Faculty of Economics, University of Niš, 16 October 2015

International Scientific Conference

CHALLENGES IN BUSINESS AND ECONOMICS: GROWTH, COMPETITIVENESS AND INNOVATIONS

EXAMINING THE EFFECTS OF THE MANUFACTURING COSTS USING TEARDOWN ANALYSIS TO MINIMIZE THE COSTS

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Abstract: *Teardown analysis is often used due to shorter product life cycle and high competition in the market for many purposes as cost minimization, functionality and innovation. However, teardown analysis which has been used for generations is only examined with the cost dimension in this research. The firms using teardown analysis should pay attention to the positive and negative effects of item changes on manufacturing overhead costs or direct labor expenses. As a result of the research it is found that teardown analysis is an effective technique to reduce costs without any decrease in the quality of the product. Consequently, it can be said that gaining cost advantage by using teardown analysis will increase the competitiveness of the firms.*

Keywords*: Competitiveness, Cost Minimization, Teardown analysis.*

1. Introduction

In the light of the recent developments in technology and change in the consumption habits, competition has become fierce than ever. These developments changed the structure, profitability and knowledge requirements of the companies. Consumers in today's global market are demanding better, improved and more functional products both small and large. These demands pave the way for rapid changes in products and shortens the life cycle of the products.

In order to survive in this rapidly changing environment, companies must obtain the information which will create a difference in products' functionality, design or cost. Easiest way of obtaining the information is examining the products of your rivals. This technique has been used for generations. The Assyrian army was using a type of chariot, and then the Egyptians captured one of the chariots and as a result of the examination process a superior Egyptian chariot was developed and was mass produced. The Roman navy was inferior to the Carthaginians until a storm wrecked several Carthaginian

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Quinquereme[1] on the Italian coast. By copying the design, better ships were built by the Roman navy. The cans which were used by the Germans to carry gasoline were noticed by the British and American forces. When it was reverse engineered and developed it was named "Jerry Can". American B-29 bombers landed on USSR land and in a few years the Soviets made the perfect copy by reverse-engineering which they called "Tupolev Tu-4". After the Second World War, Soviets captured several German scientists who had worked in German V-2 rocket production. At the end they built "Soviet R-1 Rocket" and "The Space Race" between America and the Soviet Union commenced. In 1958, an AIM 9 Sidewinder Missile was fired from Taiwan at an MİG-17 fighter. It didn't explode and lodged into the side of the jet. When the pilot landed, Russian scientists reverse engineered and created the "Vympel K-13 Missile". In 1975 Iran was in negotiations with the USA for TOW and Maverick Missile. Because of the 1979 revolution diplomatic relations ended but Iran was successful in reverse engineering and this new missile known as "Toophan" was created (www.firstratemold.com; www.historylist.wordpress.com).

Today, copying products directly or getting information from rivals in illegal ways which is known as corporate espionage or technology espionage is not tolerated. All kind of intellectual property which consist of copyrights, patents, industrial design rights, trademarks, trade dress, trade secrets are under the protection of the law. When any infringement in these intellectual property rights is realized, some legal penalties like paying for the caused damage, fine, attorney fees, court costs etc. have to be paid. In 2001 Procter&Gamble acknowledged the industrial espionage that they had taken documents from trash cans outside the Chicago offices of Unilever. At the end P&G had to pay Unilever about $10 million (www.nytimes.com).

Within the legal boundaries companies must survive and keep differentiating their products or reducing the costs. Porter has described that firms achieve and maintain competitive advantage by applying three general types of strategy namely cost leadership, differentiation and focus. Cost leadership suggests that the firm should offer products to its customers at the lowest cost in order to achieve competitive advantage. Differentiation strategy suggests that the firm should offer a variety of products or features which are different from its rivals, to its' customers. In the focus strategy the firm concentrates on few or selected markets and use differentiation or cost leadership or both by adapting its features to this target group (Porter, 1985). The firms in today's globalized world can use teardown analysis to reach the differentiation and cost leadership strategies. Teardown analysis gives the firms the opportunity to examine the costs, materials, working logic and determining the value adding features of the rivals' products within the legal framework. During the teardown analysis process not only creative ideas may occur about adding new features to the design or functionality but also cost minimization options are discussed.

