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Compare Cost of Good Quality & Cost of Poor Quality And Have a Wise Decision A study from Automobile Industry of Pakistan

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Abstract: *For the rationalization of improved quality, quality needs to be provided in numeric / monetary values, for this purpose cost of quality is measured and analyzed to get optimum levels. In this connection it is required to compare cost of good quality against cost of poor quality, to have a wise judgment of better choice. Survey was conducted in target population that helped in identification of importance of investment on cost of good quality rather than bearing loss due to poor quality. Furthermore, several other correlations were also identified between cost of quality and overall product cost.*

Purpose & Scope: *Objective of the study is to find a quantifiable relationship of cost of good quality and cost of poor quality, so the importance of quality could be explained effortlessly and effectively. Study is carried out within the automobile industry of Pakistan, mainly in the northern part of country.*

Design / methodology / approach: *In order to measure COGQ & COPQ, a structured format was developed and used for data collection (actual & hypothetical) through emails and in person interviews from industry experts.*

Findings: *Study showed that the cost of good quality is 22 ~ 50 times lower than cost of poor quality and this comparative ratio is derived and may be used as rule of thumb.*

Originality / Value: *COGQ is often compromised and ignored, as its ability to safeguard COPQ is not known in numeric terms or monetary values, this study has provided an example to calculate and compare these two costs.*

Keywords: *Automobile Industry, Cost of Good Quality, Cost of Poor Quality, Cost of Quality, Pakistan*

I. Introduction

A stitch on time saves nine; someone has said very appropriately and wisely that an effort in time saves many more of future and evil should be nipped in the bud, so that much future trouble would be avoided. In the same way, in every walk of life, things must be set right in the very beginning to avoid much future troubles.

Same could be applied to the quality, cost of quality. If it is invested rightly and timely for cost of good quality (COGQ) it will save nines of cost of poor quality (COPQ) on later stages.

As a developing economy, customers and manufacturers of automobile industry are primarily cost conscious and quality is treated as secondary trait, this has various reasons like, low purchasing power of customers, constant rise in cost of doing business, import costs, inflation, exchange rate appreciations & etc. As a result automobile industry seems to not give due attention to the investment of Cost of Good Quality (prevention, appraisal, etc) and when failures take place; industry is compelled to pay it as Cost of Poor Quality. This not only dissipate precious resources of manufacturing but also gives bad impact to the brand name and creates hectic for ultimate customer.

Objective: Primary objective of this study is to obtain quantifiable relationship between cost of good quality and cost of poor quality. This could be obtained by calculating costs of good quality that are prevention and appraisal costs to produce a quality product. Then comparing that cost with costs of poor quality that are internal & external failure costs. Such study could be done on basis of actual cases or hypothetical estimates made by industry experts.

After this study it would be possible to estimated that if one had came across, an external product failure at customer end that charged him Rs. 1000/-, how much it would had cost him (in prevention & appraisal), so that such failure would have been avoided.

Scope and Limitations: This research study systematically investigated the relationship between Cost of good Quality and Cost of Poor Quality, by conducting case study analysis. This study ends up with a generalized and quantifiable relationship of cost of good quality and cost of poor quality. Study is limited to the automobile industry of Pakistan but mainly to the north part of country that is Karachi, an industrial hub, which had complete blend of automobile industry of Pakistan.

II. Literature Review

Quality: Over the past years ‘quality’ has been described as: ‘fitness for purpose’ (Juran and Gryna, 1970); ‘conformance to requirements’ (Crosby, 1983); and ‘uniformity about a correct target’ (Deming, 1986).
In "Quality Handbook", Mr. Joseph Juran gives two denotations that he considers of vital value for managing quality:

1) Quality is meant for the features of products which meet customer requirements and thus provide customer satisfaction. However, providing better quality, as a rule, will require an investment and hence usually involves raise of costs. Higher quality in this sense by and large "costs more".
2) Quality is also meant for "freedom from the flaws” – freedom from error that have need of doing work over another time or that results in customer dissatisfaction, customer claims, field failures, etc.

