NOVA INDIKATORSKA METODA ZA OCJENU KVALITETA GLAVNOG PROCESA PROIZVODNJE

NEW INDICATOR METHOD TO REVIEW THE QUALITY OF THE PRODUCTION PROCESS

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REZIME

Ocjena kvaliteta glavnog procesa proizvodnje proizvodnih poslovnih sistema (GPPPPS) predstavlja veoma složen i kompleksan zadatak. Zato u svijetu ne postoji opšte prihvaćena metoda za mjerenje kvaliteta GPPPPS. Ovaj rad tretira jedan od mogućih načina za mjerenje i ocjenu kvaliteta GPPPPS sa ciljem postizanja što veće objektivnosti. Pored opisa načina formiranja i procedure primjene nove metode, u radu je prikazano testiranje tačnosti nove metode na uzorku od pet glavnih procesa proizvodnje metaloprerađivačkih proizvodnih sistema.

Original scientific paper

SUMMARY

The rating of quality of the main production process of production business systems (MPPMBS) is a very complex task. That is why in the world there is no generally accepted method for measuring the quality of MPPMBS. This paper deals with one of the possible ways to measure and assess the quality of MPPMBS with the aim of maximizing objectivity. Besides the description of forming and proceduring the application of the new method, the paper presents a testing of accuracy of the new method in a sample of five main production processes of metal processing production systems.

1. UVOD

Svaka od do sada poznatih metoda za ocjenu izvrsnosti proizvodnih poslovnih sistema, koje se mogu primjeniti i za ocjenu kvaliteta GPPPPS, ima svoje specifičnosti manifestovane kroz određene prednosti i nedostatke u komparaciji jedne sa drugom. Činjenica je da su sve poznate metode primjenjive na ocjenu uspješnosti kompletnog proizvodnog poslovnog sistema.

Di bi bile primijenjene za ocjenu kvaliteta jednog dijela proizvodnog poslovnog sistema (npr. glavnog procesa proizvodnje) moraju se predhodno prilagoditi u smislu odabira metode prikupljanja signifikantnih podataka za taj dio proizvodnog poslovnog sistema.

Pošto važnu ulogu u mjerenju performansi organizacije igra definisanje odgovarajućih indikatora kvaliteta koji pokazuju način za prevođenje vrijednosti, mogućnosti, napora i rezultata u mjerljive parametre, koji su razumljivi svim zaposlenim u organizaciji. To obuhvata finansijske i nefinansijske parametre [1].

1. INTRODUCTION

Each of the so far known methods for the assessment of excellence of production business systems, which can be applied to assess the quality MPPMBS, has its own characteristics manifested through certain advantages and disadvantages in comparison with each other. The fact is that all known methods are applicable to assessment of the success of the entire production business system.

To be applicable to assess the quality of a part of the production business system (eg. the main production process) they must be previously modified in terms of choosing methods of collecting significant data for that part of the production business system.

An important role in measuring the performance of the organization plays the defining appropriate quality indicators that show the way to translate values, opportunities, efforts and results in measurable parameters, which are understoodable -by all employees in organization. This includes the financial and non-financial parameters [1].

Zahtjevi koji se postavljaju novoj metodi za ocjenu kvaliteta GPP su da obuhvati što više parametara GPPPPS, da ne traži puno podataka, da se njome poveća objektivnost i smanji subjektivnost pri ocjenjivanju kvaliteta GPP, da omogući kontinuirano praćenje promjene kvaliteta GPP i da eksplicitno ukaže na slaba mjesta u GPPPPS.

2. INDIKATORSKA METODA ZA OCJENU KVALITETA GPPPPS

Novi model ocjene kvaliteta GPP zasnovan je na polazištima koja su proizašla iz sljedećih naučno istraživačkih analiza i spoznaja:

- rješenja najpoznatijih svjetskih modela izvrsnosti za oblast proizvodni procesi,
- specifična rješenja svjetskih vodećih proizvodnih poslovnih sistema (preduzeća),
- sopstvena istraživanja koja se odnose na kontinuirana poboljšanja glavnog procesa proizvodnje i
- tendencijama daljnjeg razvoja TQM u svijetu i u BiH.

Osnovna karakteristika indikatora kvaliteta glavnog procesa proizvodnje (IKGPP) koja se primjenjuje u novoj metodi predstavlja odnos vrijednosti dva ili više indikatora kvaliteta [4], iz koje se računaju vrijednost mjerodavnih indikatora kvaliteta (MIK) GPP. Dobijena vrijednost se upoređuje sa nivoom prihvatljivosti vrijednosti MIK. Nivo prihvatljivosti vrijednosti MIK predstavlja interval unaprijed propisane prihvatljive vrijednosti istih (Tolerancija odstupanja od ciljane vrijednosti). Za neke od MIK je ta vrijednost propisana standardima, dok je za neke neophodno određivanje nivoa prihvatljivosti.

