COST BENEFIT ANALYSIS FOR QUALITY COST REDUCTION PROJECTS FOR AUTOMOTIVE INDUSTRY

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Abstract: Estimate cost and benefits of quality cost reduction projects are essential information for estimating the potential gains and prioritizing different projects in terms of time, money, people and other resources. There is a need to develop a systematic approach to the cost estimating, which will make the estimates more realistic, based on a clear methodology for different departments of one company. The research proposes a methodology that uses simple information, reliable data, with no contradiction with financial statements, easy to be used by different project leaders. The calculation is done in two phases: estimate the potential savings before the project starts and the benefits after the project is closed. The methodology has been implemented in an Excel spread sheet and evaluated through three case studies.
Key words: cost benefits, quality cost, project

1. INTRODUCTION

When we speak about company' cost reduction programs, we have to identify the possible projects, to prioritize them, and accurate estimate the costs and the benefits. As budgets for such activities are limited, the company has to allocate the resources in order to obtain the maximum benefit.
Nowadays, the value stream mapping methodology (VSM) helps for the projects identification. The methodology has as final objective the waste elimination and lead time reduction, using different tools and techniques from lean manufacturing system. What is missing is the financial information related with each project and the difficulty to estimate the financial impact of continuous improvement activity (Jones and Womack, 2002), (Keller, 2010).
Other approaches, for example the Cost of Quality (COQ), assign cost for different non quality items. The waste is quantified and COQ makes the link between the outputs and the accounting system or an internal reporting system (Rusu et al., 2002).
For the investment projects, the Cost–benefit analysis (CBA) is used in order to evaluate the outputs of the intervention. It gives us the information about payback period and the benefits. It is used also for cost reduction project, main problem being the identification of all project inputs in order to be sure that are included and properly quantified all the costs and possible benefits. (Boardman et al., 2004)
The Costs & Benefits Calculation methodology, takes the advantages of all mentioned tools, eliminating the disadvantages: it identifies financial impact for the possible projects in order to prioritize the implementation and proposed a structure which helps the user to identify accurate and complete data.

2. METHODOLOGY PRESENTATION

Based on authors' experience regarding practical application for cost reduction projects, it was developed a calculation which cover various situation. The structure helps the user to identify and evaluate the cost, benefits and payback period. The formulas used are selected from different specialized publications and integrated in an excel spreadsheet (Rusu et al, 2002), (Levin, H. M.and McEwan, 2001). The tool could be applied in any industrial company, for different departments. It helps the managers to make the link between the current state of an industrial process identified through the VSM methodology and to simulate the financial impact of one or several possible interventions.

2.1. Costs Calculation

In the table 1 are presented the cost elements.

Table 1. Cost elements

	COST ELEMENT	Example
a	Number of operators hours used during the project (man hours) :	40
b	Number of staff hours used during the project (man hours) :	16
c	New line investment, not budgeted (monetary amount) :	-
d	New machine investment not budgeted (monetary amount) :	3000
e	Stations modification (monetary amount):	-
f	New computer investment (monetary amount)	-
g	No of hours line stop (number of hours)	40
h	Purchasing of furniture, tools, (monetary amount)	100

For each project, we have to take into account: manpower time, equipment investments (not budgeted), production affected (e.g. line stoppages) and other purchasing. If some production space, office or warehouse space will be modified, then the cost or benefit must be recorded, accordingly.
In order to calculate the monetary costs, the following data must be obtained from finance department (Table 2)

Table 2: Master data 1

	Data	Example
G	Cost of 1 operator for 1 hour :	28
H	Cost of 1 staff for 1 hour :	100
I	Cost of 1 hour line stoppage :	300
J	Cost of 1 Customer claim :	20000
K	Cost of 1 square meter on the shop floor :	2000
L	Cost of 1 square meter in warehouse :	2000
M	Cost of 1 square meter in facility / offices :	2000
N	Depreciation period (years)	4
O	Currency :	EUR (€)
P	Interest rate :	12%

Investment cost must be calculated for costs related with new implementations or, for the cost avoided due to new activities. Depreciation period must take into account the compliance with financial requirements. Table 3 summaries this information.

Table 3: Master data 2

Item	Depreciation period (years)
Production equipment	4 year
Component tools	3 years
Facilities	15%/ year
Furniture	10-15 %/ year
Buildings, workshop / warehouse (depreciation cost/ sqm.)	5% / year

Having all the data (table 1, 2 and 3), we can calculate the total cost of the project. The small and capital letters refers to inputs (a, b,…h, G, H...P). The data are used into table 4 formulas, 4th column.
For better understanding, different examples are presented below.