Cost of Quality: The literature provides dissimilar descriptions of the concepts of "Quality costs". The definition of quality costs has transformed with the evolution of Quality Management. Unfortunately, the definition of Cost of Quality and its integral elements fluctuate from author to author, organization to organization, industry to industry and country to country & to a certain extent it depends on the size of a QMS (Hwang and Aspinwall, 1996). There is no agreement on a single definition for quality costing. Several definitions are as follows:

1) COQ is defined as the costs of non-conformances. (Crosby, 1983).
2) Quality costs can be usually understood as the costs associated with the non-achievement of product or service quality as defined by the requirements of customers and society. Simply declared, quality cost is the cost of poor products or services (Sudhahar et al., 2009).
3) It is defined from ‘zero failure’ viewpoint as the difference between actual costs and ideal costs, the latter being incurred if a product or service is produced right the first time (Doodstadt & Marti, 1990).
4) Quality costs are expenses incurred for ensuring and assuring quality as well as loss incurred when quality is not accomplished. (BS 6143: Part2, 1990; ASQC, 1971).

The widely accepted Feigenbaum’s PAF Model classifies cost of quality into three classes: prevention cost; appraisal cost; failure cost.

Cost of Good Quality: These are the costs, which are associated with achieving, maintaining and improving the quality of products. The branches of costs of good quality are: prevention costs and appraisal costs.

Prevention costs are the costs of trying to prevent poor-quality outbreak in any process or products. Prevention reflects the quality philosophy of "do it right the first time" as the final goal of a quality management program. Examples of prevention costs include: Quality planning costs, Product design costs, Process costs, Training costs, Information costs.

Appraisal costs are the expenses of testing, measuring and analyzing materials, products and parts to make sure that product quality and specifications are being met. Examples of appraisal costs include: Inspection and testing cost, Test equipments cost, Operator cost.

Cost of Poor Quality: Besterfield et al. (1999,p.142) state that the cost of poor quality is no different than other costs so that it can be programmed, budgeted, measured, and analyzed to help in attaining the objectives for better quality and customer satisfaction at less cost. They add “a reduction in quality costs leads to increased profit”. Crosby states that the only measure of quality is the price of non-conformance (PONC). PONC is essentially the cost of getting it wrong. According to Crosby, quality costs are, first a tool for focusing management attention on quality, and second a measure of the success of a quality improvement program. Munro-Faure state that the objective of continuous improvement is to meet customer requirements at the lowest cost and that this can only be achieved by eliminating the costs of rejects and rework. They conclude that elimination of these costs is only possible if they can be identified. In the light of the above, Stevenson’s claim that “any serious attempt to deal with quality issues must take into account the costs associated with quality”, does not appear unreasonable.

COQ Models: There are various Cost of Quality models, the P-A-F (Prevention-Appraisal-Failure) is the most recognized one and it is cost categorization scheme. ABC methodology is activity oriented and process oriented. Other such models include Cosby's model, opportunities / intangible cost model and Process cost model, but there is no perfect solution that best suits all, instead one has to choose according to its own requirements.

Generic model	Cost/activity categories
P-A-F models	Prevention + appraisal + failure
Crosby's model	Prevention + appraisal + failure + opportunity
Opportunity or intangible cost models	Conformance + non-conformance Conformance + non-conformance + opportunity Tangibles + intangibles P-A-F (failure cost includes opportunity cost)
Process cost models	Conformance + non-conformance
ABC models	Value-added + non-value-added

Cost of Good Quality vs. Cost of Poor Quality: However, there is no direct and to the point study or literature, available that has compared these two costs, especially in automobile industry of Pakistan. This makes it logical and appropriate choice that researcher has taken up this topic and planned to conduct a comparative study of COGQ and COPQ in the framework of automobile industry of Pakistan.

III. Research Methodology

Method: Questionnaire and structured interview methods were used to gather quantitative data about COGQ and COPQ. For this purpose, a detailed and multi section questionnaire was developed with the help of Microsoft Excel worksheet that supports automatic and real time calculations and displays of results in form of Bar Chart. First sections consisted to take inputs for the calculations of COPQ i.e. external failure cost followed by the inputs for internal failure costs. In case there were actual failures, respondents had to quote those but in case, no actual failure was on record the inputs for these sections were based on expert judgments of industry professionals. Second section was designed to capture the detailed inputs for COGQ. Onetime costs like quality planning, supplier evaluation, etc were grouped first followed by the repetitive costs like appraisal time cost and destructive testing cost calculations.