Teardown analysis can help firms to survive in this high and fierce competition. That's why, teardown analysis has been introduced in the research at the beginning, and then its impact on direct working hours, direct material and manufacturing overhead costs explained with an application.

[1] Quinquereme is a type of ship used by the navy propelled by oarsmen.

2. Teardown Analysis

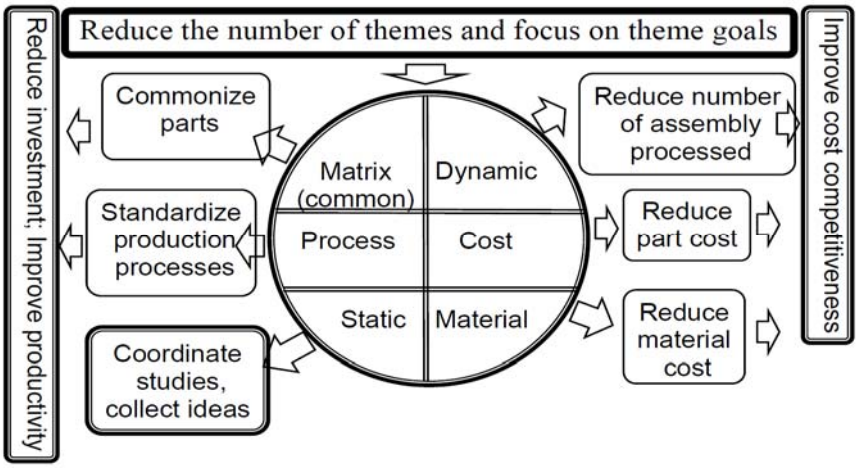
One of the first implementation of product teardown was made by US auto industry in the 1960's. Rivals' vehicles were operated, tested and then torn down for displaying the parts on tables in a large building to the engineers, manufacturing experts and marketing personnel for developing different ideas. In the early 1970's General Motor introduced teardown analysis to Isuzu (Gerhart and Rand 2006, 6). During the introduction process Yoshihiko Sato learned teardown analysis and developed the methodology to become more extensive and encompassing than the original version (Rains and Sato, 2015).

Sato and Kaufman (2005, 1) define teardown analysis as "*a method of comparative analysis in which disassembled products, systems components and data are visually compared, and their functions determined, analyzed and evaluated, to improve the value adding characteristics of the project under study*". Teardown can also be defined as a formal approach for learning about and modeling the functional behavior and physical components of a product in order to evaluate current status, technology, strengths, weaknesses, and opportunities for new products while establishing a baseline in terms of understanding and representation of the competition, gaining experience and knowledge for new concept development or solutions to problems (Sowinski et al. 2008, 1). Another definition of teardown analysis is the process of taking apart a product to understand how and what makes the product succeed in order to serve three primary purposes. First one is dissection and analysis during reverse engineering which is necessary in order to evolve the product to its next generation. Second purpose is experience and knowledge for an individual's personal database to understand how things work. Third purpose is competitive benchmarking which suggest that teardown group or team must remain competitive (Otto and Wood 2001, 198).

It is also important to differentiate teardown analysis from similar definitions like reverse engineering and benchmarking. Reverse engineering analyses a subject system to identify the system's components, their interrelations and create representation of the system in another form or at a higher level of abstraction. Generally it is used in the software industry. Focusing on the costs is the main difference of teardown analysis from reverse engineering (Chikofsky and Cross 1990; Güç 2006, 78). Benchmarking has started with the reverse engineering then developed its own methodology. When it is about benchmarking then there is mutual consent and benefit of both sides while at teardown analysis only one part benefit from obtained information (Evans et al, 2012; Güç 2006, 84).

