

## QUALITY IN WORLD CLASS MANUFACTURING

Slavko Arsovski<sup>1</sup>,  
 Ivan Đokić<sup>2</sup>,  
 Snezana Pešić – Đokić<sup>3</sup>

<sup>1</sup>Fakultet Inženjerski h Nauka,  
 Centar z a Kvalitet

<sup>2</sup>FIAT Automobiles Serbia

<sup>3</sup>Grupa Zastava Vo z ila a. d

**Abstract:** The World Class Manufacturing (WCM) is a contemporary concept that is applied by the world leaders in the business. In this concept, one of the nine pillars is directly related to the quality and the other eight are related to it indirectly. That is why is very important to investigate relations between this concept and concept of model of quality. In the end of this paper are appointed the examples of best practice.

**Keywords:** World Class Manufacturing, quality, model of quality

### 1. INTRODUCTION

Although we have witnessed the changes of economic structure from manufacturing to services, there remains a significant influence of production in creating new value and competitiveness, the level of organization, region or state [1, 2, 7, 8].

Therefore, it is still very contemporary concept of world class manufacturing (WCM - World Class Manufacturing), which was developed in nineties of the twentieth century, Hausan, Schönberger and many others.

They found that existing methods of measuring the excellence of manufacturing organizations, especially those that make the products according to work orders (MTO - Make To Order) no longer meeting requests, and it was necessary to develop a new concept that, in addition to a more realistic description of the processes, allows benchmarking on the global level [18, 19].

In Serbia, this concept is used mostly by foreign-owned companies, with international or combined management, where they monitor changes in the competitiveness of any organization on a monthly basis.

If they are a part of international company, they conduct regular internal benchmarking with other companies.

### 2. WCM BASIS

World Class Manufacturing represents a synthesis of various concepts, principles, policies and techniques for the management and operation of companies engaged in production. It's guided by the results of which enabled the revival of Japanese manufacturing after World War II and adapted the ideas that were used in the Japanese automotive, electronic and black industry, in order to achieve competitive advantage. The primary goals are to continually improve the quality, cost, production time, flexibility and customer service.

World Class Manufacturing is not a cure and should not be accepted as a religion. This is an operating strategy that if it is properly applied, gives a new dimension of production which correspond to rapid inclusion of new high quality products, faster decisions and increased productivity products.

WCM system is based on systematic reduction of all types of costs and losses from the contribution of all employees and the precise use of methods, standards and tools required by world class production. The picture below shows the functioning of WCM methodology, where it is clear that the main goal of this system will reach zero in the waste, defects, faults and stocks, and values of this system are greater involvement of people, creating better values and more satisfied customers.

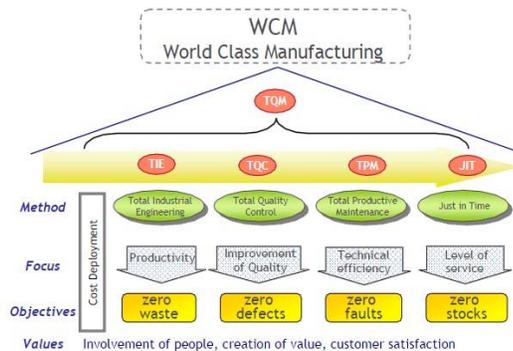


Figure 1 – WCM Concept

World class manufacturing is based on twenty pillars. On the figure 2 WCM pillars are listed, which are

divided into two groups. There are ten technical and ten managerial pillars of production.

