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QUANTITATIVE AND FINANCIAL CONFRONTATION OF ELECTRONIC ROUNDLOG ACCEPTANCE BETWEEN HARVESTER AND MEASURING FRAME KESAT

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Abstract: *In the natural forest of region Polabí is a final felling of conifer stands practiced with the high-performance harvester Rottne H-20. The most often produced assortments are the roundwood, the aggregate and the pulpwood. The biggest timber volume of producing assortments, i.e. 48,0 – 58,8 %, make up pine-roundwood and spruce-roundwood. The measuring frame KESAT takes over this assortment on the log conversion depot. When we compare the electronic acceptance of software DASA 4 of Harvester H-20 mentioned above with the measuring frame KESAT, we can see quantity differences. Summarization of these possible differences makes clear for us the monitoring and measuring of wood samples. Qualitative wood acceptances will characterize the natural conditions of stands and the possibilities of the wood production. The difference shouldn't get over 2 % of the quantity difference between the harvester and the measuring frame KESAT. The quantity differences lead to the financial and wood-producing devaluation of the forest production. In the case we find out some statistically significant difference between the acceptance tests we define a corrected coefficient for the timber value and the financial risk assessment, which are among supplying and consumer firms. The financial loss of the one cubic meter's softwood can be up to 1850,- CZK (pine) and 2450,- CZK (spruce) in the Czech Republic.*

1. Introduction

Management difficult three-stage acceptances of felled and processed wood, which are provided by various methodologies, can lead to a clear difference of the timber volumes between the producer and the last customer. The first determination of the timber volume is measured electronically during the timber harvesting and processing with the harvester technologies. The customers often disallow the results and carry out a self-acceptance of the produced wood that is registered in the certificate of delivery. The last electronical acceptance is carried out by final customer i.e. wood-processor. Hereat a producer has most easily financial losses or the customer is blamed groundless for a wilful timber volume reduction. Because there isn't the acceptance methodology, which would be accepted by customers and producers, we recommend determining the timber volume difference between the primary wood processing in stands and the material input to an industrial processing. The target would be the determination of the correction coefficient.

2. Methods

On the basis of the above-mentioned topic the first working priority is the correction coefficient determination between the timber volumes, which were calculated by the measuring programme of the harvester and the operation programme of the measuring frame KESAT.

The analysis was carried out in principal fellings of conifer stands in the Natural Forest Region Polabí (Tabel. 1). Logging operations were done by the high-performance harvester Rottne H-20. The measuring of the wood volume production was done by the measuring programme DASA 4 of the harvester. The harvester records the tree numbers, assortment numbers and assortment volumes and most of all the timber volume, which is different according to the timber species. The result of measurement is presented by the receiving report i.e. the measuring protocol. The most often produced assortments are roundlogs, aggregate roundlogs and pulps. The spruce and pine roundlogs have the greatest wood volume of the produced assortment percentage - 48.0 – 58.6 % (according to monitored forest stands). The roundlogs are taken over in a log conversion depot by the measuring frame KESAT. The comparison of the electronical acceptances can spring up quantity differences between the software DASA 4 of the above-mentioned harvester and those of the measuring frame KESAT. If differences spring up at the total summarization, we can know by the sample monitoring and measurement of spruce and pine wood, which is accepted in the saw mill Borohrádek.

Table 1: Specifications of the Old Growth

Forest stand	Age	Stocking	Management set of stands	Species	∅ volume of exploited trees
302A12	114	8	8223	spruce	0,79
				pine	0,96
				larch	0,93
305A10	98	8	8223	spruce	0,63
				pine	0,97
				larch	0,93
305C12	112	8	8223	spruce	0,54
				pine	0,96
328A10	96	8	8433	spruce	0,34
				pine	0,98
329B10	94	8	433	spruce	0,83
				pine	0,96
				larch	0,97
333A12	118	8	273	spruce	0,34
				pine	0,99
333F10	98	9	273	spruce	0,40
				pine	0,88

The wood quality is specified for natural conditions of the forest stands and for technologies of wood species cultivations. The supposed difference is into 2 % of the quantity disparity between the measuring system of the harvester and the measuring frame KESAT. The reduction coefficient between electronical acceptances of the harvester and the measuring frame will be calculated from this percentage for the difference compensation and the examination of financial profits and losses, which are in supply and customer companies.

