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The Industrial Process Benchmarking
(Companies Producing the Same Product in Different Plants)

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Abstract

This work represents the UP' – Production Unit methodology (Calculations and examples about this methodology can be found in the paper "UP' – Production Unit, a New Method to Measure Costs and Industrial Controls" [1], presented in the 1st Annual Congress on Industrial Engineering Applications and Practice) used to measure the production effort of equal products produced in different plants, for example, the same product produced by a poultry company (like frozen chicken breast) in different plants. The UP' methodology measures the production effort during the production process and represents the result in UP's, independent of any monetary unit. With this comparable unit we can measure the total UP's of each product and comparing with the total UP's of another product (same product) but produced in another plant. The big advantage of this comparison is that we are measuring the total amount of product work (effort) involved in the production process and not the product cost, because the product cost is always affected by idle capacity, productivity, etc., and it is also affected by inflation rate. If we can compare the same product and measure the production effort we can understand better where the differences in effort and cost are between them.

Keywords: Cost, UP, Allora, Production, Unit

1. The UP' Method

A factory production during a set length of time (period) corresponds to the amount of objects produced or those under manufacturing process. How to measure this production? Up to now, except in the case when only one product is manufactured, the quantity and types of manufactured products can only be counted what's a slow and meaningless job regarding the total factory production. To have a real idea of what's been produced we need to use conventional measuring unit, such as meter, kilogram, peace, etc., which can better apply to the product manufactured.

The number of pieces and meters in the weaving and manufacturing textile units, kilos in the steel foundries, in some cases the number of worked hours, etc., are all faulty units that will not show the real value of the total production. In short, a proper production measuring unit is not available in the market no matter what product you consider.

A single production measuring unit would eliminate those doubts if based on the notion of "Production effort". This new notion is the expression, of the human effort, the machine, the financial, the applied energy, and other efforts directly or indirectly applied. The production efforts, so defined, originated in all the sectors of the factory and their machines, notwithstanding their different sources such as lathes, cutting machines, assemblage, etc. have, all of them, fundamental attributes: they can be added summed up.

We can then assume that the total effort of production of a factory is the result of the addition of all partial production efforts carried out in each one of the operational sites (manufacturing operations). All products, no

matter how diversified or how numerous they were can be measured through the amount of effort necessary to manufacture them since they went through the various manufacturing operations and submitted to such efforts.

By means of the diagram below (Figure 1) the effort undertaken can be understood, i.e. the "production effort" is the factory work accomplished to the raw material in a finished product. This work can be called "effort" and it will be the sum and total of the human, financial, energy and other direct and indirect efforts.

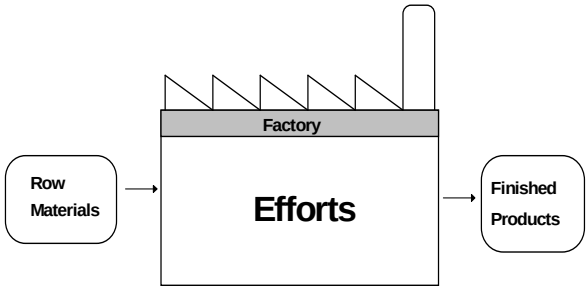

Figure 1: Graphic representation of the production effort.

To measure a production effort, let's take a lathe and a cutting machine working within specific conditions. These two machines develop, per hour, production effort whose absolute value is only abstract. But an element can be defined, calculated and measured: the ratio between the two efforts. This leads to the basic principle of our method, The principle of hidden constants: "No matter how different the unit prices are, the production efforts developed by the various elementary (basic) work operations in a factory, are interconnected to one another through constant ratios in a period of time".

The system (method) measures, at a fixed moment (instant) all the cost of all production efforts and calculates the ratios among them. Once it's done, the system operates only with the "ratios" which are designated as "UP'" or "Production Units" (also known as UEP - Production Effort Unit – UP are the Portuguese initials of Production Unit). The production efforts in each work site are expressed and measured as quantities of UP/h and all the products by the number of UP' accumulated during their manufacturing processes.

The total of production efforts in UP', which is equal to the sum of each product, measures the factory production. The periodical UP' value in money, a very simple calculation, will show its actual real value, allowing in this way to quantify in UP's and in money any product or production, no matter how diversified they are.

The UP's (Production Units) remain constant for a long time. The theory accepts that and the experience demonstrated that recalculations and revisions made after 5 or more years in many companies, where there were remarkable increases in plants, employees and machines show insignificant variations for the UP's reinforcing their constant behavior in the long run.

All the theorems and principles were exhaustively studied by important Brazilian Universities, proving its suitability and reliability, through Post-Graduation Ph.D. theses, giving, this way, a high scientific content to the UP's method.

