Professional MBA
Automotive Industry

Door Panel Production Cost versus Productivity Loses

A Master's Thesis submitted for the degree of
"Master of Business Administration"

supervised by
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Vienna, 29.10.2019

Affidavit

I, **ING. ATTILA ZEMES**, hereby declare

1. That I am the sole author of the present Master´s Thesis, "DOOR PANEL PRODUCTION COST VERSUS PRODUCTIVITY LOSES", 59 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. That I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, 29.10.2019

Signature

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Preface

This master thesis represent the author's final part of master's degree in Professional MBA "Automotive Industry" at the Technical University of Vienna.
The practical part of the thesis was elaborated at SMP Automotive Solutions Slovakia s.r.o.

We would like to express our appreciation to everyone who have encouraged us during the thesis work and made it possible for us to succeed.
We would like to thank Mr. Igor Žársky and Mr. Radovan Malec for giving us the opportunity to realize the thesis work at SMP and to Mr. Peter Daniel our supervisor at Technical University of Vienna, for his guidance.

Abstract

Increasing productivity of a business organization is a dominant factor of its competitiveness. Productivity growth provides for the company growth and incremented economic value added simultaneously. Almost every key player in the automotive industry is currently in a way present in the Eastern European market. Lower salary costs and production cost compared to Germany decisively motivate companies to transfer their production activities to eastern countries, well-educated and flexible labour force makes eastern markets more attractive. This is likely one of the very last options to reduce the production cost and resist strong competitors.
Master thesis concerns door panel's production cost and production loss. The thesis focuses on comparison of door panels produced in two production facilities owned by their parent company SMP (Samvardhana Motherson Peguform). Both facilities produce very similar types of door panels installed in car model Audi A3. The theoretical part conceptually defines the methods and procedures providing insight to the subject matter. The practical part analyses the current status of both production facilities and compares cost efficiency by implementing the aforesaid methods and procedures.
The Master Thesis aims to answer the fundamental question whether Slovak companies keep higher cost efficiency compared to companies run in Germany.
Key words: Productivity, Production cost, efficiency

List of abbreviations:

C – Costs

FIX – Fixed costs

VC – Variable costs

Q – Quantity

P – Profit

FiC – Gross margin

S – Sales

SP – Selling price

TCR – Total costs ratio

OEM – Original equipment manufacturer

BOM – Bill of material

I.P. – Improvement proposal

TPM – Total productive maintenance (TPM)

AM – Autonomous maintenance

TL – Team leader

GL – Group leader

CIP - Continuous improvement process

PDCA – Plan, do, check, act

SMART - Specific, Measurable, Attainable, Realistic, Timely

KPI – Key performance indicator

PPM –Parts per million

1. Introduction:

1.1. Automotive industry in the Slovak Republic

While part of Czechoslovakia, the proportion of Slovak companies active in the automotive industry, was very small. Slovak automotive industry was formed by first manufacturers coming from abroad after Czechoslovakia split. Nowadays the automotive industry fuels Slovak economy. Slovakia globally ranks among the best based on the number of cars manufactured per one thousand inhabitants.

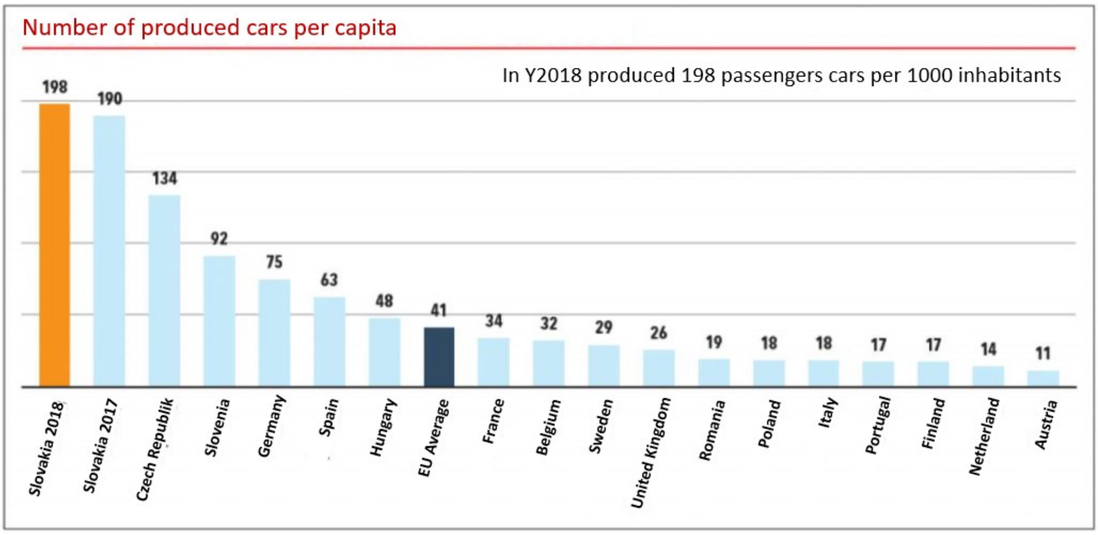


Figure 1. Number of produced cars per capita: (Sebesta M. 2019)

13% is the contribution of automotive industry to the gross domestic product of the Slovak Republic, automotive sector employs 130 000 people. Preliminary data estimate more than 1 080 000 cars were produced in Slovakia in 2018. Economic forecast for 2019 anticipates 1 150 000 produced cars to be dispatched from Slovak production facilities.

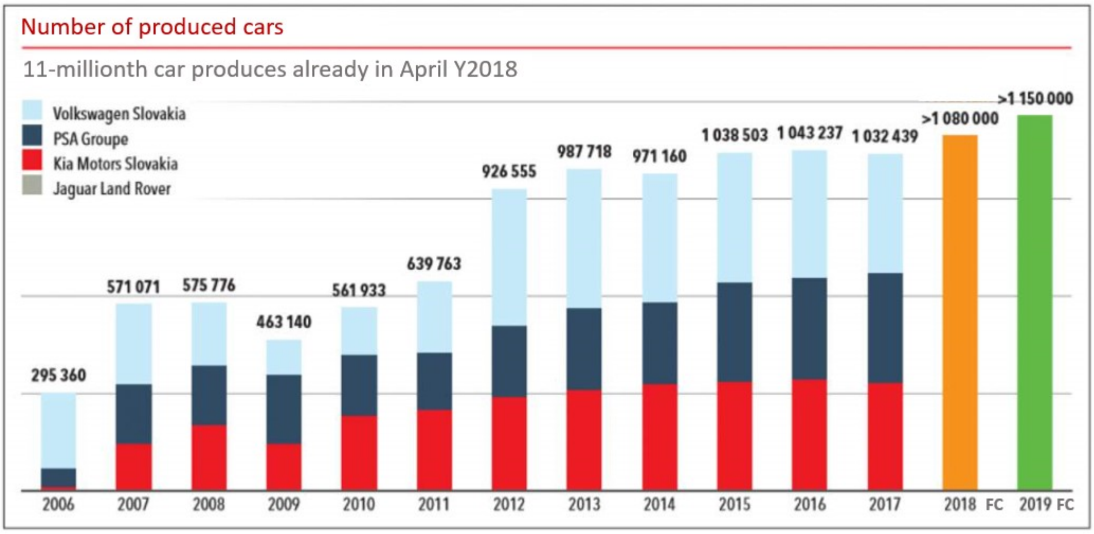


Figure 2. Number of produced cars in Slovakia: (Sebesta M. 2019)

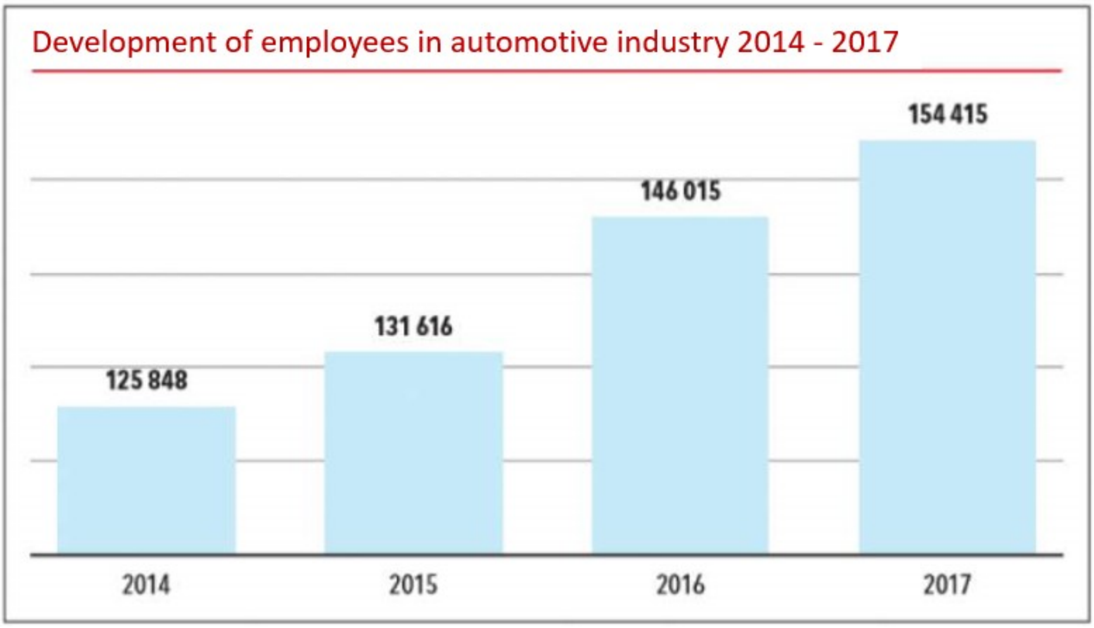


Figure 3. Development of employees in automotive industry in Slovakia: (Sebesta M. 2019)

Four production plants (OEM) were established in the Slovak market. Nitra-based Jaguar Land Rover being the most recent. Jaguar Land Rover plant launched its production at the turn of 2018. The production plant is currently initiating its operation, full performance is scheduled throughout 2019. Affirmations provided so far anticipated 150 000 annually produced cars.

Second production plant is based in Trnava and owned by PSA Group with record 5% year-to-year growth maintained for seven years in a row and its production dominated by Citroën C3. The latter makes up for 68% of the total production, the rest is attributed to Peugeot 208. Recent data estimate that 90% of PSA production is delivered to European Union markets.

Žilina-based Kia scored the third, modified portfolio of Kia models can be clearly observed in the arrangements of vehicles dispatched from production plant premises. Kia Sportage constituted 66% of 333 000 vehicles produced totally, followed by Kia Ceed. Kia Venga booked remaining 1%.

Last but not least, is the most important automotive manufacturer, Volkswagen, modified models of large SUV manufactured in Bratislava and widened the offer by a brand new model Audi Q8. The popularity of the latter accounts for the production rate of 400 000 cars in Devínska Nová Ves. (Sebesta M. 2019)

1.2. Research focus and problem

The master thesis analysed the question of costs efficiency of Door panel production (focus on Personnel and quality costs) versus productivity loss by comparing Slovakia and German region.

1.3. Research question and aim

Based on the research problem and focus, the following research question should be answered:

- Are the Low cost countries really cost efficient?
- The impact of lost productivity on economic evaluation
- Possible future development

The aim of the master thesis is to develop a method for proving the costs efficiency of an Eastern European country Slovakia compared to the German region.

1.4. Hypothesis statement

Based on the professional experience of the author and the current knowledge obtained from the reviewed literature, the following hypothesis is stated:

The impact of the cost efficiency on production in Slovakia is still favourable compared to the German region. Through comparison of the impact on the personnel and quality costs we will prove the cost efficiency of the Slovak region.

1.5. Methodical approach and structure

The master thesis uses literature researches and simulation approach to work up the research aim thereof and to answer the research questions. The master thesis is structured in five chapters detailed below:

The first chapter introduces the theme of the automotive production in Slovakia and defines the key aspects of the research and problem of the thesis. The research question and the research aim as well as the formulated hypothesis statement and methodical approach and structure of the master thesis are defined.

In the second chapter the theoretical background of the production costs and productivity loss are studied. The definition of the term “Production costs” and the presentation of the key elements of the costs drivers which are contributing to the profit increase as well as the description and definition of the “Productivity loss” also with focus on Quality costs.

In the third chapter we will describe production of both the plants located in Slovakia and those in Germany. The production of the same product family allows to compare the production layout with the key production parameters.

The fourth chapter is assigned to the evaluation the key production figures on the total profitability of the products. In this chapter we will estimate the time frame until when the Slovak market can benefit from the lower personnel costs.

Chapter five “Summary and conclusion” will answer the research question and summarise the results of the master thesis.

2. Theoretical background

2.1. Costs and the influence on the profitability

Achieved profit is also influenced by changes in costs. In order to analyse the impact of costs on profit creation, cost models analyse the development of costs by pairing production volume and costs in a simple regression and correlation analysis. Cost functions: linear cost function, exponential cost function, logarithmic curve. The linear cost function represented by a line is the commonest at the level of companies:

$y = a + bx$,

i.e.: $C = FIX + VC * Q$

(VC = variable costs per unit)

(Q = quantity)

This formula is the background for management analysis of profit creation. The formula below defines impacts of changed agents which create profit when considering the classification of costs to fixed and variable costs:

$P = S – (VAR + FIX)$,

$P = \Sigma Qi * (SPi - VCi) – FIX = \Sigma Qi*FiC_i - FIX$

$FiC = SPi - VCi$

(Q= Quantity; SP= Selling price; VC= Variable cost; FIX= Fixed cost; P- Profit

(FiC = Gross margin contribution to FIX and creation of profit)

The most complicated part of cost analysis for the purposes of company profit analysis is to define the appropriate method of dividing total costs into fixed and variable costs. Fixed costs are created irrespective of the status of production or sale of products. Examples of total fixed costs include underwriting, lease, personnel (clerks) salaries and some types of tax. Variable costs depend on performance. They tend to increase as the performance rises and decrease when performance is reduced. Examples of total variable costs are used resources, basic material, wages of production workers. Mixed costs, such as maintenance and repairs costs, generate problems with costs classification.

Costs are magnitudes, they measure company activity (the consumption of production factors included) at certain point of time. Costs are allocated to clearly defined object - performance, product, service, customer, etc.

The following should be distinguished:

- costs from the perspective of financial accounting,
- costs from a taxation perspective,
- costs in the internal accounting of an organization,

Owners (shareholders, employees, etc.) consider costs as reduction, decrement of their capital. From the taxation perspective, costs represent consumption which cannot be avoided should income be reached, obtained and maintained. In the internal accounting of an organization, costs are effective and purposeful expenditure to company economic growth. Efficiency is defined by cost-effectiveness and purposefulness by the value adding aim of incurred economic resource.

Classification of costs:

- based on type (material, salaries, financial costs, etc.),
- based on purpose (direct costs, indirect costs),
- based on total performance (variable costs, fixed costs),
- based on adopted decisions (relevant, irrelevant)

The accounting is an essential source of analytical data. There are three levels of cost analysis:

- financial accounting level (total costs analysis: operating costs, financial costs, extraordinary costs, cost-effectiveness: total cost ratio (TCR) = Costs/Incomes),
- internal accounting level (analysis of costs by profit centres, analysis of product costs),
- Decisive tasks

Financial accounting reflects the incurred economic resources and detects rate of return and replacement of money. Costs define components of assets in the balance sheet or components of net profit in the financial statement. Financial accounting operates with 2 groups of costs:

- Costs associated with a specific performance/activity (costs were the cause of such an activity - proper production costs),
- Costs not identified with a specific performance/activity (costs incurred to run cost-effectiveness operations in the company)

Total costs analysis: data about operating, financial and special costs are taken from the financial statement.