Kao problem pri određivanju nivoa prihvatljivosti je činjenica da ne postoje standardizovana metoda niti za način njihovog određivanja niti za vrijednosti gornje i donje granice. Pogotovu, ako se uzme u obzir činjenica da su parametri GPP raznodimenzionalne veličine i u tehničkom i u fizičkom smislu.

Dimenzionalna raznovrsnost IKGPP uslovljava i to da se vrijednosti pojedinih IKGPP, pri ocjenjivanju kvaliteta GPP, ne mogu uzeti sami već se kombinuju sa drugim pokazateljom (planirani i utrošeni sati sami za sebe ne govore ništa o kvalitetu GPP, ali njihov odnos je karakteristika mjerodavna za kvalitet GPPPPS).

The requirements regarding the new method for evaluating the quality of MPP are to include as many parameters of MPPMBS, to not require a lot of data, to increase objectivity and reduce subjectivity in the evaluation of quality of MPP, to enable continuous monitoring of changes in quality of MPP and to explicitly draw attention on the weak places in MPPMBS.

2. THE INDICATOR METHOD FOR EVALUATION OF QUALITY OF MPPMBS

The new model of assessment of quality of GPP is based on approaches which are derived from the following scientific research analysis and insights:

- Solutions of the most famous models of excellence in the field of manufacturing processes,
- Specific solutions of world-leading manufacturing business systems (enterprise)
- Own research related to the continuous improvement of the main production processes and
- Trends of further development of TQM in the world and in Bosnia and Herzegovina.

The main characteristic of indicators of quality of the main production process (MIQPP) applied in the new method is the ratio of values of two or more quality indicators [4], from which the value of the relevant indicators of quality (RIQ) of MPP is calculated. The resulting value is compared with the level of acceptability of RIQ value. The level of acceptability of RIQ values represent the interval of pre-specified acceptable values (tolerance of deviations from the pre-specified values). For some of the RIQ the value is prescribed by standards, while in some it is necessary to determine the level of acceptability.

As a problem in determining the level of acceptability is the fact that there are no standardized methods nor in the way they are set nor in values of the upper and lower limits.

Especially if you take into account the fact that the parameters of the MPP are different sized in technical and physical terms.

Dimensional diversity of IKGPP conditions that the value of certain MIQPP, when assessing the quality of MPP, can not be taken alone but combined with other indicators (planned and spent hours in themselves say nothing about the quality of MPP, but their attitude is characteristic relevant for the quality of MPPMBS).

2.1. Osnovne predpostavke na kojima se bazira indikatorska metoda za ocjenu kvaliteta GPP

Nova metoda ocjene kvaliteta GPPPPS u sebi sadrži neke osnovne pretpostavke koje moraju biti ispunjene da bi dala dobre rezultate u smislu postizanja odgovarajućeg nivoa zahtjeva koji se postavljaju pred njom. Te pretpostavke su sljedeće:

- procesni pristup u organizaciji GPPPPS,
- sistemski pristup upravljanju procesima,
- kontinuirana poboljšanja procesa,
- donošenje odluka na osnovu objektivnih pokazatelja,
- ljudski faktor,
- orijentisanost na kupce,
- stalno praćenje IKGPP uz obavezno pisano evidentiranje njihovih vrijednosti i definisanje tendencija i
- pretpostavlja određeni stepen razvijenosti informacionog podsistema PS.

Jedana od glavnih karakteristika nove metode jeste smanjenje ili otklanjanje subjektivnosti pri donošenju suda o kvalitetu odvijanja GPP. Dakle, smanjiti procjenu a favorizirati mjeru kvaliteta. Objektivnost se ogleda u pokazateljima koji nepobitno imaju svoju vrijednost, i kao takvi služe menadžerima da donesu pravu odluku.

2.2. Principi i način formiranja nove metode

Ocjenjivanje kvaliteta GPPPPS ovom metodom izvodi se u trodimenzionalnom prostoru:

- vrijeme –prilaz,
- praćenje IKGPP i
- ocjenjivanje i poboljšanje GPP.

Za određivanje ocjene GPPPPS ovom metodom, potrebno je prvo definisati vrijeme za koje se prate (mjere) IKGPP. Pošto nema strogih ograničenja vremenskog intervala mogu se pratiti i mjeriti IKGPP u malom vremenskom intervalu. To daje mogućnost njihove brze i efikasne analize.