Teardown analysis consists of six sub methods according to their focus area. These teardown methods are Dynamic, Cost, Material, Matrix, Process and Static (Rains and Sato 2015, 3). As it is seen at the Figure 1, by using teardown analysis firms try to reach two main objectives which are differentiating products and lowering costs. In order to reach one of these main objective firms use these sub methods separate, multiple or all of them at the same time.

Figure 1. Detail of the Teardown Elements



Source: Rains and Sato 2015, 3

At figure 1 six sub-elements of teardown analysis are shown and their aim summarized. But these six sub-elements of teardown analysis can be defined as below (Rains and Sato 2015, 4):

Dynamic teardown analysis; focuses on assembly process, especially effort and time it takes to assemble and disassemble the product.

Cost teardown analysis; differences with rivals components are noted and a cost estimate for this difference is determined.

Material teardown analysis; focuses on material choices, material surface treatments and altering material chemical properties through various treatments such as heat treating and stress relief.

Matrix teardown analysis; focuses on reducing part numbers through the utilization of common parts on different products.

Process teardown analysis; helps firms to minimize the process development time and production rates which leads to lower capital, tooling investment and lower piece part costs.

Static teardown analysis; is the original element of teardown presented to Sato by General Motors. In this analysis component parts are displayed to the brain team for investigation, creating new designs and cost reduction.

During the implementation process of any teardown analysis there are some common steps to be taken. It starts with defining the objective for the teardown. Then competitors should be identified and competitors' products should be procured. Data from the Web source, manufacturer datasheet, user manual and service manual should be gathered. All the technical parameters like technology assessment, product specifications and features, aesthetics, components, user interfaces should be identified based on the teardown requirements. Teardown analysis worksheets and templates should be created.

Product disassembly should be performed and after photographic images documented, performance testing on competitors' products should be conducted (HCL 2011, 6).

Today professional companies like Techinsight, MuAnalysis etc. are performing necessary steps for their customers. And all process and specifications of the analyzed product documented on a report professionally. These reports include general and technical specifications, features, dimensions, predicted manufacturing costs, each part of the product's probable cost etc. If a firm can't conduct teardown analysis properly then it can use these companies' reports as an alternative solution. But teardown analysis not only gives the company costs it also helps firms to develop new ideas about design, process and functionality. That's why conducting teardown analysis in the company is always more useful for the firms. Besides that, even if firms conduct teardown analysis, it is always helpful to obtain third party's report about the subject.

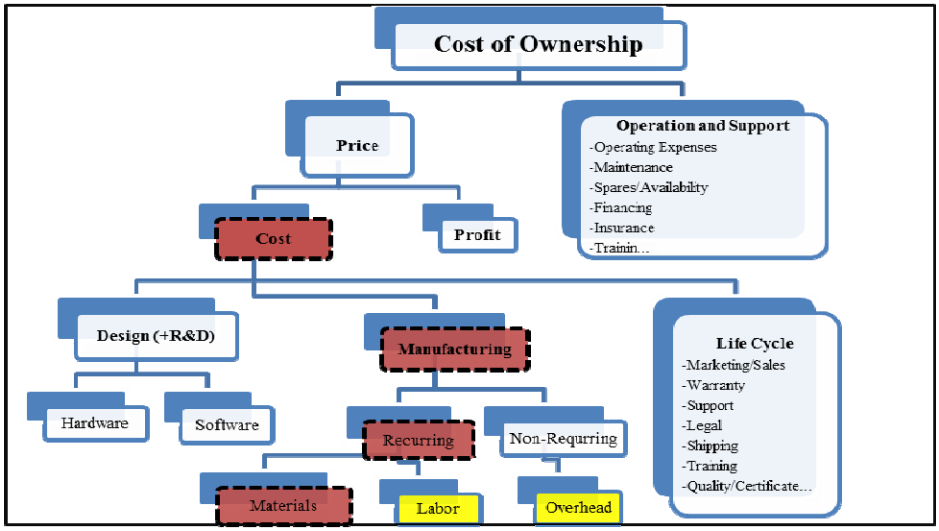
3. Effects of Teardown Analysis on the Manufacturing Costs

Cost minimization is important for the firms since they try to compete at many sectors by lowering costs (Ju et. al 2009, 216). Actually the factors like many firms in the market, high competition and shorter product life cycle force firms to minimize their costs. Especially shorter product life cycle forces firms to conclude their cost minimization efforts in a limited time.