This analysis transforms company costs generated at the company level (financial accounting) into internal organizational units (profit centres, cost centres) and converts them into bearers of the cost (calculated units). Costs are classified into:

- direct costs (to be attributed to and summed to individual activities),
- overhead costs (shared by all or the majority of activities = indirect costs + portion of direct costs).

Analysis of costs by profit centres analyses overhead costs.
Division: overhead material, overhead salaries, overhead variable costs, etc.,
Detailed division: costs associated with profit centre existence (lease fee, underwriting, insurance), costs incurred by the real volume and structure of overhead activities
Procedure: differential methods, implementation of fixed and variable budgets, application of capacity deviations and consumption variables.
Analysis of product costs: As for the purpose, the analysis studies direct (unit) costs, i.e. data for calculation. It is long-term analytical forecast which monitors the formula used in calculations, in other words, the development of proportion of individual unit and overhead costs within total product costs. The analysis compares the planned and the output calculations. It deals with standards, updates to standards and deviations from standards.

Selection of variant solution takes costs into consideration. Namely to select an alternative performance of certain business activity which proved optimal compliance with cost-effectiveness and efficiency criteria. Management accounting provides and processes necessary cost related data.
Classification of costs:

- relevant costs (influencing future cash flow and valid only for that specific selected and intended variant), irrelevant costs (relevant for another selected intended variant),
- likely to be influenced (created by the adoption of a decision and excluded if decision is not adopted), uninfluenced (also called tied up - created once we excluded all variants, they cannot influence subsequent decision, or previously incurred and already decided costs which cannot be impacted by future decisions),
- opportune costs (for forfeited opportunity, i.e. opportunity which could not be performed because limited economic resources had been previously allocated to other opportunity.)

2.2. Definition of the production costs

Production costs define costs needed to manufacture a product. They include all costs to provide material and production. They are calculated per item or piece. The structure of project monitoring recognizes (variable and fixed) production costs:

Total Costs		Sales:	0,00 €		parts per carset:	1	0 parts/year	
			Costs per carset EUR	cost ratio % TC	Contri-bution EUR	CM % Sales	Costs per year kEUR	Contri-bution kEUR
1	Raw material	Raw material		0,00%	-	0,00%	0	0
2	components self nominated	Components SMP nom.		0,00%	-	0,00%	0	0
3	components OEM nominated	Components OEM nom.		0,00%	-	0,00%	0	0
4	freight	Freights on Components		0,00%	-	0,00%	0	0
5	Σ MEK (=1+2+3+4)	Material Costs Direct	0,00	0,00%	-	0,00%	0	0
6	subcontracting	Subcontracting		0,00%	-	0,00%	0	0
7	Labor costs	Labor Costs		0,00%	-	0,00%	0	0
8	Prod. Costs direct var - Energy	Prod. Costs direct var - Energy		0,00%	-	0,00%	0	0
9	Prod. Costs direct var - Maintenance	Prod. Costs direct var - Maintenance		0,00%	-	0,00%	0	0
10	Prod. Costs direct var - Others	Prod. Costs direct var - Others		0,00%	-	0,00%	0	0
11	Σ FEK var (=6+7+8+9+10)	Prod. Costs Direct var	0,00	0,00%	-	0,00%	0	0
12	Prod. Costs direct fix - Depreciation	Prod. Costs direct fix - Depreciation		0,00%	-	0,00%	0	0
13	Prod. Costs direct fix - Interest	Prod. Costs direct fix - Interest		0,00%	-	0,00%	0	0
14	Prod. Costs direct fix - Insurance	Prod. Costs direct fix - Insurance		0,00%	-	0,00%	0	0
15	Prod. Costs direct fix - Room	Prod. Costs direct fix - Room		0,00%	-	0,00%	0	0
16	Prod. Costs direct fix - Others	Prod. Costs direct fix - Others		0,00%	-	0,00%	0	0
17	Σ FEK facility fixed (=12+13+14+15+16)	Prod. Costs Direct fix	0,00	0,00%	-	0,00%	0	0
18	SEKF	Special Direct Costs Production		0,00%	-	0,00%	0	0
19	Σ FEK (=11+17+18)	Production Costs Direct	0,00	0,00%	-	0,00%	0	0
20	Prelogistics	Prelogistics		0,00%	-	0,00%	0	0
21	logistic costs A'	Logistic Costs A		0,00%	-	0,00%	0	0
22	Σ HK direkt (=5+19+20+21)	Manufacturing Costs Direct	0,00	0,00%	-	0,00%	0	0
23	logistic Costs B	Logistic Costs B		0,00%	-	0,00%	0	0
24	SEKV	Special Direct Costs Distribution		0,00%	-	0,00%	0	0
25	Σ Einzelkosten (=22+23+24)	Product Costs Direct	0,00	0,00%	-	0,00%	0	0
26	Overhead costs material	Overhead Costs Material		0,00%	-	0,00%	0	0
27	overhead costs production	Overhead Costs Production		0,00%	-	0,00%	0	0
28	overhead costs logistics	Overhead Costs Logistics		0,00%	-	0,00%	0	0
29	overhead costs administration	Overhead Costs Administration		0,00%	-	0,00%	0	0
30	Σ HK indirekt (=25+26+27+28)	Manufacturing Costs Indirect	0,00	0,00%	-	0,00%	0	0
31	overhead costs HQ	Overhead Costs HQ		0,00%	-	0,00%	0	0
32	others	Others		0,00%	-	0,00%	0	0
33	Σ VSK (=25+30+31+32)	Total Costs	0,00	0,00%	-	0,00%	0	0
					-	0,00%		0

Figure 4. Structure of the production costs: (Internal documentation of SMP)

Variable costs:

Costs varying with the production volume, i.e. costs which depend on the production volume. They adopt variety of forms and course depending on the production volume. Proportional costs increase proportionally with increments of the production volume, i.e. changed increment of production is proportionately reflected in increments of costs (i.e. linear cost function). Non-proportional costs can be progressive (supra-proportional costs), degressive (sub-proportional costs) or regressive (Figure 5).

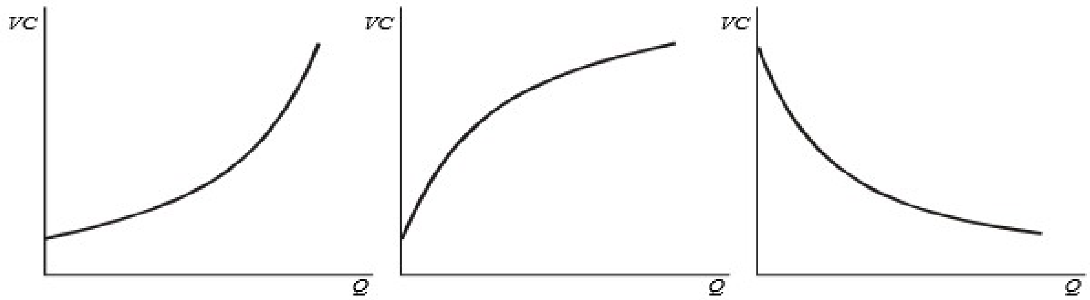


Figure 5. Progressive, degressive and regressive costs - development of non-proportional costs.

Variable costs include:

- Direct material costs

Costs to be directly attributed to a product. Examples range from the basic material, plastic components, screws, mats to foil, foam, etc. purchased based on the nature of supplier; either appointed by our company or OEM.
Material consumption is therefore recorded in the Bill of Material (BOM).
Transport costs incurred to provide so called “transport in” material form integral part of material costs.

- Direct variable production costs

This category shall mean costs of contracted subcontractors, direct production personnel costs, energy costs, machinery maintenance and repair costs.

Fixed costs:
Costs relatively independent on the production volume (the company must pay them even if the production is halted). Usually represented by overhead costs (lease fee, building maintenance, interests, fixed payments, advanced payments, etc.).
Experience showed even fixed costs are subject to changes. Such changes are typically sudden increments, e.g. increased lease fee, increased advanced payments for energy supply, etc.

Category of fixed costs includes:

- Direct fixed production costs:

This category denotes all costs associated with production premises (buildings), depreciation of machinery and equipment, insurance costs and interests if either the equipment or the building are funded by a credit loan.

- Costs of logistics:

Costs incurred to transport product to a customer, packaging costs, renting a logistics area in Module Centres if required by final installation and product sequencing, software costs to support inventory strategies just-in-sequence (JIS), just-in-time costs (JIT)

- Overhead costs:

Overhead costs associated with support services and processes. Costs incurred by human resources department, financial department, research and development, purchase and company management costs.

2.3. Characterization of productivity loss

There are two main subgroups of work productivity loss:

A. Basic types of waste
B. Loss related to machinery, equipment and assembly line idling

A. The theory recognizes 8 basic types of waste:

- Overproduction

The production of production units for an internal customer or for the next production step by earlier delivery of goods, excessively quick delivery or delivery of larger amount than necessary. The overproduction does not respond to customers' wishes, it increases the stock.

- Transport

Impractical transfer of components or information between procedural steps. Transport closely relates to resources and costs which are not value adding can be allocated to value added creation.

- Stock

Material on premises of warehouse, if not soon consumed in the upcoming period of time, does not have value added. This also applies to administrative procedures, e.g. excessive information or documents about the same issue or concern.

- Unbalanced processes

Work procedures and processes lacking any value added from customer's point of view, e.g. misspending of costing tools when a simple tool is sufficient, redundant or duplicate checks and release.

- Redundant mobility

Any redundant mobility of people, material or information to complete processes. A reason of such redundancy are missing standards = work procedures or disarranged workplaces, long distances to be covered due to inappropriate workplace layout.

- Holding time

Components or a worker is waiting for the process or production stage prior to or following the latter to be completed. Holding time are usually caused by inefficiently organised work, missing tools and aids, lacking release / approval.

- Defective products & repairs

Defective production, data, product or components, their parameters do not comply with customer's requirements and result in repairs or extra work.

- Unused ideas & missing information

Time loss, lost skills, ideas, improvements and opportunities to learn are included. This is outcome of a failure of daily cooperation.

B. Loss related to equipment and assembly line idling

a) Failures - (caused by machinery fault)

Failure: full or reduced loss of machinery functions account for the most serious loss. Failure of machinery shortly disturbs the operation, reduces the speed and interrupts functions of a machine

5 reasons of machinery failures

- Failure to fulfil the basic requirements for machinery maintenance (tightening of loose bolts, cleaning, greasing, etc.)
- Poor compliance with work conditions (temperature, speed, pressure, torque, etc.)
- Under-qualified workers (errors in inspections, errors of operators, etc.)
- Wear and tear (bearings, cogwheel, centric parts, etc.)
- Structural defects (material, dimensions, etc.)

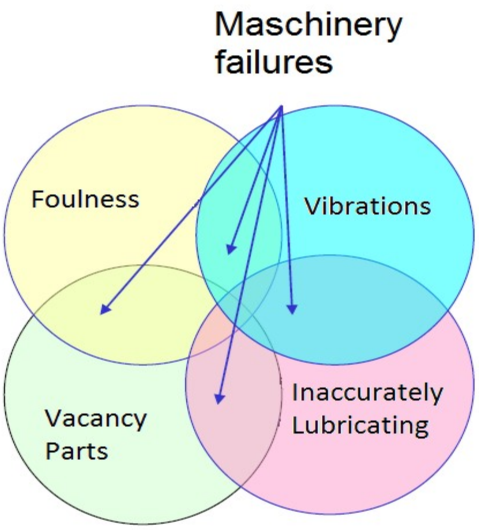


Figure 6. Maschinery failures: (Internal documentation of SMP Galanta 2016, Lean trainig documents SMED Analysis)

b) Sequencing and settings - (erroneous sequencing)

Differences are made between internal and external sequencing

Shift of internal sequencing to external one

Investigation of internal sequencing methods and time reduction

Precision control of agents and tools, elimination of settings.

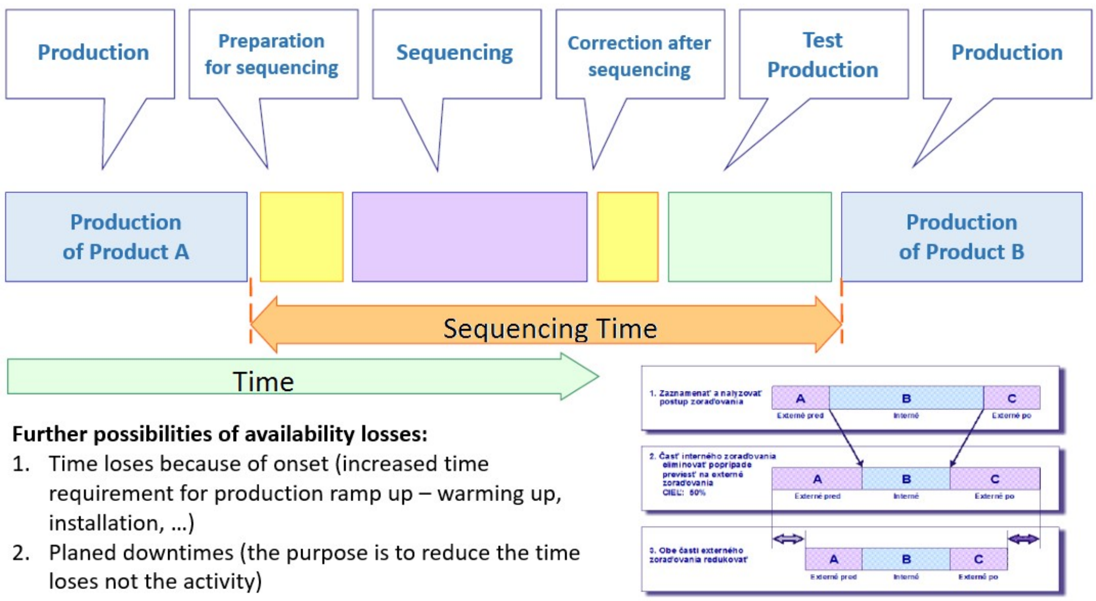


Figure 7. Sequencing and setting: (Internal documentation of SMP Galanta 2016, Lean trainig documents SMED Analysis)

c) Idling, short interruptions - (breaks caused by poorly organised process)

Short interruption (SI) shall not mean a failure. SI defines the idle time or production stoppage caused by temporary issues of equipment (a product stuck in a feeder),

- The equipment restores its functionality after a stuck piece is removed
- Short interruptions may seem minor but they constitute a serious problem.

They interrupt the production without resulting in a real failure
They exclude full automation (operator must be present)
Their determination is complicated, frequently referenced as mark-up cost in a standard

Remedies:

- Search for causes of temporary failures (observe the process)
- Never underestimated "minor, small defects" - remedy (remove) them
- Understand and guarantee optimum conditions (temperature, dust, etc.)

d) Speed reduction - (reduced cycle time of machinery, etc.)

Difference between reference speed (in tables) and real speed
Unstable product quality or mechanical problems

Remedies:

- Identification of the root cause
- Precisely determined maximum speed for individual products
- Understanding of speed limits
- Shortened idle times during machining, cycle diagram is analysed

e) Production start - (prolonged period between engine start and a stable operation)

Time loss before the production is stabilized (machine preheating, etc.)

