frequently occurs only on a monthly basis in 62,5 % of cases. In 12,5 % of cases, the company, in addition to reviewing performance indicators at the monthly level, also approaches quarterly, semi-annual and yearly.

Company	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Weekly									x							
Monthly	x	x	x	x		x	x	x		x	x		x		x	x
Quarterly			x				x							x		
Semiannually			x				x					x				
Annually			x		x		x									

Table 6. Time frames for reviewing the performance indicators of manufacturing process

When it comes to how companies relate to key performance indicators (KPIs) and benchmarking, it can be stated that 56, 3% of companies are tracking KPIs and 62,5 % of companies are performing benchmarking. In 50 % of cases, the company simultaneously monitors KPIs and performs benchmarking, while 31,3 % of the companies do not track KPIs or conduct benchmarking. Table 7 shows the attitude of individual companies towards KPIs and benchmarking.

Company	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
KPI	x	x		x			x	x			x		x	x		x
Benchmarking		x	x	x			x	x		x	x		x	x		x

Table 7. The attitude of individual companies towards KPIs and benchmarking

4. Conclusion

Based on the questionnaire survey, it can be concluded that a relatively small number of companies are performing benchmarking and tracking KPIs. The number of companies that use information systems in their business practice is inadequate. It should also be noted that the production downtime caused by failures is much more frequent than by the scheduled maintenance. Production procedures in general are often not clearly defined, since they are defined in a large number of cases through personal oral communication. Analysis of performance indicators only on a monthly basis, the most commonly used, is insufficient and allows companies to use only lagging metrics.

Analysis shows that although there is no visible nonresponse pattern, the limitation of this research is relatively small response rate. Future research could include the use of more alternatives for companies to complete and return questionnaires in order to achieve higher response rate. In this way, companies could be grouped according to industry branches. The behaviour of companies in service sector should be explored as well.

5. References

[1] Stainer, L. (2006). Performance management and corporate social responsibility: the strategic connection. Strategic Change, Vol. 15, (August 2006) pp. 253-264, ISSN 1099-1697

[2] Velimirovic, D.; Velimirovic, M. & Stankovic, R. (2011). Role and importance of key performance indicators measurement. Serbian Journal of Management, Vol. 6, No. 1, (May 2011) pp. 63-72, ISSN 2217-7159

[3] Atanasov, N. & Lecic-Cvetkovic, D. (2009). Production key performance indicators in global crisis environment, Available from: http://spin.fon.bg.ac.rs/doc/Zbornik09.pdf Accessed: 2017-04-29

[4] Shahin, A. & Mahbod, M. A. (2007). Prioritization of key performance indicators: An integration of analytical hierarchy process and goal setting. International Journal of Productivity and Performance Management, Vol. 56, No. 3, (March 2007) pp. 226-240, ISSN 1741-0401

[5] Ghalayini, A. M. & Noble, J. S. (1996). The changing basis of performance measurement. International Journal of Operations & Production Management, Vol. 16, No. 8, (August 1996) pp. 63-80, ISSN 0144-3577

[6] Vergidis, K.; Tiwari, A. & Majeed, B. (2008). Business process analysis and optimization: Beyond reengineering. IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews), Vol. 38, No. 6, (January 2008) pp. 69-82, ISSN 1094-6977, DOI 10.1109/TSMCC.2007.905812

[7] Stojkic, Z. & Majstorovic, I. (2012). Improving Business Organization through the Implementation of Integrated IS, Annals of DAAAM for 2012 & Proceedings of the 23rd International DAAAM Symposium, 24-27th October 2012, Zadar, Croatia, ISSN 2304-1382, ISBN 978-3-901509-91-9, Katalinic, B. (Ed.), pp. 0853-0856, Published by DAAAM International, Vienna, Austria, 2012

[8] Bosilj Vuksic, V.; Brkic, Lj. & Baranovic, M. (2016). Business Process Management Systems Selection Guidelines: Theory and Practice. 39th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO) 2016, May 30-June 3 2016, Opatija, Croatia, ISBN 978-953-233-088-5, Biljanovic, P. (Ed.), pp. 1476-1481, Croatian Society for Information and Communication Technology, Electronics and Microelectronics-MIPRO, Rijeka, Croatia, DOI 10.1109/MIPRO.2016.7522372

[9] Skrinjar, R.; Bosilj Vuksic, V. & Indihar Stemberger, M. (2008). The impact of business process orientation on financial and non-financial performance. Business Process Management Journal, Vol. 14, No. 5, (September 2008) pp. 738-54, ISSN 1463-7154

[10] Hernaus, T.; Pejic Bach, M. & Bosilj Vuksic, V. (2012). Influence of strategic approach to BPM on financial and non-financial performance. Baltic Journal of Management, Vol. 7, No. 4 (October 2012) pp. 376 -396, ISSN 1746-5265