Population / universe: Automobile industry of Pakistan was the sampling universe that comprises of more than 50 OEMs (engaged in assembling and manufacturing of 2 wheelers, 3 Wheeler Rickshaws, Passenger Cars, Light, Medium & Heavy Duty Commercial Trucks, Tractors and Buses) and more than 400 vendors that are serving local automobile industry. There is a huge variation in the business scale, volumes, product variety and way of practicing business.

Source List: Source list for this research study were member directories of Pakistan Automotive Manufacturers Association (PAMA, 2015, July) and Pakistan Association of Automotive Parts and Accessories Manufacturers (PAAPAM, 2015 July). Further, vendor directory of some other OEMs was also utilized to choose respondents

Sampling Unit: Comparison of COGQ & COPQ is studied on the basis of individual part cases, to have the judgment of better and least expensive choice, the unit of study was individual cases of parts and assemblies instead of companies. From each respondent company (OEM & vendors), three questionnaire replies were invited from their product ranges. Each of three replies differs from each other in terms of price range (high, low and medium costs). The purpose of calling three cases from each respondent was to judge the impact of product cost variety on Cost of Quality.

Sample Size: 10% sampling was targeted for this research study, from cited population and 47 companies were selected as sample population from OEMs and vendors of Pakistani automobile industry. Questionnaires were sent to the sample population through emails accompanied with an introduction to the research subject for ease of understanding and urge of reply.

Sampling Technique: Stratified sampling technique was applied to have representation of each stratum i.e. from vendor / OEM and from each part category. Further convenience and random sampling techniques were applied to finalize the list of respondents from each stratum. Automotive parts and assemblies were divided into 14 categories:

Exemptions to some costs: Comparative study of COGQ & COPQ demands in depth and detailed study of each cost factor to have very decisive outcome but due to some limitations and other technical reasons, some cost factors are ignored / exempted in this study, such cost factors are:

- For Cost of Good Quality (Prevention + Appraisal Cost), **In-Process Inspection cost** (Time Calculation) is ignored, as it is usually on the part of production person and no additional time is provided to him for this activity, it goes as a parallel activity. In some cases, where a detailed inspection is carried out after a certain number of production parts, this unit time (time / frequency number) is very minute and ignorable.
- Another exemption is made for Cost of Poor Quality (COPQ) in case of External Failure and it is about **transportation cost for vendors & suppliers**, because of:

- Sometimes, vendor’s prices are ex-factory based.
- Replacement is adjusted from stock available at customer end against debit note or likewise mechanisms.
- Replacement is provided to the customer with regular supply transportation, so cost becomes very minute hence ignorable.

But for OEMs, in case of external failure, (if they are bound in form of guarantee or warrantee conditions), this cost includes transportation, replacement, third party charges (3S Dealer), etc.

IV. Analysis & Findings

47 participation requests were sent for research study, while 18 replies were received that is about 38%. Out of these 18 replies, 2 were from OEMs which is 11% of total replies and represent 4% of OEMs, other 16 replies were from vendor industry and it is about 89% of total replies and represent 4% of vendors. All 18 replies carried 3 cases each and all together there were 54 cases for research study purpose. Out of 18 respondent organizations, 8 posses QMS certification (ISO 9000) which is 44% while other 10 organizations, which account for 56%, are not certified for cited program.

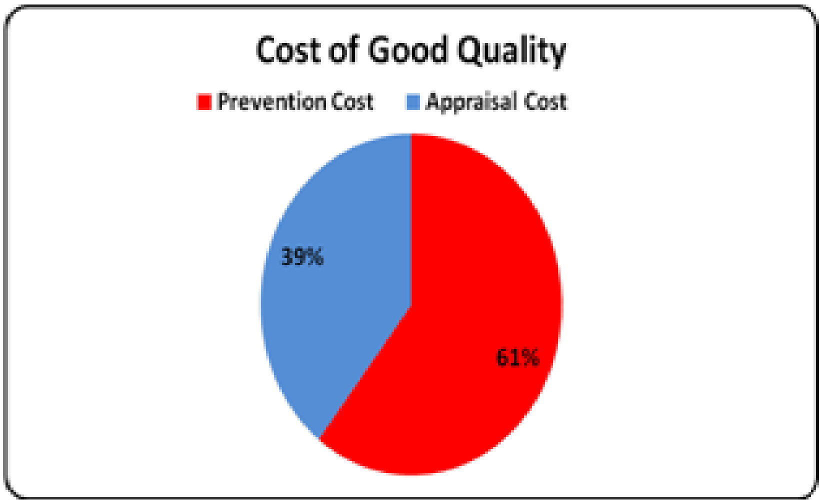
Analysis of the respondents revealed that variety of the company professionals responded the survey, which included: Directors; CEO; CTO; Quality managers; Production Managers and Proprietors. Respondents had a rich professional experience, majority had a more than 25 years of experience while the least experienced person had more than 6 years of experience while the other respondents had a mid range experience of 11 ~ 25 years.