Osim te pogodnosti primjene ove metode, izdvaja se i činjenica da je moguće stalno pratiti i ocjenjivati IKGPP, a za ocjenu uzeti vrijednosti iz vremenskog perioda za koji se smatra da je bitan u donošenju odluka o uspješnom upravljanju kvalitetom GPPPPS. Koji vremenski period će se uzeti za ocjenjivanje zavisi od cilja i svrhe ocjenjivanja kvaliteta GPP.

2.1. The basic assumptions on which the indicator method for assessing the quality of GPP is based.

New method of quality assessment of MPPMBS contains some basic assumptions that must be fulfilled in order to give good results in terms of achieving an appropriate level of requirements placed upon it. These assumptions are the following:

- A process approach in the organization of MPPMBS,
- Systematic approach to managing processes,
- Continuous improvement of process,
- Decision making on the basis of objective indicators,
- Human factor,
- Orientation to customers,
- Constant monitoring MIQPP with obligatory written record of their values and define tendencies and
- Assumes a certain level of development of information subsystem PS.

One of the main features of the new method is the reduction or elimination of subjectivity in making judgment about the quality of GPP. Therefore, reduce the assessment and favor the measure of quality. Objectivity is reflected in the indicators, which undeniably have their value, and as such are used to managers to make the right decision.

2.2. Principles and method of forming the new method

Evaluating qualityof MPPMBS with this method is performed in three-dimensional space:

- Time -Access,
- Monitoring IKGPP
- Evaluating and improving MPP

To determine the ratings of MPPMBS with this method, it is first necessary to define the time for which it monitors (measures) the MIQPP. Since there is no strict limit of the time interval one can monitor and measure IKGPP in a small time interval. This gives the possibility of their fast and efficient analysis.

In addition to these benefits of applying this method, amazing is the fact that it is possible to continuously monitor and evaluate the MIQPP, and for evaluation one can take the value from the time period for which we think is important to us in making decisions about the successful quality management of MPPMBS. What period of time will be taken for evaluation depends on the object and purpose of evaluating quality of MPP.

Nova metoda pretpostavlja određeni stepen razvijenosti informacionog sistema koji se već primjenjuje u PPS.

2.3. Opis procedura pri korištenju nove metode

Primjena ove metode se odvija kroz nekoliko koraka koji sadrže određene aktivnosti. Prvi korak je priprema i planiranje ocjenjivanja kvaliteta GPPPPS, a to podrazumijeva:

- Imenovanje osoba zaduženih za ocjenjivanje kvaliteta GPP.
- Priprema obrazaca i tabela za evidentiranje vrijednosti IKGPP [7] za određene podintervale vremenskog perioda za koji se vrši ocjena kvaliteta GPP.
- Proces evidentiranja podataka.
- Analiza vrijednosti podataka o IKGPP – preduzimanje aktivnosti za poboljšanje uočenih slabih mjesta.
- Prevođenje podataka u mjerodavne karakteristike.
- Dodjeljivanje vrijednosti mjerodavnim karakteristikama IKGPP.
- Ocjena kvaliteta GPPPPS.
- Analiza rezultata.
- Detektovanje slabih mjesta u GPPPPS.
- Prijedlozi za poboljšanje kvaliteta GPP.

Način dobijanja vrijednosti MIK dat je u Tabeli 1.

The new method represents a certain level of development of information systems that are already applied in PPS.

2.3. Description of procedures when using new method

Application of this method is carried out through several steps that contain certain activities. The first step is the preparation and planning of evaluation of quality of MPPMBS, which implies:

- The appointment of people responsible for evaluating the and planning of evaluation of quality MPP.
- Preparation of forms and tables to record the value of MIQPP [7] for certain subintervals of the time period for which we assess the quality of MPP.
- The process of recording information.
- Analysis of the data values of MIQPP - Undertaking activities to improve the perceived weak spots.
- Translation of data into relevant characteristics.
- Assigning values to relevant characteristics of MIQPP.
- Evaluation of the quality of MPPMBS.
- Analysis of the results.
- Detection of weak spots in the MPP MBS.
- Suggestions for improving the quality of MPP.

The way of obtaining RIQ values given in Table 1.