3. Results and Discussion

3.1 Harvester ROTTNE H-20 – Measuring System DASA 4

The main function of the measuring installation is a distance measurement and a thickness measuring. *The trunk length* is measured by a spring-loaded toothed wheel. The Wheel is shifted on a trunk, which is dragged through the harvester head. The revolving wheel registers impulses, which match a specified unit of the length. There is calculated the tree length or the assortment length from impulse numbers, which is need for the cubature calculation. The accuracy of measurement is one centimetre. The inaccuracy of measurement is able to spring out of the tooth wear, badly implementation calibration or in the event of the swollen trunk, when the wheel goes over asperities. The stripped bark is transported on the trunk in exception conditions and the wheel is blocked (sap time). The wider wheels can be installed for a reduction of inaccuracies at the sap time or they are installed two side by side. Adjustments of the measuring wheel are possible for other specific characteristics of wood species that can be e.g. stark bark (Malík-Dvořák, 2007).

The trunk diameter is measured in two vertical directions after ten centimetres, which are averaged. The scanning of the diameters is provided by the potentiometers, which respond to knife movements. The signals merge into an electronic troop and consequently to the operating system in the driver's cabin, where are processed.

The special DASA 4 software is installed for the trunk sorting in the machine computer. There are inputted price matrices for the individual assortments and their proportions (lengths, diameters), which are used for the maximal trunk encashment. The sorting technology of the harvester:

1. The trunk is felled and is transported through the harvester head. The trunk parameters are measured on the basis of the wood species eventually of the manual dated up qualities there.

2. The diameter and length values are collected. The assortment computer has after the definite distance available enough dates (the gaude length before the forecast) to be able to form the trunk model in dependence on the felled wood species. The length, that model is in computer based on, is the supposed length and is determination of the calculated length.

3. The measuring installation does a profile prognosis of felled profiles from the form factor at the back-cut and the profile prognosis is more specified by the trunk shift across the harvester head. The optimal sorting is worked for the maximal wood yield and the wood commercialization in dependence on the measured and the supposed length.

4. After the cut-off of the first assortment followed by every further assortment a new prognosis is repeated until it isn’t possible to produce other assortments from the tree top.

3.2 Mechanical Wood Acceptance on Skid Way

The wood acceptance is provided in skid ways by a forester. The roundlog volumes are measured in the deck (length x height x with of a load) on a haul rig. The calculated timber volume is reduced to the solid cubic meters by the reduction coefficients (spruce – 0.62; pine – 0.59). It would be better, if the roundlong and the aggregate roundlog would be accepted in separate logs on the basis of a middle diameter and a length. The wood volume is elicited from log volume tables. The results are related to the certificate of delivery, which is the batch control card to customers or wood processors. Forest owners and wood suppliers realise the accuracy of measurement of the harvester systems more and more and they respect harvester output values. The total load volume is performed in the last resort by the qualified estimation and the forester respect to the electronic calculated timber volume of the customers.

Figure 1: Harvester Rottne H-20 with the Measuring System DASA 4 (left), Control centre of the manipulation line with the stationary measuring frame KESAT (right)

3.3 Measuring Frame KESAT – URSYM PC System

The third stage of the acceptance is realized right in manipulation lines of the wood-working saw. Introduced results are often the obligatory volume of felled and delivered wood for all previous producers or customers.

The URSYM PC programme is for the sawing proposals optimalization of the roundlogs and of the tree-length log in manipulation lines according to Doležal et al. (2002). All data about the processed trunks and the produced cuts are registered and they are to the disposal for others processing. Diameters are measured, when the cuts go through the measuring frame. Diameter values are measured in two vertical directions after ten centimetres of the length and these are saved to the table. It can sometimes become, that buttress or rests of the some bark overshadow the frame and the regular data aren't measured. The frame sends error messages in this case and these dates are eliminated at the evaluation. The determination of the regular value is carried out using other filtration of the connected series diameters because of eliminations of local variations. Local influences of burls or depressions (mechanical damages) will be displaced that way. Values are stored in the diameter table and it is for the determination of the trunk mid diameter and of the trunk orientation for the sorting depending on requirements, for the allocation butts and mid diameters of cuts. The trunk length is depending on a movement of the longitudinal chain conveyor, which carries the trunk. The chain wheel of the conveyer is linked to the pulse generator. The actual length will be specified on the basis pulses from the generator at the moment of the shading and screening of the measuring frame with the trunks. The trunk length is corrected on centimetres using the conversion constant. A nominal log length is designated from the real length.

The volume is determined on the basis of the mid diameter and the nominal length, which is calculated by the standard ČNS 48 0009.

$$V = \frac{(D - 2k) \cdot 2 \cdot \pi \cdot L}{40000} \tag{1}$$

where V, D, 2k and L are stem volume or cut rindless (m^3), mid diameter of trunk or cut over bark (cm), double diameter of bark and length of trunk or cut (m)

Data of the processed trunks are stored to date files on the basis of supplies, produced assortments and of next technological entry elements (timber species, quality and other).