2. Total UP's and Products Cost Calculations in Two Different Plants

Plant 1: Let's compile a chart (Table 1) with all the operational sites (OS) and their expenses, as described in the previous item, resulting in the Operational Site Photo Index (OSPI) chart:

Where: 1 Direct Manpower
2 Indirect Manpower

3	Social Charges
4	Technical Amortization
5	Specific Consumption Materials
6	Maintenance Spare Parts
7	Electrical Power
8	Maintenance
9	Utilities

OS	Operational Site
OSPI	Operational Site Photo Index ($/h)
BPI	Base Product Index ($)
TBPI	Total Base Product Index ($)

Table 1: Hour-cost for each operational site in $/h

OS	1	2	3	4	5	6	7	8	9	Total
7001-1	4,00	2,00	7,20	3,20	5,30	3,10	3,10	1,20	1,06	**30,16**
7010-1	5,00	3,00	9,60	5,60	6,10	6,20	2,30	5,20	5,28	**48,28**
7020-1	7,00	4,00	13,20	2,30	3,10	4,20	1,23	4,10	2,81	**41,94**
7030-1	5,00	4,00	10,80	2,50	0,50	3,20	2,40	1,90	0,08	**30,38**
7050-1	4,00	3,00	8,40	1,20	1,00	1,20	3,50	2,30	0,58	**25,18**
7051-1	4,00	3,00	8,40	1,30	1,00	1,40	2,10	3,20	0,72	**25,12**

According to this chart, we have the OSPI, calculated in $/h.

Plant 2: Same as the Plant 1 (Table 2):

Table 2: Hour-cost for each operational site in $/h

OS	1	2	3	4	5	6	7	8	9	Total
7001-2	4,10	2,10	7,44	3,30	5,80	3,20	3,00	1,21	1,02	**31,17**
7010-2	5,20	3,20	10,08	6,10	6,50	6,10	2,00	5,00	5,50	**49,68**
7020-2	7,20	4,10	13,56	2,40	3,20	4,00	1,03	4,00	2,85	**42,34**
7030-2	5,10	4,30	11,28	2,30	0,80	3,50	2,00	1,20	0,09	**30,57**
7050-2	4,40	3,20	9,12	1,20	1,10	1,00	3,00	2,30	0,70	**26,02**
7051-2	4,50	3,10	9,12	1,20	1,20	1,30	2,00	3,30	0,52	**26,24**

According to this chart, we have the OSPI, calculated in $/h.

Let's suppose we chose the product "X" as the Base Product (to calculate the UP' unit comparable and constant the base product must have the OS of the two factories), it's BPI will be:

OS	OSPI ($/h)	Time (h)	BPI($)
7001-1	30,16	0,01200	0,362
7020-1	41,94	0,01152	0,483
7030-1	30,38	0,01000	0,304
7051-1	25,12	0,00838	0,211
7001-2	31,17	0,01300	0,405
7020-2	42,34	0,02100	0,889
7030-2	30,57	0,01700	0,520
7051-2	26,24	0,00938	0,246

Total = 3,420

By dividing OSPI's by Total BPI (TBPI) (Plant 1 and Plant 2) we will have the OS's UP/h for each plant according (Equation 1):

$$UP/h = \frac{OSPI\ (\$/h)}{TBPI\ (\$)} \quad (1)$$

Pant 1:	OS	OSPI ($/h)	BPI ($)	UP/h
	7001-1	30,16	3,420	8,82
	7010-1	48,28	3,420	14,12
	7020-1	41,94	3,420	12,26
	7030-1	30,38	3,420	8,88
	7050-1	25,18	3,420	7,36
	7051-1	25,12	3,420	7,35

Plant 2:	OS	OSPI ($/h)	BPI ($)	UP/h
	7001-2	31,17	3,420	9,11
	7010-2	49,68	3,420	14,53
	7020-2	42,34	3,420	12,38
	7030-2	30,57	3,420	8,94
	7050-2	26,02	3,420	7,61
	7051-2	26,24	3,420	7,67

Let's assume that these plants produce products A, B, C, D, and so on we should assemble its process sheets, it means, flows and times of each operational site (OS) for each product in the plant. We are going to assemble the sheet for only one product for each plant in these example, the Product A (imagining the plant is a poultry company, and the product is a frozen chicken breast, so, it is a product that can be produced in two different plants and its production process can be measured and compared in UP's) and the other products of this company follow the same calculation criteria's and analysis of Product A.

It's noted that the operational sites of these two plants are similar, this means, they both have the same production technology, only their costs are different.

Product A produced in plant 1:

OS	UP/h	Time (h)	UP's
7001-1	8,82	0,092	0,81
7020-1	12,26	0,102	1,25
7050-1	7,36	0,212	1,56
7051-1	7,35	0,035	0,26
		Total =	3,88

Product A produced in plant 2:

OS	UP/h	Time (h)	UP's
7001-2	9,11	0,086	0,78

7020-2	12,38	0,093	1,15
7030-2	7,61	0,103	0,78
7101-2	7,67	0,082	0,63
		Total =	3,34

So at this moment we can conclude that Product A has a different effort to be produced in plant 1 than in plant 2. We can see that the effort applied in the production of the Product A in plant 1 is bigger, this means that the production process of this plant is less efficient than the production process of plant 2. Now we should calculate the costs of Product A in both plants, so we can understand the differences between effort (UP's) and cost ($).

