Quality in Engineering Based on Feedback

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ABSTRACT

Quality in production these days is a very important subject for all manufactures. Several researches mention customer's dissatisfaction with quality of products they buy. Quality experts concentrate on the relations between quality and products, for example the relation between quality and price, between quality and market share, generally speaking, quality improvement projects may lead to higher or lower total profits?.

This study has two main chapters; first chapter shows a project about quality problem for window lifter part of car in IKCO (Iran Khodro Company) which explains what are the steps for solving a quality problem in a specified factory (car producer factory) based on feedback. Following chapters explain a structure of quality improvement process that can be used for any kind of quality improvement project. It also deals with quality problem in any kind of factory.

Keywords: Quality, window lifter, IKCO, questionnaire forms, action plan, side effects, project team, feedback, feasibility studying

ÖZ

Günümüzde kalite tüm üreticiler için önemli bir konudur. Sadece bazı araştırmalar, müşterilerin satın almış olduğu ürünlerdeki kalite memnuniyetsizliği konusunu ele almaktadır. Kalite uzmanlarının odaklanmış olduğu kalite ve ürün arasındaki ilişkilere örnek olarak; kalite ve fiyat, kalite ve ürünün piyasadaki payı sayılabilir fakat genel anlamda kalite artırımı projelerinin toplam karı artıracağına mı ya da azaltağına mı yoğunlaşmaktadır.

Bu çalışma iki bölümden oluşmaktadır; ilk bölümde çalışma İKCO(İran Khodro Şirketi)'nun araç pencere kaldıraçlarındaki kalite problemlerinin çözümünde araç üretici firmaları tarafından kullanılan geri bildirim temelli kalite geliştirme adımlarını içeren bir projeyi açıklamaktadır. İlerleyen bölümlerde kalite geliştirme projelerinde kullanılabilecek, kalite geliştirme süreçleri yapılarından ve her üretim tesisinde karşılaşılabilecek kalite problemlerinden bahsedilmektedir.

Anahatar kelimeler: Kalite, pencere kaldıracı, İKCO, anket formları, eylem planı, yan etkiler, proje takımı, geri bildirim, makuliyet araştırmaları.

DEDICATION

To my mother for her guidance and support during all my life.

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Chapter 1

INTRODUCTION

1.1 History of IKCO

Iran Khodro Company was established in August 1962. In 1966, Iran Khodro started to cooperate with Rootes Company to produce a sedan named 'Paykan'. Untill 1978 Paykan was montaged in many types of station, basic, sport, deluxe and etc. Buses were produced as super deluxe and rural, also ambulances and minibuses were produced in the 'Iran National'.

In 1974, simultaneous with the exchange revenues and higher price of petrol, 'Iran National' chose to montage Peugeot automobiles. In 1977, the company started to produce Peugeot 305 which replaced by Paykan that had passed its time. In 1985 Peugeot 405 sedan produced under the control of the Ministry of Industries and IDRO (Iran's Industries Development and Renovation Organization). Paykan was returned on assembly line in 1991, and SAPCO (Supplying Automotive Parts Company of Iran Khodro) was established. The year of great improvement as Iran Khodro planned a program for 7-year was 1994. One of achievements in this program was improvement in quality which remained stable. Iran Khodro R&D (research and development) center was established with considerable investment, lead to Samand sedan was produced. Iran Khodro In 2002, planned a program for 10-year leaded to globalization and improvement in quality, wide range of product,

especially Paykan phase-out, Samand models, competitiveness, and transferring of technology.

In 2003, Samand, Pars and Peugeot 206 sedan were produced. In 2004, two sedans of Samand Lx and Pars ELX were presented to the market. In 2005, Paykan phase-out regarded to better customer satisfaction. In this time also, CNG-based engine was designed by Iran Khodro and presented for markets. In 2006, Samand sedan assembly lines and the national engine assembly line in Belarus, Azerbaijan and Syria launched to produce. Meanwhile, Tondar 90 sedan (Renault Logan) joined Iran Khodro automobiles, Samand project in Venezuela also launched this year.

In 2008, the company presented Samand Soren to the market. Moreover, Iran's Industrial Management Organization announced IKCO as the best company under the titles of:

1. Best industrial group in Iran's car producer companies
2. Best of all pioneer companies in Iran
3. First rank in Sale
4. First rank in job creation
5. Second rank in profitability

Latest IKCO's automobile Dena includes high standards regarding technology and design. This sedan was presented on April 2011.

1.2 Subsidiaries

There are some subsidiaries that we can list them as follows:

IKCO spare parts & after sales services (ISACO), Auto parts Supplying, Engineering & Designing (SAPCO), Iran Auto Parts Industrial Group (IAPCO), Industrial Service Engineering of Iran khodro Co. (ISEIKCO), Iran Khodro Customized Automotive Production Company (OPCO), Iran Khodro Automobiles Peugeot Joint Venture Company (IKAP), etc.

1.3 Production and Size

The company is the biggest car producer in the North Africa, Central Asia and Middle East. In Iran, it is the biggest car producer company, having an average share of 65 percent of domestic car manufacturing. IKCO has 12 production sites, 6 sites inside of Iran and 6 other in outside markets.

Table 1: Domestic Plants of IKCO [Source: IKCO Documents]

Plant	Production Capacity	Product	Location
IKCO (main plant)	700000	Roa, Peugeot 405, Peugeot 206 family, Peugeot 207i, Samand, Tondar 90, Soren family,	Tehran
Tabriz	120000	Samand EF7, Samand Arisan Instead of Bardo Pick-up Paykan	Tabriz
Fars	30000	Pars Sedan (Peugeot 405 and samand to be produced later)	Shiraz
Semnan*	100000	Samand family	Semnan
Khorasan	150000	Suzuki Grand Vitara, Pars, Peugeot 405	Mashhad
Mazandaran	15000	Samand Sarir	Babol

1.4 Export Markets

The company won the annual national prize for export activities in years 2006, 2007. Syria, Russia, Iraq, Turkey, Ukraine, Azerbaijan, Algeria, Bulgaria and Egypt are among the most important aim markets for the group. In 2004, Iran Khodro group moved to global markets, the company has exported more than 150,000 units of automobiles in different models and classes to other countries mainly in Middle East region. By this Iran Khodro has ranked as 24th company between 100 top companies in Islamic world in year 2008. The company plans to increase its exports to more than 600,000 automobiles per year in 2018. IKCO also planned to get a 51% share of the Iranian market in 2018, while improving the quality of its products. Iran Khodro is currently exporting its productions to almost 40 countries around the world.

Table 2: Foreign Sites [source: IKCO Documents]

Plant	Production Capacity	Product	Location
Unison	60000	Samand	Belarus
Azsamand	10000	Samand	Azerbaijan
SIAMCO	30000	Samand	Syria
CDC	15000	Peugeot Pars	Egypt
SENIRAUTO	30000	Samand	Senegal
VENIRAUTO	16000	Samand	Venezuela

1.5 Aim of the Study

Nowadays production's quality is a very crucial issue for all producers because if the product has good quality, it will have a good feedback in market and company can be competitive in market. In IKCO, quality is one of the most important issues for products because there are more than 2 main competitors (SAIPA and PARS KHODRO) in IRAN market and also there is a standard organization that according

to a quality checklist they categorize products according to their grade and quality parameters. In this work at first part we will study an empirical project about quality improvement based on feedback and collecting data from customers that has been done in IKCO and in second part we organized and introduce a structure for implementing of quality improvement in a factory in general way.

1.6 Research Methodologies

For studying about quality problems in a factory, we need to get feedback from clients in aftersales offices, collecting data, analyze data, prepare and present an action plan to solve the problem. As follows, we can see steps for this method:

1. Collecting data by inquiry forms from customers in aftersales representative offices and production line quality experts

2. Analyzing data by excel to find out what are the major and minor problems and the affecting of action plans on parts based on feedback

3. Doing action plans by redesigning, renew and changing material of parts by redrawing and correcting of molds, etc.

Chapter 2

LITERATURE REVIEW

2.1 General Aspect of Quality

Nowadays production's quality is a very crucial issue for all producers. Experts focused on the correlations of quality, for example what is the relation between price and quality, between market share and quality. Five essential methods to define quality can be mentioned as follows:

1. The transcendent method of philosophy
2. The relation between economics and product based method
3. The user based method of economics marketing and operations management
4. The manufacturing based method
5. Value-based method of operation management

2.1.1 The Transcendent Method of Philosophy

Quality is meeting the highest standard which it doesn't mean satisfying with the fraudulent or sloppy. For achieving higher quality, it needs to define new methods and standards according to need of customers to stay competitive in markets.

2.1.2 The Product Based Method

Quality defined by the amounts of the priceless manner included in each unit of the priced manner. Product based explanations are completely different, they explain quality as a measurable variable and precise. Referring to this view, differences in quality show differences in the quantity of some ingredient or manner of production procedure.

2.1.3 The User Based Method of Economics Marketing and Operations Management

Quality includes capacity to satisfy requirements and also is the definition that a special product meet the requirements of a special clients. Quality is any characteristics of a product consisting the services included in the contract of sales, which affects the demand function. In conclusion, quality involves the service specifications that you want.

2.1.4 The Manufacturing Based Method

Quality means conformity with requirements. Quality is the degree to which a special product adapts to a design or characteristic.

2.1.5 Value Based Method of Implementation Management

Quality is defined by achieving an affordable price and reaching the affordable cost.Quality means best certain client conditions, these conditions are:

1. The real use
2. The selling price of the product

Marketing members typically take a user-based or product-based method to the subject. For them, higher quality defines by better function. Manufacturing members normally take a different method. For them quality means conformity to characteristics. Manufacturing members usually expect quality boosts that result in cost saving.

2.1.6 Eight Factors of Quality

1. Function
2. Perspective
3. Reliability
4. Conformity

5. Endurance

6. After sale service

7. Elegance

8. Perceived quality

2.1.7 Correlates of Quality

Managers are eager in quality primarily because of its financial implications and marketing. Attention must be concentrated on the separated factors of quality. Markets must be closely tested for any untapped quality niches and the companies must be tailored to keep the desired concentration. Once these methods have been adopted, cost reduction, market share gains and profitability boosts can hardly be far behind [1]. Perceived quality is one of the most crucial factors underlying success of automotive manufacturers today. From an engineering point of view, perceived quality is explained in the literatures mainly by the work that assesses different aspects of perceived quality in order to evaluate them in the primary design levels [2].The studies show that no theoretical framework has yet been obeyed that mix the engineering perspectives of this broad term and client view on perceived quality. There is a need to standardize the terminology and explanations connected to perceived quality more concretely. The studies show that, there is also a connection between theoretical frameworks in a try to make a model, consisting different concepts of perceived quality regarding car manufactures requirements [2].

2.2 Quality in Industry

The studies show that, despite the development in making subjective product characteristics objective and searching them made by sophisticated methods, it is not true to believe that one could explain a unique and clear set of requirements from the beginning of a development project and the studies show that getting rid of both designers' intuition and client feedbacks along the product development timeline. There are four reasons for the product development:

Conformity of factors and clients, number of factors (cultural ones have been noticed for all sectors), necessary trade-offs within the company and decisions made progressively along the product development timeline. We can also study for the three industrial sectors: automotive design (especially acoustics and driving comfort), fashion design and food design [3]. They are very different in the nature of information and actors that affect the power of the product design path to cumulate the subjective specifications of a product. Each sector has its own manner and rules to consider requirements, making an idea, prototypes and client tests and product design path launch. Feature investigations are desired allow bettering finding why design experiences can be too much different in different industrial areas [3]. High quality product has been one of the keys to Japanese success in American markets. Today, many American companies are also beginning to detect its competitive importance [4]. The studies show that finding brand reputation has a "double" benefit. High-reputation brands are rewarded three years sooner for an ascendant in quality and penalized one year studies show that for a descendant in quality compared to low-reputation brands. These differences in definite time are a meaningful measure of brand equity. Finally, the studies show that testing the

differences between quality, effects across several product- and field-specific variety and search for the results of our studying[5], [6].

2.3 Quality in Car Manufacturing

Core values defined by: Q = quality, S = safety, E = environmental care. To conclude this concepts, the core values of VCG (Volvo Car Group's) and GTT (Volvo Group Truck Technology's) have not changed over time, but the characteristics that studies show that those core values are dynamically changing. This concept can help descend the distance between the studies show that the meaning of professionals and clients, which can guide to boost product development in world markets [7]. The following table consists of the list of manners and dependence companies and core values (core values):

(Q = quality, S = safety, E = environmental care) [7], [8].

Table 3: Core values [7]

		Cars			Trucks		
Abbr	**Attribute**	**Q**	**S**	**E**	**Q**	**S**	**E**
Abr	Active Braking					x	
Acc	Acceleration time	x			x		
ACr	Adaptive Cruise Control system					x	x
Aer	Aerodynamic exterior shape			x	x		x
Air	Air freshness	x			x		
BrN	Volvo brand name / Brand of truck	x	x	x	x	x	x
BSD	Blind spot detection system		x			x	
CO2	Carbon dioxide emissions			x			x
Com	Comfort	x			x		
CSF	Colors and surface finish	x			x		
CSS	City safety system (low speed crash avoidance)		x				
Dig	Digital speedometer	x	x				
DnM	Durability and maintainability	x	x	x	x	x	x
DrE	Drive-E (efficient engine technology)			x			
DST	Dynamic stability and traction control		x				
EIP	Energy absorbing instrument panel					x	
EnN	Engine noise				x		
ESP	Electronic Stability Program (ESP)					x	

The studies show that we can find several developed observation methods for the analysis of non-ideal parts. Objective of these methods is the support of product improvement by giving a geometric interpretation of tolerance impacts [8], [9]. For each presented observation method, the fundamental concept can be explained and a suitable visualization example for design support tools can be given. The studies show that, using of different methods for the analysis of individual non-ideal parts and montage for statistical analysis of multiple variants in a single scene can be suggested. For the analysis of surface data, surface smoothness can be tested by comparing surface normal. In comparison to pure gap measurements, this method studies parts separately. It is especially suitable to find dents on large sheet metal parts and unsteadiness of adjacent parts. Gaps between the studies show that parts can be examined by a large number of distance measurements [10], [11].

For product developers, it suggests better insight and meaning of tolerance influences because of a geometric representation. With his way, it also developed relations between product developers and tolerance analysis experts [9]. The studies show that we can have a conclusion that to a huge extent, an automotive company has a clear structure of reference when explaining all needed on fair output variety.

Automotive is such normal product, that the relationships between the studies show that the exterior parts are very similar on different models. This lead to, reuse of judgments and knowledge when making a new automotive model as the studies show that all as competitor analysis on a detailed numeric level. As a result, the situation at the company does probably not to include that for other less excellent products. On the other hand, this maturity makes it unlikely that other industries would show more improved method to visual quality or observed sensitivity. The relation of addressing

and observing sensitivity in product boost, as represented by this organization, depends on a quantity of conditions. These required being a risk for geometrical variation, and these required to be a realistic possibility of descending risk or to change the product aspect. Observation sensitivity is therefore relation at various stages throughout the product boost process, but not often specially addressed.