Structure of the production costs consist of different costs which occurred during the production. That's why teardown analysis focus on 3 main points for cost minimization:

1. Minimizing the direct raw materials and supplies expenses,
2. Minimizing the direct labor expenses,
3. Minimizing the manufacturing overhead costs.

Figure 2. Cost Analysis



Source: Sandborn et al. 2009, 3; Okutmuş and Kahveci 2015

Costs consist of materials, labor and overhead expenses as it is seen at the Figure 1 and cost minimization efforts are focused on these three main points. However, before taking the decision to change a direct raw materials and supplies according to the teardown analysis, it is also necessary to evaluate this decision's effects on direct labor expenses and manufacturing overhead costs (Okutmuş and Kahveci, 2015). For example, after the teardown analysis it is found out that the firm buys X material for 10 ₺[2] while his rival is buying it for 8 ₺. At first sight, it seems to be logical to buy the rival's material for 8 ₺ due to lower cost. But after the evaluation of this material's effects on other costs, it is found that direct labor expenses will increase 2 ₺ and manufacturing overhead costs will increase 1.50 ₺. So changing this material is no longer logical because its total cost will be 11.50 ₺ with the additional costs. Detailed analysis should be made about cost elements during the teardown analysis with cost dimension.

In the teardown analysis it is also possible to only focus on direct labor expenses and manufacturing overhead costs without taking the decision to change direct materials. After the teardown analysis, choosing the indirect material used in rival's product, the firm will lower its manufacturing overhead costs without changing any direct material. After the teardown analysis it is also possible to lower the manufacturing overhead costs by totally eliminating an indirect material. For example using silicon for fixing a material instead of four screws will not only improve heat isolation but also lower manufacturing overhead costs. Apart from these, using silicon will shorten the direct labor hours spent per unit and in total will lower the direct labor expenses.

First, firm tear its own product down and list the parts while conducting teardown analysis with cost dimension. Then rival's products are torn down and similar items are analyzed in means of durability, weight, functionality and cost. These items' direct material costs, direct labor expenses and their percentage in the total cost are estimated. Items which have the highest percentage of total cost should be focused first. Item costs of rival's product are compared with the item costs of the firm's product and price differences between items are determined. Besides that, effects of possible item changes to direct labor expenses and manufacturing overhead costs are analyzed. Finally cost minimization for each item is listed in a table in case of the firm decides to use cheaper items in the products. That also shows total cost minimization in one product after teardown analysis and reported to the management for final decision (Okutmuş and Kahveci, 2015).

4. Examining the Manufacturing Costs with Teardown Analysis: An Application

X gun factory was established in 2005 in Beyşehir/Turkey. Factory's production is focused on shotguns and exports 95% of its products. The factory operates on 7.000 m² land and in 2.500 m² indoor space. Main products of the company are pump-action, automatic, semi-automatic and over&under. So in total 13 different types of shotgun are produced. 34 employees work at the manufacturing department while 16 employees work at the other departments in the factory. Firm's GA-33 basic model semi-automatic has been selected for the teardown analysis. Main features of the GA-33 are gas operated system, 12 caliber, 55 cm barrel length, manual safety, 3,2 kg weight, plastic fore-end

[2] ₺ is the currency sign for Turkish Lira.

and black color. Rival's product RP-22 which is chosen for teardown analysis has the same features as GA-33.

Factory's total production capacity is 5.000 units in a month. Components of GA-33 is produced in the CNC machines (factory has 11 CNC machines) and combined with the outsourced materials in the montage department. After routine tests like barrel tests and shooting tests are done products are packed for shipping. X gun factory selling price of GA-33 is 400 ₺ ($140). Data used in the analysis belongs to the February 2015. Before teardown analysis, factory's total manufacturing costs consisted of 556.975 ₺ direct raw material, 27.508 ₺ direct labor expenses, and 205.500 ₺ manufacturing overhead costs in February 2015.