Through the questionnaire, respondents were inquired for various COQ attributes like quality planning, supplier evaluation, training & education, internal failure, external failure, etc. For reply, respondents had option, if there was a actual scenario of failure they can mention that but if there were no reported failure, the reply was the expert judgment of experienced industry professionals. COQ attributes have a positive correlation with sale price, but this is not of equal value for all attribute and varies for each attribute. Differently, all COQ attributes have a negative correlation with amortization quantity but again it varies for each attribute.

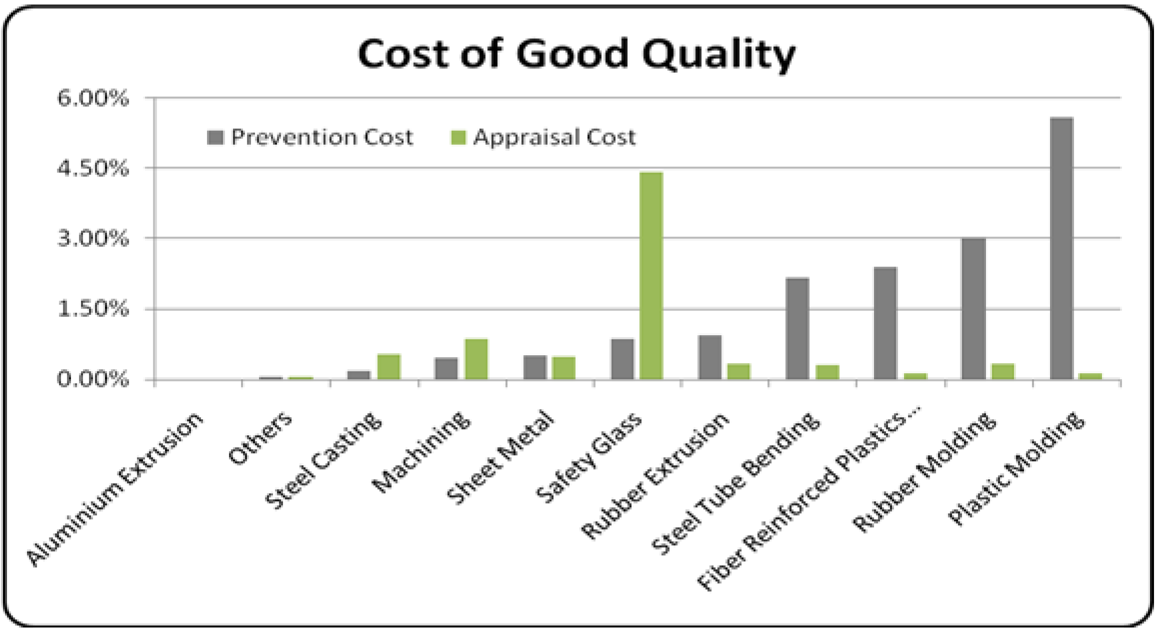
Survey data is summarized here in a table along with the Pearson’s Correlation of COQ attributes vs. Sale price and Amortization Quantity.