Tabela 1. *Način dobijanja mjerodavnih indikatora kvaliteta GPPPPS*
Table 1. *The way of obtaining the relevant quality indicators MPP MBS*

No	Šifra MIKGPP Code	Način dobijanja
1.	MIK-01	$\sigma_p = \sqrt{\frac{(\bar{p}\,(1-\bar{p}))}{n}}$
2.	MIK-02	$C_p = \frac{GGT - DGT}{6\,\sigma} = \frac{T}{T_p}$
3.	MIK-03	$C_{pk} = \frac{\Delta_{krit}}{3\,\sigma};\ \Delta_{krit} = GGT - \bar{p}\ ili\ \Delta_{krit} = \bar{p} - DGT$
4.	MIK-04	$C_o = \frac{2\lvert\bar{p} - \bar{r}\rvert}{DGT + GGT}$
5.	MIK-05	$f_p = \frac{6\sigma_p}{GGT - DGT}$ $GGT = \bar{p} + 3\sqrt{\sigma_p}\,; DGT = \bar{p} - 3\sqrt{\sigma_p}$
6.	MIK-06	$\frac{Ikgp30}{Ikgp4}$
7.	MIK-07	$Ikgp2$

8.	MIK-08	$POC = \frac{\frac{OOP}{POP} + PNP + P\check{S} + \frac{PS}{US} + PR}{5}$
9.	MIK-09	$\frac{Ikgp9}{N}$
10.	MIK-10	$\frac{Ikgp11}{Ikgp12}$
11.	MIK-11	$\frac{Ikgpp31}{Ikgp11}$
12.	MIK-12	$\frac{Ikgp4}{Ikgp3}$
13.	MIK-13	$\frac{Ikgp6}{Ikgp4}$
14.	MIK-14	$\frac{Ikgp5}{Ikgp4}$
15.	MIK-15	$\frac{Ikgp13}{Ikgp11}$
16.	MIK-16	$\frac{Ikgp14}{Ikgp11}$
17.	MIK-17	$\frac{Ikgp16}{Ikgp11}$
18.	MIK-18	$\frac{Ikgp20}{n_{projekata}}$
19.	MIK-19	$\frac{n_{np}}{n_{pnp}}$
20.	MIK-20	$\frac{Ikgp8}{Ikgp22}$
21.	MIK-21	$Ikgp10$
22.	MIK-22	$\frac{Ikgp15}{Ikgp11}$
23.	MIK-23	$\frac{Ikgp17}{Ikgp11}$
24.	MIK-24	$\frac{Ikgp18}{Ikgp11}$
25.	MIK-25	$\frac{Ikgp19}{Ikgp11}$
26.	MIK-26	$\frac{Ikgp22}{Ikgp21}$
27.	MIK-27	$\frac{Ikgp27}{Ikgp23}$
28.	MIK-28	$\frac{Ikgp25}{Ikgp26}$
29.	MIK-29	$\frac{Ikgp27 + Ikgp28 + Ikgp29}{Ikgp4}$
30.	MIK-30	$\frac{Ikgp24}{Ikgp22}$

2.4. Postupak vrjednovanja i dobijanje ocjene o kvalitetu GPP

Bodovanje se izvodi po Likertovoj skali a bodovi se kreću u rasponu od 1 do 5. S tim što se može neki od MIKGPP bodovati sa nulom ukoliko prelazi iz okvira definisanog nivoa prihvatljivosti u negativnom smislu. Ukoliko prelazi granice nivoa prihvatljivosti u pozitivnom smislu, potrebna je korekcija nivoa definisanosti. Zatim se ocjene množe sa koeficijentom uticaja i zbrajaju se. Maksimalno je moguće prikupiti 120 bodova.

Prije dodjeljivanja vrijednosti ocjene pojedinih MIKGPP, moraju se formirati tabele vrijednosti za svaki MIKGPP, sa definisanom veličinom prihvatljivosti, što je dato u Tabeli 2.

Određivanje granice prihvatljivosti zavisi od tipa MIKGPP. Granice prihvatljivosti složenih MIKGPP su propisane i preuzete su iz [2]. Jedno od ograničenja granice prihvatljivosti za ostale MIKGPP (maksimum ili minimum) proističe iz težnje da dati MIKGPP ima svoj maksimum ili minimum (npr. maksimum je 100 % a mnimum 0 %), posmatrano sa aspekta pozitivne ciljane vrijednosti. To znači da ako se teži da se ima GPP organizovan tako dobro da nema škarta, odnosno, da ima 0 % škarta, onda je riječ o pozitivnom minimumu kao ciljanoj vrijednosti.[5]

Ostale granice su određene tako što se rukovodilo vrijednostima za MIK na uzorcima istraživanja i te granice su unijete kao granice prihvatljivosti. Nakon određivanja granica prihvatljivosti, pristupilo se podjeli intervala granica na pet jednakih podintervala (osim za neke od složenih indikatora za koje su podintervali propisani).