GA-33 consists of 28 main components. These components are shown at the Figure 3 below.

Figure 3. GA-33 Basic Model Semi-Automatic Shotgun Item List

1	Barrel	8	Action	15	Extractor	22	Butt Plate
2	Choke	9	Locking Lugs	16	Trigger Guard	23	Magazine Cap
3	Front Sight	10	Sear	17	Magazine Plug	24	Receiver
4	Gas Chamber	11	Safety Lock	18	Elevator Assembly	25	Forend
5	Muzzle	12	Trigger	19	Ejector Spring	26	Spring Group
6	Magazine Tube	13	Hammer	20	Stock	27	Firing Pin Group
7	Action Slide Assembly	14	Firing Pin	21	Bolt	28	Packing Box - Warranty

Table 1. Components of Total Manufacturing Costs and Cost Percentage of Items

Item Code	Item Name	Amount of Used Item	Price	Percentage of the Cost
1	Barrel	1	8.00 ₺	7.18%
2	Choke	1	1.00 ₺	0.90%
3	Front Sight	1	1.50 ₺	1.35%
4	Gas Chamber	1	1.50 ₺	1.35%
5	Muzzle	1	3,25 ₺	2.92%
6	Magazine Tube	1	1.15 ₺	1.03%
7	Action Slide Assembly	1	6.00 ₺	5.39%
8	Action	1	1.60 ₺	1.44%
9	Locking Lugs	1	0.30 ₺	0.26%
10	Sear	1	0.25 ₺	0.22%
11	Safety Lock	1	0.25 ₺	0.22%
12	Trigger	1	0.65 ₺	0.58%
13	Hammer	1	0.35 ₺	0.31%
14	Firing Pin	1	0.70 ₺	0.63%
15	Extractor	1	0.60 ₺	0.54%
16	Trigger Guard	1	1.40 ₺	1.26%

Item Code	Item Name	Amount of Used Item	Price	Percentage of the Cost
17	Magazine Plug	1	0.30 ₺	0.27%
18	Elevator Assembly	1	2.20 ₺	1.97%
19	Ejector Spring	1	1.30 ₺	1.17%
20	Stock	1	27.00 ₺	24.24%
21	Bolt	1	3.25 ₺	2.92%
22	Butt Plate	1	1.50 ₺	1.35%
23	Magazine Cap	1	0.60 ₺	0.54%
24	Receiver	1	14.50 ₺	13.02%
25	Forend	1	20.00 ₺	17.95%
26	Spring Group	1	2.00 ₺	1.80%
27	Firing Pin Group	1	1.75 ₺	1.57%
28	Packing Box - Warranty	1	8.50 ₺	7.63%
Direct Raw Materials and Supplies		Per Unit	111.40 ₺	70.50%
Direct Labor Expenses		Per Unit	5.50 ₺	3.48%
Manufacturing Overhead Costs		Per Unit	41.10 ₺	26.01%
TOTAL MANUFACTURING COST			**158.00 ₺**	**100.00%**

Cost of each item, amount of usage and each item's percentages before teardown analysis are seen in the Table 1. Sum of 28 items' prices constitute the direct raw materials and supplies. And percentages of 28 items are calculated as percentage of direct raw materials and supplies to show their share in the direct raw materials and supplies. Direct raw materials and supplies (70.50%), direct labor expenses (3.48%) and manufacturing overhead costs (26.01%) are the main cost components of a product and their shares in the total manufacturing can also be seen in Table 1. Since item 1, item 7, item 20, item 24, item 25, item 28 which shown with the red color in the percentage column have the higher percentage in the direct raw materials and supplies, these are the costs should be focused first. Detection of any cheaper compatible item during teardown analysis will have a significant impact on the costs.