Remedy

- To test the stability of a process during production start-up - Measurement of temperature dependant dimensions
- Implementation of automated machine setting

f) Inferior quality - (procedural errors and defective products - quality deficiencies)

Remedy of loss caused by defective products and repeated production is complicated

Remedy:

- Observation of current conditions (observe the process)
- Detection of small hidden defects
- Review potential causes (identify root causes)
- Preparation of remedies for all causes

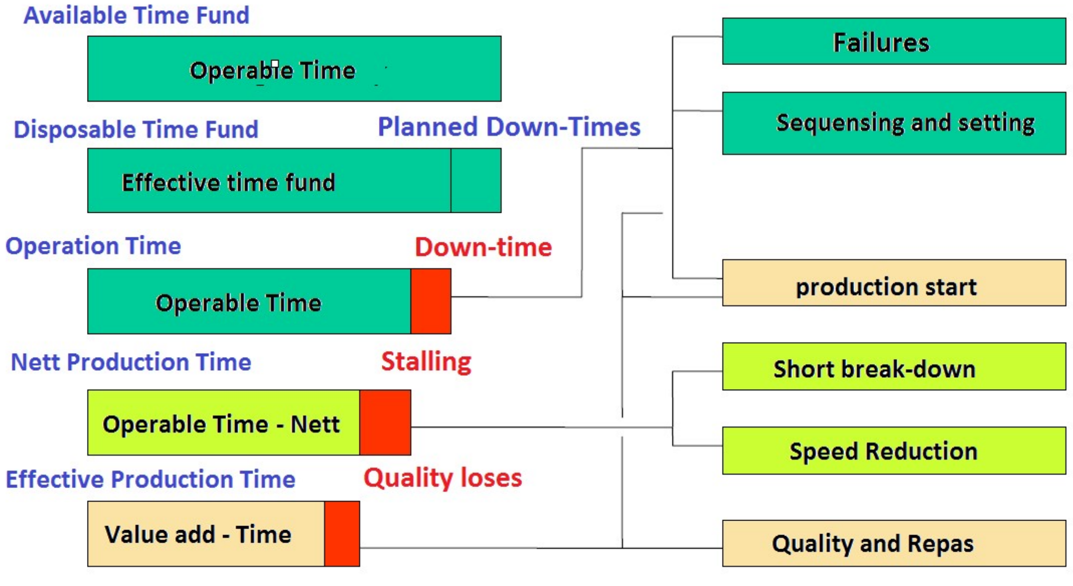


Figure 8. Relation between equipment and main loss: (Internal documentation of SMP Galanta 2016, Lean trainig documents SMED Analysis)

2.4. Lean production principles

Recent decades converted the theory of "lean (efficient) production" into necessity to survive in the competitive market. Customers' demands gradually progress, produced quantities tend to reduce as a result of variability and choice, not only must each company react in line with its currently established priorities and values, it must frequently also guarantee productions with reduced costs. Considering the constantly increasing salaries, material and fixed costs, the manufacturing of products alike 5 years ago is apparently and definitely not possible!

Two improvement strategies, innovation and lean (kaizen), have been developed.

Gradually incremented improvements result in linear percentage growth of efficiency, a real change is conditioned by process innovation or product innovation.

Lean production principles implemented in SMP Galanta:

- Elimination of basic types of loss/waste
- Exactly determined workload per employee, i.e. proportion of loss and proportion of value added are defined
- All departments and employees across the company participate in lean activities
- Innovation of process

Elimination of basic types of loss/waste

Types of loss were defined in the Productivity loss chapter above, the real benefit of gradual removal of loss will be illustrated in the laminating production line used to manufacture armrests:

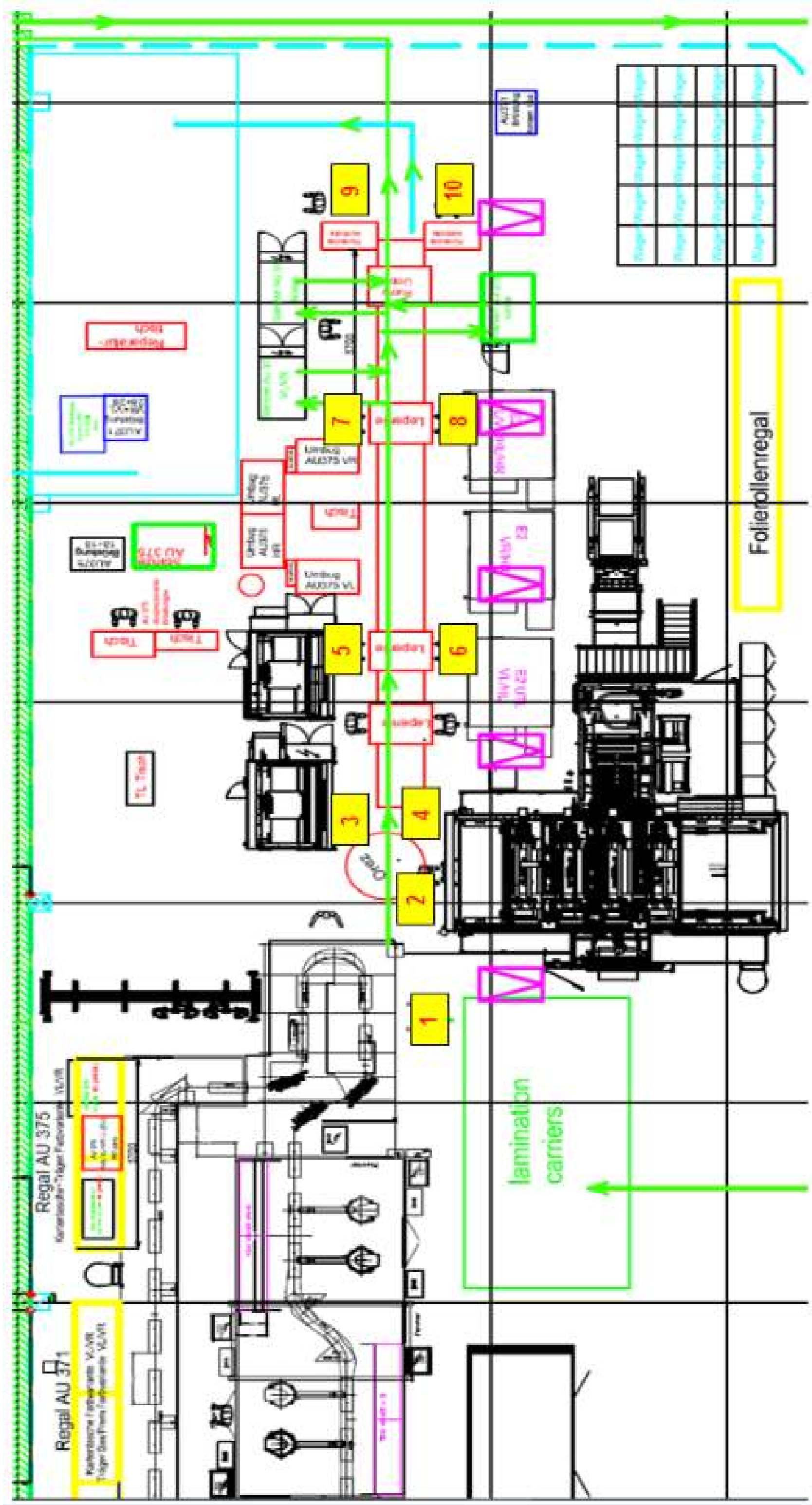


Figure 9. Layout of Production AU375 Arm rest: (Internal documentation of SMP Slovakia)

Production: product 2013 - requirements: 10 employees - extra work caused by improperly selected tools.

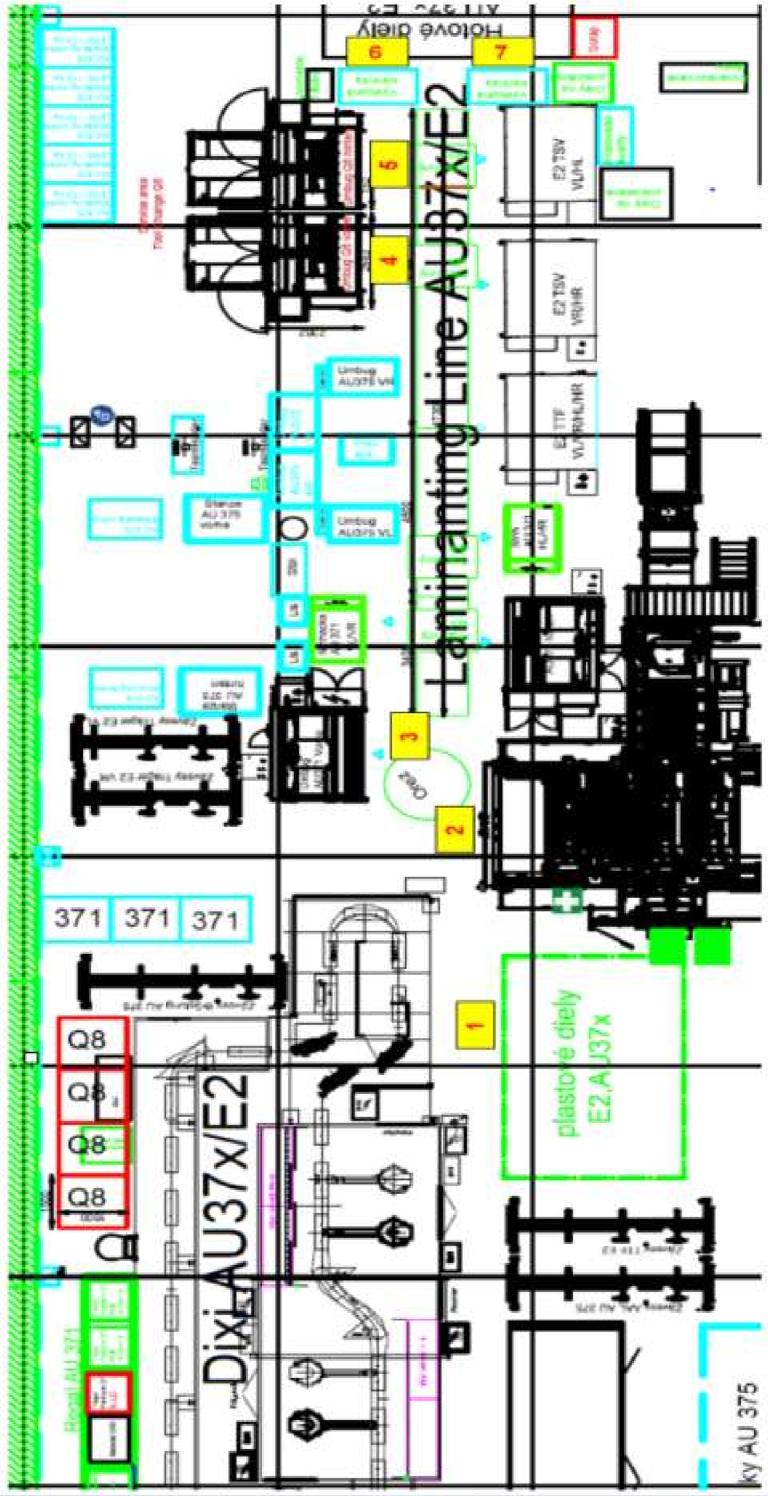


Figure 10. Layout of Production AU536 Arm rest, same line: (Internal documentation of SMP Slovakia)

Production: product 2017 - requirements: 7 Employees - extra work eliminated - maximum efficiency of the production process, further improvement conditioned by an innovation of the process.

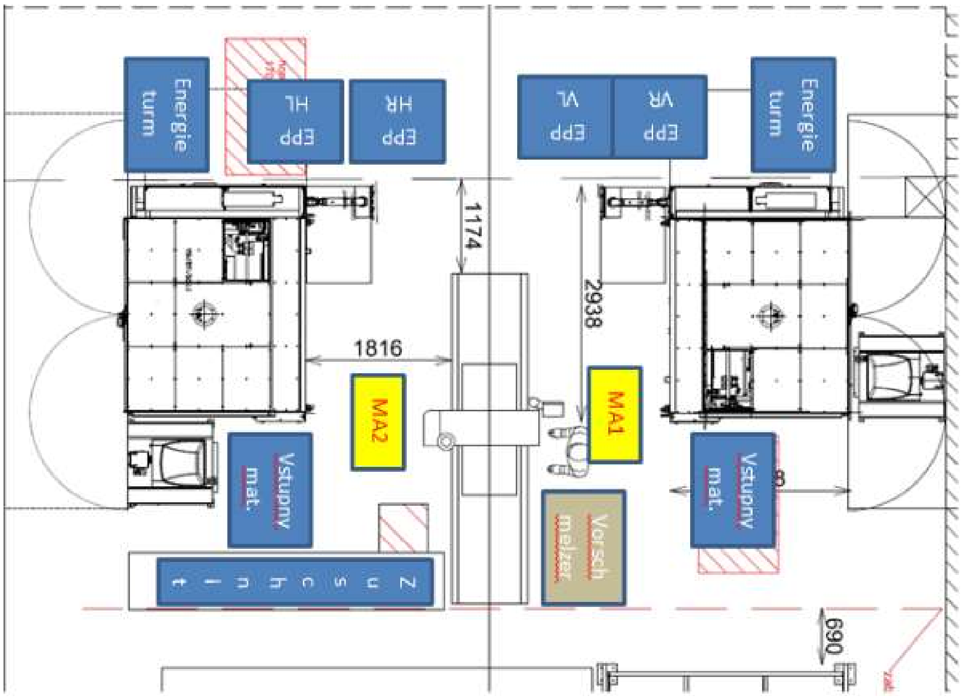


Figure 11. New production line for Production of sucessesor of AU375: (Internal documentation of SMP Slovakia)

Production: product 2019 - requirements: 2 Employees - innovated process - 3 machines merged to one.

Exactly determined workload per employee, i.e. proportion of loss and proportion of value added are defined

The solution requires definition of the value added and of the loss. Value added shall basically mean change of technological or process parameter, e.g. purpose of the product, applications of the product, etc., in other words, everything willingly paid by a customer shall mean a value added.

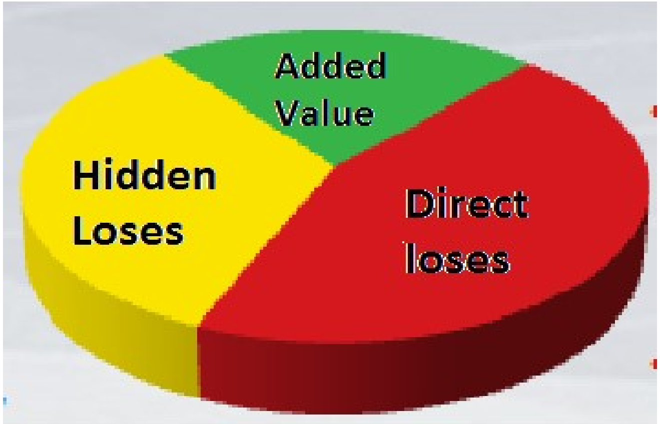


Figure 12. Proportion of value added and of loss: (Internal documentation of SMP Galanta 2016, Lean trainig documents Type of waste)

Loss shall mean activities the customer does not reimburse, we differentiate between: Hidden and direct loss.

Hidden loss

The term denotes activities which do not add up to the value added but are required by the current production process and by technologies.

Companies seek to reduce such activities.

Direct loss

The term shall mean any and all activities which are not needed and generate extra costs.

Companies seek to completely remove such activities.