3.4 Results of Acceptance

Results of the electronical acceptances of the exploitation wood inclusive roundlog from the harvester Rottne H-20 are presented in the table 2, where the individual forest stands are registered. The total volume of the produced roundlogs goes through measuring frame KESAT during acceptances in the conversion depot and it is in the measuring protocol of the harvester 1002,26 m^3 (from that spruce wood 431,46 m^3 and pine wood 570,80 m^3).

The roundlogs are transported from the forest stands to the company Prague Polyedr, a.s. - saw mill Borohrádek. We can't difference the roundlogs according to the production places (forest stands) in this case because wood is transported from the old growths to common decks in skid ways. The electronic measurement of single loads i.e. acceptances in saw mill is shown in the table 3. There can be seen comparison the wood volumes between the mechanical measurement of the load from a supplier, which is registered in the certificate of delivery and the electronical acceptance of the measuring frame KESAT. We can see the high disparity between the mechanical calculation and the electronical acceptance of the frame KESAT because the mechanical cubature measurement is done on a logging truck-and-trailer unit in desks and it isn't correct. Differences are at an interval of the absolute values from 6.99 m^3/load in the disadvantage of the customer to 4.48 m^3/load on the behoof of the customer between those two acceptance technologies. The average deviation is 2.45 m^3/load and the difference of the whole monitored supply is about 3.6 % higher from the stands than is declared by the electronical measuring frame KESAT.

Table 2: Results of the Electronic Harvester Acceptance – Forest District Choceň State Forest of Czech Republic

Forest stand	Species	Project	Rottne H-20 (DASA 4)	
			Total	Roundlog
(-)	(-)	(m^3)	(m^3)	
302A12	spruce	125,00	115,71	59,12
	pine	105,00	46,24	22,47
	larch	10,00	7,90	-
305A10	spruce	267,00	226,56	135,42
	pine	161,00	127,87	66,99
	larch	14,00	11,86	-
305C12	spruce	119,00	100,02	47,17
	pine	115,00	81,66	41,74
328A10	spruce	62,00	94,97	43,81
	pine	180,00	236,76	134,44
	larch	8,00	0,00	-
329B10	spruce	45,00	164,77	95,49
	pine	250,00	209,51	137,7
	larch	0,00	37,27	-
333A12	spruce	20,00	42,32	13,86
	pine	150,00	144,03	83,83
	larch	5,00	0,00	-
333F10	spruce	190,00	64,36	36,59
	pine	50,00	140,71	83,62
Total	**spruce**	**828,00**	**808,71**	**431,46**
	pine	**1011,00**	**986,78**	**570,80**
	larch	**37,00**	**57,03**	**-**

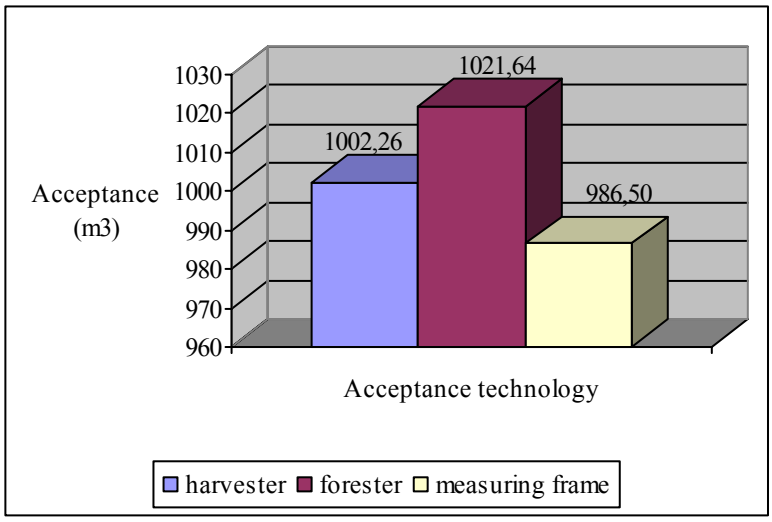

Figure 2: Total Sum of Registered Roundlogs from Monitored Stands on Dependence of the Acceptance Technology

The absolute values of the whole monitored production are presented on the figure 3. The harvester PC registered 1002.26 m^3 of the roundlogs by the electronical registration, the supplier's declare 1021.64 m^3 of the roundlogs in consignment documents and the measuring frame KESAT measured out 986,50 m^3. The disparity between electronical acceptances of the harvester and the measuring frame is so 1.6 %. This value is in the acceptable limit of two percent. The maximal difference is between the mechanical acceptance of a supplier (measurement of desks) and the measuring frame KESAT – 3.6 %.