Observation sensitivity is shown in the studies by concentrating on when setting priorities with requirements and achieving a same view within a group on what aspects to develop most. The effect of the searching is that, it was the strategy of the visual quality engineers to make the requirements level according to the studies which show the possibility in every project. An impressing subject is what kinds of automatives, in terms of required product expression and target group that could support a lot, the studies show that visual quality intended levels. Also studies show that, the in-built dynamics attitude groups makes it necessary to strongly develop the importance of an attitude in order to have an impact within the automotive projects [10].

In this competitive conditions, feature means to develop the attitude would probably be examined as useful by the visual quality group, for example through enhanced method of measuring observing sensitivity or by assessment the overall visual quality function level. It has been shown that the non-nominal observation tool primarily was used for observing connectivity during meetings. Since observing sensitivity was continuously discussed at meetings, it is possible that feature knowledge in the sectors would also prepare some meaningful input to decision making and to the necessary trade-offs that we can show this as attitudes [10],[11]. In studies we have shown that concept of quality in the car industry has moved from traditional quality

and reliability attitude to more sensory and emotional parameters. Estimation of these quality types are achieved via linguistic assessment and transformed into a quantitative score for quality management goals. This methodology is known as the Final Vehicle Product Audit (FVPA). The goal is to understand the application of FVPA within the four-wheel passenger car segment of the market. The research focuses on Original Equipment Manufacturers (OEMs) and the FVPA's role within New Product Introduction (NPI) and with the supply base. This work also shows how FVPA outputs are utilised by the OEM, the process of the audit and its link to craftsmanship. A conduct survey was prepared to detect these study objectives and was sent to allothe studies show that factories within the industry. A representative sample returned the conduct survey for analysis[12].

The car interior manufactures are competitors to improve materials, that not only perform functionally, but also prepare the right mix sensory experience (e.g. observation appeal, tactile feeling) and brand variation at very competitive prices[13]. Therefore, the objective of the studies can presented by boosting a methodology that can be used to measure client requirement of interior materials and to come up with a unique system for estimating value of different interior materials. The overall methodology consists the application of quantity of psychophysical measurement methods (e.g. Semantic Differential Scaling) and statistical methods to assess,overall client perceived quality of material, factors (or attitude) of perception, value of materials from OEM's viewpoint in terms of the measurement of perception of quality divided by a measure of cost[14]. The studies show that we can explain results of two pilot researched inducted for the feature research phases:

1. Improvement of a list of adjective pairs to explain scales for total estimation/impression of the materials (e.g. Expensive-Cheap, original-Fake, Quality-Shoddy, etc.)

2. Improvement of adjective pairs to measure parameters of perception (e.g. Soft-Hard, Light-Dark, Smooth-Rough, Glossy-Flat, Slippery-Grippy, etc.)

3. Estimation of a large amount of quantity of materials of different categories (e.g. woods, plastics/composites, fabrics, metallic, etc.) using the scales developed in primary phases[13],[15]. The studies show that we can concentrate on detecting the key attitude of subcompact automotive in markets of different sections using customers in case study of Thailand. Being the important attitude when deciding about a subpart of automotive, this search looked for to estimate a dependent variable [16]. This dual method lead to the responses to attend more positions that are realistic and to take into account what they believe to be crucial. In conclusion, the results of searches can mention the important relation between studies show that each manner (i.e., the countries, the prices and functions may also vary significantly). By cluster analysis method, the studies show that it is a proper another method that sellers can use to detect market goal sections for subpart of automotive. Also, this work picked data for Thailand samples which interested for purchasing new automotive in the near future [17], [18].

Although more similar sample used in this work may have concluded in more validity responses toward the conduct survey items, which may further result in more reliable and valid hypothesis testing managerial and academic implications knowledge of purchaser behavior is one of the most crucial subjects for marketers when improving marketing activities [19]. Combine analysis is a strong method to better find which attitudes are most crucial in customer decision for buying. In

comparison with the other questionaries' methodology, combined data selection is more reliable, and prepares results are more near to the real choice manner of clients.

New studies have implied that cluster analysis with combined data can prepare valid and meaningful require-based segmentation analysis [20]. Study limitations and offers for further studies direction show that client requirements and then meeting these are crucial if manufactures are to reach and maintain competitive benefits. Future studies should select more data from subjects with a greater variety of demographic specifications, as the studies show that as from other countries [21], [22]. The studies that have been done in these researches neglected more specific appearance, like as specific safety engine designs or features.

While the total results show that car aspect is the most crucial noticeable issue when purchasing subcompact automotive, it should be mentioned that the external appearance is too hard to measure, and can involve both aspect and color and no one can ignore and it can required to everyone [23], [24].

Also, responses can be categorized by their preferences for subpart of automotive, but it is hard to categorize them in population information variables [25].

Chapter 3

QUALITY IMPROVEMENT PROJECT

3.1 Rejected Window Lifter Graphs for Types of Cars

IKCO produce 5 types of cars that called Soren,Samand,Peugeot 405,Peugeot206 and Peugeot pars. The quantity of products are variable during month and depends on many conditions such as market demands,supplying of CKD parts ,etc. By the way the quantity of products per type of cars is atleast 15000 cars per month. As follows we can see graphs for number of rejected window lifter for types of cars [see section, 4.4.1]:

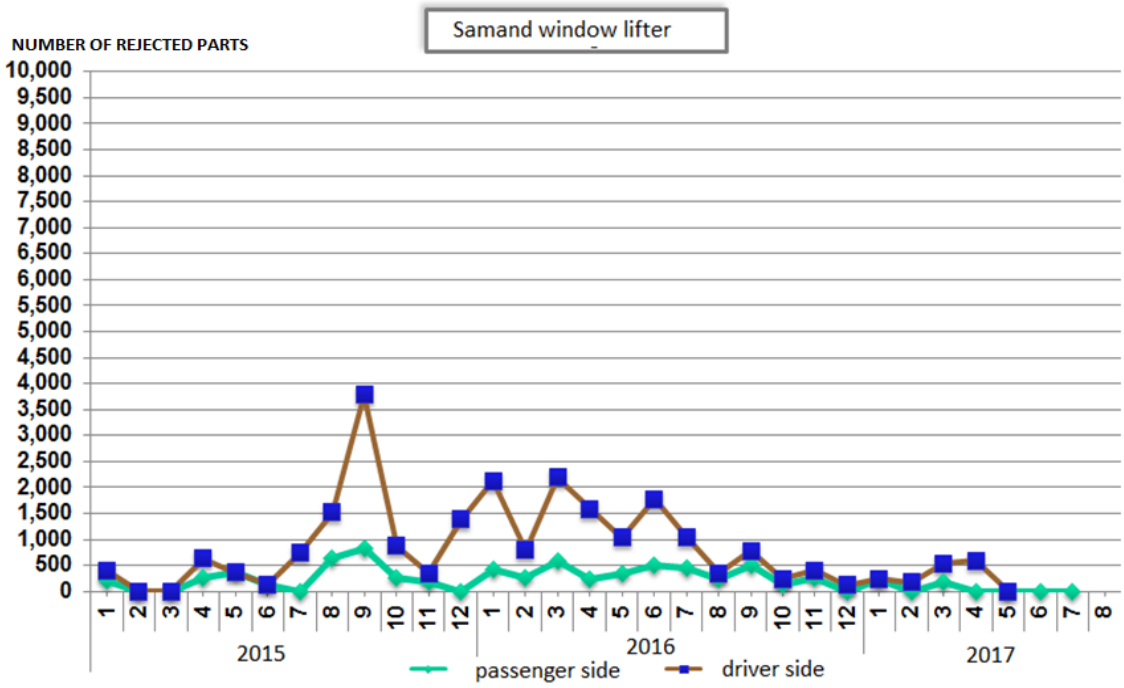


Figure 1: Samand Window Lifter Rejected Parts [Source: IKCO Documents]

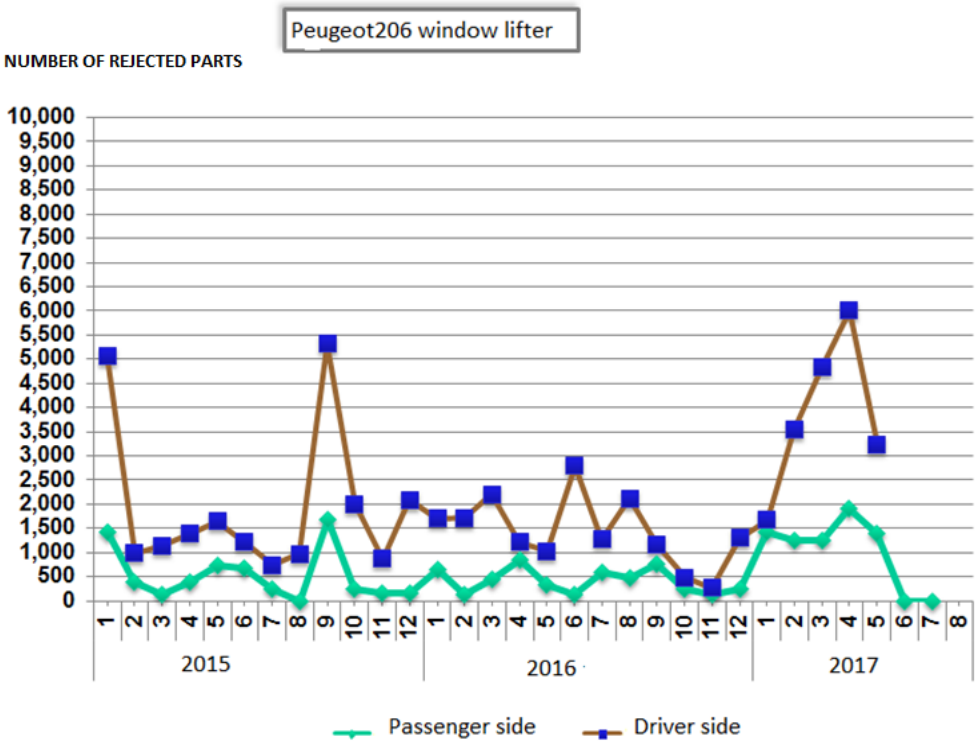


Figure 2: Peugeot 206 Window Lifter Rejected Parts [Source: IKCO Documents]

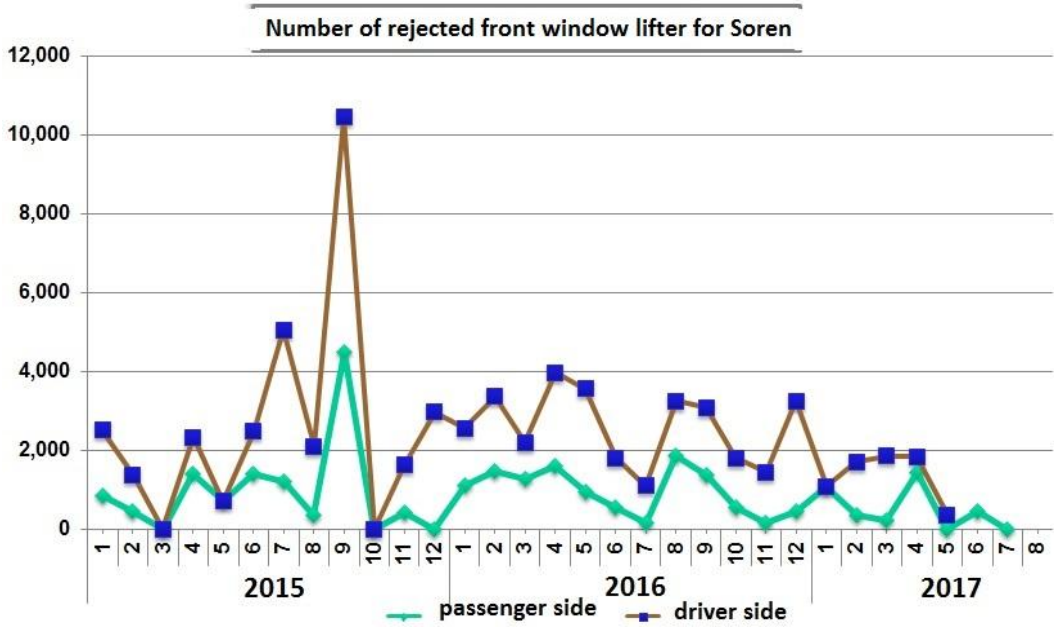


Figure 3: Soren Window Lifter Rejected Parts [Source: IKCO Documents]

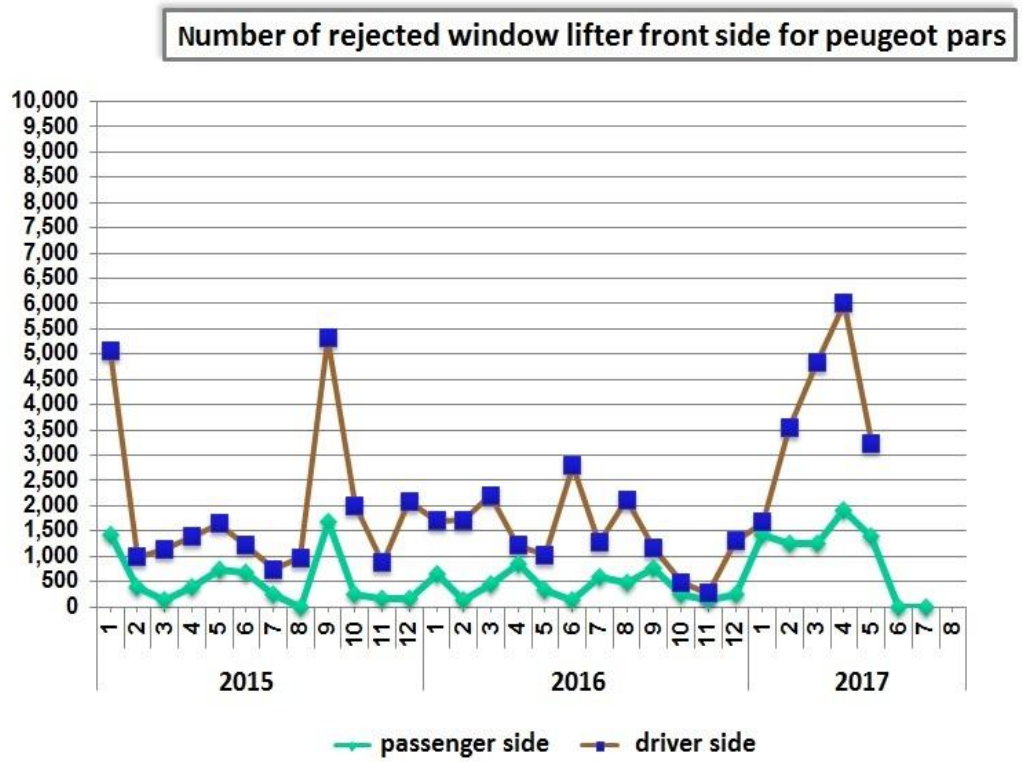


Figure 4: Peugeot Pras Window Lifter Rejected Parts [Source: IKCO Documents]