Participation of all company units and employees across the company in lean activities

Mechanisms to include employees in lean activities:

1. Improvement initiatives
2. Implementation of Total Productive Maintenance (TPM)
3. Realisation of lean projects designed by company units

1. Improvement initiative

Proposal of improvement - a remedy which aims to increase efficiency of processes. The proposal identified existing problems, defects or one-off failure, breach of work instructions, directives, non-compliant maintenance and care of tools, machinery, etc. or general unspecific motions which do not propose "what" and "how" should be improved shall not be deemed improvement initiatives ("II").

Any SMP employee is entitled to file improvement initiative, by completing page 1 of template CI-D-0003 F01.

CI-D-0003 F01/A	Proposal of improvement	SMP

Mame and Signature | **Date** | **Personal Num.** | **Ordinal Number**

………………………… | ………………… | ………………… | …………………

Short description of Probler

Improvement related to:

Where? (Process, line)

How? (proposal, design)

Strana 1/2

Vypracoval: R. Malec / rev. A | Dátum: 29.02.2016

Figure 13a. Master of Improvement proposal: (Internal documentation of SMP Slovakia)

All submitted improvement initiatives must be recorded, evaluated and archived by the LEAN manager in table “Kaizen - proposals” available for review.

LEAN manager will team up with individual departments, evaluate each initiative and complete Page 2.

CI-D-0003 F01/A **Proposal of improvement** SMP

Examination of proposal - Production **Date**

Examination of proposal - Maintena **Date**

Examination of proposal - Logistics **Date**

Examination of proposal - Quality **Date**

Examination of proposal - HR **Date**

Examination of proposal - Engineering **Date**

Examination of proposal - Controlling (in case of measurable saving) **Date**

Bonus Proposal

a) non-measurable savings (based on score)

b) measurable savings - % z annual saving

Strana 2/2

Vypracoval: R. Malec / rev. A Dátum: 29.02.2016

Figure 13b. Master of Improvement proposal: (Internal documentation of SMP Slovakia)

LEAN manager must inform the author of the initiative within 30 business days about the outcomes of the evaluation. The evaluation follows the procedure illustrated in Figure 13 “Evaluation of submitted initiative”. Approved initiative which yields non-measurable savings will be reimbursed by 10 to 30 EUR.
Approved initiative which yields measurable savings will be reimbursed by 15 EUR + 0.5 - 2% of annual savings.

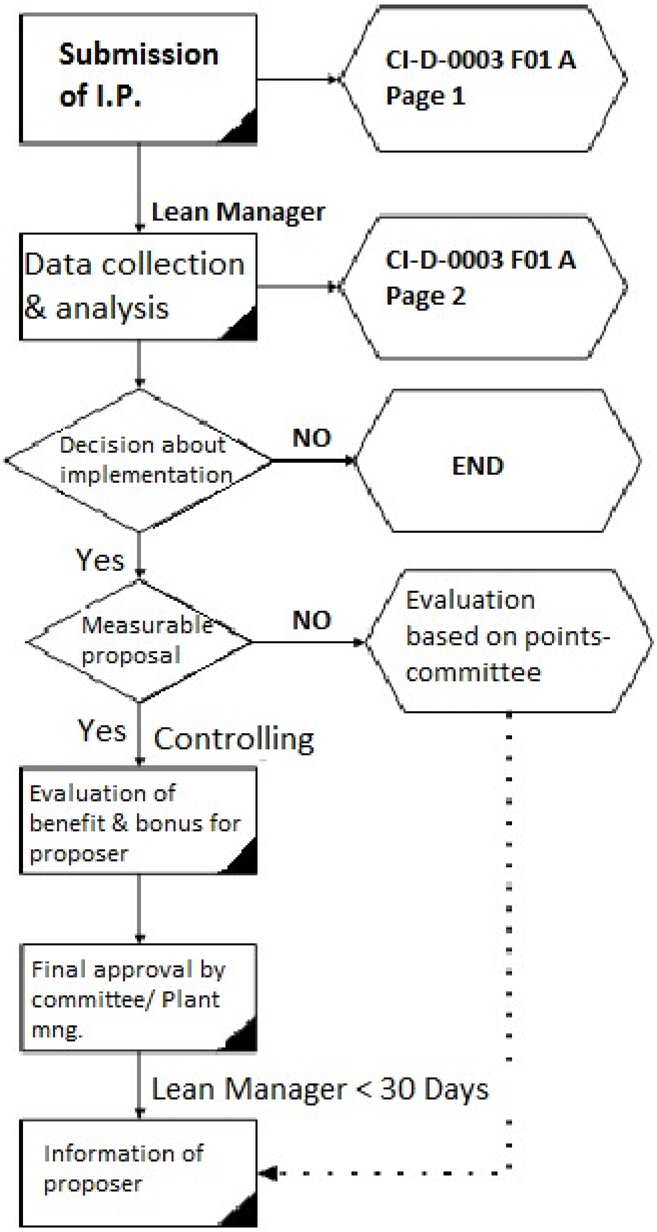


Figure 14. Diagram of submitted initiative evaluation: (Internal documentation of SMP Galanta 2016, Idea management at SMP Slovakia)

The procedure detailed in Figure 8 is well tried and tested as documented in attached Tables which recorded steady increase of the average number of improvement initiatives per employee.

Idea Management System					
Target =1 (0,25/0,5/0,75/1)		FY 2016/2017			
	15	Q2/16	Q3/16	Q4/16	Q1/17
# proposals	88	43	96	164	234
Φ FTE	250	220	220	220	220
proposals / FTE	0,4	0,20	0,44	0,75	1,06
lead time (d)	70	70	60	50	50
# open ideas	20	8	18	4	0

Figure 15. Evaluation of 2016 - 1.06 initiative per employee: (Internal documentation of SMP Slovakia)

Idea Management System					
Target =1,5 (0,37/0,75/1,15/1,5)		FY 2017/2018			
	16/17	Q2/17	Q3/17	Q4/17	Q1/18
# proposals	234	72	144	240	325
Φ FTE	220	203	174	194	194
proposals / FTE	1,06	0,35	0,75	1,24	1,68
lead time (d)	55	45	50	60	45
# open ideas	5	5	10	15	10

Figure 16. Evaluation of 2017 - 1.68 initiatives per employee: (Internal documentation of SMP Slovakia)

Idea Management System					
Target =1,5 (0,37/0,75/1,15/1,5)		FY 2018/2019			
	17/18	Q1/18	Q2/18	Q3/18	Q4/18
# proposals	325	79	143	200	273
Φ FTE	194	170	160	161	160
proposals / FTE	1,68	0,46	0,89	1,24	1,71
lead time (d)	50	55	55	50	50
# open ideas	10	18	15	16	7

Figure 17. Evaluation of 2018 - 1.71 initiatives per employee: (Internal documentation of SMP Slovakia)

We have received several high quality proposals in recent years. Two of them yielded the highest financial benefit:

Proposal to change product packaging - 6 EUR saved per package, annual savings equalled 35.000 EUR, the author of the proposal received a bonus of 700 EUR

Proposal to rework components - approved by the customer and implemented - annual savings equalled 89.000 EUR, he author of the proposal received a bonus of 1.780 EUR.

The majority of employees is willing to submit improvement innovations based on the aforesaid examples.

2. Implementation of Total Productive Maintenance (TPM)

TPM (Total Productive Maintenance) affects each company employee and forms part of the company culture.

AM - autonomous maintenance - shall mean the assumption of responsibility for entrusted production equipment to detect any defects and failures in advance

The implementation of TPM concept requires we focus on:

- Removal of loss caused by equipment
- Independent maintenance provided by the production unit
- Scheduled maintenance programme
- Employees' training and education

Sample standard autonomous maintenance:

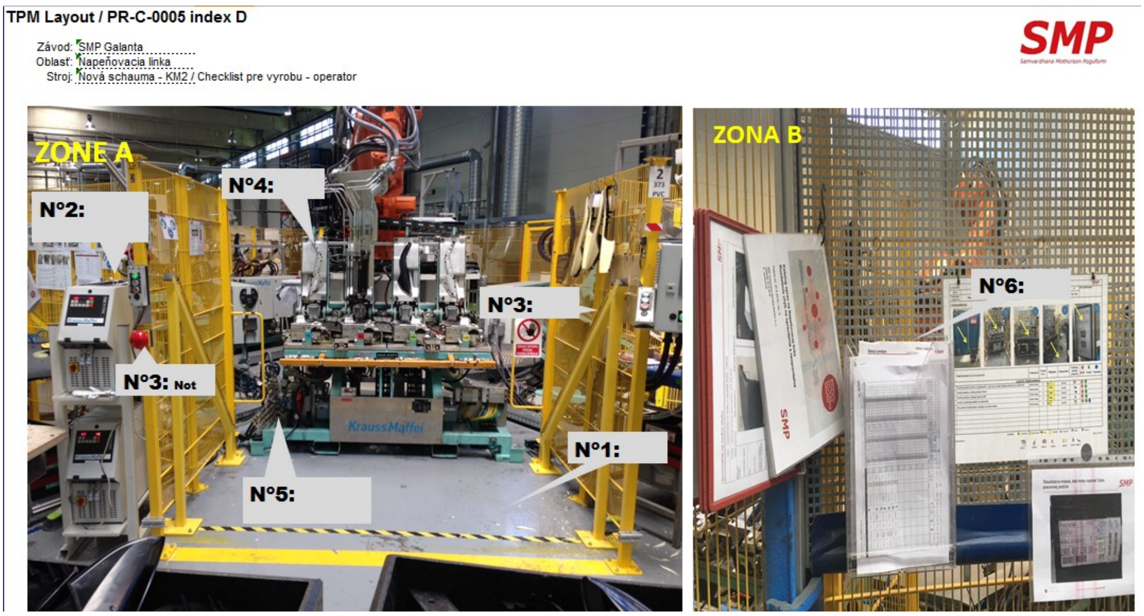


Figure 18. Check list for Production – Operator (TPM layout): (Internal documentation of SMP Galanta 2017, Implementation of TPM at SMP Slovakia)

TPM Checklist / PR-C-0005 index D

Závod: SMP Galanta | Oblasť: Napeňovacia linka | Stroj: Nová schauma - KM2 / Checklist pre vyrobu - operator

Zóna	N°	Kontr.položka	Čo robiť?	Metóda	Štandard	Nástroj	Akcia ak NOK?	Čas [min]	Frekv.	Zodpovedný	Smena	1	2	3	4	5	6	7	8	9	10	11
A	1	Formy a priestor foriem	Čisternie foriem a okolie nástrojov	Vizuálne	Forma bez nečistôt		informuj teamleadra	3	1xS	Operátor	1 2 3											
A	2	Formy a priestor foriem	Kontrola temperovacích zariadení	Vizuálne	Vrchná 38°C Spodná 46°C ±3C°		Informuj údržbu	1	1xS	Operátor	1 2 3											
A	3	Bezpečnosť	kontrola bezpečnosti (zavory, NOT AUS..)	Vizuálne	Spustenie stroja		Informuj údržbu	2	1xS	Operátor	1 2 3											
A	4	Formy a priestor foriem	Kontrola funkčnosti senzorov pritomnosti dielu a zaisťovacích čapov	Vizuálne	Rozsvietený senzor		Informuj údržbu	1	1xS	Operátor	1 2 3											
A	5	Kontrola formy	Netesnosti / Priesaky	Vizuálne	Spoje tesné, bez priesakov		Informuj údržbu	1	1xS	Operátor	1 2 3											
B	6	Kontrola pracovnej	Skontroluj podla zoznamu pritomnost potrebnej	Vizuálne	Pracovny standard		informuj teamleadra	3	1xS	Operátor	1 2											

Seite 1

Figure 19. Check list for Production – Operator (TPM): (Internal documentation of SMP Galanta 2017, Implementation of TPM at SMP Slovakia)

Autonomous maintenance is audited to verify and improve standards.

Audit autonómnej údržby

Zariadenie :		Štandard AU číslo :	
Dátum :		Hodnotení pracovníci :	
Zmena :		Auditor / ri :	

Otázka :	Kritéria / popis	NA	1	2	3	4
1.	Sú štandardy AU priamo na stroji a sú aktuálne - vypísané ?					
2.	Boli vykonané všetky definované činnosti v štandarde v požadovanom rozsahu ?					
3.	Su zapisane abnormality na kontrolovanom zariadení zo strany PROD - napr. TPM karta, hlásenie zo zmena a pod. ?					
4.	Sú všetky vypísane TPM karty na kontrolovanom zariadení v evidencii a v riešení v stanovenom termíne ? Zo strany ITD - červená TPM					
5.	Sú všetky vypísané TPM karty na kontrolovanom zariadení v evidencii a v riešení v stanovenom termíne ? Zo strany PROD - modrá TPM					
6.	Sú predpísané C činnosti vykonávané ? Sú počas auditu detekovane možnosti rozšírenia C činností ?					
7.	Kontrola efektívnosti a udržateľnosti definovaných opatrení z minulosti - porucha, ATP, TPM karta a pod. ?					

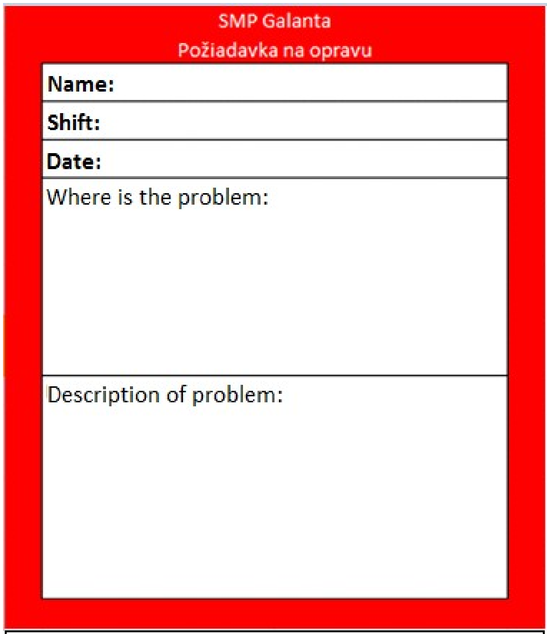
Definované body / abnormality	
časť zariadenia	Detekovaný problem
Suma bodov :	Podpis auditora :

Figure 20. Audit list of Autonomous Maintenance (AM): (Internal documentation of SMP Galanta 2017, Implementation of TPM at SMP Slovakia)

TPM cards have been implemented, they guarantee any defect / abnormality of equipment is detected in time before a serious shutdown could occur. Implemented blue and red TPM cards:

Two types of TPM card record defects:

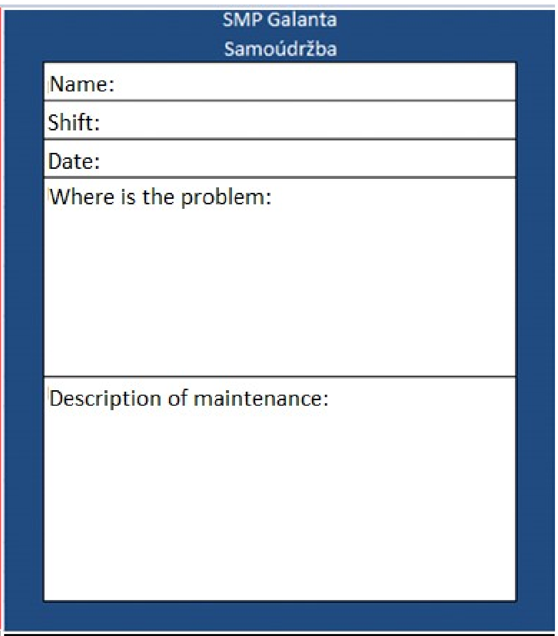
- Red TPM card (Figure 21a.)
  It serves to record detected deficiencies - repairs are required
- Blue TPM card (Figure 21b.)
  It serves to record detected deficiencies - self-maintenance is required



SMP Galanta
Požiadavka na opravu

Name:
Shift:
Date:
Where is the problem:
Description of problem:

Figure 21a - TPM card - Request to have equipment fixed
This card serves to record a deficiency / problem the production team is unable to remedy by means of autonomous maintenance (i.e. within 10 minutes after work shift ends)



SMP Galanta
Samoúdržba

Name:
Shift:
Date:
Where is the problem:
Description of maintenance:

Figure 21b - TPM card – Self-maintenance
This card serves to record a deficiency / problem the production team remedies by means of autonomous maintenance (i.e. within 10 minutes after work shift ends).