Sr. #	COQ Attribute	Pearson's Correlation		Observed Values (% of Sale Price)		
		vs Sale Price	vs. Amortization Qty	Min	Max	Average
1	Quality planning	0.3445	-0.2089	0.000%	0.133%	0.025%
2	Supplier evaluation	0.0570	-0.1243	0.000%	0.777%	0.050%
3	Final Inspection Check Sheets	0.3335	-0.1323	0.000%	1.760%	0.330%
4	Error Proofing	0.2508	-0.1277	0.000%	3.307%	0.574%
5	Quality Improvement Team Meetings	0.2671	-0.1978	0.000%	3.951%	0.282%
6	Quality Education and Training	0.0873	-0.1773	0.000%	2.222%	0.095%
7	Appraisal Time Cost	0.7336	-0.0916	0.004%	3.187%	0.456%
8	Destructive / External Testing Cost	0.1787	-0.0715	0.000%	7.882%	0.427%
9	COGQ (Prevention + Appraisal Cost)	0.4830	-0.1529	0.017%	9.823%	2.232%
10	COPQ (Internal Failure Cost)	0.5481		3%	150%	48%
11	COPQ (External Failure Cost)	0.6955		13%	600%	113%

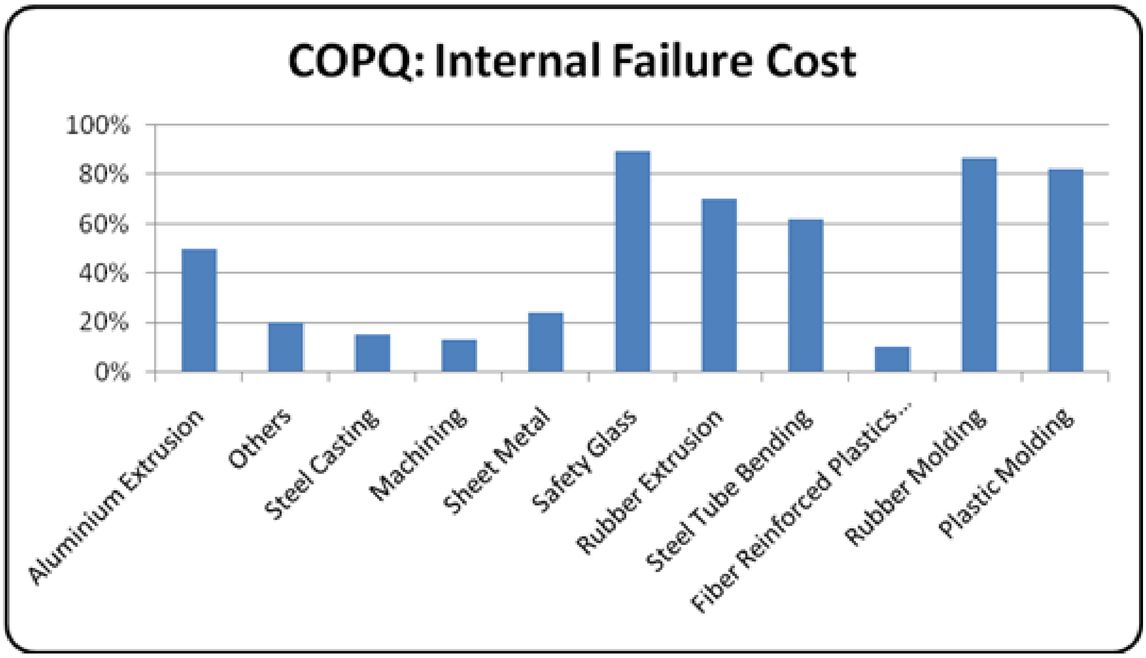
COGQ, Prevention Cost vs. Appraisal Cost: Cost of Good Quality is the sum of prevention & appraisal cost, but here these two are not equal partner. Prevention cost is incurred mainly for the planning and execution of “Measure of Control”, which are process parameters or process controls and are applied before or after the process steps. If all the measures of control are within acceptance range, definitely the resultant product will also be as per requirement. Appraisal cost is applied at the end of process steps when product has gone through all the process steps and it is used for “Measure of Result”, which is the overall result. Prevention cost is almost twice of the appraisal cost and it can be said that if measures of control are consistent and reliable, only in that case appraisal efforts and cost could be reduced. In a vice a versa case, if prevention efforts are neglected or compromised there will be increase in rejection ratio and appraisal efforts which will in turn increase the rejection rate & appraisal cost.