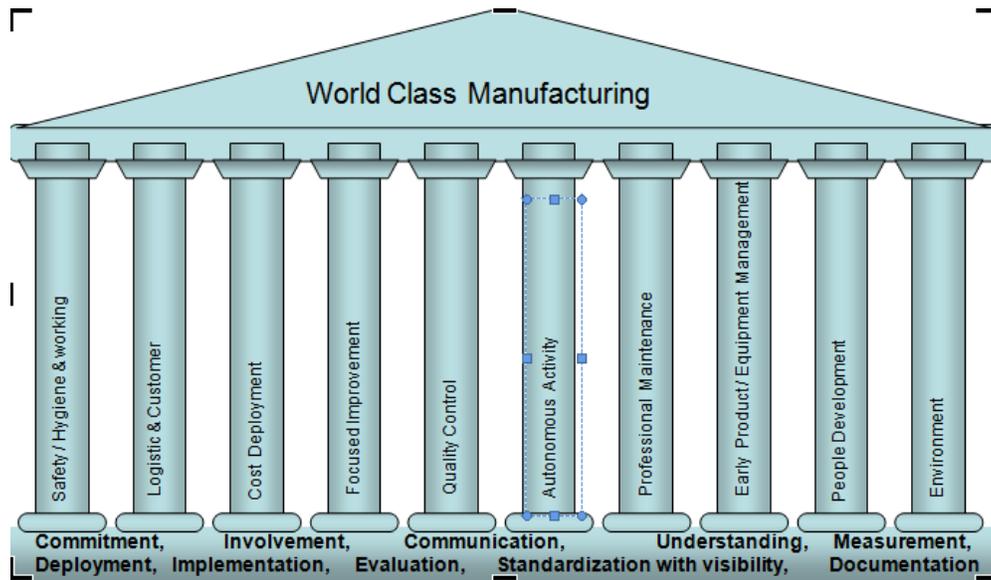


Figure 2. WCM Pillars

Each technical pillar must achieve a certain goal and they have full support from managerial pillars. With managerial pillars are requirements have been prescribed that needs to be met in order to gain better working conditions and progress of technical pillars. Each technical pillar, following prescribed standards, must go through seven steps, where each needs to fulfill certain tasks in order to go to the next step. Although we have a variety of pillars with different objectives and targets, they are closely affiliated with each other and one without the other can not work. For example, the pillar of Safety has the target to eliminate accidents, Cost Deployment aims to identify the problems from the standpoint of cost and to show to others where the same are at maximum in order to focus on their elimination. The pillar for Focused Improvement develop new knowledge and reduce costs by using appropriate methods, the pillar of Workplace Organization and Autonomous Maintenance aims to raise the competence of people on the shopfloor with right organization of the workplace where the costs are highest and where intensive work is needed. Thus, the pillars are like a linked chain, build upon each other and their cooperation, providing support for company WCM temple.

Ten managerial pillars in short are foundation of WCM:

- 1) **Commitment** – If the board members are not aware of or do not support the management in their objective of achieving world class levels of performance, the company is doomed to fail.
- 2) **Involvement** – All the people are not only

- 3) **Communication** – Before people can commit to a concept or an ideal they need to be told about it. They need to understand the how's and the why's of a decision and an objective. It is important for people to know how well they are performing against their objectives and also how the overall business is progressing towards its goals.
- 4) **Understanding** – Understanding what and where problems are is the starting point for making improvements.
- 5) **Measurement** – Measurement is key to quantify problems and prioritize them and to determine the effectiveness of improvement activities. It is necessary to measure performance before and after implementation to determine if and to what extent the changes have improved performance.
- 6) **Deployment** – Deployment relates to how objectives are translated into action.
- 7) **Implementation** – Implementation of right solutions with rigor by right people to identified problems is central to success. People can also learn things better by doing them and grow.
- 8) **Evaluation** – Evaluation needs to be an integral part of the improving process to see whether the identified problems have been solved.
- 9) **Standardization** – Once the evaluation cycle is

completed, it is time to standardize the method to manage the process to sustain the obtained result after solving the problem and not to have the same problem again.

- 10) **Documentation** – Documentation is to accumulate created knowhow to prevail and use it in other area and in the future.

The WCM system must first identify the issues to be discussed, then determine where they are and prioritize them according to cost analysis. After that, it is necessary to determine the right methods to estimate how much it cost solution to the problem with these methods. It is necessary to implement a solution with rigor and evaluate the results obtained from the original objective. The 7 steps of WCM way:

1. Identify What problems need to be addressed
2. Detect Where they are
3. Prioritize them based on cost deployment
4. Analyze them and choose Right methods
5. Estimate How much they cost to be solved
6. Implement solutions with rigor
7. Evaluate the achieved results against the original objective

To solve problems we can use WCM tools which can be split into three groups: tools for the description of the problem (eg 5W +1 H, 5G), to find the root cause