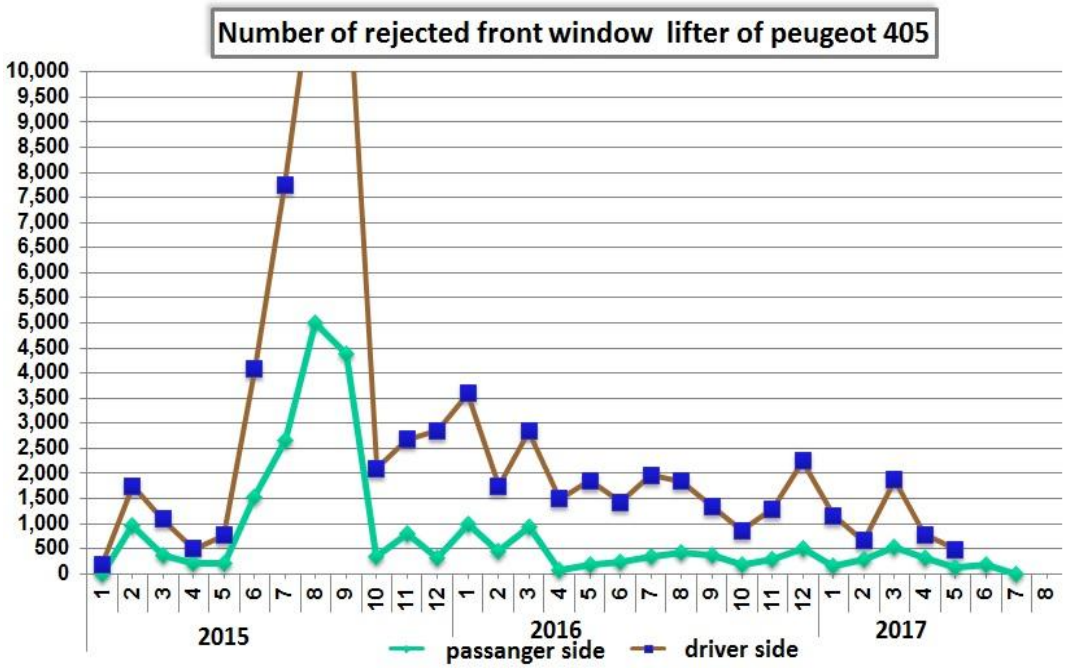


Figure 5: Peugeot 405 Window Lifter Rejected Parts [Source: IKCO Documents]

3.2 Results of Questionnaire Forms

In after sales services company, some representatives did questionnaire forms about reasons of dissatisfications for consumers,as follows we can see the sample of questionnaire form results for Peugeot 206 [see section, 4.4.1.2]:

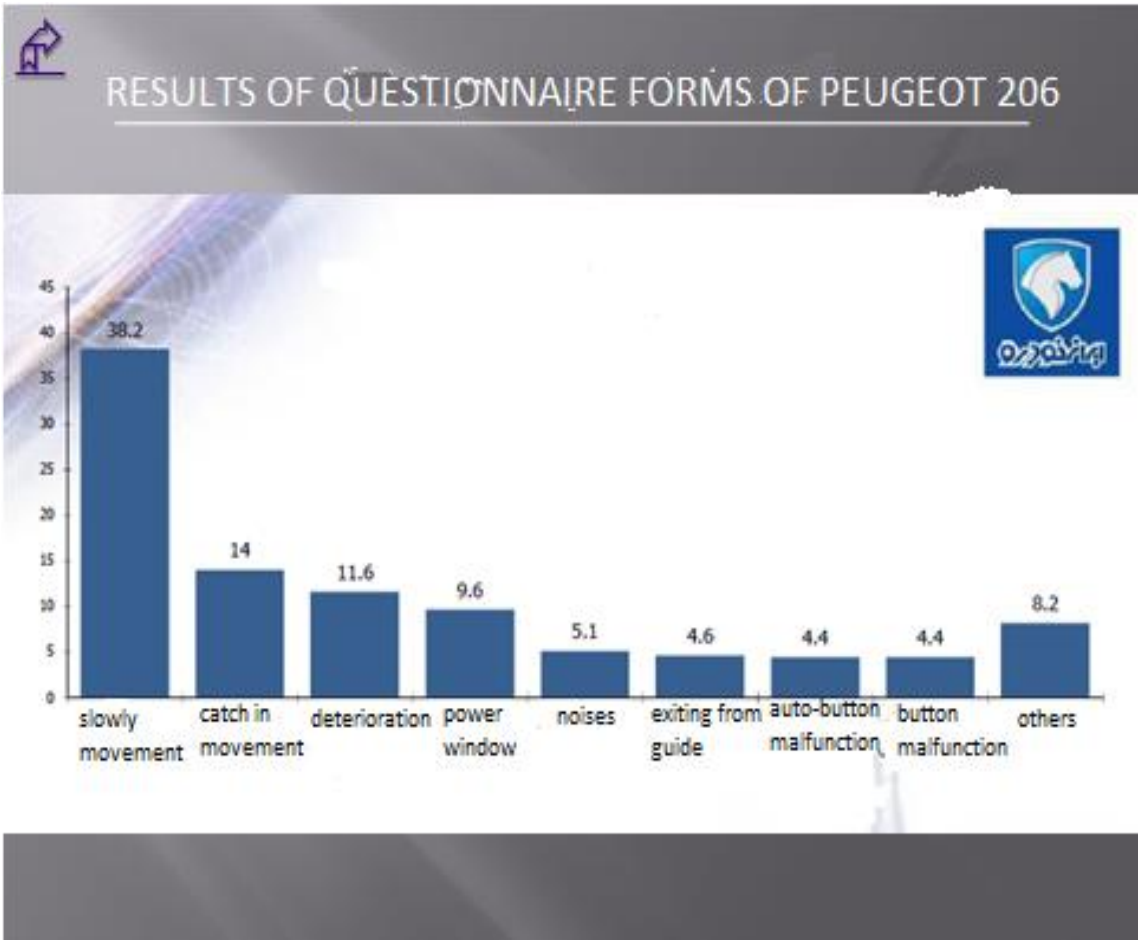


Figure 6: Results of Questionnaire Form for Peugeot 206 [Source: IKCO Document]

3.3 Structure of Some of Activities before Preparing an Action Plan

There are some steps before preparing an action plan as follows [see section, 3.2]:

3.3.1 Defining of Team Members

Before starting project, we should define members of team for all steps. We define members for this specific project as follows [see section, 4.3.1]:

- IKCO members as car producer (quality management member, product-engineering member, assembly line member),
- SAPCO members as main Supplying and Producing part Company (Quality assurance member, product design member, commercial expert),
- Supplier (quality control member, engineering department member, product department member),

3.3.2 Data Collection

- Collecting data from production line labors (technicians' interviewee)
- Collecting data from consumers in after sale-services (normal clients)
- Plotting the data for analyzing the results
- Combining of analysis

3.3.3 Paraphrasing of the Graphs

- It shows that there is a fluctuation in results of malfunction
- Malfunction in Peugeot 206 window lifter is more than Samand
- Passenger side window lifter has better results than driver side
- From questionnaire result we can conclude that there are more than one parameter effects on bad results

3.3.4 Effects of Related Parts

Within function of window lifter, there are some related parts that their dimensions and functions can affect on window lifter function. We can summarize them as follows:

- Window
- Window guide
- Exterior doorplate curve
- Interior doorplate curve
- Waterproof edge rubbers
- Side mirrors

3.3.5 Preparing of an Action Plan

The activities of the action plan are as follows:

- Checking dimensions by studying 3D & cat data drawings
- Studying test reports of a part
- Studying chain tolerances
- Checking right montage
- Implementation of correction actions

3.4 Analysis of Results (General Statement)

Figures show the number of front window lifters for five types of cars that produced in IKCO (Iran Khodro car producer Company) from 2015 to 2017, which have been rejected by after sales service companies according to malfunction and customer complain [see section, 4.4.1], [see section, 4.4.1.2]:

- Generally speaking, malfunction temporary is fluctuated, but totally fell gradually
- Number of rejected passenger side window lifters is less than driver side
- The worse results belong to Soren and the best results belong to Samand

Also determined that:

- There is more than one parameter that affects the results

- There are different parameters that affect the different types of cars

Some parts that can affect the results:

- Window lifter

- Window

- Guide

- Robber strip

- Side mirror

- Body plate (outdoor, indoor)

3.5 Structure of Action Plans

For solving the problems, we can define some actions and implement them as action plans, as follows [see section, 4.3.3], [see section, 4.4]:

- Data research (it had been done for understanding what type of cars has most crucial problem in which parts and what kind of problems are mostly reported)

- Visiting of specific cars (there are some cars which randomly chosen to study for the problems that reported, in after sales service companies)

- Using of previous studying for the same problem (if exists)

- Studying of related changes (changes that are related to other parts that work in a set) during critical periods

- Studying effects of related parts from outsourcing company by checking fixture for understanding of most affected parts

- Studying of CAD DATA for all related parts and chain tolerances

- Studying all changes during previous projects like waterproof and ORS. (Optimizing Robber Strip, sometimes for adding some options to specific device, you need to add some extra parts or change dimensions to reach the goal)

- Studying montage effect

3.6 Analysis of the Results (Detail Statement)

- According to standard of design [see section, 4.4.1.1] the resistance force during upward movement shall be maximum 8kgf (including 4kg weight of glass) but by measurement, we understood that resistance force is average 12kgf and sometimes near to 17kgf that it is too over-loaded.

- The effect of waterproof project (the motor of window lifter should be waterproof) was too low, because the dimensions change of inner body and outer body of doorplate were in tolerance range of drawing

- The effect of ORS (optimizing robber strip) on Peugeot 405 window lifter is too much (at least 2kgf extra resistance force) but on other types of cars has no major effect

- Studying CAD data, chain tolerances, test reports and measuring dimensions for all related parts

- Wrong montage also has a major effect on resistance force and it shall be considered as a major effect as follows [see section, 4.4.1.3.3]:

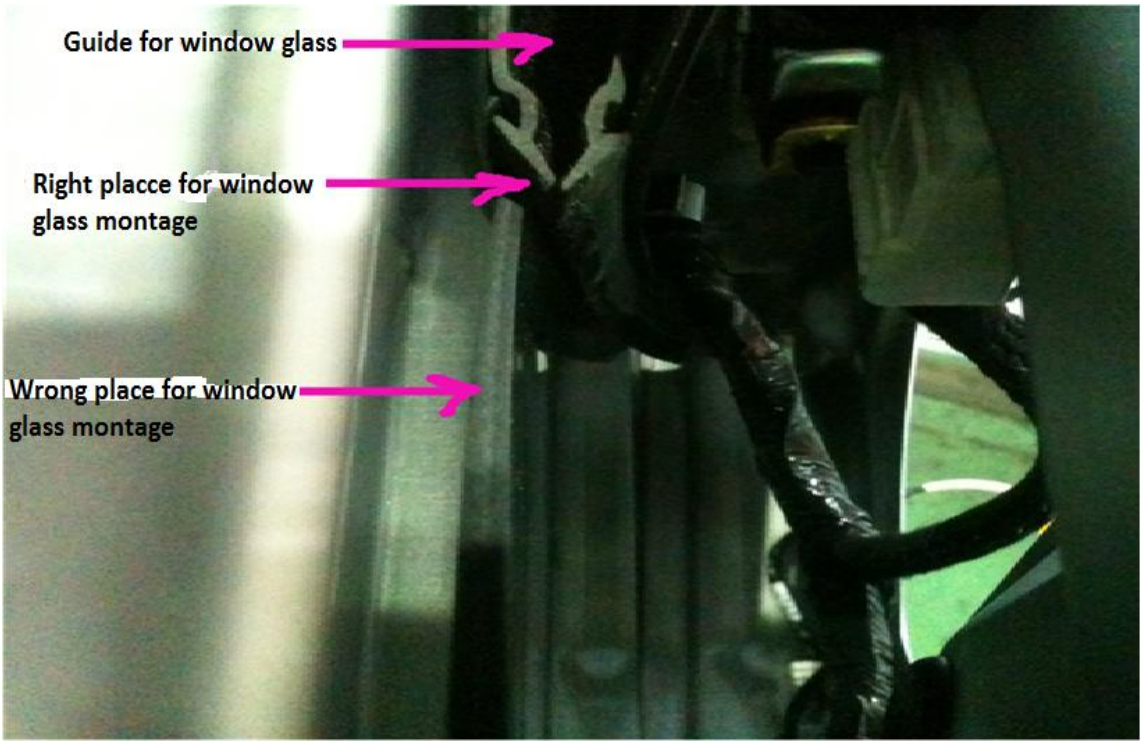


Figure 7: Wrong Montage Effect [Source: IKCO Assembly Line Documents]

3.7 Landscape

We predict that by implementation of above action plans, we can meet the goal by decreasing the quantity of rejected parts fewer than 500 per month and the fluctuation will be under control. Most dissatisfaction that to be announced from the voice of customers departments:

- Slowly movement (announced from customers and production line)
- Temporary malfunction (announced from customers and production line)
- Permanently malfunction (announced from customer)

For studying all levels of action plans, troubleshooting, getting feedback, implementation of changes, etc. We need to create a team during the process that included these members.

3.8 Evidences

There are some measurements that were recorded by a force measurement instrument that shown as follows:

Figure 8: Force Measurement Instrument [Source: IKCO R&D Documents]

As follows, we can see measurements amount of resistance force for upward movement of window lifter for types of cars:

Table 4: Resistance force [source: IKCO Documents]

Type of Cars	Force in kgf
Soren	16 kgf
Peugeot 405	6-14 kgf
Peugeot Pars	6-14 kgf
Peugeot 206	6-10 kgf
Samand	14 kgf

The amount of resistance force according to standard should be maximum: 8kgf, wide range of resistance forces are related to:

- Change of material, dimensions, or design of related parts such as (robber parts and window glass)

- Wrong montage of related parts (as shown on photo)

- Heat protector (it is a sensor that according to motor temperature that increase more than a specific temperature, will cut off the electric current) and electric cut off circuit (it is a circuit that measures electric current and if the electric current is more than definition it will cut off) have not the same timing behavior (it means in some types of Cars according to E.C.U or electric control unit of cars software the time for cutting off and turning on is different).Wide range of amount of resistance force shows that there is ununiformed quality for producing the subassembly parts.

3.9 Reasons for Defects (General Statement)

3.9.1 Slow Movement

By measuring the time for upward movement (according to standard it should be maximum 4 seconds) we understand that slow in movement appears by increasing the resistance force.

3.9.2 Temporary Malfunction

Referring to an increase of resistance force and because of the function of heat sensor protector and electric cut off circuit is not steady in types of cars, it causes temporary cutting off in electricity current and temporary malfunction in window lifter, after the heat of window lifter motor decrease, it starts to work again.

3.9.3 Permanently Malfunction

When the resistance force is too much, it causes the failure of the motor or gearbox of the window lifter. Generally, slow movement or temporary malfunction appears in mirror installation zone

3.10 Suggestions

- Measuring of window glass curve, thickness and checking the position of fixing points for fixing window glass to window lifter.