2.4 The process of evaluation and getting ratings of the quality of MPP

Scoring is conducted by Likert scale, which is ranging from 1 to 5. However, some of the RIQMPP can score with zero if they exceed the scope of the defined level of eligibility in a negative way.

If it exceeds the limits of eligibility in a positive way, a correction of the level of the definition is required. Then the scores are multiplied by the coefficient of influence and then added. The maximum amount of points is 120. Before assigning a rating of value of certain RIQMPP, tables of values must be formed for each RIQMPP with a defined size of eligibility, which is given in Table 2.

Determination of the limit of eligibility depends on the type of RIQMPP. The limits of eligibility of complex RIQMPP are prescribed and taken from [2]. One of the limitations of limits of eligibility for other RIQMPP (maximum or minimum) stems from the desire that the given RIQMPP has its maximum or minimum (eg. Max is 100% and mnimum 0%), from the aspect of the positive target value. This means that if we strive to have MPP, which is organized that well, that we have no scrap, respectively, we have 0% of waste, then it is a positive minimum as a target value.[5]

Other limits are set in the way that was guided by the values for RIQ on samples of research and these limits are entered as limits of eligibility. After defining the limits of eligibility, it has come to a division of the intervals of boundaries into five equal subintervals (except for some of the complex indicators for which the subintervals are prescribe.

Tabela 2. *Granice prihvatljivosti MIK*
Table 2. *Limits of eligibility RIQ*

MIK	Granice prihvatljiv. Limits of eligibility	Ocjena 1 Mark 1	Ocjena 2 Mark 2	Ocjena 3 Mark 3	Ocjena 4 Mark 4	Ocjena 5 Mark 5
01	[0,00-0,05]	(0,04-0,05]	(0,03-0,04]	(0.02-0,03]	(0,01-0,02]	[0,00-0,01]
02	[0,00- xx]	<1	1	(1-1,33)	1,33	>1,33
03	[0,00- xx]	<1	1	(1-1,33)	1,33	>1,33
04	[0,00-0,1]	(0,08-0,1]	(0,06-0,08]	(0,04-0,06]	(0,02-0,04]	[0,00-0,02]
05	[0,00-70]%	(65-70]	(48-65]	(24-48]	(12-24]	[0,00-12]
06	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]

07	[0,00-10]%	(9-10]	(7,5-9]	(5,0-7,5]	(2,5-5,0]	[0,00-2,5]
08	[80-100]%	80	(80-85]	(85-90]	(90-95]	[95-100]
09	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
10	[0-10] %	(8-10]	(6-8]	(4-6]	(2-4]	[0-2]
11	[0-1] %	(0,8-1]	(0,6-0,8]	(0,4-0,6]	(0,2-0,4]	[0,0-0,2]
12	[0-10] %	(0,8-1]	(6-8]	(4-6]	(2-4]	[0-2]
13	[0,00-0,05]	(0,04-0,05]	(0,03-0,04]	(0.02-0,03]	(0,01-0,02]	[0,00-0,01]
14	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
15	[3-15]%	(12,5-15]	(10-12,5]	(7,5-10]	[5-7,5]	<5
16	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
17	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
18	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
19	[0->1]	[0-0,25)	[0,25-0,5)	[0,5-0,75)	[0.75-1)	≥1
20	[0-1] %	(0,90-1]	(0,75-0,90]	(0.5-0.75]	(0,20-0,5]	[0,0-0,20]
21	[50-100]%	<60	[60-70)	[70-80)	[80-90)	[90-100]
22	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
23	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
24	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
25	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
26	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
27	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
28	[0-5] %	(4,5-5]	(3,5-4,5]	(2-3,5]	(0,5-2]	[0,0-0,5]
29	[0-1] %	(0,90-1]	(0,75-0,90]	(0.5-0.75]	(0,20-0,5]	[0,0-0,20]
30	[0-10] %	(8-10]	(6-8]	(4-6]	(2-4]	[0-2]

2.5. Testiranje nove metode

Za testiranje tačnosti nove metode odabran je postupak upoređivanja ocjena pomoću dvije postojeće metode (EFQM-MH i TQM-VM postojeće metode ocjene izvrsnosti PS za kriterijum procesi) i ocjene novom metodom.