(4M, 5Why’s) and to standardize the results (eg, OPL, GAV ). When problem arise it needs to be described with the use of appropriate tools. Tools 5W +1H we can describe deeply the problem by completing a standardized form with questions. After detailed problem description we can start to search for the root cause of the problem with the tools 4M (Men, Machine, Material, Method), which uses a fish bone diagram for describing all possible root causes of the problem, which can be caused by man, machines, methods or materials. After generating all possible root causes they needs to be analyzed one by one in order to eliminate ones that are not really root cause. In the end, the remaining possible root causes are analyzed into the depth of the problem using the tool 5Why’s. Ask ourselves Why, at least five times, we can determine the actual root cause of the problem. The above tools are tested and they can help in faster and easier problem elimination with removing possibility of arising again. At the end of a successful problem elimination, solution of the problem is accepted as a standard and helps to eliminate future same or similar problems.As all the WCM pillars, and implementation of WCM approach has 7 steps. Those steps are presented on Figure 3, with all the major activities that are necessary to be completed in order to finish full implementation.

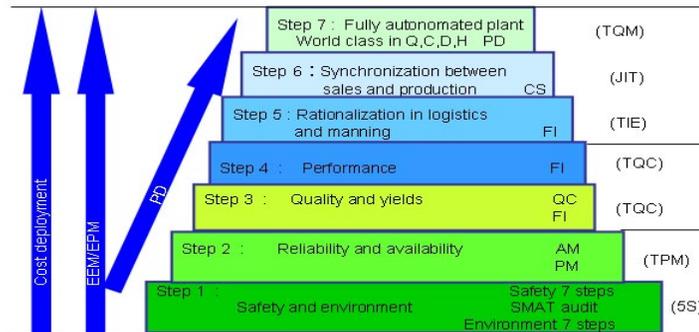


Figure 3 – Seven Steps of WCM approach

Step 1 deals with safety and environment - These are fundamental issues for a manufacturing company to be responsible for the safety of the people who work there and for being a respectable existence for the community surrounding it.

Step 2 relates to reliability and availability – These require to develop the skills, capabilities and experience of operators under the heading of “Autonomous Maintenance” and to involve the maintenance crew in doing work to ensure that plant and equipment do not break down during required production periods. The maintenance crew need to develop a deep understanding of the plant and equipment under their care. This process needs to be carefully managed to balance the cost-benefit relationship between

maintenance costs and delivered performance improvements.

Step 3 seeks to build on the quality and the yields being achieved from processes – The focus is on building-in quality at the process, and maximizing yields, looking for ways to minimize waste and losses by the use of the tools of quality and especially Total Quality Control.

Step 4 brings the full focus on to performance - By this time the company and its people understand their operations and processes in a very deep way. Planned daily production output must be achieved and plant performance is at its highest level. Achievements being made at steps 1, 2 and 3 enable the improvements at Step 4.

Step 5 moves towards the use of the tools and techniques of Total Industrial Engineering – The focus is on rationalization in both the areas of logistics (production and service delivery). Efforts must be made to reduce the logistics burden both internally and externally. Step 5 is also meant to introduce LCA and labour saving devices. Step 6 looks at completing synchronization between the sales and manufacturing areas. Efforts must be used in order to look at the full supply chain and to identify and remove waste and losses throughout the system. Companies focus their attention on the advanced use of Just in Time techniques, using their responsiveness to meet market needs rather than relying on large inventories of either finished goods or raw materials. It is important to realize that Step 6 looks at waste along the full supply

chain. This chain stretches from the raw material suppliers right through to the consumer.

Step 7 is the point where businesses are fully aligned with market requirements. Automated and autonomated plants and machines are producing at world class levels in terms of both internal and delivered Quality, where product, warranty and full life Costs are at the highest levels, where Deliveries are made as and when the customers require, each and every time and where the workforce can operate in a safe and healthy environment.

The best way to achieve good results in WCM implementation is to apply Kaizen methodology. AS shown on Figure 4, performance level can be reached at very high level with Kaizen methodology, by improving working standards.