- Controlling of robber strip profile

- Right montage of all related parts

- Controlling of window glass curve, guide curve and inner door curve and chain tolerances

- Setting the accurate time of heat sensor protector for cutting off the electricity current as follows:

- Increasing the minimum electric current cutting off time from 4 seconds to 15 seconds (test plan revision needed)

- Adding the definition of maximum electric current cutting off time to 60 seconds (according to KIA company standards)

- Increasing in upward movement force in window lifter set (needed to redesign of motor, gearbox, and mechanism)

3.11 Implementation of Action Plan

3.11.1 Percentage of Rejected Parts According to Type of Cars

First we need to analysis data that have been collected from after sales services and assembly line in IKCO about the percentage of rejected parts according to type of cars. As follows, we can see the table about the data that have been collected [see section, 4.1.1]:

Table 5: Rejected Window Lifter Parts in % [Source: IKCO Documents]

Rejected Window Lifter Parts in %		
Type of Car	Driver Window Lifter Rejected Parts in %	Passenger Window Lifter Rejected Parts in %
Soren	33%	44%
Peugeot 405	26%	23%
Peugeot Pars	20%	11%
Peugeot 206	13%	11%
Samand	8%	11%

3.11.2 Frequency of Defections Recognized According to Existence

There are 3 main reasons for malfunction of window lifter recognized according to existence. Defect of spiral gearwheel, waterproof problem of electric motor (electric motor of window lifter should be waterproof) and other defects. As follows, we can see the table included the percentage of defects according to existence [see section, 4.1.1].

Table 6: Frequency of Defects in % [Source: IKCO Documents]

Type of Defects	Reason of Malfunction in %
Defect of Spiral Gearwheel	45% to 50%
Water Proof Problem of motor	40% to 45%
Other Defects	5% to 15%

As follows, we can see details of defection percentage graph:

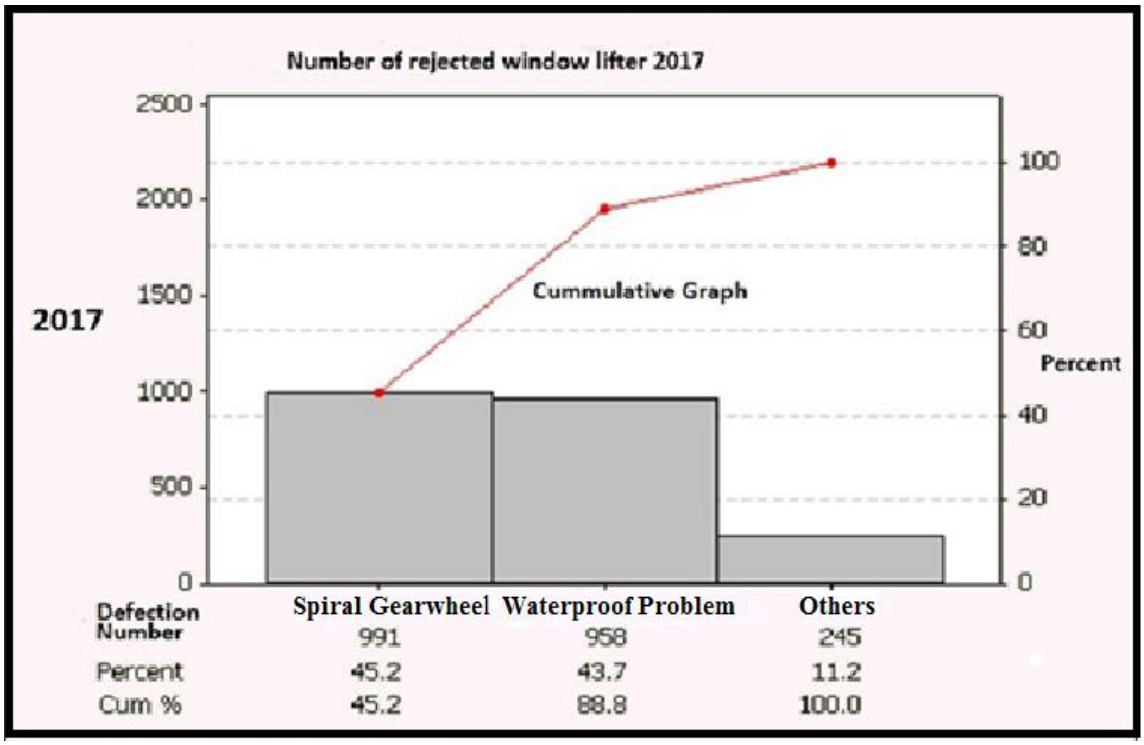


Figure 9: Defections Graph [Source: IKCO Documents]

Referring to side effects of other related parameters during function of window lifter such as window glass, doorplate, strip, etc., we should study side effects of related parts.

3.11.3 Studying Side Effects of Related Parts for Diagnostics Test

As we discussed, some related parts can affect on malfunction of window lifter set that we study as side effect of related parts. By here, we can study about some problems that occurred during window lifter operation, analysis of cause and action plans for solving problem as follows:

- Window lifter malfunction
- Noise during operation
- Window glass will be out of guide during window lifter operation

(Note: figures 10 to 16 are taken from the documentation of the suppliers)

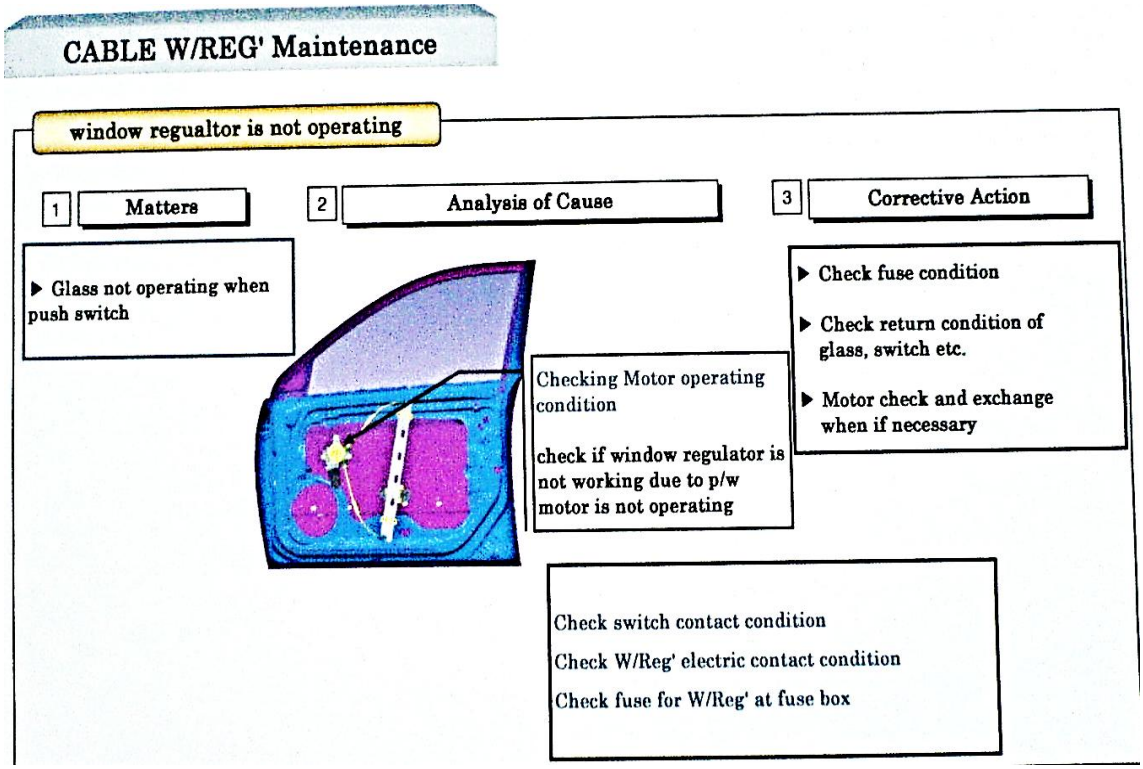


Figure 10: Malfunction of Window Lifter [Source: Supplier Documents]

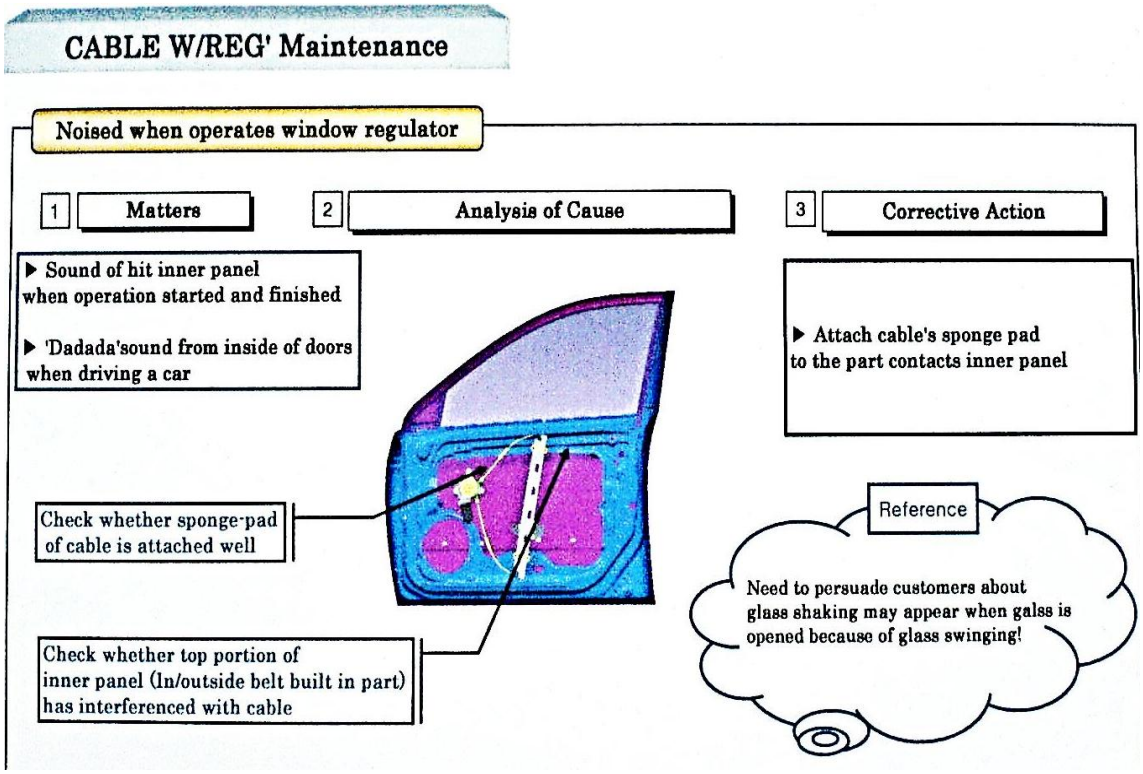


Figure 11: Noise Problem for Window Lifter [Source: Supplier Documents]

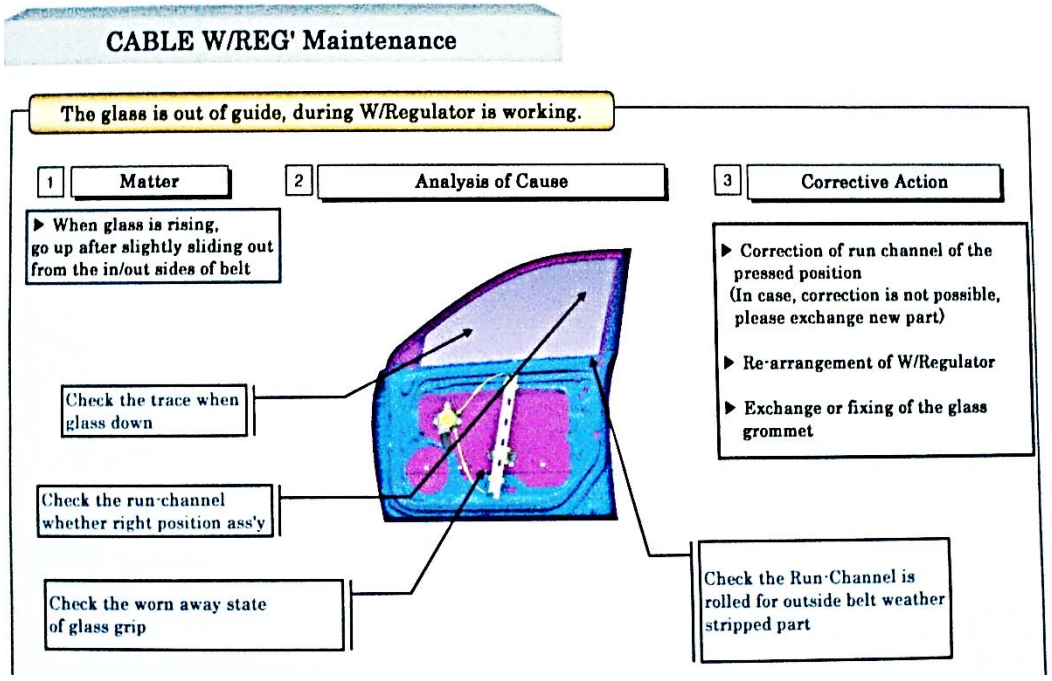


Figure 12: Window Glass Problem [Source: Supplier Documents]

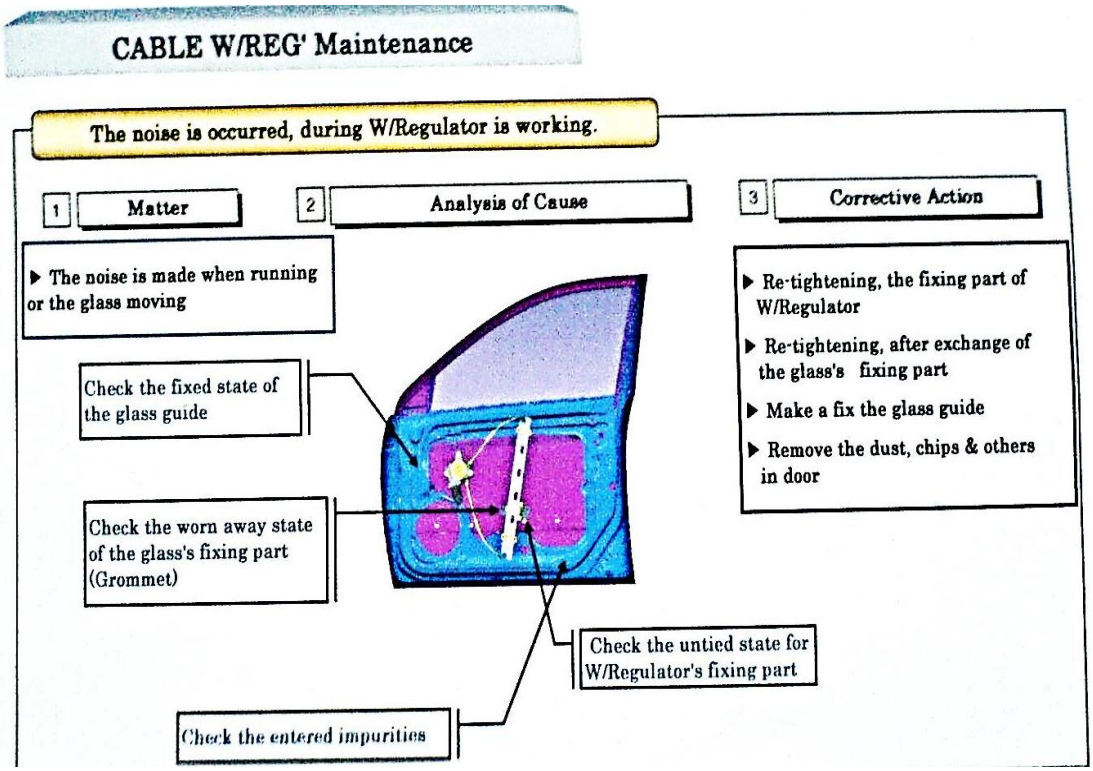


Figure 13: Noise Problem for Set [Source: Supplier Documents]

By here, we can study about noise problem details as a sample problem in 3 steps, customer complain, analysis of problem reasons and proposal for improvement as follows: (Note: figures are taken from the documentation of suppliers)

1) Customer complain

<IKCO Khrasan>

Motor operating sound has fluctuation during the window regulator travel. While glass opening motor operating sound was stable but from the half way closing motor operating sound was fluctuating.