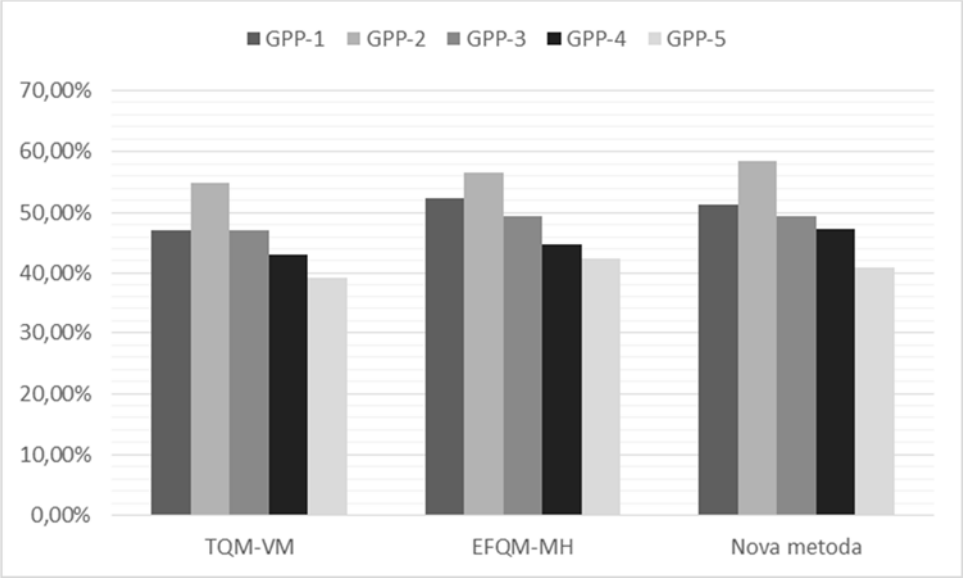
Da bi bilo moguće upoređivati ocjene kvaliteta GPP po navedenim metodama, podatke o ocjeni kvaliteta GPP moraju se svesti na istu dimenziju. Jer samo veličine iste dimenzije mogu se upoređivati. Pošto je ocjena kvaliteta GPP po EFQM-MH metodi izražena u procentima ostvarenog kvaliteta GPP posmatrano u odnosu na ciljanu vrijednost, [6] onda je logično da se i ocjene ostale dvije metode prevedu u procentualne vrijednosti. Ta vrijednost je određena prema maksimalno mogućoj vrijednosti sakupljenih bodova koja po TQM-VM metodi iznosi 140 bodova, dok za novu metodu iznosi 120 bodova.

Upoređivanje ocjena kvaliteta GPP, pomoću metoda primijenjenih prilikom istraživanja, najbolje se vidi ako se predstave grafički, slika 1.

2.5 Testing of new methods

To test the accuracy of the new method we have chosen a procedure of comparison between the ratings with the help of two existing methods (EFQM-MH and TQM-VM existing methods for rating of excellence PS for criteria processes) and the ratings with the new method. To be able to compare the rating of quality of MPP with these methods, we have to make the data of the rating of the quality of MPP reduced to the same unit. Because only the sizes of the same unit can be compared. Since the rating of the quality of MPP by the EFQM-MH method is expressed as a percentage of the ratio of the resulting quality of MPP and the target value,[6] then it is logical that the ratings of the other two methods translate into percentage values as well. That value is determined by the maximum possible value of the collected points, which according to the TQM-VM method is 140 points, while according to the new method it is 120 points.

The best way to see the comparison between the ratings of the quality of MPP, using the methods applied during the research, is presenting them graphycally, Figure 1.



Slika 1. *Uporedni prikaz procenta ostvarenih bodova za tri primijenjene metode*
Figure 1. *Comparison of percentage of marks recieved for the three methods*

Vidimo da GPP-5 ima najmanju ocjenu po svim metodama, dok GPP-2 ima najveću, pa je PPS sa GPP-2 u navedenom uzorku, vodeći PPS, posmatrano sa aspekta kvaliteta GPP.