Procedure followed when deficiency is detected:

1. When a deficiency is detected, production team records the latter on a red or blue TPM card, including name, work shift, date (when deficiency was identified), indicator of location (production line, part of the equipment), detailed description of problem / deficiency
2. Red TPM card has 3 pages (original + 2 copies), blue card has 2 pages (original and 1 copy), both are stored next to TPM noticeboards, there is one

in each production line, Group Leader is responsible for sufficient supply of TPM cards

3. Red TPM card has 3 pages, the worker who completed the card, separates first copy from the original and appends it to defective spot while preventing disruption of machine functionality, the original and the second copy of the card must be delivered to her/his team leader of group leader responsible for defective equipment. Team Leader / Group Leader will record data from original TPM card in online records (Excel sheet):
4. The online record is accessible on the network under predefined location and form. Each record in this file has to contain the following information's – TPM card number (series number to follow), location of defect, description of defect, name of employee who reported the defect, date of finding (see Figure 22). Team Leader / Group Leader will deliver the original of completed TPM card to the maintenance department (namely the mailbox for such purpose). Fist copy of TPM card will be stored in classifier intended for such purpose. Team Leader / Group Leader regularly (at least once a week) controls measures adopted to remedy defects and requests the maintenance unit removes them within 14 days since reported. Should the maintenance unit be unable to remedy the defect, the problem is escalated to the process unit. Should there be objective reasons preventing the solution of a deficiency within agreed deadline (the reasons must be recorded on the back of TPM card + reschedule deadline to remedy a deficiency - TPM card must be pinned to TPM noticeboard. Maintenance worker who remedied deficiency recorded on a TPM card must eliminate the copy of TPM card appended to the defective spot. This worker will record the issue has been solved on the back of original TPM card pinned to TPM noticeboard and delivers the card to the Team Leader / Group Leader who inspects the machine and verifies it was remedied. If everything is fine, TL/GL records in the TPM cards register the date of remedy and eliminates the original of TPM card.
5. Blue TPM card has 2 pages, the worker who completed the card, separates first copy from the original and appends it to defective spot while preventing disruption of machine functionality, the original and the second copy of the card must be delivered to her/his team leader of group leader responsible for defective equipment. Team Leader / Group Leader will record data from original TPM card in online records (Excel sheet):

6. The online record is accessible on the network under predefined location and form. Each record in this file has to contain the following information's – TPM card number (series number to follow), location of defect, description of defect, name of employee who reported the defect, date of finding. Fist copy of completed TPM card will be stored in classifier intended for such purpose. Team Leader / Group Leader regularly (at least once a week) controls measures adopted to remedy defects and requests the maintenance unit removes them within 7 days since reported. Should there be objective reasons preventing the solution of a deficiency within agreed deadline (the reasons must be recorded on the back of TPM card + reschedule deadline to remedy a deficiency - TPM card must be pinned to TPM noticeboard. Production unit employee who remedied deficiency recorded on a TPM card must eliminate the copy of TPM card appended to the defective spot. This worker will record the issue has been solved on the back of original TPM card pinned to TPM noticeboard and delivers the card to the Team Leader / Group Leader who inspects the machine and verifies it was remedied. If everything is fine, TL/GL records in the TPM cards register the date of remedy and eliminates the original of TPM card.
7. When defects are remedied, the production unit and the maintenance unit also consider the need of updating work instructions, such as autonomous maintenance, TPM Checklist, planned maintenance, etc. to prevent recurrent defects.

TPM zapis evidencia - Poziadavka na opravu / Samoudrzba

Datum	Meno	Zmena	Popis miesta problemu (kde)	Popis problemu (co)	Status	Zodpovedný za úlohu	Termín do	Poznámka	Datum splnenia
07.04.2016	Kondakorova H.	3	Poskodene kolieska na baliacich jednotkach vozikoch pre Br.371/Br.375	Poskodene alebo zlomene koieska na posuv vozikov pre diely Br.371/Br.375	nok	A. Rozsar	02.05.2016		

Figure 22. Record of defects: (Internal documentation of SMP Galanta 2017, Implementation of TPM at SMP Slovakia)

3. **Realisation of lean projects designed by company units**

At the beginning of the year, each company unit must define lean projects to be evaluated on monthly basis at management meetings.

Continuous improvement of processes, procedures and technologies across the company forms integral part of the SMP Galanta company culture. So called Lean Team must be appointed to guarantee efficiency of the process. Lean Team is formed by employees of several company units who regularly meet, at least on monthly basis, to evaluate accomplished activities, approve planned activities and discuss possible improvements in the operation of company units.

Lean Manager collects data about current status and needs to prepare Lean Roadmap - planned improvement activities with 1.5-year forecast (improvement concept). Company units managers cooperate with Lean Manager to write CIP Activities Plan and projects for the upcoming year wherein they define basic parameters of projects considering PDCA Management Method and SMART objectives in line with CI-M-002 F01 A CIP Activities Project Plan.

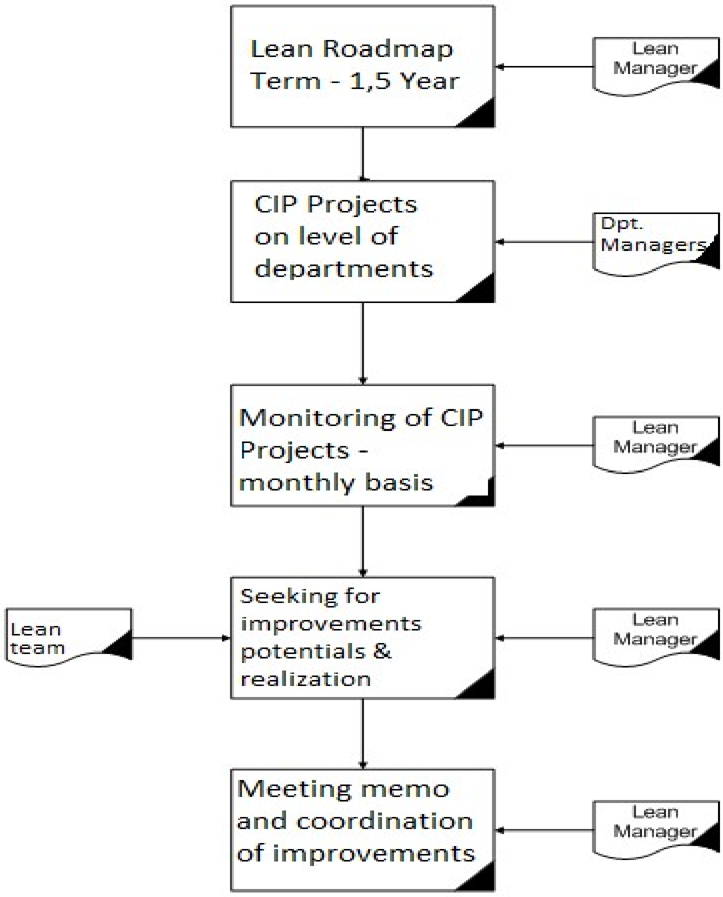


Figure 23. Scheme of LEAN philosophy achievements across the company: (Internal documentation of SMP Galanta 2016, Implementation of Lean philosophy at SMP Slovakia)

CIP Projektplan Proces SMP Galanta

Stand: 26.09.19

KW39 PRIO1

S - spezifisch M - messbar A - akzeptabel R - realistisch T - Termin abgrenzbar

Nr.	Einordnung	Projekt	Bemerkung	Ziel (laut SMART)	Geplante Start	Geplante Ende	Verantwotl. PM	Mit Vem	Bemmerkung zum Status	Anfrage / Konzept	Umbau	Testphase	% Aufgabeerfüllung	KW11	KW12	KW13
1	38x Projekt	Dosiahnutie vykonov, spotrieb a funkcnost strojov - celej linky podla LD	Fokus na cas taktu stroja, spotreby materialov a potreby nadprace	Dosiahnutie dat podla zadania projektu	01.04.2019	30.10.2019	A. Rozsar Z. Marton A. Gajdos	R. Malec	QS problem, nasadenie plasmi	x	x	x	75%			
2	PST	znizenie scrapu na KM 1	Prestavba , riesenie bodov s KM a Alba , nasledny problem solving	Dosiahnutie cielu scrap na vyrabanych artikloch na KM1	01.05.2019	01.08.2019	A. Gajdos	Udrzba, QS , lean	Technicke problemi vyriesene, QS pretrvavaju	x	x		50%			
3	316 Projekt	Podpora PM v konstrukcnej faze		Ciel - 1 stroj na PVC aj KLED verziu	01.06.2019	31.03.2020	A. Rozsar, Z. Marton	Drinka, Malec	Done - SDR	x	x	x	100%			
4	J1 Projekt	Dosiahnutie vykonov, spotrieb a funkcnost strojov - celej linky podla LD	Fokus na cas taktu stroja, spotreby materialov a potreby nadprace	Dosiahnutie dat podla zadania projektu	01.04.2019	30.10.2019	A. Gajdos	Malec	Projekt bezi z BY 18/19	x	x	x	50%			

Figure 24. Examples of lean projects created by the process unit: (Internal documentation of SMP Slovakia)

Summary of projects in previous 2 years

	Number of Projects Year 2018/19	Number of Projects Year 2019/20
Production	6	6
Engineering	9	8
Quality	10	8
Maintenance	4	5
Logistics	14	8
Human Resources	5	6
Project management	15	12
Total	**63**	**51**
Fulfillment	**85%**	**30%***
Savings	222 T€	87 T€

*) Evaluation after first quarter of the current Business year 2019/2020

Figure 25. Summary of CIP activities of last two years: (Internal documentation of SMP Slovakia)

3. Organisation of productions

3.1. Introduction to the plants and the production

Samvardhana Motherson Peguform (SMP) has achieved the market position of the lead supplier of high quality interior and exterior products for automotive industry and related sectors. The company was founded in 1959 in the municipality of Bötzingen, its original name was Badische Plastikwerke.

Its business activities range from development to the production of plastic components and highly integrated modules. Specialising in the production of cockpits, door panels, bumpers and innovative plastic components for automotive industry, the company is represented almost on all continents. Be it Europe, North and South America and Asia.

The most influential automakers, Audi, BMW, Daimler, MAN, Porsche and other, became company clients.

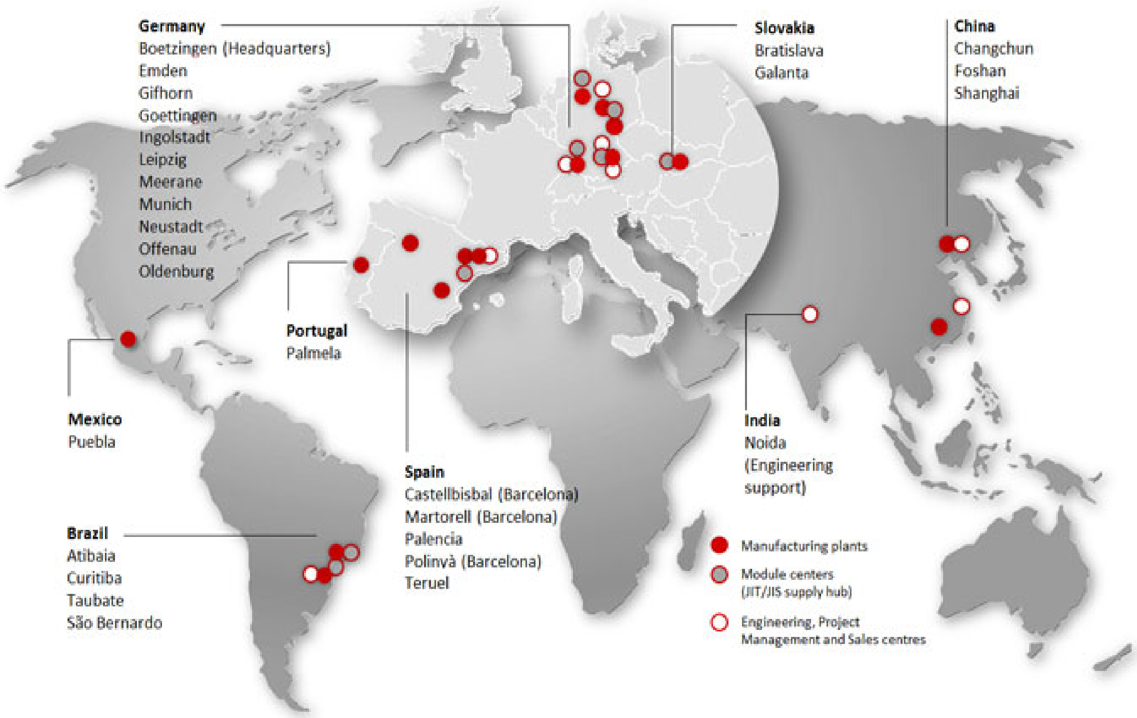


Figure 26. Presence of SMP worldwide: (Internal documentation of SMP Slovakia)

3.2. Organization of the production in Slovakia

Background data:

With its 170 employees, production plant SMP Galanta is an important employer in the region. The area and production make it the smallest production plant of SMP Group. This production plant was founded in 2010, it manufactures door panels and other interior components for the automotive industry. Annual turnover of the production plant is approximately 19 million EUR.

Audi A3 production line we observed to compare production effectiveness is characterised by:

Number of operators: 22

Assembly line cycle time: 58.1 sec

Area: 758 m2

Produced car derivatives: 371 (limousine) a nd375 (cabriolet)

The assembly line consists of a front and a rear line with pair production of door panels (i.e. the left and the right side). The production method is identical, only the number of operators changes because front door is larger and require longer production time. The production line assembles 2 derivative models, internally referred to as AU371 (limousine) and AU375 (cabriolet).

First component is assembled on the laminating production line, trim panel is assembled to plastic - 2 lines for model 371 - front line (2 components) and rear line (2 components), 1 line for model 375 (4 components). Hook conveyor system will transport produced component to the welding equipment.