<IKCO Tehran>

Operator are having difficult due to insufficient closing power of window regulator.

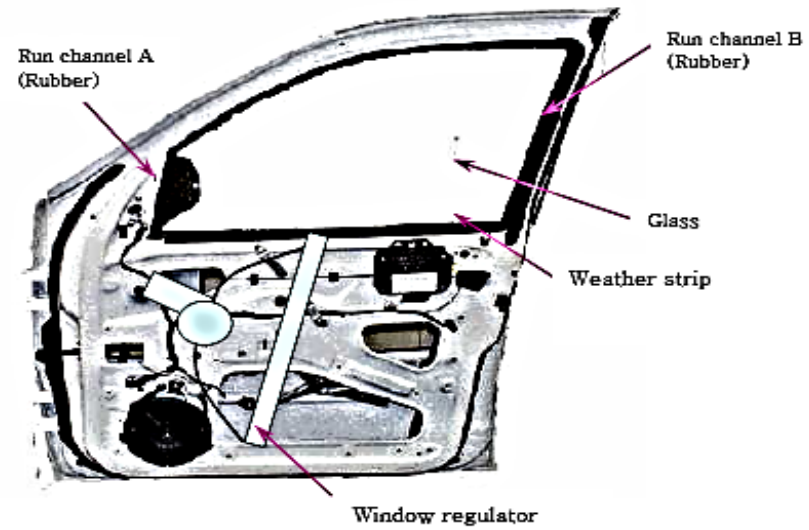
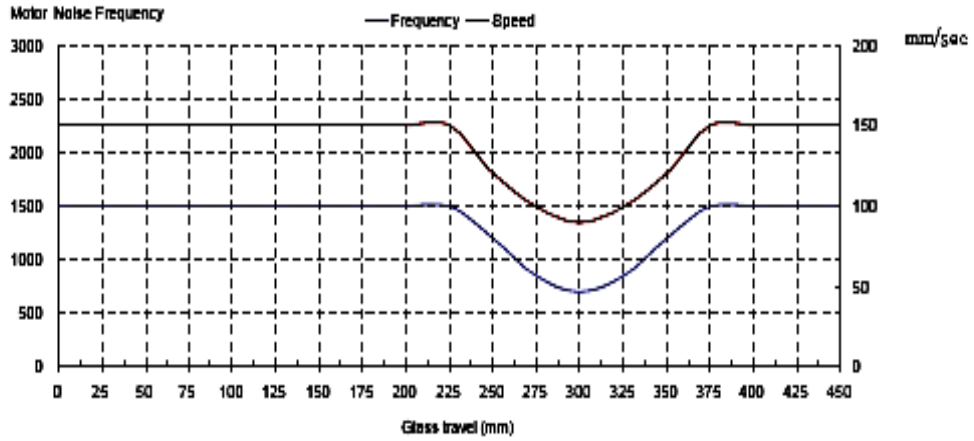


Figure 14: Customer Complain about Noise Problem [Source: Supplier Documents]

2) Cause analysis

<IKCO Khrasan> – Motor noise

Motor operating sound is fluctuating by motor speed and glass friction.



Operating sound fluctuation pattern in IKCO door assembly line

In IKCO door assembly, the frictions of glass moving are not stable in total travel range. The friction are suddenly increasing from the half of travel and this imposing load to motor shaft via worm wheel and motor shaft rotating with partially torsion, it is main caused to fluctuation motor operating sound.

It is normal to motor is having low frequency noise with shaft torsion at high friction area and come back normal frequency in ordinary speed area by the character.

<IKCO Tehran> – Insufficient closing force

Glass is barely moving both direction of closing and opening due to high door frictions.

Figure 15: Cause Analysis [Source: Supplier Documents]

3) Proposal to improvement

Door systems are consist of many component such as window regulator, weather strip, run channel glass and door frames but it is usual to imposing responsibility to window regulator because it generating power.

However, to make quality door all of related parts maker's collaboration is essential because door frictions are caused by all of components as mentioned above.

For example, Glass radius, run channel radius, constant dimension of door frames, surface roughness of weather strip, radius of window regulator guide rail and hole location of door inner panel are related to door quality and it come out to glass friction.

To taking care these complete systems, an automobile maker's leading is most important. Usually auto maker opening periodic technical committee to targeting improvement and this committee including all related parts maker which is call TFT (Task Functional Team). This TFT listing all aspects are effect to quality of door and improving by time table it taking 6 months or 1 year to achieving goals.

Boths of ICKO Factory Khrasan and Tehran has same problem basically as high friction of door and it complaining noise or low power of window regulator.

In addition sufficient power supply in door assembly line will help more faster moving in door closing ICKO in Tehran.

Figure 16: Proposal for Improvement [Source: Supplier Documents]

There is a table for some problems and solution for defects and action plans as follows:

Table 7: Defects and Action Plans

Defects and Action Plans					
Defects	Action Plans	Apperance Date	Action Plan Date	Presentation Date	Effectiveness
Broken Carrier	Reinforcement by Molding Process	2015/4	2015/5	2015/10	100%
Cap Opening	Adding Glue to Screw during Montage	2015/5	2015/6	2015/10	100%
Reel Edge Opening	Making Wrinkle on Reel Edge	2015/5	2015/8	2015/10	100%
Broken Plastic Clutch	Inform The Supplier	2016/11	2017/5	2017/11	Under Endurance Test
Broken Spring	Redesign	2016/10	2017/3	2017/10	Dispatching to Assembly Line
Rubber Damper Tearing	Changing of Material	2016/9	2017/2	2017/9	Dispatching to Assembly Line

Table 8: Most Important Defects and Action Plans

The Most Important Defects				
Noise Problem				
Action Plans	**Apperance Date**	**Action Plan Date**	**Presentation Date**	**Effectiveness**
Changing in Tolerances between Bush and Shaft	2016/4	2016/5	2016/6	Regarding to Customer Voices It Improved
Improving in Grease Grade and Grease Process				
Shifting of Bush Fixing Point to End Point of Shaft				
Additional Rib on Motor Housing				
Waterproof Problem				
Using Waterproof Glue for Electric Socket	2016/9	2016/9	2016/9	100%

We can see some figures as follows, which related to Implementation of correction on some window lifter parts according to action plan that source of them, are IKCO suppliers:

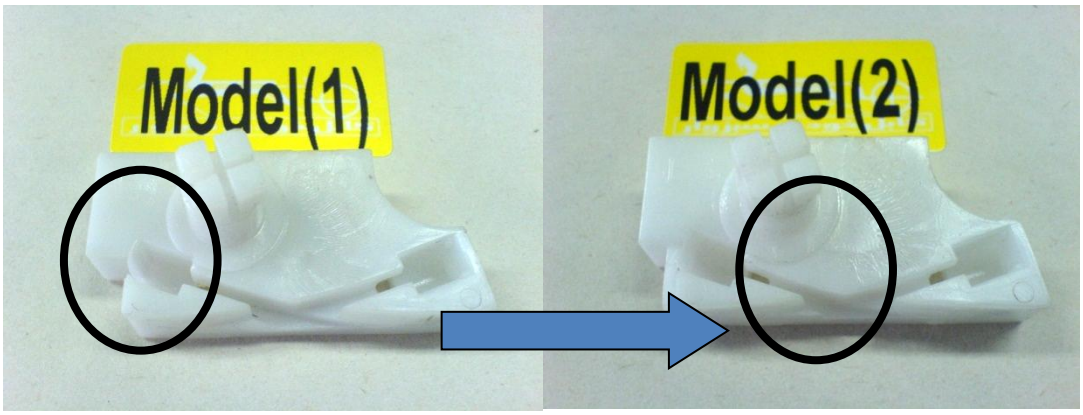


Figure 17: Implementation of Correction on Carrier [Source: Supplier Documents]

Adding glue to screw during montage (cap opening problem):

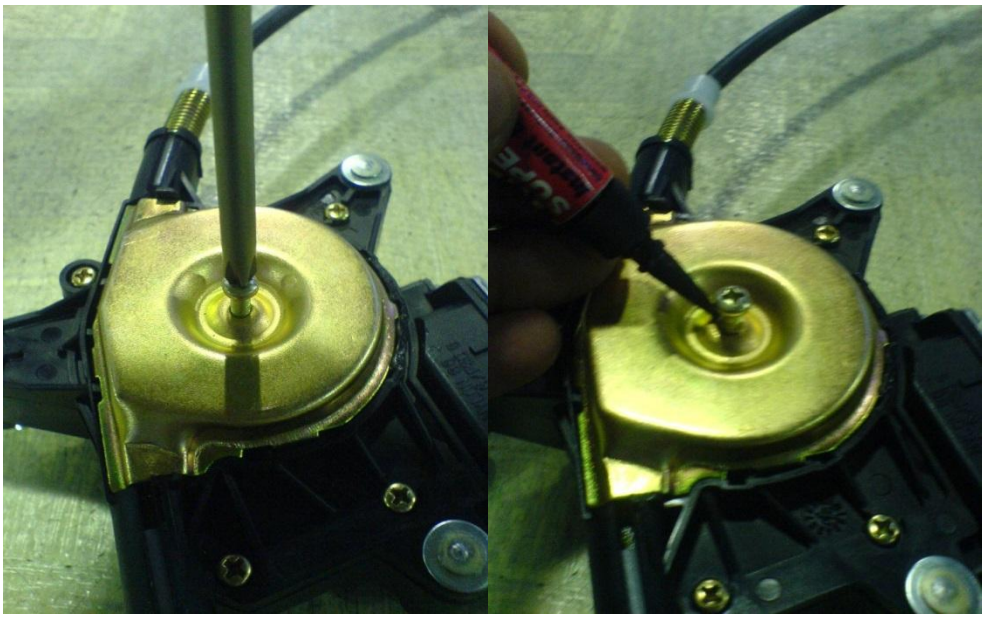


Figure 18: Adding Glue to Screw [Source: Supplier Documents]

Crack on motor housing causes noise problem has been solved by additional rib on motor housing, we can see the results as follows:

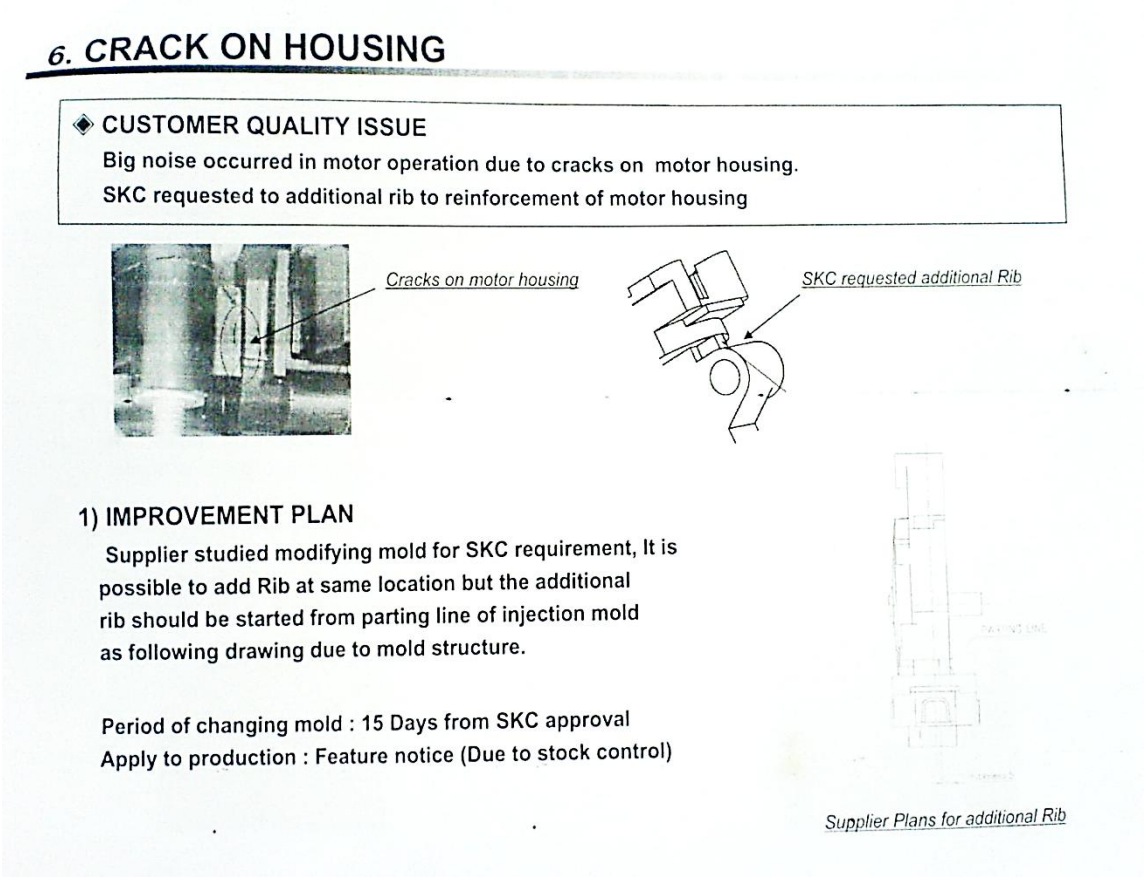


Figure 19: Crack on Motor Housing Causes Noise [Source: Supplier Documents]

Results of noise was improved after implementation of action plan as follows (figures are taken from the documentation of suppliers):

4. TEST DATA

[WINDOW REGULATOR ASS'Y]

1) CHARACTERISTIC

Test	Up				Down			
	Operating time (s)	General current (A)	Blockage current (A)	Noise [dB(A)]	Operating time (s)	General current (A)	Blockage current (A)	Noise [dB(A)]
Before	3.1	8.1	21.8	50.1	2.1	4.3	18.1	53.3
After	3.3	7.7	20.5	48.8	2.1	3.6	19.5	52.4
Variation	6.45	-4.94	-5.96	-2.59	0.00	-16.28	7.73	-1.69