2.5.1. Provjera tačnosti nove metode

Za provjeru tačnosti nove metode najpogodnija je metoda testiranja jednakosti srednjih vrijednosti dva osnovna skupa [3]. Prvi skup čine rezultati mjerenja po dosad korištenim metodama (TQM-VM i EFQM-MH), a drugi skup rezultati mjerenja pomoću nove metode. Radi komparacije uzimaće se vrijednosti mjerenja istih dimenzija, odnosno, procentualne ocjene za datih pet GPP.
Procjena varijanse za razmatrana dva skupa rezultata mjerenja računa se prema izrazu:

$$s^2 = \frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2} \quad ...(1)$$

gdje su: $s_1^2\ i\ s_2^2$ varijanse skupova 1 i 2. Standardna greška razlike sredina $\bar{x}_1 - \bar{x}_2$ je:

$$s_{\bar{x}_1-\bar{x}_2} = s\sqrt{\frac{1}{n_1}+\frac{1}{n_2}} \quad ...(2)$$

dok se veličina t računa po formuli:

$$t = \frac{\bar{x}_1-\bar{x}_2-(\mu_1-\mu_2)}{s_{\bar{x}_1-\bar{x}_2}} \quad ...(3)$$

We see that GPP-5 has the lowest rating by all methods, while the GPP-2 has the highest, so the PPS with GPP-2 in the sample, is the leading PPS, from the aspect of the quality of MPP.

2.5.1. Checking the accuracy of new method

For checking the accuracy of new method the most suitable is the method of testing the equality of mean values of two basic sets [3]. The first set consists of measurement results by previously used methods (TQM-VM and EFQM-MH), and second set measurement results using the new method. For comparison, value of measurements will be taken the same dimensions, that is, the percentage score for the given five MPP.
Estimation of variance for considering two sets of measurement results is calculated according to the formula:

$$s^2 = \frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2} \quad ...(1)$$

where: $s_1^2\ and\ s_2^2$ are variances of sets 1 and 2. The standard error of the difference between means $\bar{x}_1 - \bar{x}_2$ is:

$$s_{\bar{x}_1-\bar{x}_2} = s\sqrt{\frac{1}{n_1}+\frac{1}{n_2}} \quad ...(2)$$

While the t is calculated by the formula:

$$t = \frac{\bar{x}_1-\bar{x}_2-(\mu_1-\mu_2)}{s_{\bar{x}_1-\bar{x}_2}} \quad ...(3)$$

Odnosno, za Studentovu raspodelu sa brojem stepeni slobode $\vartheta = n_1 + n_2 - 2$, ako je hipoteza $H_0(\mu_1 = \mu_2)$ tačna;

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s_{\bar{x}_1 - \bar{x}_2}} \quad ...(4)$$

Testiranje nulte hipoteze se izvodi na osnovu vrijednosti za t . Iz tabele B2 [93; str.207] očitava se vrijednost $t_{13;0,05} = 1{,}160$ *i* $t_{13;0,01} = 3{,}012$ (vrijednosti *t* za tačnosti 95 % i 99 % respektivno, za 13 stepeni slobode).
U Tabeli 3, su prikazani rezultati testiranja nove metode.

For the Student's distribution with the number of degrees of free $\vartheta = n_1 + n_2 - 2$, if the hypothesis $H_0(\mu_1 = \mu_2)$ is true;

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s_{\bar{x}_1 - \bar{x}_2}} \quad ...(4)$$

Testing the null hypothesis is based on the value of t . The table B2 [93; str.207] reads the value $t_{13;0,05} = 1{,}160$ *i* $t_{13;0,01} = 3{,}012$ (the value *t* for accuracy 95 % and 99 % respectively, for 13 degrees of free).
In Table 3, there are shown the results of testing the new method.

Tabela 3. *Rezultati testiranja nove metode za ocjenu kvaliteta GPPPPS*
Table 3. *Results of testing new methods for assessing quality RIQMPP*

n_1	10	$s_{\bar{x}_1 - \bar{x}_2}$	2,99
n_2	5		
$\bar{x}_1$	47,69		
$\bar{x}_2$	49,48	t	-0,16
s_1^2	28,56		
s_2^2	32,38		
s^2	29,74		

Upoređivanjem apsolutne vrijednosti izračunate za *t* i standardne vrijednosti dolazimo do sljedećih zaključaka:

$$|t| = 0{,}16 < t_{13;0,05} = 1{,}160 \text{ i}$$

$$|t| = 0{,}16 < t_{13;0,01} = 3{,}012$$

što znači da je $(\mu_1 = \mu_2)$ u oba slučaja, pa je i nulta hipoteza, $H_0(\mu_1 = \mu_2)$ tačna i prihvata se. Dakle, skup 1 (mjerenja kvaliteta GPP po EFGM-MH i TQM-VM) i skup 2 (mjerenje kvaliteta GPP novom metodom) imaju jednake srednje vrijednosti, čime je prihvatljiva nulta hipoteza po studentovoj raspodjeli, što dovodi do zaključka da se nova metoda može primjenjivati za mjerenje kvaliteta GPPPPS.
Pošto se gore navedeno testiranje izvodi samo uz predpostavku da normalne raspodjele imaju jednake varijanse što utvrđujemo F-testom. Sam naziv govori da se testiranje sprovodi varijablama F-raspodjele.
Neka je nulta hipoteza da su varijanse dva osnovna skupa jednake tj: $H_0(s_1^2 = s_2^2)$
Onda je: $F_0 = \frac{s_2^2}{s_1^2}$=1,134; varijabla F-raspodjele sa stepenom slobode brojnika $\vartheta_1 = n_2 - 1 = 4$, i nazivnika $\vartheta_2 = n_1 - 1 = 9$.