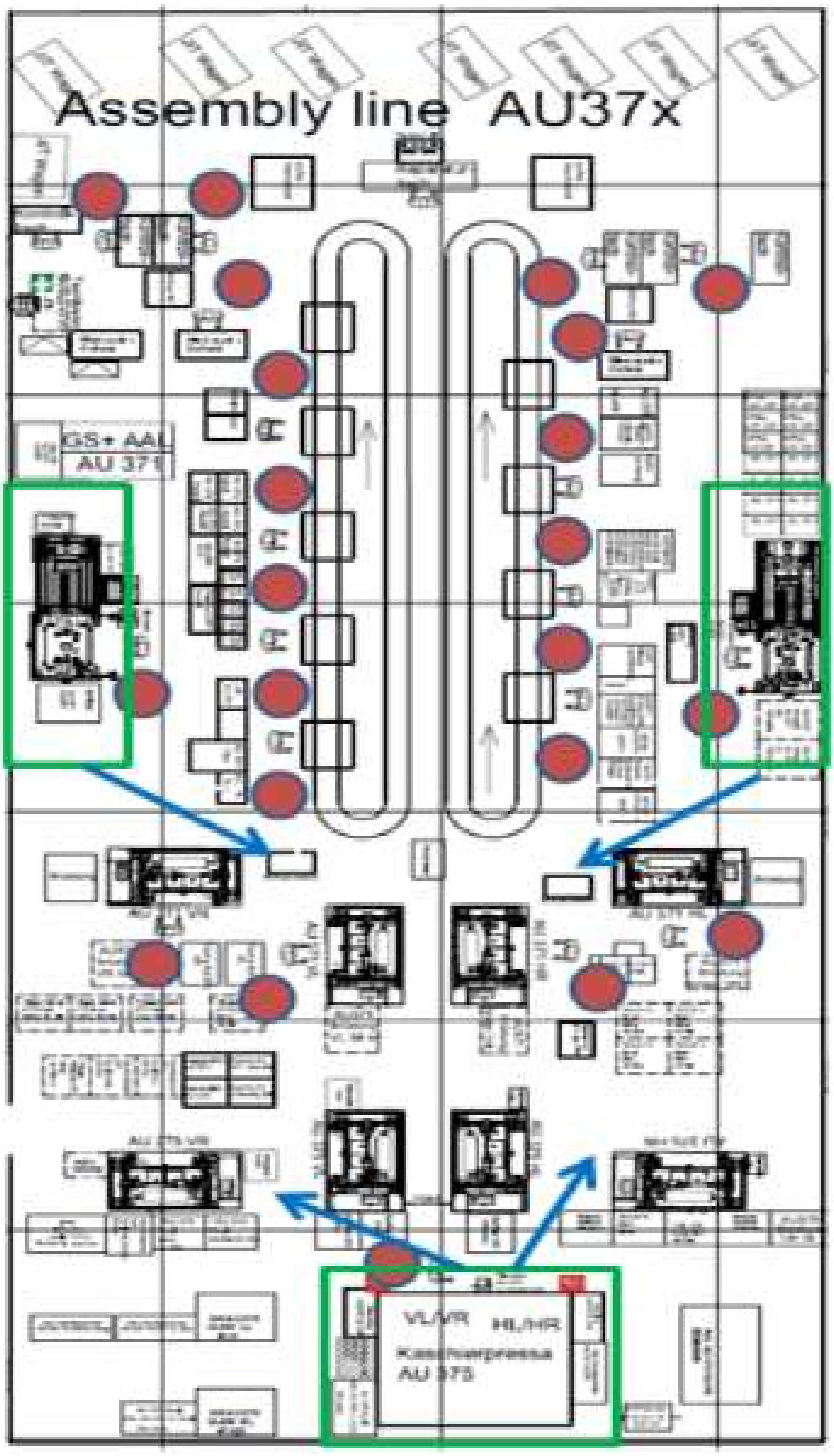


Figure 27. Laminating line - models 371 and 375 - first step on assembly line: (Internal documentation of SMP Slovakia)

In the second stage, door panel will be welded. There is separate welding equipment for front and back side of car door, therefore we need 8 welding devices - 4 for model 371 and 4 for model 375.

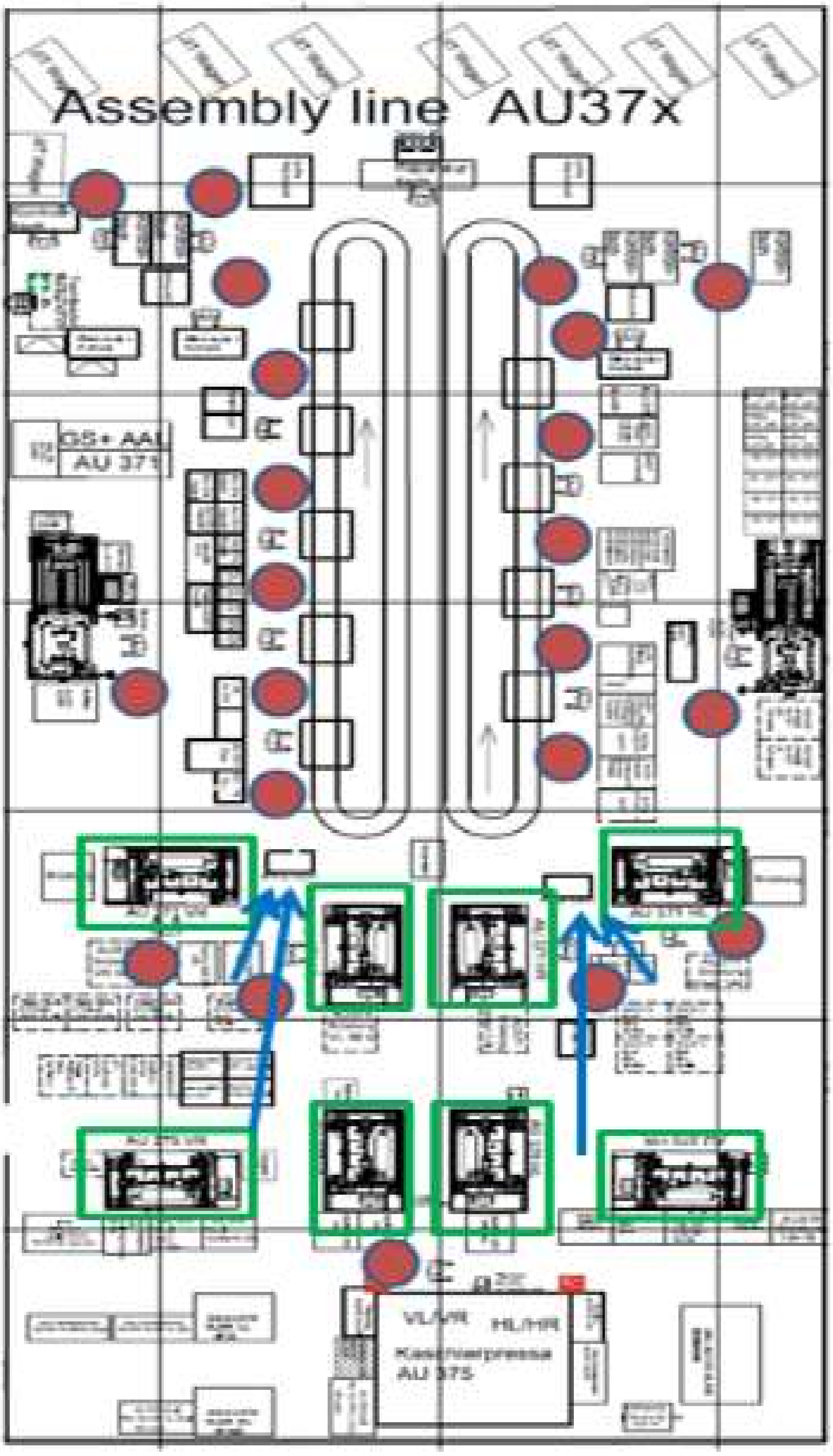


Figure 28. Welding - models 371 and 375 - second step on assembly line: (Internal documentation of SMP Slovakia)

Welded door panels are transported to conveyor belt trolleys, both products in the same trolley, one trolley operates on the front assembly line and one on the rear assembly line.

In the third stage, door is completed and installed, front assembly line is serviced by 5 operators, rear line by 4.

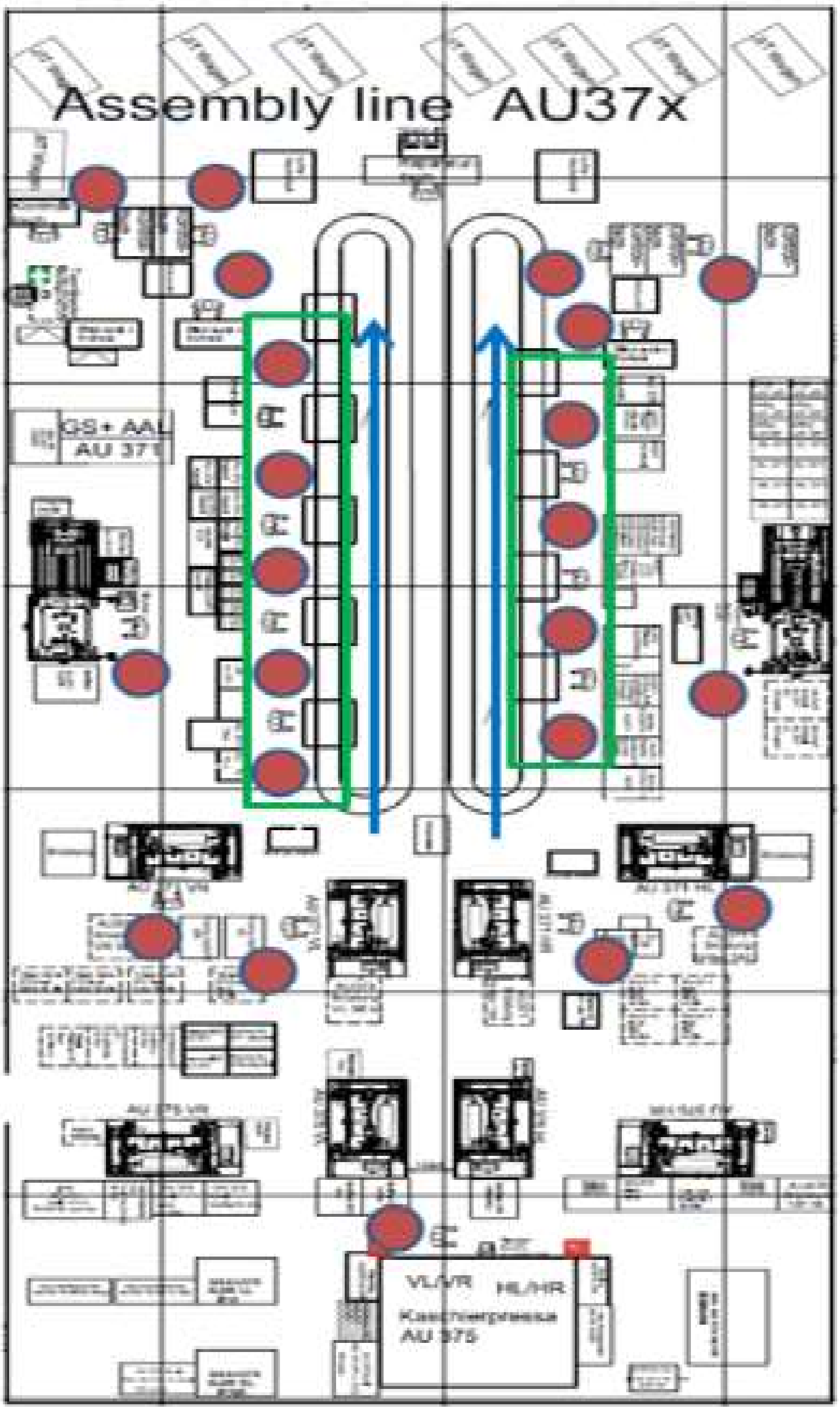


Figure 29. Assembly - models 371 and 375 - third step: (Internal documentation of SMP Slovakia)

In the last but one stage, door accessories are inspected against the real status - E Check and Blind Audit - appointed worker selects individual components actually installed in a door panel, the system inspects the accessories according to door panel sticker and ordered accessories.

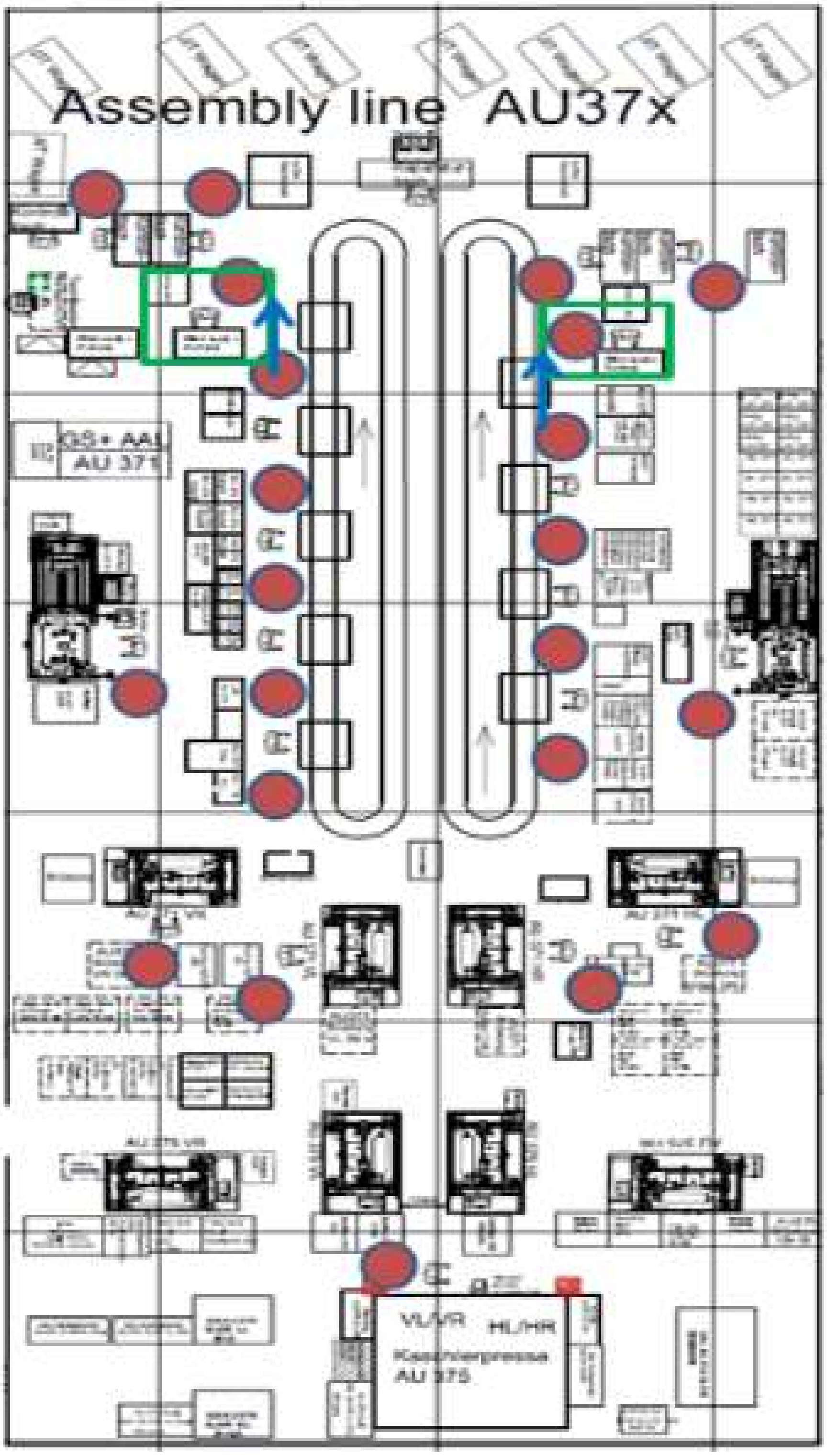


Figure 30. E check - models 371 and 375 - fourt step: (Internal documentation of SMP Slovakia)

The fifth stage concerns visual test of final door panel because it is a highly visible components and defects are unacceptable. 2 operators are in charge of each production line because the time slot for visual test and packaging is 115 seconds.