2) NOISE

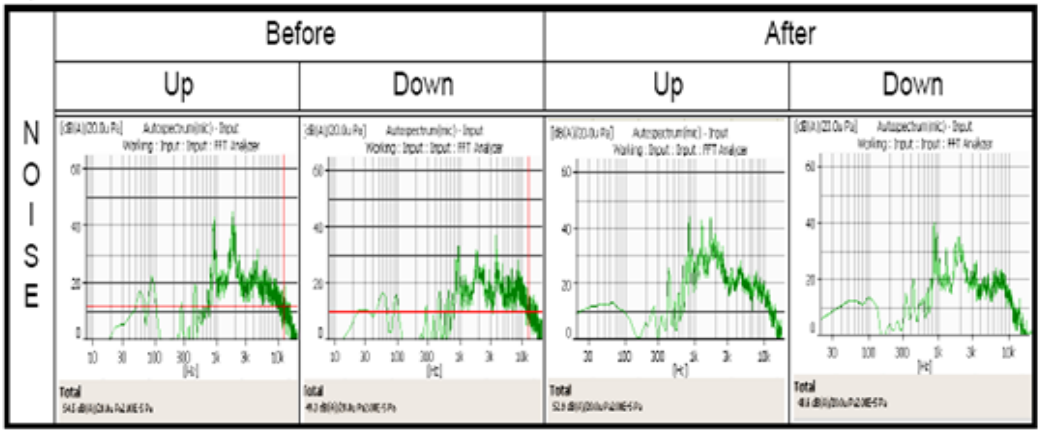
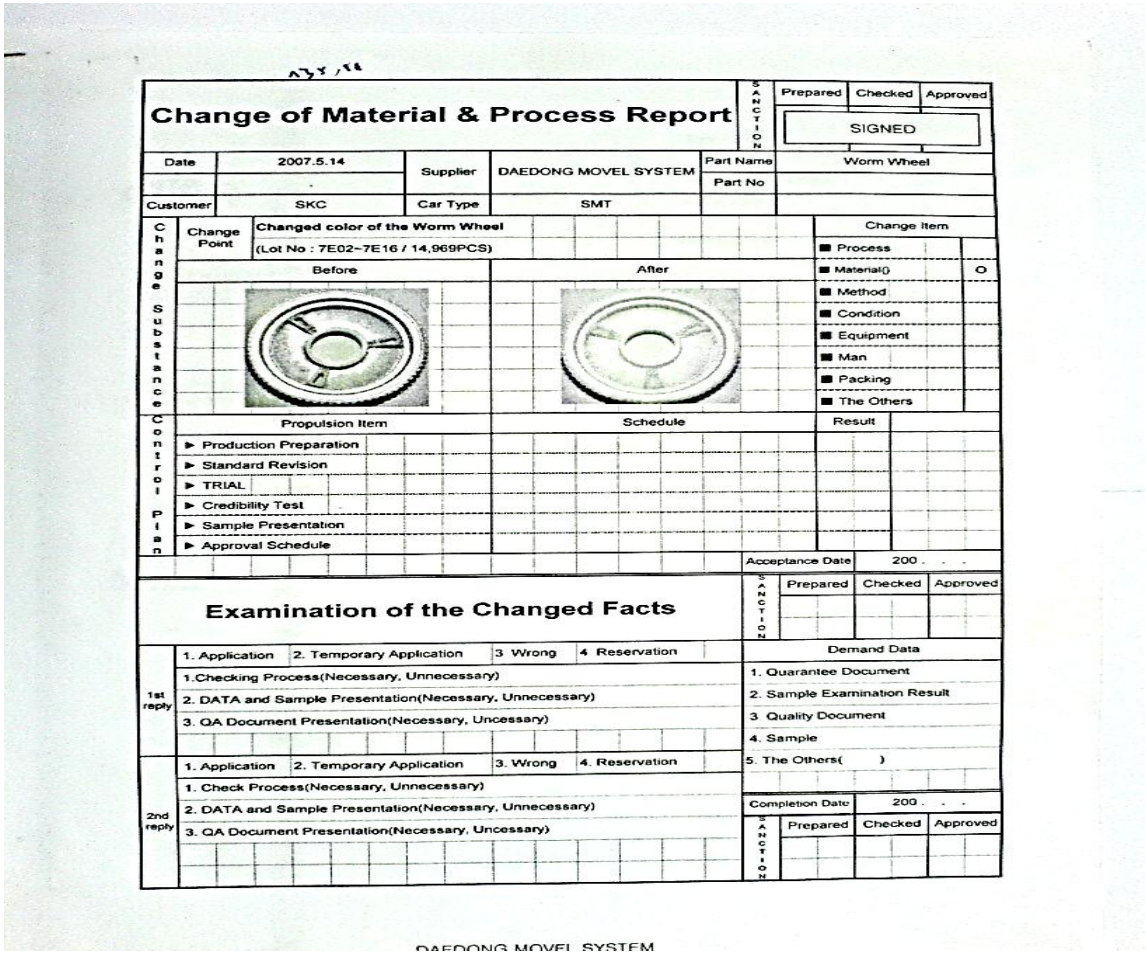


Figure 20: Results of Noise was Improved [Source: Supplier Documents]

Changing of grade of gearwheel of window lifter gearbox for heat reinforcement (figures are taken from the documentation of suppliers):



Change of Material & Process Report

SANCTION	Prepared	Checked	Approved
	SIGNED		

Date	2007.5.14	Supplier	DAEDONG MOVEL SYSTEM	Part Name	Worm Wheel
				Part No	
Customer	SKC	Car Type	SMT		

Change Substance

Change Point	Changed color of the Worm Wheel (Lot No : 7E02~7E16 / 14,969PCS)	Change Item	
		■ Process	
Before	After	■ Material()	O
		■ Method	
		■ Condition	
		■ Equipment	
		■ Man	
		■ Packing	
		■ The Others	

Control Plan

Propulsion Item	Schedule	Result
► Production Preparation		
► Standard Revision		
► TRIAL		
► Credibility Test		
► Sample Presentation		
► Approval Schedule		

Acceptance Date 200 . . .

Examination of the Changed Facts

SANCTION	Prepared	Checked	Approved

					Demand Data
1st reply	1. Application	2. Temporary Application	3. Wrong	4. Reservation	1. Quarantee Document
	1.Checking Process(Necessary, Unnecessary)				2. Sample Examination Result
	2. DATA and Sample Presentation(Necessary, Unnecessary)				3. Quality Document
	3. QA Document Presentation(Necessary, Uncessary)				4. Sample
2nd reply	1. Application	2. Temporary Application	3. Wrong	4. Reservation	5. The Others( )
	1. Check Process(Necessary, Unnecessary)				Completion Date 200 . . .
	2. DATA and Sample Presentation(Necessary, Unnecessary)				
	3. QA Document Presentation(Necessary, Uncessary)				

SANCTION	Prepared	Checked	Approved

DAEDONG MOVEL SYSTEM

Figure 21: Changing of Grade of Spinal Gear [Source: Supplier Documents]

Sealing glue for motor socket (waterproof problem, figures are taken from the documentation of suppliers):

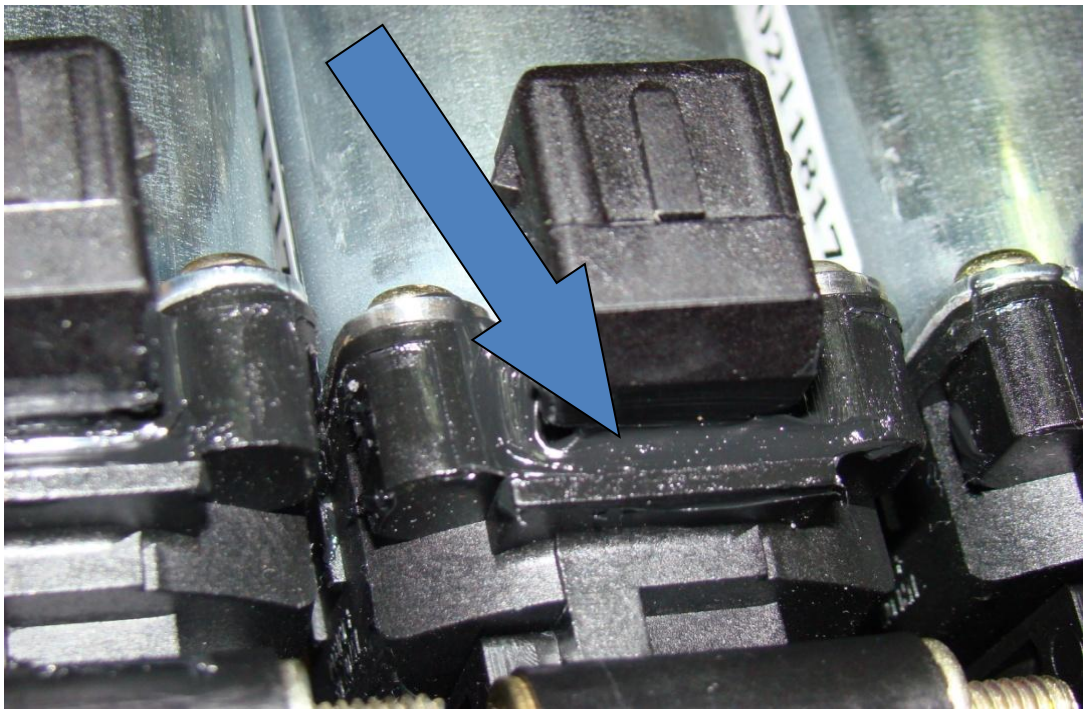


Figure 22: Sealing Glue for Motor Socket [Source: Supplier Documents]

Motor clutch problem (figures are taken from the documentation of suppliers):

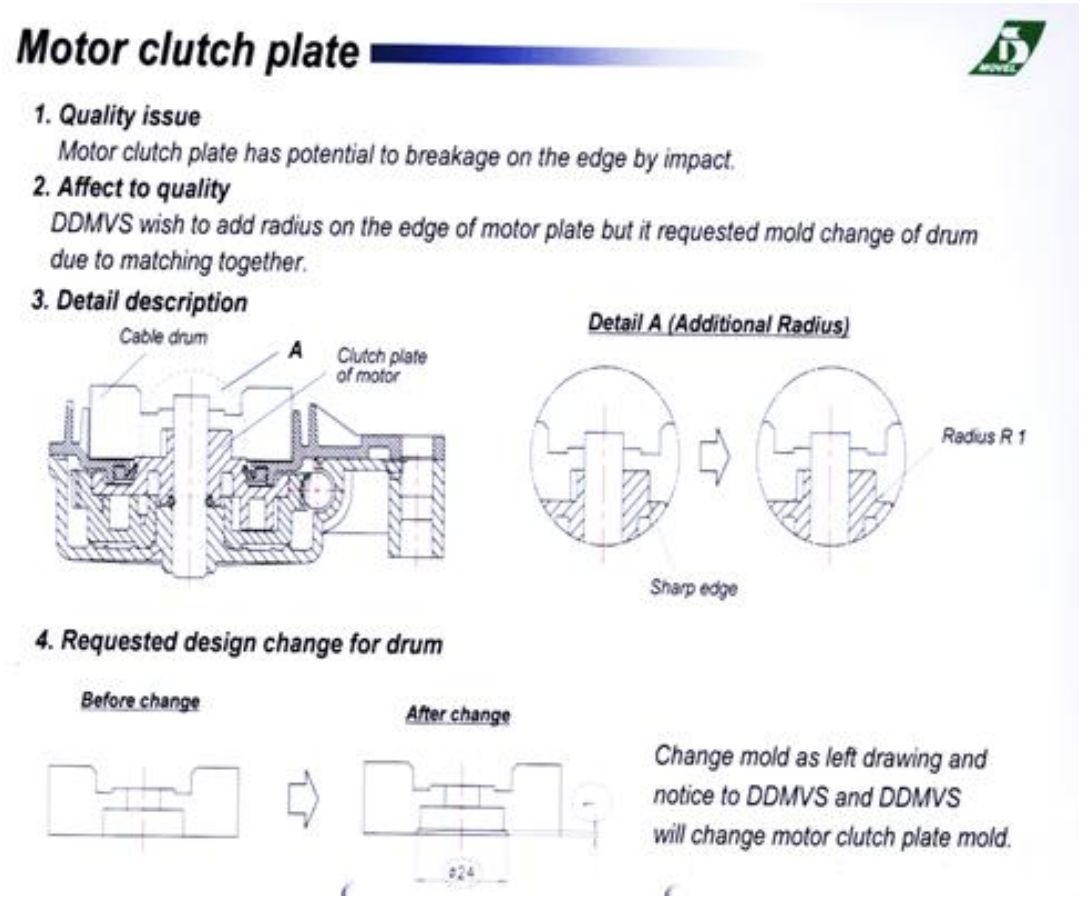


Figure 23: Motor Clutch Problem [Source: Supplier Documents]

Chapter 4

STRUCTURE OF QUALITY IMPROVEMENT PROCESS

Definitions:

- **Customer**: Company who order for producing some parts and is the owner of concept.
- **Contractor**: Is a company that has a supplying contract to supply subparts for car producer Company.
- **PDPC**: Product Development Process Control
- **CKD**: Completely Knocked Down, would mean that certain parts of the car are shipped to the country of sale where they will be assembled to form a complete car.
- **GANTT CHART**: Illustrate the start and finish dates of terminal elements and summary elements of project. Terminal elements and summary elements constitute the work break down structure of the project. Modern Gantt charts also show the dependency (i.e., precedence network) relationships between activities.
- **DFMEA**: Design Failure Mode and Effect Analysis, is the application of failure mode and effect analysis, a method specifically to product/service design.
- **PFMEA**: A Process Failure Mode Effects Analysis (PFMEA) is a structured analytical tool used by an organization, business unit, or cross-functional team to identify and evaluate the potential failures of a process.

4.1 Object

PDPC is a subsystem of the company's contractors quality assurance system whose object is production of quality products at first shot. In this subsystem, efforts are made to assure the quality of the product by applying systematic methods and quality factors, as well as taking of measures affecting the sources and upgrading product quality. The present procedure describes the preventive measures that company's experts and the contractors should apply to assure product quality. The starting point of this procedure is the input of the part into the self-sufficiency process and the final stage would be the approval of the self-sufficiency process for the said part. Institutionalization of this method for developing parts is a big step toward global competition.

4.2 Application

PDPC is for application in the following circumstances:

- New product (newly designed)
- New contractor for a certain product
- Parts, which have not passed through this process before
- Major changes in certain parts (as recognized by the quality specialist)
- Interruption in production of certain parts exceeding 6 months
- Major changes in manufacturer's production process (as recognized by the quality specialist)

4.3 Structure of the Activity

4.3.1 Organization of the Project Team

All activities within the framework of PDPC must be conducted through teamwork among the specialists on engineering design, fabrication commerce, quality, engineering project control and fabrication from company as well as the contractor's project manager, Engineering and Fabrication Manager must appoint company team members at the outset of each project [see section, 3.3.1].

4.3.2 Initial Planning (under company Fabrication Commerce Expert)

The fabrication commerce expert must, in cooperation with other company project team members, prepare an initial project time-schedule at the first stage of project definition. This is achieved through completion of the PDPC schedule format. This format comprises three sections. The first section should be completed at the initial stage of the activity and before designation of the contractor. The second section is for completion after designation of the contractor (but prior to conclusion of the contract). The third section relates to the post-contract period and time forecasts in this section must accord with the chart received from the contractor.

Reminder: The date of performance of each task in the form should be indicated by ''the responsible person'' in the relevant column and then, the documents will be submitted to the designated quality control officer for review. Date of approval by the quality control officer must also be noted in the respective column by the responsible person. In the event that any deficiency in performance of the tasks is discovered at the time of issuing either of the preliminary or the final approvals, the issuance of such approval would be postponed to the time the deficiency is rectified.