By comparing the absolute values calculated for t and standard values we come to the followingconclusions:

$$|t| = 0{,}16 < t_{13;0,05} = 1{,}160 \text{ i}$$

$$|t| = 0{,}16 < t_{13;0,01} = 3{,}012$$

which means $(\mu_1 = \mu_2)$ in both cases, so the null hypothesis, $H_0(\mu_1 = \mu_2)$ is true and is accepted. So, set 1 (measurement of quality of GPP with EFGM-MH and TQM-VM) and set 2 (measurement of quality of MPP with new method) have same mean values, which means that the null hypothesis is acceptable with the student's distribution, which leads to the conclusion that the new method can be used to measure the quality of MPPMBS.
Since the above testing is performed only with the assumption that the normal distribution have the same variance which we establish with the F-test. The name itself suggests that the test is performed with variables of F-distribution.
Let the null hypothesis be that the variances of the two main sets are equal: $H_0(s_1^2 = s_2^2)$
Than: $F_0 = \frac{s_2^2}{s_1^2}$=1,134; is the variable of F-distribution with the degree of free of the numerator $\vartheta_1 = n_2 - 1 = 4$, and denumerator $\vartheta_2 = n_1 - 1 = 9$.

Tablična vrijednost F_0 za vjerovatnoće $P(F_0 > F_\alpha) = 0{,}05/0{,}01$ i navedene stepene slobode nazivnika iznosi: 3,63/6,42 [93; B4, str 209].
Može se konstatovati da je : F_0 =1,134 <3,63 i F_0 =1,134 <6,42 što znači da nema signifikantne razlike u varijansama varijabli za dva skupa, pa je nulta hipoteza za F-test prihvatljiva, a time je Studentov test valjan.
Dakle, nova metoda je tačna, i kao takva može se primjenjivati za ocjenu kvaliteta glavnog procesa proizvodnje proizvodnih poslovnih sistema metaloprerađivačke djelatnosti.

3. ZAKLJUČAK

Indikatorska metoda, i pored svoje kompleksnosti, može biti primijenjena za ocjenu kvaliteta GPPPPS.
Nova metoda nam pokazuje kako je moguće atributivne karakteristike nekog procesa pretvoriti u numeričke. To se najbolje vidi kod određivanja devijacije procesa.
Ova metoda je i sveobuhvatna, jer tretira svaki pokazatelj unutar GPP. Također, ona daje mogućnosti proširenja praćenja i nekih drugih karakteristika koje se mogu javiti kao značajne varijable za odvijanje GPPPPS.
Sa ekonomskog gledišta, ova metoda ocjene kvaliteta GPP, je jeftina. Ne zahtijeva angažovanje velikog broja ljudi, niti materijalnih sredstava. Primjenjiva je na različite vremenske periode i daje dobre podatke, kao argumente, za neodložno djelovanje i korigovanje uzroka pojave slabih mjesta.

The table value F_0 for probabilities $P(F_0 > F_\alpha) = 0{,}05/0{,}01$ and mentioned degree of free of denominator is: 3,63/6,42 [93; B4, pg 209].
We can conclude: F_0 =1,134 <3,63 and F_0 =1,134 <6,42 which means that there is no significant difference in variances of variables of the two sets, so the null hypothesis for F-test is acceptable, so the Student's test is correct.
Thus, the new method is correct, and as such may be used to assess the quality of the main production processes of production business systems metal processing activities.

3. CONCLUSION

The indicator method, despite its complexity, may be used to assess the quality of MPPMBS.
The new method shows us how it is possible attributive characteristics of a process to convert to numerical. This is best seen in determining the deviation of the process.
This method is comprehensive, as it treats each indicator within the MPP. Also, it gives the possibility of extending the monitoring and other characteristics that may occur as a significant variable for running MPPMBS.
From an economic point of view, this method of evaluating the quality of MPP, is cheap. It does not require involvement of a large number of people or material resources. It is applicable on different periods of time and gives good information, as arguments for undeniable action and correction of causes of weak places.

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