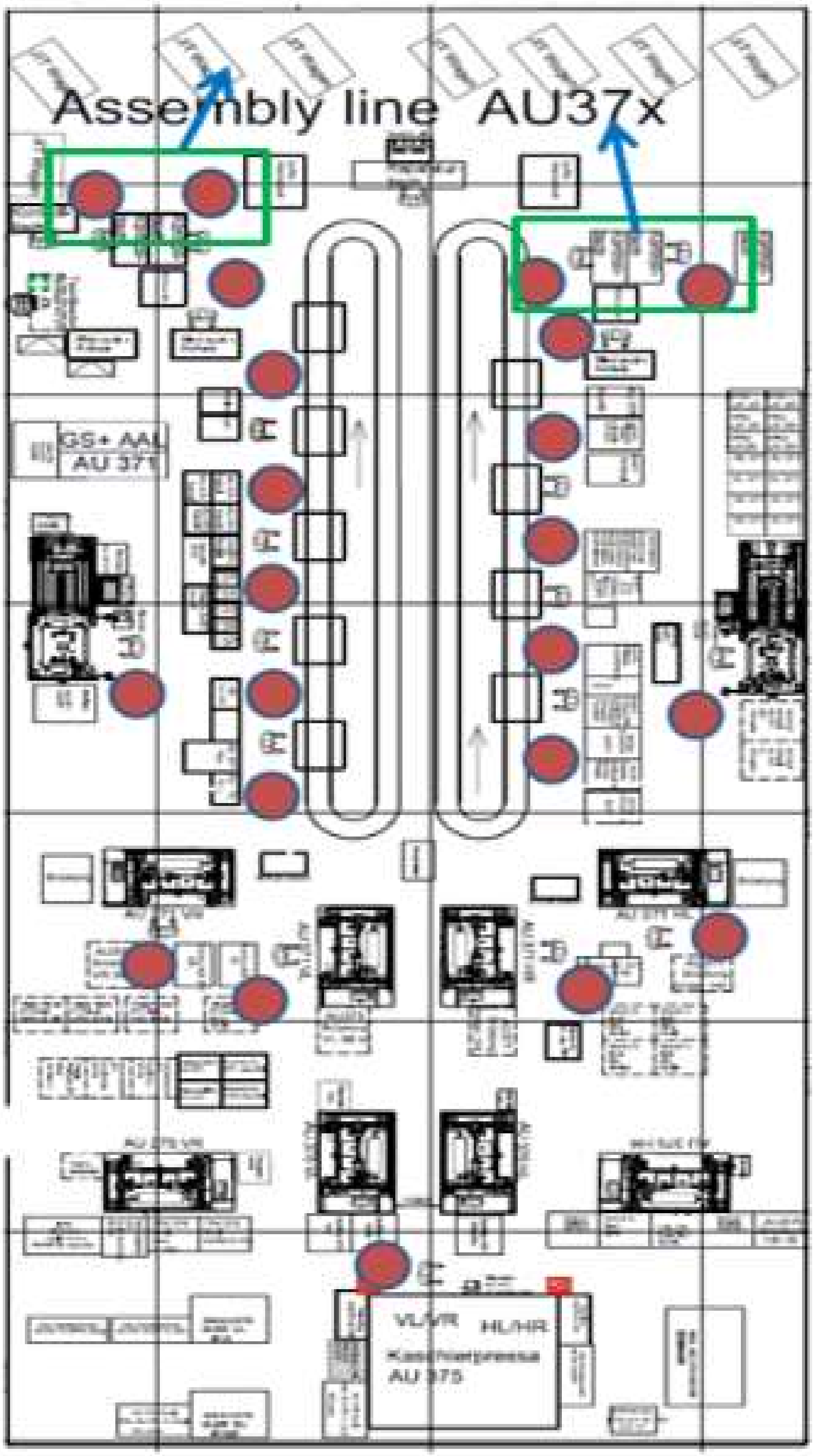


Figure 31. Visual check - models 371 and 375 - fift step: (Internal documentation of SMP Slovakia)

Advantages of the production line layout defined above:

- 4-cycle alternatives based on real customer's methods and references - 160 to 220 cars are produced per work shift
- One piece flow production - door panels go all over the assembly line - redundant manipulation and movements have been eliminated

Disadvantages of production line layout:

- 8 welding devices require more space, should universal skids be used, the same amount of components could be produced by 4 or under ideal circumstances 2 devices
- Higher demand of assembly line operators to perform activities which could be automated, e.g. 1 operator of the front line and 1 on the rear line tighten 13 bolts to every door panel

3.3. Organization of the production in Germany

Background data:

Employer of 2200 people, production plant SMP Neustadt is the biggest employer in the Neustadt town. The area and production make it the biggest production plant of SMP Group. This production plant was founded in 1986, it manufactures lacquered bumpers, car door threshold bars, door panels, dashboards and other interior components for the automotive industry. Annual turnover of the production plant equals to 517 million EUR.

Audi A3 production line we observed to compare production effectiveness is characterised by:

Number of operators: 6

Assembly line cycle time: 79.0 sec

Area: 450 m2

Produced car derivatives: 373 (hatchback)

Production lines installed in Germany are not split into the front and the rear line, the produce complete cars, i.e. each machine was designed for 4 sides (front right, front left, rear right and rear left). Hook conveyor is installed above the whole line, manual handling of components between the individual operations is unnecessary. This results in savings by excluding operators helpers.

Narrow spots, which tend to slow the production line down, are automated, e.g. tightening of screws, welding of door frame, etc.). This reduced the number of operators per work shift to 6.

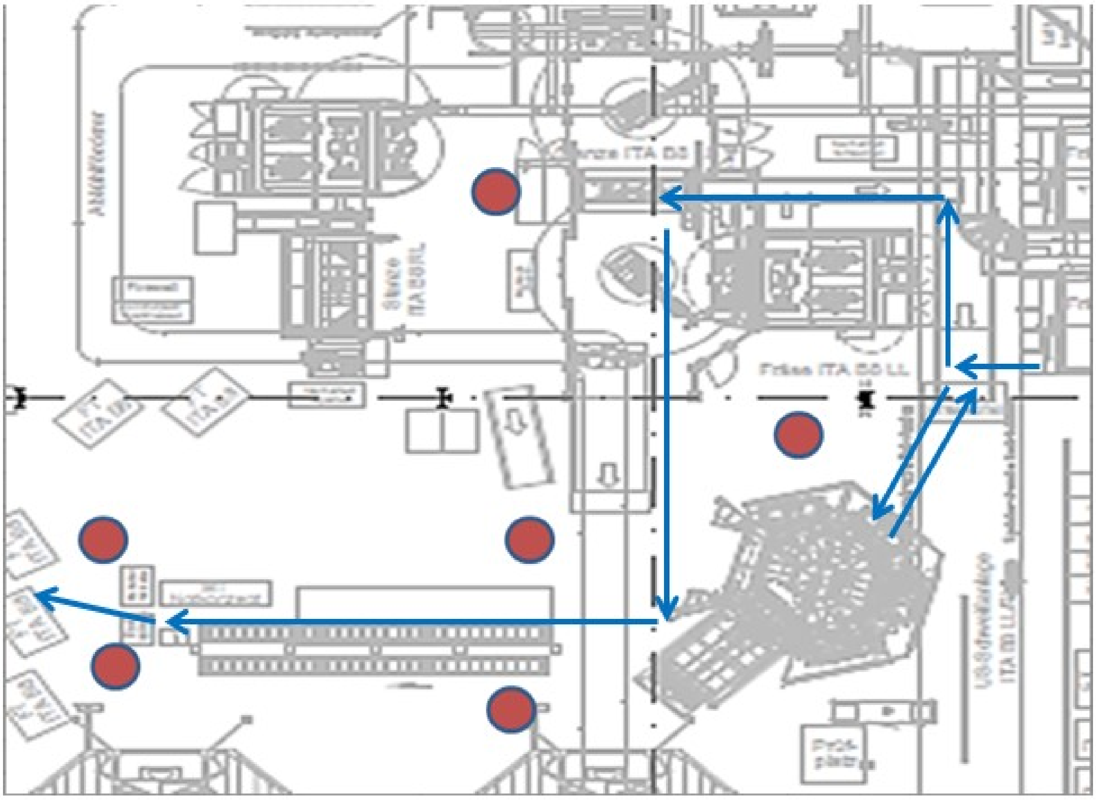


Figure 32. Layout of SMP Germany assembly line - production flow displayed: (Internal documentation of SMP Germany)

Advantages of the production line layout defined above:

- The line produces cars in their entirety, i.e. 4 doors at the same time
- One piece flow production - door panels go all over the assembly line - redundant manipulation and movements have been eliminated
- Automation of all possible production and logistics steps
- Only 6 operators needed

Disadvantages of production line layout:

Longer cycle time (production): 79 sec

4. Impact of Productivity loses on Production costs

4.1. Productivity per employee

Long-term company growth is a prerequisite of company success, whether focused on performance, benefits or profit. Sustainable growth shall mean continuously increasing productivity.

The productivity is defined as "effectiveness of using production factors in the production process. The productivity concerns all business subjects, manufacturing or non-manufacturing units, because the broader term of production denotes the transformation of inputs to useful outputs - products or services." (Klečka, 2008)

Productivity monitoring targets the production system in general since it is defined by units of production input, production output and production process. General definition of productivity is the output value/input value ratio, namely:

$$\text{Productivity} = \frac{\text{Output}}{\text{Input (e.g. wage)}}$$

Output: academic publications define the following indicators in the numerator: value added, revenues, incomes, net profit or loss, profit, gain/benefit.

Input: inputs shall generally mean the average number of employees, the number of hours worked (a more accurate indicator), costs

The general definition remains the same, be it related to a workplace, a production system, a company, a national economy or political system. The productivity concerns all manufacturing or non-manufacturing companies because it defines how effective the conversion of inputs into outputs (products or services) is. The productivity aims to express the efficiency of transformation of used production factors. It denotes the efficiency of the process of transformation.

The most important and practically most applied productivity is the work productivity. Likewise with the general calculation of productivity, the work productivity indicates the outputs/inputs ratio, while the inputs consist of the direct labor.

The analysis of the work productivity requires the following be determined:

Indicators and units of the production volume.

Period of time for which productivity is monitored (annual productivity, monthly, daily, hourly productivity).

The number and category of workers whose productivity is being defined.

Each measurement of productivity in the company sector indicates how inputs are reflected in the outputs. Every such measurement must focus on how customers' demand is satisfied. The measurement is based on available data. Its results must be reasonably justified and understood by the author of the measurement. Measured data will be analyzed by the management according to their preferences and considering the sustainable growth of measured productivity must be maintained. The productivity is increased provided that:

- the same outputs are obtained with lower inputs,
- higher outputs are obtained with the same inputs,
- inputs are lower and outputs higher,
- outputs are reduced, but inputs decreased more (proportionally),
- both the inputs and the outputs are increased, but proportional growth of inputs is smaller.

Productivity in SMP Slovakia compared to Germany

The basic supposition influencing the scope of automation, value added and the work productivity in general is the amount of produced goods. In average, SMP Slovakia daily produces 400 cars, SMP Germany 1 000, which results in the key supposition in terms of the period needed for the return on investment and the scope of automation. The second most important factor is the salary, if we consider the average annual salary paid to 1 employee in Slovakia, i.e. 13.500 EUR, compared to 45.000 EUR in Germany, the return on investment of each invested EUR is logically three times quicker.

Example:

Automated Screw Drive System: 13 screws installed on a car door

Machine price: 350.000 EUR

Savings: labor force reduced by 2 employees per work shift

Return on investment - Germany:

3-shift production = 3 * 2 operators (who are not needed) = 6 * 45.000 EUR = 270.000 EUR / year

Machine price compensated: 350.000 EUR / 270 000 EUR = 1.3 year

Knock-out criterion – investment compensated up to 1.5 year – machine approved

Return on investment - Slovakia:

2-shift production (smaller production volume) = 2 * 2 operators (who are not needed) = 4 * 13.500 EUR = 54.000 EUR / year

Machine price compensated: 350.000 EUR / 54.000 EUR = 6.5 year

Knock-out criterion – investment compensated up to 1.5 year – machine not approved

These supposition are sometimes not published and available, but they directly influence achieved performance and productivity. Is the production in Slovakia still competitive, despite the fact?

	Slovakia	Germany
Number of employees	22	6
Tact Time	58.1 sec	79.0 sec

Figure 33. Basic parameters of production: (Internal documentation of SMP Slovakia)

In this case the number of employees is defined to produce the requested amount.

"Cycle time is the maximum time allowed to accomplish a task or process step. Several process steps may be necessary to complete the product.

Tact time is determined by the customer and is the speed at which completed units must be produced to satisfy the customer demand." (Heizer, 2014:412)

Output per one hour:

Is defined as number of sec divided by Tact Time

	Slovakia	Germany	Index
Output per one hour (Cars)	62.0	45.6	0.74
Number of cars per employee	2.8	7.6	2.70
Hourly rate of Direct employee (EUR)	6.65	22.0	3.31
Personnel cost per Car	2.36	2.90	1.23

Figure 34. Derived parameters of production: (Internal documentation of SMP Slovakia)

The table above implies the production of a car model by SMP Germany is 2.7 times more productive compared to SMP Slovakia (7.6/2.8). However, salaries paid by SMP Germany are three times higher meaning that production volume of SMP Slovakia and its scope of automation might be lower, but the Slovak subsidiary of

SMP is still 1.23 times more efficient in terms of produced pieces and salary costs than SMP Germany.

4.2. Analysis of hourly rate (wages and salaries)

Cost efficiency of Slovakia is highly dependent from the development of the hourly wage rate. Generally under the hourly rate we understand the amount of money that is paid to the employee for every hour worked.

If we compare the hourly rate in Germany, than we see that there is significantly higher. This gives Slovakia a type of cost benefit, which allows to produce the products cheaper than in Germany.

On the other hand we have to consider also the increase of the hourly wage rate.

In the last five years the average wage has grown in Slovakia faster than in Germany, which was leading also to increase of the hourly wage rate.