Controlling the product manufacturing process need comprehension and analysis surveying and getting assured of the completion of functional drawings and product standards and comparing the drawings with the CKD sample (in case it exists) collecting customers' voices and studying the qualitative antecedence of the part. Understanding the technical particulars of the product and process, feasibility and planning holding contract, selecting potential contractors, introductory definition of the project [see section, 3.2].

4.3.3 Feasibility and planning

Before starting any project, we need to study about feasibility, reliability, and possibility of implementation of project. Then we can plan for all level of project. For this, we need to have:

- Presenting the feasibility report
- Studying and analyzing the feasibility report
- Presenting a time-table (Gantt chart)
- Studying the time-table
- Approving the feasibility and time-table
- Holding a contract with the contractor need comprehension and analysis Feasibility, planning, and holding contract, designing, controlling, and approving the manufacturing process [see section, 3.5]. Designing, controlling and approving the manufacturing process bringing part drawings under control and studying DFMEA of the parts, in case they exist. Designing manufacturing process preparing the PFMEA and control program by contractor and their study by expert's confirmation of production test shall be considered as below steps:
- Auditing prior to the first sample
- Production of first samples and doing the necessary tests

- Issuing the temporary approval

- Auditing before one day of line production

- Production of one-day cargo for the line and making the needed tests

- Issuing the assembly approval

- Accepting the process and issuing the final approval

- Inspecting the time progress and good qualitative performance of the product manufacturing projects.

Table 9: Controlling the Product Manufacturing Process

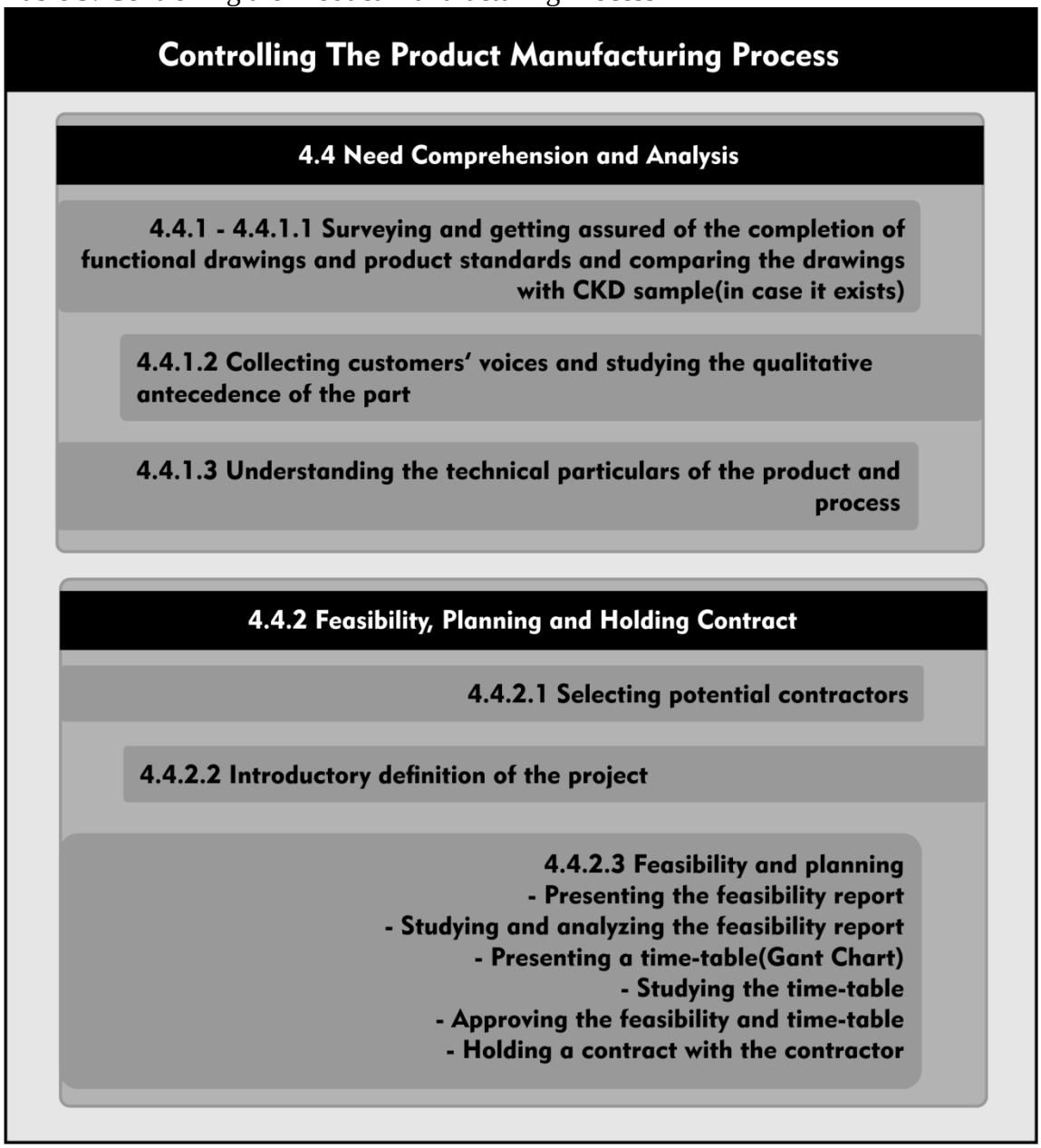


Table 9: Controlling the Product Manufacturing Process (continue)

4.4 Description of the Phases

PDPC is a systematic method for ensuring the proper definition, designation, and performance of the required tasks in the course of product development. PDPC encompasses supervision and control over the following three phases [see section, 3.5]:

1- Understanding and analysis of the need

2- Feasibility study, planning and contract conclusion

3- Design, control, and approval of the processes

4.4.1 Understanding and Analysis of the Need

4.4.1.1 Examination and Assurance of Completeness of Functional drawings and Product Standards for Reference to Production (by the Engineering Design Specialist).

The engineering design specialist must in the first instance after thorough review of the technical drawings that included 2 sections, first is functional drawing that is related to 3D or CAD data and next one is 2D that included BOM and documents of the respective part, satisfy himself of completeness of functional drawings and product standards [see section, 3.1].

Obviously, in the event of any deficiency in technical documents, the engineering design specialist is required to immediately ask for completion of the documents by the relevant authorities [see section, 3.4], [see section, 3.6]. Simultaneously, the CKD sample of the part (if available) will be requisitioned from the inventory by the commercial department expert and submitted to the engineering design specialist in order to compare that sample with the drawings. The latter will compare the part with

the drawings, in case of conformity, will approve the CKD part for reference to the contractor, and returns it to the inventory [see section, 3.11.1], [see section, 3.11.2].

In case of nonconformity of the drawings with the CKD part, it will not be approved by the specialist and the customer will be inquired as to which should serve as the manufacturing model. The result of inquiry will be communicated the fabrication commerce expert. If the CKD sample is selected as model, request for modification of the drawings must be addressed to customer and the necessary follow-up measures must be taken. An approved sample of the part (if available) will be submitted to contractor by the commercial department expert together with the drawings and technical documentation, and the contractor will be asked to immediately inform the expert of any discovered discrepancy between the drawings and the CKD sample, so that necessary action be taken by the company team to remove the discrepancies.

4.4.1.2 Collecting Customer's Feedback and Examination of the quality history of the part (through teamwork and under the quality expert's responsibility).

For collecting customer's feedback and quality history of the part, the following information and records (if available) must be examined:

- Car manufacturer's reports
- After-sale services reports
- Line feedback reports and goods input reports
- Reports on consumers' problems
- Identification of important points in assembly and disassembly
- Identification of problems in similar parts in other car makes or similar parts in the same car if the part has already been locally manufactured, all information and quality records must be examined by the quality expert, while the important parts

with a potential of causing difficulties should be recorded in the ‘’part quality problems record’’ format [see section, 3.2], [see section, 3.4].

In the event that the part has no record of local manufacture, one can draw pat of the required information through reference to the records of similar parts in other cars or the same car. In cases where no quality record is found for the said part or similar parts, this must be noted in the ‘’part quality problems record’’.

4.4.1.3 Understanding the Technical Features of the Products (through teamwork and under the responsibility of the engineering design specialist)

4.4.1.3.1 Study, examination and analysis of the technical drawings and documentation and preparation of the test plan at this stage.

The engineering design specialist should prepare the test plan after having studied all drawings, technical documents, and part standards. It said test plan must be sent to customer by the engineering design specialist to obtain customer’s approval and must be pursued until obtainment of positive response. Eventually, the approved test plan must be attached to the Product Features Paper.

4.4.1.3.2 Study of Environmental Conditions (in case that exists)

Company’s engineering design specialist will attempt to identify the risks and problems as soon as possible by examining the product sample to define the reliability and safety factor against uplift and adjustment factor. He should consider the following items:

- Conformities, alignments, and loose parts
- Damage risk due to vicinity to other parts
- Environmental Conditions (temperature, corrosion, vibration, etc.)
- Special conditions (oil or antifreeze leakage, etc.)
- Strained conditions (inappropriate application by customer)

Before starting any kind of project experts shall be consider about environmental conditions (such as temperature, corrosion, vibration…) that may affect on specific parts during project.

4.4.1.3.3 Examination of problems in assembly/disassembly

The engineering design specialist will identify the points to be taken into account in fabrication, having regard to the conditions of assembly/disassembly [see section, 3.6].

4.4.1.3.4 Examination of proper packing conditions

Engineering design specialist must examine the packing design of the product if any and satisfy himself as to worthiness and sufficiency of the design for damage prevention during transport. If such a design does not exist, request for preparation of packing design must be submitted to the packing engineering department.

4.4.1.3.5 Review of the quality problem records of similar parts

The engineering design expert must examine the product features that according to former experience as indicated in the quality problem paper have caused problems concerning the respective part. The results of the above activities must be registered in the Product Features Paper.

4.4.1.4 Preparation of the Initial list of Product's Important Features (under the responsibility of the engineering design and quality experts)

The engineering design specialist must in cooperation with the project team preparing the features list of the product, while the quality expert completes the process specification list. The basis for preparation of this list would be the data already collected and analyzed. Furthermore, such items as the followings will also be considered by the company team:

- Product-related assumptions based on analysis of customer's needs and expectations

- Identification of the special features in the manufacturing process (on the basis of team's conception of the ideal manufacturing process)

- DFMEA analysis of the part or of similar parts (if available)

Company's fabrication commerce expert is bound to ensure that these special features of the process or the product have been identified in manufacturer's feasibility study; he must also assess the sufficiency of this study through its comparison with the list prepared by the company project team. The results of the above activities must be recorded in ''summary of product's important features'' and ''summary of the important features of the process' 'Controlling the product manufacturing process need comprehension and analysis surveying and getting assured of the completion of functional drawings and product standards and comparing the drawings with the CKD sample (in case it exists) collecting customers' voices and studying the qualitative antecedence of the part understanding the technical particulars of the product and process feasibility, planning and holding contract selecting potential contractors introductory definition of the project feasibility and planning for these purposes engineering design and quality experts member are responsible for:

- Presenting the feasibility report

- Studying and analyzing the feasibility report

- Presenting a time-table (Gantt chart)

- Studying the time-table

- Approving the feasibility and time-table

- Holding a contract with the contractor

For Preparation of the Initial list of Product's Important Features, we need comprehension and analysis feasibility, planning and holding contract, designing, controlling, and approving the manufacturing process. Designing, controlling and approving the manufacturing process bringing part drawings under control and studying DFMEA of the parts, in case they exist. Designing manufacturing process, preparing the PFMEA and control program by contractor and their study by experts.

Confirmation of test production:

- Auditing prior to the first sample
- Production of first samples and doing the necessary tests
- Issuing the temporary approval
- Auditing before one day of line production
- Production of one-day cargo for the line and making the needed tests
- Issuing the assembly approval
- Accepting the process and issuing the final approval

Also for Preparation of the Initial list of Product's Important Features we need Inspecting the time progress and good qualitative performance of the product, manufacturing projects and controlling the product manufacturing process need comprehension and analysis surveying and getting assured of the completion of functional drawings and product standards and comparing the drawings with the CKD sample (in case it exists). Collecting customers' voices and studying the qualitative antecedence of the part understanding the technical particulars of the product and process feasibility, planning and holding contract selecting potential contractors are also some important features of products.

Introductory definition of the project:

- Feasibility and planning
- Presenting the feasibility report
- Studying and analyzing the feasibility report
- Presenting a time-table (Gantt chart)
- Studying the time-table
- Approving the feasibility and time-table
- Holding a contract with the contractor need comprehension and analysis making the needed tests
- Issuing the assembly approval
- Accepting the process and issuing the final approval

4.4.2 Feasibility Study, Planning, and Contract Conclusion

4.4.2.1 Selection of potential contractors (by the fabrication commerce expert)

Company fabrication commerce expert must select the appropriate contractor for manufacture of the part from among the potential contractors, while having in mind such factors as the followings:

- Alignment with the organization's purchasing policy
- Achievement of the minimum grade required for qualification
- Capability of supplying products of high quality, low cost, and timely delivery
- Contractor's prior records of cooperation with SAPCO
- Availing of a suitable project management system (which conforms the system of company and ability to provide project monthly progress reports on this basis)
- Availability of competent human resources for management, execution and control of the projects.

4.4.2.2 Preliminary definition of the project

4.4.2.2.1 Preliminary definition of the project and provision of the functional drawing

The fabrication commerce expert has to define and clarify the general features of the project in a meeting with the contractor as well as the required technical documentation and the CKD sample (if available) to the contractor upon selection of the appropriate-contractor. Hence, he must ensure contractor's knowledge of the scope of works in the course of providing him with functional drawings, product standards and the project performance period. At this stage, the CKD sample (if available) must also be submitted by the fabrication commerce expert to the contractor, and the latter must be asked to inform the expert of any discrepancies between the drawings and the sample. In this meeting, the expert must ask the contractor to become familiar with the product's important features. Subsequently, contractor must fill in the product specifications forms and submit them to company at the latest together with feasibility report. At the end of the session, the fabrication commerce expert should sign a minutes of meeting with the manufacturer incorporating all the above information to be kept in the records.

4.4.2.2.2 Request for designation of the project manager by contractor (raised by the fabrication commerce expert)

At this stage, the fabrication commerce expert would ask the contractor to nominate its project manager for fabrication of the respective part to company. The expert must direct the contractor to nominate a competent project manager who would be vested with full authority (by the management of the contractor) and would conduct the planning, direction and control of all project tasks within the defined time and budget.

In every aspect of the project, company representatives will solely contact the project manager who is responsible for the flow of information and assignment of tasks within contractor's organization as well as communicating the results to company.

4.4.2.2.3 Request for preparation and submission of the feasibility report by the contractor (raised by the fabrication-engineering expert)

Customer will ask the contractors involved in fabrication of the part to perform a feasibility study prior to submission of the commercial proposals in order to verify that they are completely aware of the requirements for performance of their contractual obligations. In order to ensure contractor's full knowledge and understanding of the manufacturing process required technologies, necessary facilities and equipment, relevant specialties etc. Company's fabrication commerce expert should also inform the contractor to help him prepare a comprehensive feasibility report.