Table 3: Mechanical Acceptances of Load with Supplier and Electronical Acceptances with the Frame KESAT

Acceptance number / load	Acceptance		Difference		Load encashment
	Supplier	Customer (KESAT)			
	(m^3)	(m^3)	(m^3)	(%)	(CZK/m^3)
12009-0001	30,53	27,14	-3,39	-12,5	46011
12009-0002	32,22	31,44	-0,78	-2,5	53747
12009-0003	30,54	30,48	-0,06	-0,2	51236
12009-0004	27,8	28,02	0,22	0,8	54086
12009-0005	32,57	33,18	0,61	1,8	72144
12009-0006	32,57	32,81	0,24	0,7	71220
12009-0007	40,21	35,03	-5,18	-14,8	82872
12009-0008	27,94	27,84	-0,1	-0,4	65381
12009-0009	27,66	25,57	-2,09	-8,2	60243
12009-0011	26,24	26,63	0,39	1,5	63219
12009-00010	40,78	38,87	-1,91	-4,9	91645
12009-00012	41,51	35,54	-5,97	-16,8	81945
12009-00013	30,67	25,76	-4,91	-19,1	45422
2009-00021	34,94	33,58	-1,36	-4,1	58396
2009-00022	31,88	29,3	-2,58	-8,8	51565
2009-0028	32,22	34,31	2,09	6,1	61355
2009-0026	40,2	33,21	-6,99	-21,0	78660
2009-0027	40,49	35,21	-5,28	-15,0	83332

2009-00024	41,95	36,92	-5,03	-13,6	72104
2009-0030	32,9	34,63	1,73	5,0	59003
2009-0037	32,22	35,06	2,84	8,1	62765
2009-0029	33,24	34,73	1,49	4,3	62236
2009-0032	34,58	33,9	-0,68	-2,0	77343
2009-0033	42,21	40,89	-1,32	-3,2	88247
2009-0035	32,9	33,56	0,66	2,0	57705
20010-0031	28,33	32,81	4,48	13,7	72745
20010-0036	32,56	30,99	-1,57	-5,1	71032
2009-0039	28,24	25,33	-2,91	-11,5	55323
20010-0038	26,86	30,73	3,87	12,6	68440
20008-0053	29,02	25,51	-3,51	-13,8	42978
20010-0053	25,66	27,52	1,86	6,8	60564

3.5 Financial Results

The customer has set redemption prices (Tabel 4) and regulated terms for the supplier. The spruce assortment has to have the minimal average of the top end 13 cm, the butt end is unlimited. A wood stain is acceptable only for the "D" quality, maximal to the 1/3 of the butt. A stem composite curvature isn't acceptable. If a single curvature the cut has, it has to go through the manipulation line and the electro measurement.

Table 4: Redemption Prices of the Spruce and Pine in August, 2007

Quality	Diameter grade							
	1.		2.		3.		4.	
	Redemtion prices							
	(CZ/m^3)	(€/m^3)	(CZ/m^3)	(€/m^3)	(CZ/m^3)	(€/m^3)	(CZ/m^3)	(€/m^3)
SPRUCE A/B 4 a 5 m	1500	53	1800	64	1900	68	1350	48
SPRUCE C 4 a 5 m	1100	39	1450	52	1500	53	1200	43
SPRUCE D 4 a 5 m	900	32	1050	37	1100	39	900	32
PINE A/B 4 a 5 m	1550	55	1700	60	1750	62	1600	57
PINE C 4 a 5 m	1300	46	1500	53	1550	55	1400	50
PINE D 4 a 5 m	1000	36	1150	41	1200	43	900	32
Exchanche rate in August, 10th 2007 – 1 CZK = 28,12 €								

The minimal average of the top end is for pines 13 cm (rind less). The maximal curvature is for the "C" quality 2 % and for the "D" quality 3 %. The wood stain can be only with the "D" quality, maximal to 1/2 of the butt end. The butt diameter is unlimited. The curvature has to go through the manipulation line and the electro measurement. If some assortment doesn't fulfil contract conditions, redemption price will be 350 CZK/m^3 (12 €/m^3).

There are presented financial results in the table 5 by the above-mentioned conditions and the ratio of produced assortments of the experimental monitored production. Tables 4 and 5 show, that prices of the roundlog sank on the ground of the gale disaster "Kyrill" in the Czech market. The prices of the pine roundlog sank in separate quality classes and diameter grades from February by July about 100 - 450 CZK/m^3 (3,6 – 18,0 €/m^3) and the spruce roundlog about 150 - 1050 CZK/m^3 (5,3 – 37,1 €/m^3). The Czech crown strengthed in face of the Euro about 0,20 Heller over the same period. The total delivery of monitored stands was valued on 71 483 €.