2.1.1. Example: Manpower cost calculation

The manpower cost (€) spent during the project request the following data:

- No. of people participating in the project.
- No. of hours per person.
- Standard Cost / Hour (finance data).

Formula:
No. people x No. hours x (Price/ hour) = ... €
Example: 4 people, 10 hours project, 15 €/hour.
Manpower cost (€) = 4 x 10 x 15 = 600 €

2.1.2. Example: Investment cost calculations

The Investments cost (€) for the project request the following data:

- Material.
- External support (if needed).
- Equipment investment (depreciation).

Formula:
Material (€) + Ext. Support (€) + Equip. (€) = ... €
Example: 1.500 € Material, 1.000 € External support, 1.000 € (4.000 € in 4 years) new equipment.
Investment cost = 1.500 + 1.000 + 4.000 = 6.500 €

2.1.3. Example: Line stoppage cost calculation

The Line stoppage cost (€) for the project request the following data:

- Cost of 1 hour line stoppage :
- No. hours

Formula:
Cost of 1 hour line stoppage (€) x No. hours = ... €
Example: Line stoppage cost (€) = 300 €/ 1 hour line stoppage x 40 hours = 1.200 €

Table 4: Total Project Costs

	TOTAL PROJECT COSTS :		Formula		EUR (€)
	Manpower				
a	# of operators hours used during the project (hours) :	40	a x G	=>	200
b	# of staff hours used during the project (hours) :	16	b x H	=>	128
	Equipment investment :				
c	New line investment, not budgeted (input amount) :	-	c / N	=>	0
d	New machine investment not budgeted (input amount) :	3000	d / N	=>	750
e	Stations modification (input money amount) :	-	e	=>	0
f	New computer investment (input money amount) :	-	f	=>	0
	Line stoppage :				
g	Number of hours line stop (input number of hours)	40	g x I	=>	12000
	Other purchasing (furniture, …)				
h	Purchasing of furniture, tools, … (input money amount)	100	h	=>	100
	TOTAL COSTS		=>	=>	13178

2.2. Benefits Calculation

For benefits calculation we need the yearly volumes (no. of pcs/ year) and cost per main products, for each product family (A1, A2, …). These data will be taken into account, according to logistics forecast (table 5):

Table 5: Forecast per product family

Product Family	No. pcs/ year forecasted Year _____	Average cost/ pcs.
A 1		
A 2		
B 1		
....		

In order to calculate the savings obtain from reject decrease or elimination, we need the cost for components, work in progress (WIP) and finish goods (FG). For WIP cost we need to identify the process phase where the reject is done and the associated costs (table 6), the cost of components assembled (table 7) and the cost of manpower and utilities consumed till this phase

The impact of stock reduction will be calculated as cost of working capital, which means the multiplication between the standard interest rate and stock value. In our example the interest rate is 12%.

Table 6: A1 product cost, in different phases

A 1 product - cost/ production phase (representative product)	
WIP/ FG	COST (EUR/ unit)
A 1 phase 1 (components 1-> 3)	
A 1 phase 2 (components 1-> 5)	
A 1 phase 3 (components 1-> 10)	
Finished product	
Production overhead	

Table 7 – Components costs for product A1

A1 product – components cost	
Components	COST (EUR/ unit)
Component A11	
Component A12	
....	
Component A110	

Other benefits are coming from: product or component changes which affect the production cost, layout modification, investment avoided, transport optimization etc. For better understanding some calculation examples are presented below:

2.2.2. Example: Efficiency (EFF) improvement

Needed data:

- EFF before(1) & after(2). (labor min./pcs)
- Yearly volume. (No. pcs/ year)
- Standard Man Cost/ Hour (Finance Data).