Items and item costs of the company's product GA-33 and rival's product RP-22 are seen in the Table 2. Cost differences between products are calculated by subtracting and the costs which detected as "firstly focused" in Table 1 are highlighted with red color. However, it is assumed that the rival has the same costs with the company in means of direct labor expenses and manufacturing overhead costs since it is not possible to get while conducting teardown analysis. As seen in Table 2 company has some advantages in some of the items. That's why at the last column it is suggested that firm should keep using the item or should start using the rival's item and it is assumed that item's compatibility checked up by the technical department. As seen in the Table 2 cost difference between the company and its rival is 7.13 ₺ which means the rival produces its products cheaper than the firm.

Table 2. Comparison of the Item Costs

Item Code	Item Name	Amount of Used Item	Item Costs to Company	Item Costs for Rival	Cost Difference	Suggested Items for Usage
1	Barrel	1	8.00 ₺	8.20 ₺	- 0.20 ₺	Company
2	Choke	1	1.00 ₺	0.85 ₺	0.15 ₺	Rival
3	Front Sight	1	1.50 ₺	1.50 ₺	- ₺	Company
4	Gas Chamber	1	1.50 ₺	1.35 ₺	0.15 ₺	Rival
5	Muzzle	1	3.25 ₺	3.50 ₺	- 0.25 ₺	Company
6	Magazine Tube	1	1.15 ₺	1.10 ₺	0.05 ₺	Rival
7	Action Slide Assembly	1	6.00 ₺	5.00 ₺	1.00 ₺	Rival
8	Action	1	1.60 ₺	1.60 ₺	- ₺	Company
9	Locking Lugs	1	0.30 ₺	0.27 ₺	0.03 ₺	Rival
10	Sear	1	0.25 ₺	0.25 ₺	- ₺	Company
11	Safety Lock	1	0.25 ₺	0.25 ₺	- ₺	Company
12	Trigger	1	0.65 ₺	0.75 ₺	- 0.10 ₺	Company
13	Hammer	1	0.35 ₺	0.40 ₺	- 0.05 ₺	Company
14	Firing Pin	1	0.70 ₺	0.75 ₺	- 0.05 ₺	Company
15	Extractor	1	0.60 ₺	0.55 ₺	0.05 ₺	Rival
16	Trigger Guard	1	1.40 ₺	1.50 ₺	- 0.10 ₺	Company
17	Magazine Plug	1	0.30 ₺	0.25 ₺	0.05 ₺	Rival
18	Elevator Assembly	1	2.20 ₺	2.20 ₺	- ₺	Company
19	Ejector Spring	1	1.30 ₺	1.35 ₺	- 0.05 ₺	Company
20	Stock	1	27.00 ₺	23.00 ₺	4.00 ₺	Rival
21	Bolt	1	3.25 ₺	3.10 ₺	0.15 ₺	Rival
22	Butt Plate	1	1.50 ₺	1.50 ₺	- ₺	Company
23	Magazine Cap	1	0.60 ₺	0.50 ₺	0.10 ₺	Rival
24	Receiver	1	14.50 ₺	15.00 ₺	- 0.50 ₺	Company
25	Forend	1	20.00 ₺	18.00 ₺	2.00 ₺	Rival
26	Spring Group	1	2.00 ₺	2.00 ₺	- ₺	Company
27	Firing Pin Group	1	1.75 ₺	1.55 ₺	0.20 ₺	Rival
28	Packing Box - Warranty	1	8.50 ₺	8.00 ₺	0.50 ₺	Rival
Direct Raw Materials and Supplies		Per Unit	111.40 ₺	104.27 ₺	7.13 ₺	
Direct Labor Expenses		Per Unit	5.50 ₺	5.50 ₺	0.00 ₺	
Manufacturing Overhead Costs		Per Unit	41.10 ₺	41.10 ₺	0.00 ₺	
TOTAL MANUFACTURING COST			**158.00 ₺**	**150.87 ₺**	**7.13 ₺**	