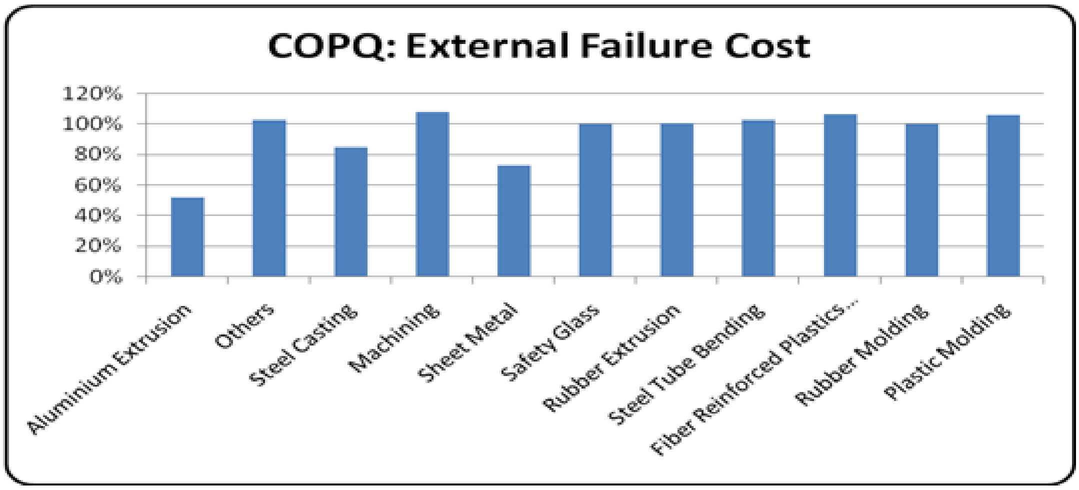
COGQ is not same or identical for all part type, this largely depends on manufacturing process and other inputs. If the manufacturing process comprises of large number of steps or the output is inconsistent or if there is no chance of rectification of an error in initial step, need for monitoring and control efforts will be on higher side and as a result COGQ will increase. Steel Casting, Safety glass, rubber molding and plastic molding have the highest COGQ, this is due to the fact that these parts are irrecoverable for any error in their only manufacturing step, so higher is the vigilance and the cost.



Internal Failure Cost: Internal failure can cost up to 90% of the sale price, for example the case where material & process cost is irrecoverable and reworking is expensive. Such examples include cases of safety glass production, rubber and plastic molding, rubber extrusion and steel tube bending, in these cases there is neither the chance of reworking nor the recycling of raw material. For the cases where, reworking is possible and not so costly, internal failure cost is on lower side.

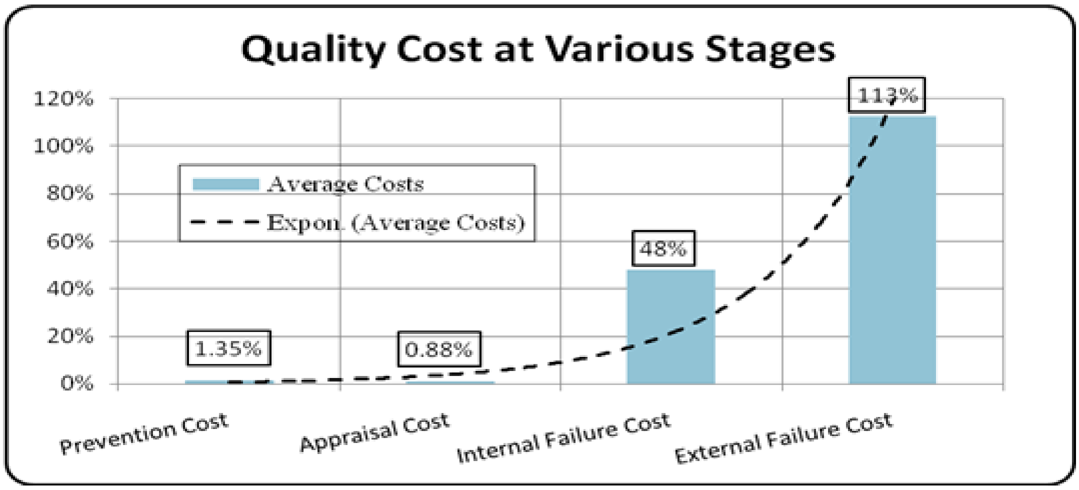


External Failure Cost: Internal failure cost ranges from 50% to 114% of the sale price. For the cases it less than 100% is due to the recyclability of material and parts for aluminum extrusion, sheet metal parts and steel casting. Where this cost is more than sale price it is due to the additional cost of replacement efforts and time. Furthermore the external failure has additional damages like customer dissatisfaction, damage to brand name, loss of future sale, etc.