Formula:

(EFF(1)-EFF(2)) x (No. pcs/year) x (Standard cost)

Example: 1 min EFF(1), 0.9 min EFF(2), 200 000 pcs/ year, 15 €/ hour

Saving (€) = (1-0.9) x 200.000 x 15 = 300.000 €

2.2.3. Example: Non quality reduction

Needed data:

- Number of components or finish goods scraped before(1) & after(2)
- (No. pcs/ year)

Formula: ((No. pcs scraped)(1)- (No. pcs scraped)(2)) x (Cost/pcs)

Example: 2.000 pcs scraped (1), 1.000 pcs scraped (2), 1 €/pcs

Saving in non-quality (€) = (2.000 – 1.000) x 1 = 1.000 €

2.2.4. Example: Product changes (€)

Needed data:

- Cost / pcs before(1) & after(2 (€)
- Yearly volume. (No. pcs/year)

Formula:((Cost/pcs)(1)-(Cost/pcs)(2))x(No. pcs/year)

Example: 1 €/pcs(1), 0.9 €/pcs(2), 200 K pcs/year

Product changes (€) = (1–0.9) x 200.000 = 20.000 €

2.2.5. Example: Surface workshop (€)

Needed data:

- Square meters before(1) & after(2) (sqm)
- Amortization cost/sqm (€), (Finance Data)

Formula:

((Sqm)(1)- (Sqm)(2)) x (Amortization cost/sqm)

Example: 25 sqm(1), 20 sqm(2), 20 €/sqm

Saving in surface workshop = (25 – 20) x 20 = 100 €

2.2.6. Example 8: Stock (€) (One time gain)

Needed data:

- Stock before(1) & after(2) (No. pcs)
- Cost / pcs (€)
- Interest rate 12% (for 1 month it is 1%)

Formula: ((No. pcs)(1) - (No. pcs)(2)) x (Cost / pcs)

Example: 1.000 pcs before, 250 pcs after, 1 € / pcs

Stock (€) = (1.000 – 250) x 1 x 12/12= 750 €

The total project benefits data is summarized in the in the table (table 8). The small and capital letters refers to inputs (i, j,…h, A, B...F). The data are used into table 8 formulas, 4^{th} column, for savings calculation.

2.3. Return of investment

The estimation of cost and benefits, will lead us to calculate the project balance.

For the example summarized into table 4 (total cost 13178 €), and table 8 (total savings 9143 €/ year) we can calculate :

- The payback period 17.3 months.
- The project results in five years 32535 €/ 5 y

For accurate data, the calculation will be done again, after the project will be closed.

Table 8: Total project benefits

	TOTAL PROJECT BENEFITS :		Formula		EUR
	EFF improvement :				
i	EFF before the project (minutes) :	2.5	(I - j) x k x G	=>	4167
j	EFF after the project (minutes) :	2			
k	Yearly production volume (units)	100000			
	Rejection rate improvement :				
l	Number of rejects per month before the project :	480	(l-m) x n x 12	=>	2976
m	Number of rejects per month after the project :	400			
n	Cost of 1 reject	3.1			
	Customer claims reduction :				
o	Number of customer claims per year before the project :	2	(o-p) x J	=>	2000
p	Number of customer claims per year after the project :	1			
	Space savings :				
q	Square meters used before project (shop floor) :	-	(q-r) x K	=>	0
r	Square meters used after project (shop floor) :	-			
s	Square meters used before project (warehouse) :	-	(s-t) x L	=>	0
t	Square meters used after project (warehouse) :	-			
u	Square meters used before project (facility / offices) :	-	(u-v) x M	=>	0
v	Square meters used after project (facility / offices) :	-			
	Inventory savings :				
w	Inventory before project (# of parts) :	-	(w-x) x y x P	=>	0
x	Inventory after project (# of parts) :	-			
y	Cost of 1 part (average if multiple parts) :				
	Investments after project :				
z	New line investment project (reduced amount) :	-	z / N	=>	0
A	New stations investment project (amount) :	-	A/ N	=>	0
	Piece price reduction :				
B	Piece price before project	-	(B-C) x D	=>	0
C	Piece price after project	-			
D	Annual volume	-			
	Transportation cost :				
E	Transportation cost before (1 year)	-	E-F	=>	0
F	Transportation cost after (1 year)	-			
	Misc. savings :				
	TOTAL SAVINGS			=>	9143

3. CONCLUSIONS

The companies identify different possible projects in order to reduce the costs. The resources are limited and it is not possible to start all these projects in the same time. As consequence, the inputs are typically measured in terms of opportunity costs - the value in their best alternative use.

The methodology described in this paper called "Costs & Benefits Calculation" use different estimation such as scrap reduction, efficiency improvements, product change, stock reduction, etc.. The structure and content design helps the user to clearly identify all needed data. The calculation is the basis of a more comprehensive analysis which is used to justify a cost reduction project and compare different projects benefits. The methodology is useful for cost reduction or continuous improvement projects identified through the VSM methodology. It has been implemented in an Excel spreadsheet and evaluated through three case studies.

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