4. Conclusion

Conclusion speaks in the benefit of electronic acceptances:

1. The difference between electronic acceptances of the harvester Rottne H-20 and the electronic measuring system of the frame KESAT is 1.6 %,

2. The difference between mechanical acceptances of suppliers, which is registered on certificates of deliveries and the measuring frame KESAT is 3.6 %.

Results show, that the accuracies of electronical measurements of logging mechanizations and stationary measuring installations are high in manipulation lines and in saw mills. For all, that risk of possible inaccuracies during measurements spring up (burr, bark scrape and slip of the measuring wheel and other), is the difference acceptable. On the contrary specifications embody unavailing and inaccurate administrations of mechanical acceptances, which are often subjective estimations of the deck volume on the skid way or on the haul rig.

We can consider as unavailing claim of customers for inaccurate measurements of acceptance wood. If it spring up after all, reasons is incorrect calibration of measurement systems and a human failure.

Table 5: Results of Acceptances with the Frame KESAT and Financial Results According to Price List from February, 2007

Assortment	KESAT	Revenue		Ratio of assort.
	(m^3)	(CZK/m^3)	(€/m^3)	(%)
PINE-AB1	0,88	1549	55	0,09
PINE-AB1/ 5 m	7,40	13024	460	0,75
PINE-AB2	22,30	41924	1481	2,26
PINE-AB2/ 5 m	140,38	263914	9326	14,23
PINE-AB3	23,45	44086	1558	2,38
PINE-AB3/ 5 m	23,97	45064	1592	2,43
PINE-AB4	1,11	1998	71	0,11
PINE-C1	5,14	7813	276	0,52
PINE-C1/ 5 m	23,66	35963	1271	2,40
PINE-C2	29,22	48505	1714	2,96
PINE-C2/ 5 m	106,10	176126	6224	10,76
PINE-C3	11,49	19073	674	1,16
PINE-C3/ 5 m	15,68	26029	920	1,59
PINE-C4	0,00	0	0	0,00
PINE-D1	0,30	369	13	0,03
PINE-D1/ 5 m	2,31	2841	100	0,23
PINE-D2	1,90	2717	96	0,19
PINE-D2/ 5 m	7,28	10410	368	0,74
PINE-D3	1,29	1845	65	0,13
PINE-D3/ 5 m	0,00	0	0	0,00
PINE-D4	0,00	0	0	0,00
PINE-KOV	0,74	259	9	0,08
PINE-NEST	2,31	809	29	0,23
SPRUCE-AB1	4,46	9366	331	0,45
SPRUCE-AB1/ 5 m	46,41	97461	3444	4,70
SPRUCE-AB2	180,64	433536	15319	18,31

SPRUCE-AB2/ 5 m	120,36	288864	10207	12,20
SPRUCE-AB3	77,91	186984	6607	7,90
SPRUCE-AB3/ 5 m	0,75	1800	64	0,08
SPRUCE-AB4	5,61	14025	496	0,57
SPRUCE-C1	2,00	3600	127	0,20
SPRUCE-C1/ 5 m	20,09	36162	1278	2,04
SPRUCE-C2	37,68	79128	2796	3,82
SPRUCE-C2/ 5 m	34,44	72324	2556	3,49
SPRUCE-C3	16,78	35238	1245	1,70
SPRUCE-C3/ 5 m	0,77	1617	57	0,08
SPRUCE-C4	2,77	6094	215	0,28
SPRUCE-D1	0,43	559	20	0,04
SPRUCE-D1/ 5 m	0,62	806	28	0,06
SPRUCE-D2	2,12	3392	120	0,21
SPRUCE-D2/ 5 m	2,26	3616	128	0,23
SPRUCE-D3	1,28	2048	72	0,13
SPRUCE-D3/ 5 m	1,00	1600	57	0,10
SPRUCE-KOV	0,38	133	5	0,04
SPRUCE-NEST	0,83	291	10	0,08
CELKEM	986,50	2022961	71483	100,00
Exchanche rate in February 28th – 1CZK = 28,30 €				

Conclusions recommend:

- Electronical acceptances of suppliers shall be respect the metrical measurements - harvester operators with measurement results confirm the accuracy bear.
- Reduced coefficient is 0,984 for softwood (roundlog), which is produced with harvesters.
- Unification of the rounload measurement for producers, suppliers and customers.

6. References

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