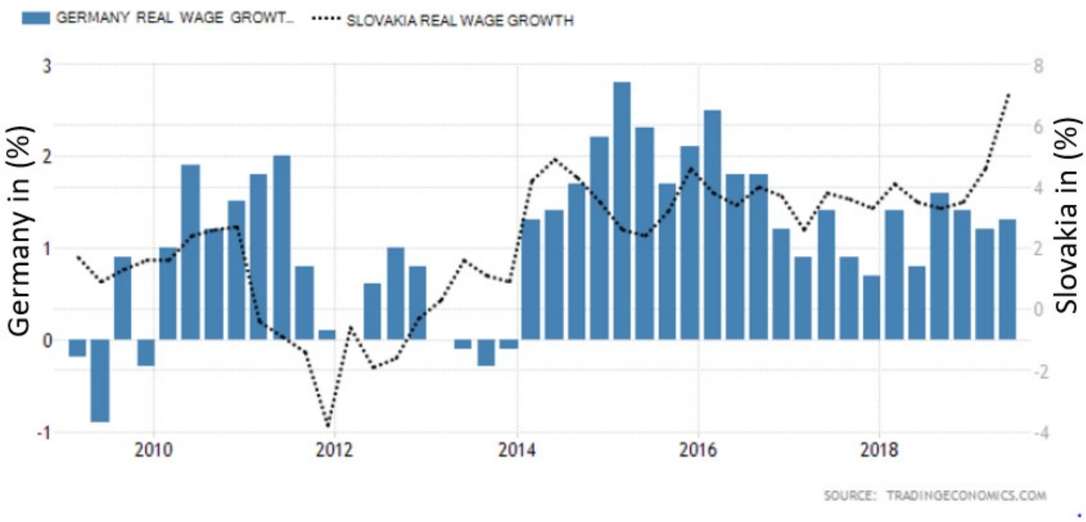


Figure 35a. Real wage growth (Germany/Slovakia) [1)]

	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017	Q1 2018	Q2 2018	Q3 2018	Q4 2018	Q1 2019	Q2 2019
Germany	1,8%	1,2%	0,9%	1,4%	0,9%	0,7%	1,4%	0,8%	1,6%	1,4%	1,2%	1,3%
Slovakia	4,0%	3,7%	2,6%	3,8%	3,6%	3,3%	4,1%	3,5%	3,3%	3,5%	4,6%	7,0%

Figure 35b. Real wage growth in figures (Germany/Slovakia) [1)] :

(www.tradingeconomics.com; Statistical office of Slovakia)

[1)] The growth is measured over the same month in the previous year

In case that this trend will continue with this accelerated growth rate in Slovakia, than the cost advantage will be lost in few years.

For the calculation purposes of the breakeven point when Slovakia will lose the cost advantage, we have taken as an indicated growth for the future years the average growth rate of the second Quarter of Y2019.

Slovakia Growth +7,0% YoY

Germany Growth +1,3% YoY

Slovakia	Y+0	Y+1	Y+2	Y+3	Y+4	Y+5	Y+6	Y+7
Number of employees	22	22	22	22	22	22	22	22
Output per one hour (Cars)	62,0	62,0	62,0	62,0	62,0	62,0	62,0	62,0
Number of cars per employee	2,8	2,8	2,8	2,8	2,8	2,8	2,8	2,8
Hourly rate of employee (EUR)	6,65	7,12	7,61	8,15	8,72	9,33	9,98	10,68
Personnel cost per Car	**2,36**	**2,53**	**2,70**	**2,89**	**3,09**	**3,31**	**3,54**	**3,79**

Germany	Y+0	Y+1	Y+2	Y+3	Y+4	Y+5	Y+6	Y+7
Number of employees	6	6	6	6	6	6	6	6
Output per one hour (Cars)	45,6	45,6	45,6	45,6	45,6	45,6	45,6	45,6
Number of cars per employee	7,6	7,6	7,6	7,6	7,6	7,6	7,6	7,6
Hourly rate of employee (EUR)	22,00	22,29	22,58	22,87	23,17	23,47	23,77	24,08
Personnel cost per Car	2,90	2,93	2,97	3,01	3,05	3,09	3,13	3,17
Delta cost per Car	-0,54	-0,41	-0,27	-0,12	0,04	0,22	0,41	0,62

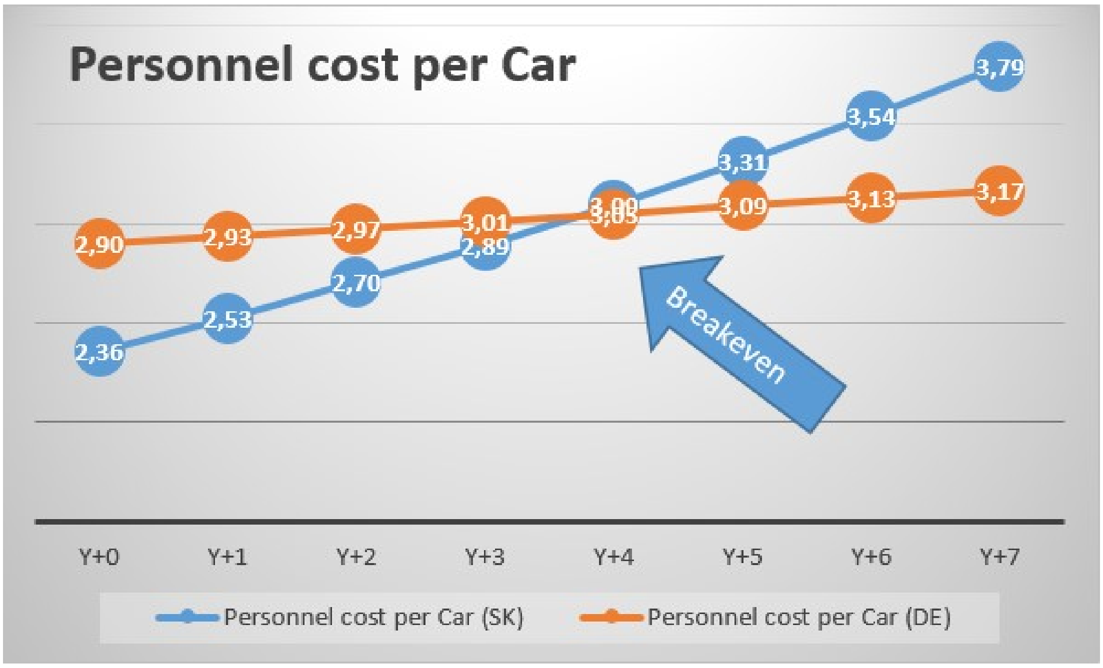


Figure 36. Analysis of breakeven point

As from the analysis visible, if the trend of wage increase will continue with the same intensity as in second quarter of Y2019, then Slovakia will lose his cost advantage after four years.

4.3. Comparison of the quality costs

Quality is nowadays a decisive instrument towards company success and competitiveness. The value of products is defined by the quality/price the customer is willing to pay ratio. The know-how of entrepreneurship relies on defined relation of production maximization and production costs on the one hand, and the creation of value added, i.e. customers' satisfaction with the quality on the other hand. The quality shall mean materialized hypothesis what customers would like to buy because they find the product convenient, i.e. the quality oriented to incomes. Another definition stipulates the quality is oriented to the reduction of costs related to deficiencies, product faults caused in the production stage or by its use. Quality improvement is associated with higher price of the product because the improvement of the existing and the introduction of new parameters trigger higher costs, and vice versa, the removal of defects in the production stage and during the use of the product minimizes costs by reducing repetitive measures, loss by paying guarantee, reimbursement of complaints.

Globally speaking, product quality significantly impacts net profit or loss of the company. With regards to the aforesaid, a complex evaluation of quality related activities is meaningful, i.e. quality should be evaluated both in terms of the production technology and efficiency. The monitoring of quality costs and calculations of quality improvement efficiency became the basics of the quality economy, a pillar of the quality system in every company.

Importance and methods of quality cost monitoring

Quality costs are an efficient instrument in the economic management of companies, strategic quality management instrument and important indicators of activities performed by manufacturers. Their importance lies in:

- the identification of all significant impacts on the quality of a selected product,
- the definition of the cost effectiveness of capital expenditures in the quality management system,
- the dynamics of quality cost development which indicates how efficient the company quality system is,
- the classification of positive and negative impacts on quality,

- pointing at places and factors which increase quality costs,
- determination of measures to be adopted to remove causes of deficiencies, measures to identify how total costs can be reduced, measures to increase the sales volume and the profit,
- they serve as arguments during top management negotiations regarding the next quality management trends,
- their potential to define the economic optimum of quality, etc.

Quality costs - expenses by the manufacturer, user and the company related to a product quality, in other words those costs incurred to achieve defined requirements of the product quality.

Classification of costs according to EOQ, European Organization for Quality:

1. Costs to guarantee the conformity of products
    1.1. prevention costs
    1.2. evaluation costs
2. Costs to remedy inferior quality
    2.1. costs to remedy internal deficiencies
    2.2. costs to remedy external deficiencies
    2.3. costs to remedy excessive requirements
3. Loss opportunity cost
    3.1. order cancelation
    3.2. unperformed purchase orders

Quality costs of the plants

The quality costs are the one of the most important cost element of the production plants. Based on our production policy, the quality has to be produced and not checked. Because the customer satisfaction is the primary goal of all business activities, we also pay high focus on it. Globally within the group is the quality measured by several KPIs. The basic parameters are the PPM and the ratio of quality costs against sales (Total quality costs and Scrap).

Regarding the production process the most important KPI is the scrap ratio. Under scrap we understand the fragments of stock removed in production process or produced articles rejected or discarded, which are useful only as material for reprocessing.

Scrap is showing the operational excellence and the production efficiency of the plant. Is highly dependent from the level of automatization. Of course is the level of automatization is higher, than the production process is also stable and lead to decreased scrap rate. SMP Slovakia is regarding the level of automatization behind the German plant. This is also the reason, why is the scrap rate of Germany better than in Slovakia.

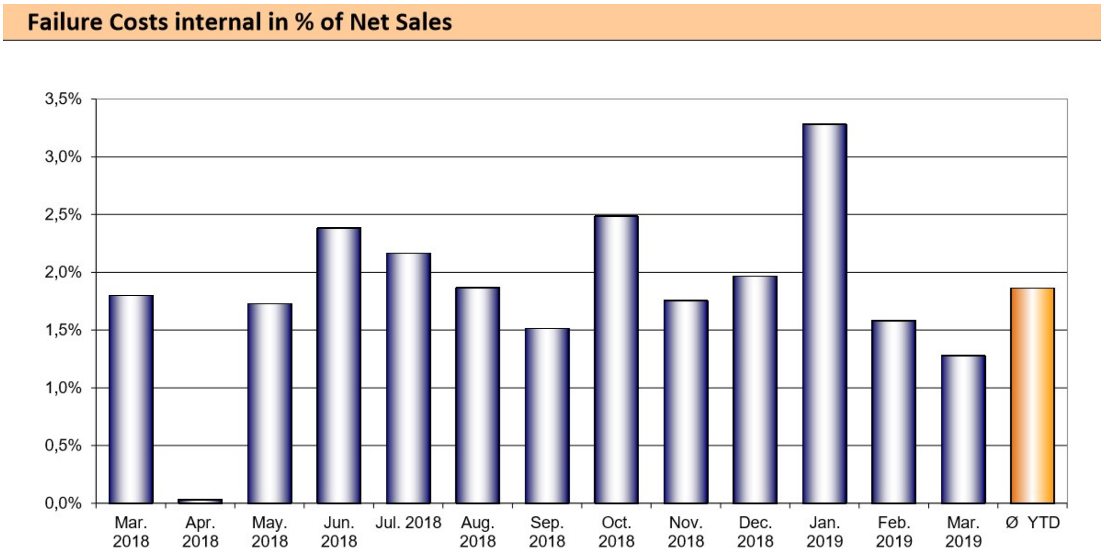


Figure 37a. Comparison of the Scrap Rate (Slovakia): (Internal documentation of SMP Slovakia)

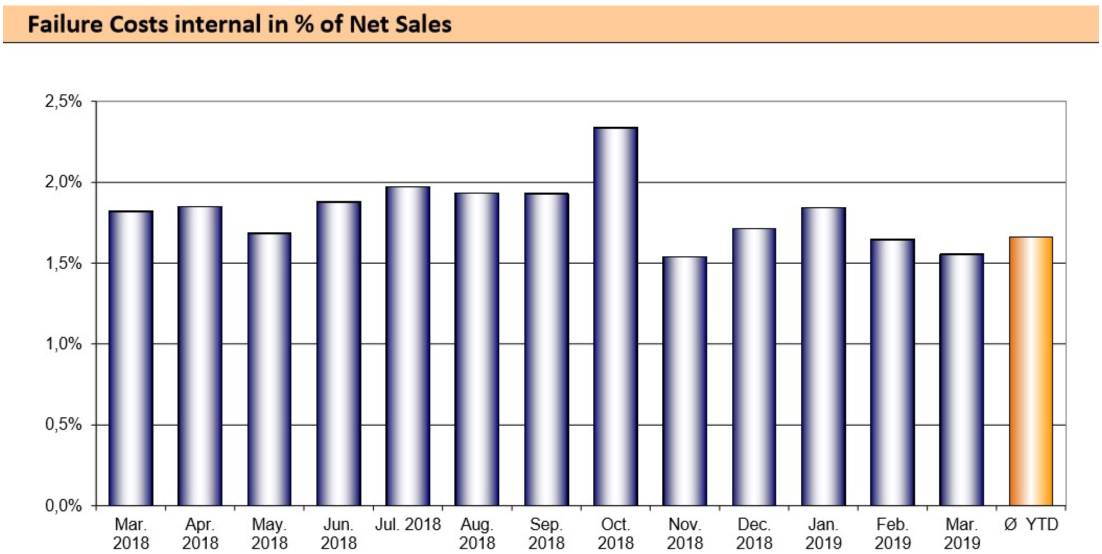


Figure 37b. Comparison of the Scrap Rate (Germany): (Internal documentation of SMP Slovakia)

Period	Slovakia	Germany	Delta
Mar-18	1,80%	1,82%	-0,02%
Apr-18	0,03%	1,85%	-1,82%
May-18	1,73%	1,68%	0,05%
Jun-18	2,38%	1,88%	0,50%
Jul-18	2,17%	1,97%	0,20%
Aug-18	1,87%	1,93%	-0,06%
Sep-18	1,51%	1,93%	-0,42%
Oct-18	2,49%	2,34%	0,15%
Nov-18	1,76%	1,54%	0,22%
Dec-18	1,97%	1,71%	0,26%
Jan-19	3,28%	1,84%	1,44%
Feb-19	1,58%	1,65%	-0,07%
Mar-19	1,28%	1,55%	-0,27%
Average scrap rate	1,86%	1,66%	0,20%

Figure 37c. Comparison of the Scrap Rate (Germany/Slovakia): (Internal documentation of SMP Slovakia)

From the provide data is visible that the German plant is more effective in production process, because they have achieved in average a lower scrap/waste rate by 0.20%. If we would like to express it in amount of EUR, we have to derive this figure from average sale per one car. In our case the average sales per car is 181.05 EUR. This mean that the German plants material consumption is by 0.36 EUR per car lower than in Slovakia.

5. Summary and the conclusion

This master thesis researched the question of door panel production in comparison of productivity loses between two affiliated companies in Germany and Slovakia. Both companies are producing door panels for the same product family of Audi A3.

In the theoretical background of the master thesis were introduced the key aspects and methods how the production costs influence the profitability and the way how the lean theory and lean production principles contribute to increase of productivity.

With detailed study and description of organization of productions in both facilities we were able to make the necessary comparison, which helped us to proof the hypothesis statement of this master thesis and answer the main research question.

Are the low costs countries really cost efficient?
We have proved, that the German plant is more 2.7 times more productive compared to Slovakia. However, salaries paid by SMP Germany are three times higher meaning that production volume of SMP Slovakia and its scope of automation might be lower, but the Slovak subsidiary of SMP is still 1.23 times more efficient in terms of produced quantity and salary cost.
This statement is valid also in case, when we include to the valuation the impact of the quality costs due to lower automatization in Slovakia.

Conclusion of the master thesis is, that with regard to the lower automatization the low costs countries are still cost efficient. However due to increasing live style in Eastern European (EE) countries the efficiency is declining due to accelerated increasing of wages in EE region compared to the Germany. In case that this trend will continue, the costs advantage will be lost and the global companies will relocate there production more to east, in direction to Asia.

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