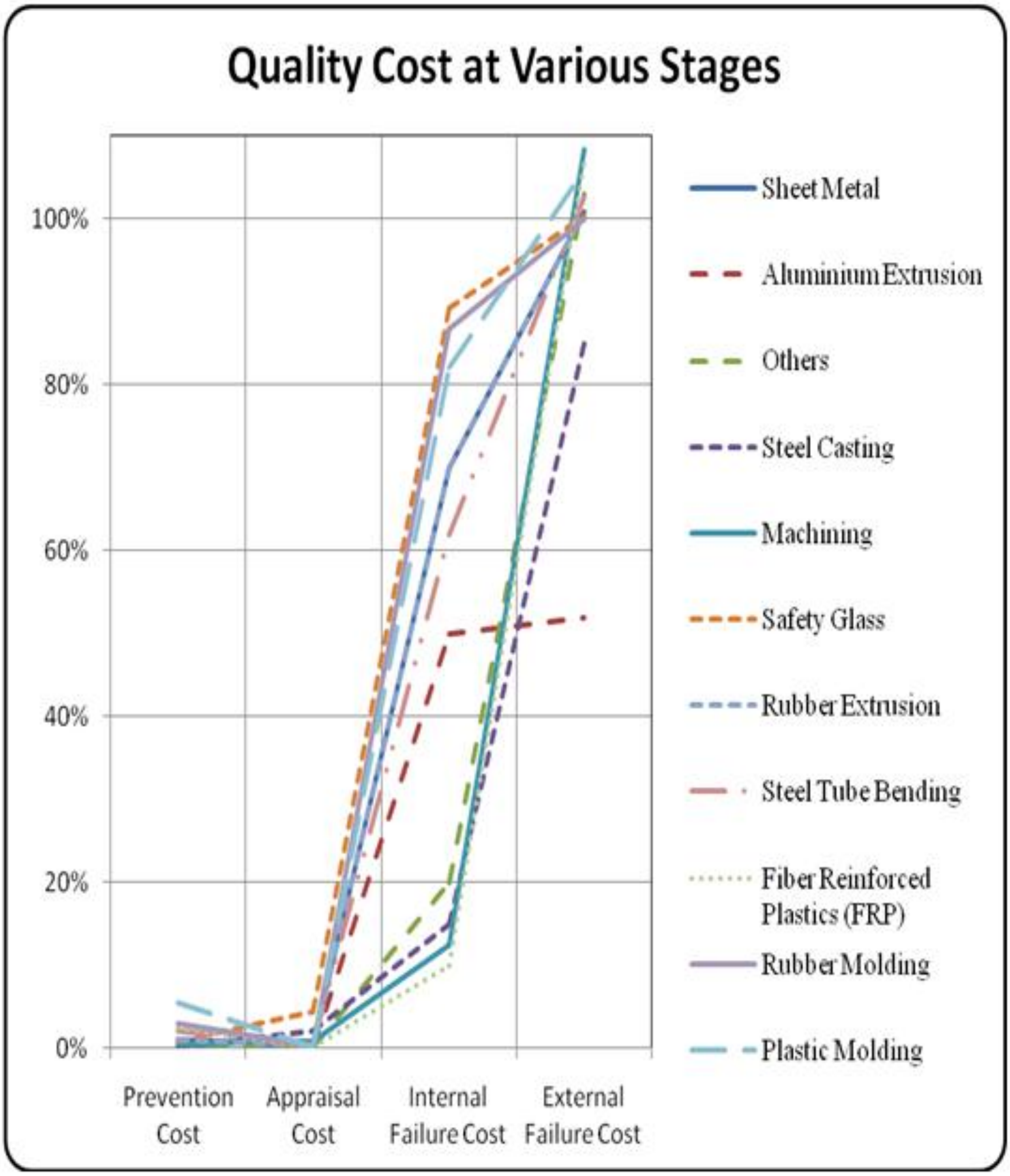


COPQ, Internal Failure vs, External Failure: Cost of poor quality may occur in anyone form, internal failure or external failure, but the resultant loss is not equal in both cases, it is more than the double of internal failure if external failure occurs. From survey data, the average internal failure cost is 48%, while external failure cost is 113%.