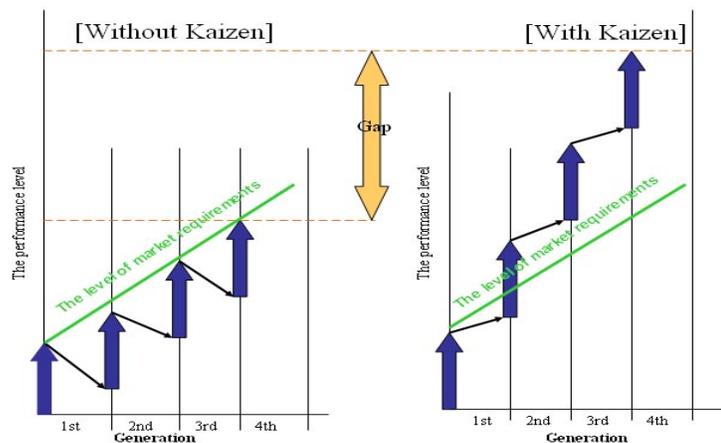


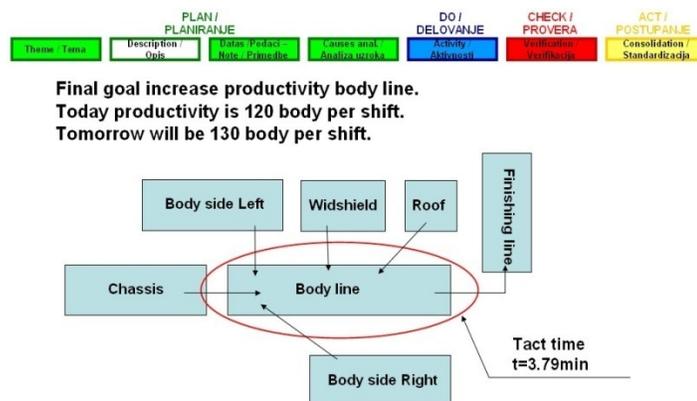
Figure 4 – Increasing the performance level with and without Kaizen approach

### 3. WCM CASE STUDY

#### Decrease tact time on body line – Body shop

As one of the good reason why to start Kaizen

activities, is bottleneck in production. So, on body welding there was the bottleneck on operation 40. In order to achieve higher level of production, target was to decrease tack time of that operation from 3.79 to 3.46 minutes.



Figures 5 – Degfining bottle neck operation

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After setting the target and defining the team and action plan, proper usage of tools must be followed. In Kaizen technics and Focused Improvement approach the right way of WCM tools is settled as follows: a) define the problem, b) full problem description; c) root cause analysis.

So when problem was defined, tools for deeper problem analysis have been used: 5G & 5W+1H. Tool 5G (Gemba, Gembutsu, Genjitsu, Genri & Gensoku) have been used immediately after problem setting and tool 5W+1H was applied when the problem was fully understood

Theme / Tema	PLAN / PLANIRANJE	DO / DELOVANJE	CHECK / PROVERA	ACT / POSTUPANJE
Description / Opis	Datas / Podaci - Note / Primedbe	Causes anal. / Analiza uzroka	Verification / Verifikacija	Consolidation / Standardizacija
<b>5W + 1H</b>				
Fabrika / Shop: KAROSERIJA	Datum / Date: 27.11.2009.	UTE: 2	Projekat / Project: Smanjenje vremena izrade	Tim / Team: Vladan Radosavljević
BODY SHOP				
Definisavanje problema / Problem definition				
Šta / What:				
Koji proizvod/mošina/materijal o kojima se radi? Koje veličine?				
Linija zavarene školjke / Body line				
Kada / When:				
Kada je uočen problem? U toku proizvodnje kontinualno ili povremeno? U fazi pokretanja proizvodnje? Pre ili posle promene tipa? U kom satu, u kom periodu?				
U toku proizvodnje / During production				
Gde / Where:				
Gde je uočen problem (linija, mašina, robot)? Na kom specifičnom delu je uočen problem? Gde je fizički uočen problem?				
Linija zavarene školjke / Body line				
Ko / Who:				
Da li se problem odnosi na specifične mogućnosti? Da li neka specifična ponašanja mogu prouzrokovati problem? Samo neki radnici imaju ovaj problem? Problem se pojavljuje samo u nekim smenama? Tehnolog je primetio problem, ali ne i konduktor ili obratno?				
Problem je nezavistan od smene ili obučenosti pojedinca / The problem is independent from shift/skills.				
Koji / Which:				
Koje su karakteristike vezane za problem? Problem se pojavljuje nasumično ili konstantno, ili ima povezanost sa nečim? Problem se pojavljuje u određenoj zoni?				
Kontinualno / In continuous				
Kako / How:				
Da li je promenjeno stanje opreme u poređenju sa optimalnim uslovima rada? Koliko se često dešava problem? Oprema nije menjana / Nothing change on equipment				

Figures 6 – Tool 5W+1H (problem description)

After detailed problem description and understanding, there is a need to find out what is the root (main) cause of the problem. In order to analyze that there are 4M and

5Why's tools.