4.4.2.4 Review and analysis of the submitted feasibility report and the project schedule (by the fabrication commerce expert, quality expert, and engineering design expert)

The prepared feasibility report must be carefully studied by the project team members. There after the fabrication commerce expert will chair a meeting of the project team members as well as the contractor's project manager to decide on the sufficiency of the followings:

4.4.2.4.1 Contractors' quality assurance system

The project team must verify that the contractor:

- Avails of sufficient knowledge and understanding of the company's quality assurance systems for the contractors
- Holds the full set of manuals and documents on company's quality control system

4.4.2.4.2 Designating the structure of the project management team

The company project team must ensure that the contractor has properly defined the leadership, scope of powers and responsibilities in the project.

4.4.2.4.3 Allocation of necessary work force and resources

The company project team must ensure that the contractor has allocated the necessary work force and specialties to the project, including technical expertise, project management and control, etc. Meanwhile, other required resources for performance and direction of the project including equipment, machinery, control and test tools, project management and control systems and software (according to company requirements) must be precisely identified.

4.4.2.4.4 Understanding major product qualities by the contractor

The company project team must satisfy itself of contractor's clear understanding of the project and definition of final product specifications, having the following items in mind:

- Contractor has the latest version of product's technical documentation (drawings, standards, functional parameters, etc.)
- Contractor has understood the quality targets as well as the expected credibility of the product (through study of the quality records and customers' views regarding the respective part)
- Contractor has paid attention to such parameters as definitions, functions, ambiguous demands, environmental conditions, assembly and disassembly conditions, packing, transportation, and marking (part number, descriptions…)
- Contractor ought to have defined the measurable specifications, which must be verified throughout the whole production process

In conclusion, sufficiency of the product major qualities identified by the contractor must be judged by the project team through comparison with items recognized by them.

4.4.2.4.5 Production process quality analysis

Company project team must ensure contractor's knowledge of the production process according to the following items:

- Preliminary Fabrication Process

Contractor has already suggested the preliminary fabrication process and has substantiated its suggested method with reasoning. In order to apply novel techniques in manufacture of a certain product, contractor must give prior notice of the followings to the company team:

- Date of establishing the production and control tools
- Date of operation
- Control and Production Fixtures

Contractor must indicate the need to special control and production fixtures, while programming the different phases of their preparation and construction, so that they will be prepared at the time of starting the manufacturing line. In conclusion, sufficiency of the process major qualities identified by the contractor must be judged by the project team through comparison with items recognized by them.

4.4.2.4.6 Project time schedule verification

The company project team must verify that contractor has prepared at this stage, a comprehensive project time-schedule encompassing all major project activities and the allocated periods to each. In this line, the following points must be considered:

- The project must be divided into tasks capable of being performed by individual workers through application of the itemized breakdown method

- The necessary tasks for completion of the project must be indicated while paying attention to the order of priority among tasks

- The project master chart must incorporate all activities demanded from contractor by the present procedure

4.4.2.5 Approval of Feasibility (by the fabrication expert)

At the end of this examination, in the event that all items mentioned in 4.4.2.4 are covered by contractor's feasibility report, the company project team will complete the feasibility checklist. The said checklist will be approved by the project team only if the critical questions have been fully addressed.

In the event of any shortcoming in responses to noncritical questions, contractor should submit a time schedule for their completion. The project team must after having approved the feasibility, obtain the final approval of the quality senior expert and the fabrication engineering manager on the checklist.

4.4.2.6 Choice of the best contractor and conclusion of the contract (by the fabrication commerce expert)

If the feasibility report submitted by the contractor is approved by the project team and the contractor himself is recognized to be fully qualified for manufacture of the respective part then appropriate action will be taken by the fabrication commerce expert to conclude a contract with him. Meanwhile, the project time-schedule must be attached to the contract. The fabrication commerce expert must specify a date for submission of the project monthly progress reports and description of the latest status of the tasks in the master schedule which must have been completed by the date of the report. This report must indicate the extent of progress in each task with the time schedule.

4.4.3 Design, control and Approval of the Manufacturing Process

The purpose of this stage is to ensure the development of a production system whose various aspects have been fully considered and is able to meet the carmaker's expectations, needs, and demands. The activities to be performed and recorded at this stage are:

4.4.3.1 DFMEA examination of the parts produced by contractor (by the engineering design expert)

In cases where preparation of part drawings must be done by contractor, completion of the DFMEA for the parts by contractor is recommended. Therefore, in such a case, the engineering design expert of company should review the DFMEA prepared by the manufacturer and in the event of any deficiency, direct the latter towards their correction and removal. The engineering design expert must in cases of high PRN rating, take either of the two following measures:

1) Ask the contractor to correct the design, or

2) Draw the contractor and the quality expert's attention to necessity of observing the above consideration through issuance of a written warning.

4.4.3.2 Establishing control over the part drawings prepared by the contractor (by the engineering design expert)

In the event that the part drawings are not available and are not submitted to contractor by company, the contractor should prepare the part drawings relying on functional drawings and the presented standards. For this purpose, the drawings should be controlled by company's engineering design expert prior to checking of the preliminary samples in order to ensure that the contractor producing the said samples will be able to execute the line and mass production based on the samples.

It is noteworthy that controlling the drawings will not necessarily mean their full submission to company and it would suffice to keep the documents control table and part standards in the file of the relevant part in company. The engineering design expert must ask the contractor to immediately inform company of any modifications so that the modified versions are controlled and recorded in the list.

4.4.3.3 Review of the control plan (by the quality expert)

After the contractor completes the process control plan based on its production flowchart, company quality expert must ensure that the general frameworks for preparation of the control plan have been observed by contractor, while the necessary instructions must be given to contractor to improve the plan. The control plan must be constantly consulted as a live document during the whole manufacturing process and if necessary, be completed based on results obtained from PFMEA. This document must be prepared before checking of the preliminary sample, while the quality expert must review this document. Where such keeping is not possible, the quality expert should, after having ensured the availability of the document with the contractor as well as its correctness and sufficiency, obtain the approval of the superior expert on quality with respect to lack of this document in the file.

4.4.3.4 Review of the prepared PFMEA (under the responsibility of the quality expert)

After the contractor has analyzed different states of manufacturing process defects by means of the PFMEA technique, it is necessary that company's quality expert review the said document in terms of its observance of the frameworks and general principles of PFMEA and instruct the contractor to remove the defects if necessary.

The PFMEA document is regarded as a live document during the whole manufacturing process and must be continuously consulted by the contractor to identify process defects and improve the process. This document must be prepared before checking of the preliminary sample, while the quality expert should review this document.

Note: Preparation of different PFMEA will not be necessary for similar parts manufactured by contractor. Reference to specific items in the global PFMEA will be sufficient.

4.4.3.5 Approval of experimental production

The purpose of this phase is to ensure contractor's capability in homogenous manufacture of the product with a quality comparable to accepted and agreed standards during the whole production process.

4.4.3.5.1 Verification of preparedness for experimental production

Prior to experimental production of the part, the quality expert must ensure that the preliminary samples are produced with suitable equipment, in favorable conditions and by qualified workers. For this purpose, contractor must complete its action list after having ensured the approval of its process, and send the same to company in order to invite company experts to check the preliminary samples. Thereafter, company quality expert must check the process. The actions to be taken before checking are:

- Preparation of the control plan by contractor
- Preparation and analysis of the PFMEA
- Completion of the control plan according to PFMEA and agreement in principle of company quality expert with the plan

- Completion of contractor's action list the list of actions to be taken by contractor in order to prepare for checking before manufacture of the preliminary sample, a copy of which should be sent to company's expert

- Verification of the sufficiency of tools and measurement methods for specifications defined in the control plan. Company quality expert must after verifying such readiness, express its approval of the preliminary samples

4.4.3.5.2 Approval of the preliminary samples and issuance of provisional acceptance (by the quality expert)

Upon approval of the contractor's manufacturing of the preliminary samples by the quality expert of company, contractor must commence production of the samples according to the control plan. Thereafter, all the tests indicated in the test plan of the part must be performed and in the event of satisfactory results, the guarantee certificate will be completed and sent to company. Upon confirmation of positive test results by customer, the provisional acceptance will be issued by company engineering and fabrication department.

Note: If the samples are not approved in the first round, the quality control must check whether contractor has already analyzed through PFMEA the- defect, which has caused non-approval of the part, and if yes, he should remove the defect. In the event that any modification in drawings is necessary for removal of the problem, such drawings must be re-checked after modifications. Thereupon, the production line should be checked in line with the modified control plan. Eventually, submission of the samples will depend on approval of the superior expert on quality.

4.4.3.5.3 Checking prior to one-day production of the line (by the quality expert)

Upon issuance of the provisional acceptance and contractor's notice of readiness for one day production through dispatch of contractor's completed action list, the company quality expert must through checking of the production line, satisfy itself as to the followings:

- The final control plan is in place and it is observed
- Production process instructions are in place and are compatible with the control plan and PFMEA results
- All gauges, fixtures, and measuring tools are available and have the required correctness and precision

It is noteworthy that company's agreement with one-day production for issuance of the acceptance will depend on approval of the proper- rectification measures taken in accordance with the former stage of checking.

Note: Process checking for each similar part is not required (checking prior to fabrication of the preliminary sample and prior to one-day production). The positive results of the tests at contractor's site which are reported to company will suffice.

4.4.3.5.4 Approval of one-day production of the line and issuance of assembly certificate

Following the receipt of the order for one-day production of the line, contractor will produce the first lot according to the production control plan, and will dispatch the same to company together with the test results and the completed form of the guarantee certificate.

Company will perform the required tests on the lot according to its discretion, and then, dispatch the lot to customer for assembly tests. In the event of positive results, customer will issue the assembly approval.

Otherwise, it would be necessary for the company quality expert to verify that the problem has been analyzed by contractor through PFMEA and the control plan will be revised accordingly. Upon re-checking of the production line by the quality expert and approval of the superior quality expert, contractor will be permitted to redispatch the lot.

4.4.3.5.5 Acceptance of the process and issuance of the final acceptance (by the quality expert)

After securing customer assembly approval and provided that, if the following expectations have been met by contractor, the production process will be approved by company and thereupon, the final approval will be issued which shall mean acceptance of the mass production to be performed by contractor. Approval of the process will depend on the following conditions:

- The key points of the process have been rendered immune from errors as much as possible
- The description of the production control plan has been accepted in principle
- Part drawings are complete
- Process checking has led to positive results
- Results on preliminary sample tests and one-day production are satisfactory
- All rectification measures indicated in prior checks have been performed an approved by company quality expert
- The production line of the car manufacturer has expressed no dissatisfaction

4.4.4 Supervising Performance of Projects

4.4.4.1 Supervising the Progress of Projects in terms of their Time Span (by the fabrication commerce expert and the project control expert of the engineering and fabrication department)

As already noted, the company fabrication commerce expert must declare the time for submission of the monthly progress report to contractor. Such reports should be prepared in due course by contractor based on the recorded progress against the master schedule and be submitted to the fabrication commerce expert for precise review. In the event of any deviation from the schedule, the fabrication commerce expert is obliged to discover the causes of delay and minute such items with contractor's project manager with a view to offset the deviation from schedule. Furthermore, the matter must be formally communicated to contractor's managing director. If the deviation cannot be compensated, it would be necessary to update the master schedule after the approval of the engineering and fabrication manager is obtained. The fabrication commerce expert must submit the monthly progress reports to the project control expert after review. Thereafter, the project control expert would be required to collect the reports and mark the deviations for later reporting to the manager of the department in monthly meetings and taking of appropriate measures.

4.4.4.2 Supervising the proper quality of project performance (by the superior quality expert)

In order to maintain constant supervision over the execution of individual projects from the quality point of view, the superior quality expert must in addition to the quality expert's supervision of the activities in the course of the project, personally review the compiled quality documents.

All quality-related documents including the quality records paper of the part (if such records exist), technical specification lists, product's major features list, control plan, PFMEA, as well as the pre-manufacture and one-day production checking reports must be reviewed by the quality expert prior to submission to company and then final-checked by the superior quality expert. The results obtained from review of the quality file of each project must be recorded and kept in the format by the superior quality expert (Assessment of project quality-related activities). In the event that any of the prepared documents has a deficiency, the quality superior expert shall mark the ''rectification measures required'' box in the format and set the- agreed date with contractor for rectification of the defects. Upon re-submission of the documents and their review by the quality expert, the corrected documents must be sent to the superior quality expert for checking and update. In case of contractor's delay in presentation of quality documents, he will be treated by the fabrication commerce expert as in the cases of delay in other master chart tasks. The results recorded in the format, will be extracted on a monthly basis as the summary of the project status and will be recorded in a grand status format of all department and will be communicated to the department manager in monthly meetings.

Chapter 5

CONCLUSION AND FUTURE WORK

In chapter 3, an improving quality project was studied by the details, the case study was window lifter and we collected data for 2 years from assembly line labors, customers, suppliers and etc. Referring to these data and feedback we started to define an improving quality project as an action plan and again we get the feedback from customers and we conclude that we reach our main goal (quality improvement for this case study).In chapter 4, we summarized and explain the steps of the method and procedure of PDPC, that we can use it for other quality improvement cases and problems in other industries. As follows we can see tables for the result of improvement of implementation of action plan for every problem by details. Tables illustrate that we had 100% of improvement in quality problems and according to customer voice and conduct survey forms form after sale services representatives, customers satisfied with the quality of window lifter and one of the most important defects (noise problem) have been solved.

Table 7: Defects and Action Plans

Defects and Action Plans					
Defects	Action Plans	Apperance Date	Action Plan Date	Presentation Date	Effectiveness
Broken Carrier	Reinforcement by Molding Process	2015/4	2015/5	2015/10	100%
Cap Opening	Adding Glue to Screw during Montage	2015/5	2015/6	2015/10	100%
Reel Edge Opening	Making Wrinkle on Reel Edge	2015/5	2015/8	2015/10	100%
Broken Plastic Clutch	Inform The Supplier	2016/11	2017/5	2017/11	Under Endurance Test
Broken Spring	Redesign	2016/10	2017/3	2017/10	Dispatching to Assembly Line
Rubber Damper Tearing	Changing of Material	2016/9	2017/2	2017/9	Dispatching to Assembly Line

Table 8: Most Important Defects and Action Plans

The Most Important Defects				
Noise Problem				
Action Plans	**Apperance Date**	**Action Plan Date**	**Presentation Date**	**Effectiveness**
Changing in Tolerances between Bush and Shaft	2016/4	2016/5	2016/6	Regarding to Customer Voices It Improved
Improving in Grease Grade and Grease Process				
Shifting of Bush Fixing Point to End Point of Shaft				
Additional Rib on Motor Housing				
Waterproof Problem				
Using Waterproof Glue for Electric Socket	2016/9	2016/9	2016/9	100%

Studies show that the definition of perceived quality and product quality does not yet included all factors, especially when it comes to the area of the automotive Industry. There are certain integrations and disjoints in the description and terminology use. The studies show that there is a comprehensive framework of terminology regarding perceived quality in the automotive industry by concentrating on the broad definition of perceived quality factors in relation to the automotive industry. Therefore, the defined framework is only a primary level for future research.

The importance of the variety concepts concerned about perceived quality will become evident over time. This is appearing mainly as a conclusion of the severe competitive and Premium automotive sector and the drawbacks resulting from the technocratic way of regarding communication of the quality can be obtained.

Therefore, future research might further expand the understanding of this work with regard to what kind or style of car would be the most requiring feature to the majority of clients, as the studies show well as to crucial subcategories.

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