2.1. UP' Value Calculation for the Plant 1

Total UP's produced in the period

Product	Total Produced	UP's	Total UP's
A (calculated in the example above)	2.000 pc	**3,88**	7.760
B	3.000 pc	9,39	28.170
C	500 pc	5,20	2.600
D	2.740 pc	7,30	20.002
E	11.524 pc	2,00	23.048
	Total UP's produced in the period =		81.580

The UP' value calculation (equation 2), where the industrial expenses are $ 115.000,00 will be:

$$\text{UP' value (\$/UP')} = \frac{\text{Total industrial expenses (without raw-materials)}}{\text{Total UP's produced in the period}} \quad (2)$$

$$\text{UP' value (\$/UP')} = \frac{115.000{,}00\ (\$)}{81.580\ (\text{UP's})} = 1{,}41\ \$/\text{UP'}$$

2.2. UP' Value Calculation for the Plant 2

Total UP's produced in the period

Product	Total Produced	UP's	Total UP's
A (calculated in the example above)	2.000 pc	**3,34**	6.680
B	2.900 pc	9,50	27.550
C	200 pc	5,01	1.002
D	2.500 pc	7,40	18.500
E	11.200 pc	1,93	21.616
	Total UP's produced in the period =		75.348

The UP' value calculation like (equation 2), where the industrial expenses are $ 132.000,00 will be:

$$\text{UP' value (\$/UP')} = \frac{132.000{,}00\ (\$)}{75.348\ (\text{UP's})} = 1{,}75\ \$/\text{UP'}$$

2.3. Products Transformation Costs (Effort)

Product A on plant 1:

3,88 UP's * 1,41 $/UP' = 5,47 $

Product A on plant 2:

3,34 UP's * 1,75 $/UP' = 5,85 $

Obs.: In this example the UP' methodology is developing only the product effort calculation (transformation cost), the row material cost is not being considered. To calculate the row material cost is only necessary calculate how much of each material was spent in the product and then multiply the value by their unitary cost.

To calculate row material cost we don't need a methodology for calculation, we need a computer software to calculate the consumption's and costs.

3. Differences Analysis

We can now resume all the calculation above putting in evidence the differences achieved:

Plant 1:	Product A:	3,88 UP's
	UP' value:	1,41 $/UP'
	Transf. Cost (Prod. A):	5,47 $
Plant 2:	Product A:	3,34 UP's
	UP' value:	1,74 $/UP'
	Transf. Cost (Prod. A):	5,85 $

1. Product A produced in plant 1 (3,88 UP's) consumes more effort (UP's) to be produced than Product A produced in plant 2 (3,34 UP's). This means that the production process of this product is less efficient in plant 1 than in plant 2. We should remember that this conclusion is due to the production technology being the same in both plants. If we had to produce the same product in different plants with a different production technology we should have this situation in mind when we comparing the amount of UP's of the analyzed products. These differences seen in these examples are caused by different operation of each plant and productivity of each operation, and this results in a different UP's for each product (hour-cost (UP/h) of each operational site by the production time). This happens because it is being expressed the real effort applied to produce the product independent of any monetary unit. This comparison becomes very interesting when we analyze same products of same companies produced in different plants (other countries), where in spite of the cost being expressed in the country currency we can analyze the effort independent of monetary unit, steady in time and comparable.

2. The UP' value ($/UP) and the cost of the product are consequences of the activity level or productivity reached by the plant in the period. The UP' value is obtained by equation 2, where we can verify that this value is obtained by dividing the monthly expenses by the company production amount, in this case expressed in UP's, so it is by

itself an economic productivity index, where its value only decreases when a productivity raise is reached, this means, more production with the same or less production expenses.

3. In the calculated example, the Product A in plant 1 has a bigger effort than the same Product A produced in plant 2, this means that if the technology used is the same, as it is in the example, the plant 1 must be able to produce the Product A with the same quantity of UP's (effort) as plant 2 does.

4. In spite of the competitive advantage that plant 2 have (lower production effort to do the Product A), it have a lower productivity, this means the UP' value is bigger, the plant loses this advantage and have the Product A with higher cost ($ 5,85) than the plant 1 ($ 5,47), so the plant 2 goal should be the reduction of the amounting UP's of the Product A.

4. Conclusion

With the UP' unit we have a tool to measure the production effort and then compare it with other plants, this is possible even in different countries, and it is possible because the UP' is not a monetary unit but a unit to measure the production effort of the product. In Brazil we have a "Case Study" of this application the Industrial Process Benchmarking with excellent results in cost reduction and process improvement. This case was developed in Sadia S.A. Company, which is the biggest poultry company in Latin America and use the UP' methodology as was described in this paper to accomplish this production process benchmarking.

References

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