On the figure 10 is 4M tool represented with Ichikawa Diagram.

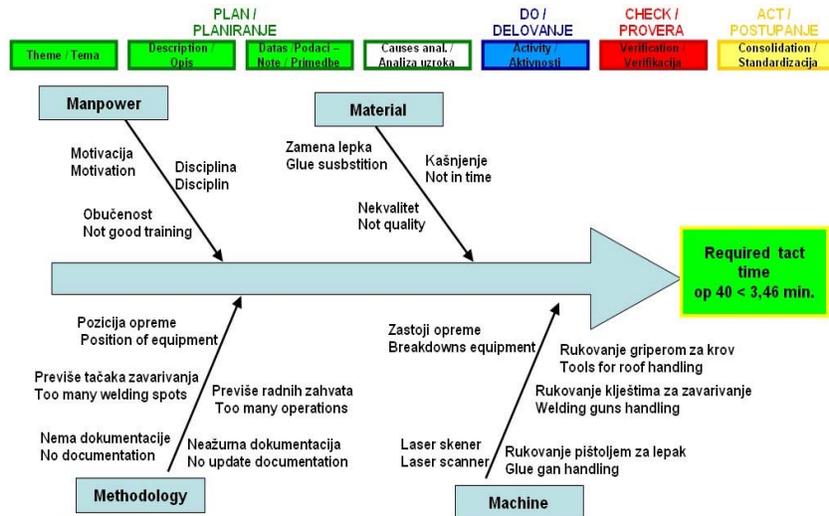
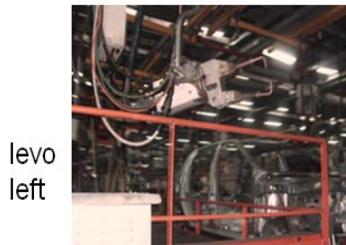


Figure 7 – 4M analysis (Ichikawa diagram)

## Countermeasures

PLAN / PLANIRANJE		DO / DELOVANJE	CHECK / PROVERA	ACT / POSTUPANJE
Theme / Tema	Description / Opis	Causes anal. / Analiza uzroka	Verification / Verifikacija	Consolidation / Standardizacija

- 2. Workers involved in activities WCM / AM on the model zone L-48 body line op. 20
- 3. OPL made for training of workers related to sharpening electrodes and placed on the station op. 40
- 10. i 11. The station 40 has been done following :  
Installed 1 +1 welding machines with 1 +1 welding guns



levo  
left



desno  
right

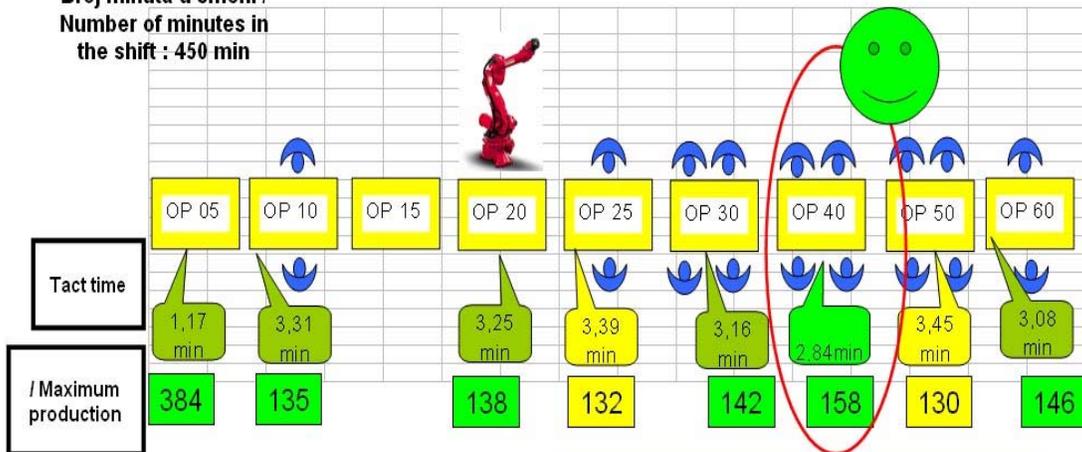
- Add 1 worker to the right side
- 1+1 welding spots transferred to op.20 robot 3

- 16. Moved laser scanner which a worker received more space for manipulation

PLAN / PLANIRANJE		DO / DELOVANJE	CHECK / PROVERA	ACT / POSTUPANJE
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### Takt time body line

Broj minuta u smeni /  
Number of minutes in  
the shift : 450 min



Number of workers: 18 + 2 (replacement)

Realized tact time < 3,46 min.