Table 3. Item Selection and Their Effects on Total Costs

	Items of the Product	Amount of Used Item	Costs Before Teardown Analysis	Suggested Items for Usage	Possible Costs After Teardown Analysis	Possible Cost Reduction	Actual Costs After Teardown Analysis
1	Barrel	1	8.00 ₺	Company	8.00 ₺	- ₺	8.00 ₺
2	Choke	1	1.00 ₺	Rival	0.85 ₺	0.15 ₺	0.85 ₺
3	Front Sight	1	1.50 ₺	Company	1.50 ₺	- ₺	1.50 ₺
4	Gas Chamber	1	1.50 ₺	Rival	1.35 ₺	0.15 ₺	1.35 ₺
5	Muzzle	1	3.25 ₺	Company	3.25 ₺	- ₺	3.25 ₺
6	Magazine Tube	1	1.15 ₺	Rival	1.10 ₺	0.05 ₺	1.10 ₺
7	Action Slide Assembly	1	*6.00 ₺*	*Company*	*5.00 ₺*	*1.00 ₺*	*6.00 ₺*
8	Action	1	1.60 ₺	Company	1.60 ₺	- ₺	1.60 ₺
9	Locking Lugs	1	0.30 ₺	Rival	0.27 ₺	0.03 ₺	0.27 ₺
10	Sear	1	0.25 ₺	Company	0.25 ₺	- ₺	0.25 ₺
11	Safety Lock	1	0.25 ₺	Company	0.25 ₺	- ₺	0.25 ₺
12	Trigger	1	0.65 ₺	Company	0.65 ₺	- ₺	0.65 ₺
13	Hammer	1	0.35 ₺	Company	0.35 ₺	- ₺	0.35 ₺
14	Firing Pin	1	0.70 ₺	Company	0.70 ₺	- ₺	0.70 ₺
15	Extractor	1	0.60 ₺	Rival	0.55 ₺	0.05 ₺	0.55 ₺
16	Trigger Guard	1	1.40 ₺	Company	1.40 ₺	- ₺	1.40 ₺
17	Magazine Plug	1	0.30 ₺	Rival	0.25 ₺	0.05 ₺	0.25 ₺
18	Elevator Assembly	1	2.20 ₺	Company	2.20 ₺	- ₺	2.20 ₺
19	Ejector Spring	1	1.30 ₺	Company	1.30 ₺	- ₺	1.30 ₺
20	Stock	1	*27.00 ₺*	*Rival*	*23.00 ₺*	*4.00 ₺*	*23.00 ₺*
21	Bolt	1	3.25 ₺	Rival	3.10 ₺	0.15 ₺	3.10 ₺
22	Butt Plate	1	1.50 ₺	Company	1.50 ₺	- ₺	1.50 ₺
23	Magazine Cap	1	0.60 ₺	Rival	0.50 ₺	0.10 ₺	0.50 ₺
24	Receiver	1	14.50 ₺	Company	14.50 ₺	- ₺	14.50 ₺
25	Forend	1	*20.00 ₺*	*Rival*	*18.00 ₺*	*2.00 ₺*	*18.00 ₺*
26	Spring Group	1	2.00 ₺	Company	2.00 ₺	- ₺	2.00 ₺
27	Firing Pin Group	1	1.75 ₺	Rival	1.55 ₺	0.20 ₺	1.55 ₺
28	Packing Box - Warranty	1	*8.50 ₺*	*Company*	*8.00 ₺*	*0.50 ₺*	*8.50 ₺*
Direct Raw Materials and Supplies		Per Unit	111.40 ₺		102.97 ₺		104.47 ₺
Direct Labor Expenses		Per Unit	5.50 ₺		5.50 ₺		4.50 ₺
Manufacturing Overhead Costs		Per Unit	41.10 ₺		41.10 ₺		34.85 ₺
TOTAL MANUFACTURING COST			**158.00 ₺**		**149.57 ₺**	**8.43 ₺**	**143.82 ₺**

Items should be selected after teardown analysis and their effects on total manufacturing costs are shown in Table 3. If the company only takes the cheaper items into consideration then costs per unit after teardown will be 149.57 ₺ as seen at the "Possible Costs After Teardown Analysis" column. "Possible Cost Reduction" column shows the difference between "Costs Before Teardown Analysis" and "Possible Costs After Teardown Analysis" and it shows 8.43 ₺ predicted total cost reduction. However,

changing an item not only reduces the direct raw material costs but also does affect the direct labor expenses and manufacturing overhead costs. At teardown analysis these effects are also taking into consideration to have a decision about keep using the company's item or start using rival's item as seen at the "Suggested Items for Usage" and "Actual Costs after Teardown Analysis" columns.