Figure 8&9 – Countermeasures taken and achieved results

### Benefit - B

Theme / Tema	Description / Opis	PLAN / PLANIRANJE Data / Podaci - Note / Priloge	Causes anal. / Analiza uzroka	DO / DELOVANJE Activity / Aktivnosti	CHECK / PROVERA Verification / Verifikacija	ACT / POSTUPANJE Consolidation / Standardizacija
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#### Facts and calculations

PODACI / FACTS	Worker gross wages	Total number of workers	Production plan for 2010
	15 € / day	110	15 000 bodies

CALCULATIONS	Number of workers	Number of body per shift	Worker/body	Required number of workers in 2010.	Required number of working days
Current state	19	120	19 / 120 = 0,158	0,158 x 15 000 = 2370	15 000 / 120 = 125
New state	20	130	20 / 130 = 0,154	0,154 x 15 000 = 2310	15 000 / 130 = 115

BENEFIT	Workers per year	Working days per year	Workers per day	Benefit 1	Benefit 2	Total benefit
	2370-2310 = 60	125-115 = 10	60 / 115 = 0,52	0,52 x 115 days x 15€/day = 897 €	110 workers x 15€/day x 10 days = 16500 €	897 + 16500 = 17 397 €

### Costs - C

Theme / Tema	Description / Opis	PLAN / PLANIRANJE Data / Podaci - Note / Priloge	Causes anal. / Analiza uzroka	DO / DELOVANJE Activity / Aktivnosti	CHECK / PROVERA Verification / Verifikacija	ACT / POSTUPANJE Consolidation / Standardizacija
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#### Facts and calculations

PODACI / FACTS	Worker gross wages	Employers gross wages
	15 € / day	20 € / day

#### Costs of people:

Preparation of the welding machine and guns for welding and install:

5 workers x 3 days x 15 € = **225 €**

Setting of welding robots : 1 worker x 1 day x 15 € = **15 €**

Moving the laser scanner : 2 workers x 1 day x 15 € = **30 €**

The involvement of technology and technologists maintenance : 2 workers x 2 days x 20 € = **80 €**

The involvement team for the project : 4 workers x 1 day x 20 € = **80 €**

#### Costs of material:

Holder electrodes and electrodes: **500 €**

Other material: **100 €**

Petrol: **20 €**

**Total costs:**  
225 + 15 + 30 + 80 + 80 + 500 + 100 + 20 = 1050 €

### Benefit / Costs - B/C

Theme / Tema	Description / Opis	PLAN / PLANIRANJE Data / Podaci - Note / Priloge	Causes anal. / Analiza uzroka	DO / DELOVANJE Activity / Aktivnosti	CHECK / PROVERA Verification / Verifikacija	ACT / POSTUPANJE Consolidation / Standardizacija
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Benefit / costs – B/C = 17397 / 1050 €

B/C = 16,57

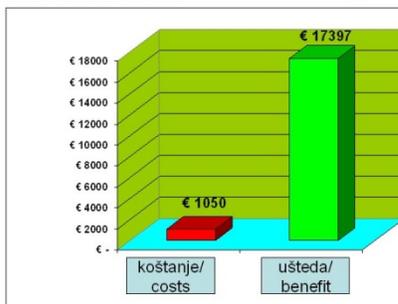


Figure 10 – Cost Benefit Analysis

#### 4. CONCLUSION

In a world class company, there are a few positive differences in many aspects from other companies. There is no short cut to become a world class one. The essence of success is to do right things thoroughly. Company should not make wrong efforts but right

efforts to become a world class one. To apply WCM gives a way to become a world class one. For this company must create competent leaders. WCM implementation is a matter of time. The main question is whether it is possible to have long term commitment of the top management?

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