Item 1 and Item 24 were mentioned as "firstly focused" in Table 1 due to its share in the costs. They will keep using these items in the products since it is found out that company has cost advantage in them.

Rival's "action slide assembly (item 7)" is cheaper and compatible with the product of the company in means of design. But deciding to use this item will increase the assembly duration from 2 minutes to 4 minutes. These will lead 0.40 ₺ increase in manufacturing overhead costs and 1 ₺ in the direct labor expenses. At first using rivals item (5 ₺) instead of company's item (6 ₺) seems logical but it will bring additional 0.40 ₺ (5₺ + 1 ₺ + 0.40 ₺) cost in total. Because of that it is suggested that company should keep using its item after teardown analysis.

Rival's "Stock (item 20)" is assembled with two screws while company's stock is assembled with four screws. When it is decided to use rival's stock it will reduce the manufacturing overhead costs 2.5 ₺ per unit. Since two less holes will be opened by workers on the stock it will reduce the direct labor expenses 1 ₺.

Rival's "Forend (item 25) has fastenings which avoid the use of 6 screws. Because of that deciding to use rival's forend will also lead to 3.75 ₺ decrease in manufacturing overhead costs.

Cost of rival's "Packing Box-Warranty" is 0.50 ₺ cheaper but company decide to keep using its "Packing Box and Warranty" due to the quality concerns.

Company's total manufacturing cost is reduced to 143.82 ₺ from 158 ₺ per unit by taking into account all these effects of possible item changes in teardown analysis. Due to the item changes manufacturing overhead costs decreased to 34.85 ₺ from 41.50 ₺ per unit while direct labor expenses decreased to 4.50 ₺ from 5.50 ₺ per unit.

As a conclusion of teardown analysis it is seen that the company can increase its profit to 256.18 ₺ (400 ₺ -143.82 ₺) from 242 ₺ (400 ₺ - 158 ₺). So it seems that possible cost minimization is 14.18 ₺ per product and when company's 5.000 unit production in February considered, company would have 70,900 ₺ (5.000 unit*14,18 ₺) cost minimization in total. In other words the company would have 70,900 ₺ (5.000 unit*14.18 ₺) increase in the total profit. This amount is also equal to the production cost of 493 GA-33 shotguns which will lead more profit in return.

5. Conclusion

Teardown analysis is often used due to shorter product life cycle and high competition in the market for many purposes as cost minimization, functionality and innovation. In this research teardown analysis is examined with the cost dimension in a gun factory, and as a result the following findings were reached:

- The firm gained 14.18 ₺ cost advantage per unit,
- The firm's total cost advantage is 70,900 ₺ (5.000 unit*14.18 ₺) in total,
- Rival used to have 7.13 ₺ (158 ₺ - 150.87 ₺) cost advantage per unit before teardown analysis. After teardown analysis the firm gained 7.05 ₺ (150.87 ₺ - 143.82 ₺) cost advantage per unit by minimizing its costs,
- The firm decided not to use the items which will lead to an increase in manufacturing overhead costs or direct labor expenses with teardown analysis.

In the light of the findings above, even if the item in the rival's product is cheaper than the company's, it is important to pay attention to the positive and negative effects of item changes on manufacturing overhead costs or direct labor expenses. Another important point during teardown analysis is to include experts from technical and other departments. With the teardown analysis gained cost advantage can be used for new products which are better in means of quality and functionality compared to the rivals, or this gained cost advantage can be used for satisfying the demand of customers by differentiating the product.

In this study teardown analysis is only examined with the cost dimension. In the future studies, examining the main rivals of a company with teardown analysis and representing the results would be useful for the managers. Besides that, academicians would extend the teardown literature by examining teardown analysis with differentiation dimension and compare the results with cost dimension.

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