Quality Cost & Loss on various stages: Quality has a cost to produce it or to bear the loss of not producing it. Initially if one opts to invest efforts and funds to ensure quality of end product, cost of good quality is lowest, among COGQ costs; it is higher for prevention activities. But if one has to bear the loss of not producing quality, either in case of internal failure or external failure with due courses of actions, that loss or quality cost is very much higher.



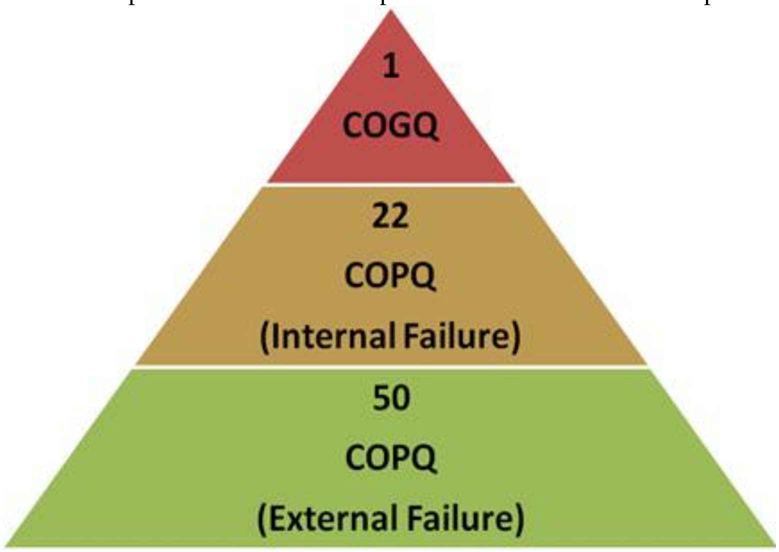
From whole survey data, average COGQ is calculated as 2.2% of sale price, but in case of internal failure average COPQ is 48% which is about 22 times higher. And in case of external failure average COPQ is 113 % which is about 50 times higher than the COGQ.



According to the part categories, the ratios of COGQ vs. COPQ (Internal Failure) vs. COPQ (External Failure) vary. For aluminum extrusion products these ratios are at minimum side (0.03% : 50% : 52%) and reason behind is the recyclability of raw material i.e. aluminum. Further, it has reasonable value as scrap. In cases of safety glasses, these ratios are at highest level (3.7% : 89% : 100%) again the reason is raw material but in this case it is neither recyclable nor has a reasonable value as scrap.
From survey data, range of COGQ is calculated between 0.03% ~ 4.04%, range of COPQ (Internal Failure) 10% ~ 89% and COPQ (External Failure) 52% ~ 114%.

V. Conclusion

Cost of conformance is preventive approach with prevention and appraisal actions/costs but Cost of non conformance (Cost of Poor Quality) is reactive approach, which has to be paid when failure happens before or after the shipment of product / service. Opting for COGQ is a choice and a wise decision, as it is applied before the production process takes place, one can plan COGQ, while COPQ is not a choice, but an obligation to accept, as it take place after the processes are done and product has taken the final shape.



Calculating COPQ provides opportunity to translate things into money that can be eliminated being wastes, it further enables the prioritization of work thus promotes the effective use of resources.
Reducing the COPQ is one of the best ways to increase profitability of organizations and reduction in COPQ shows the effectiveness of improvement & corrective actions in processes, as well as of COGQ activities.
Among the prevention and appraisal costs, prevention cost is primary that ensures the “measure of controls” and further ensures “measure of results”, so higher prevention cost is not bad but necessary for lower appraisal cost.
Prevention and appraisal costs have to go up, before COPQ can go down, these costs are also the area for cost reduction, but only if the causes of the failures are identified and removed.
COPQ or failure costs are too high and prevention / appraisal costs are comparatively too low.
At an average drawn from survey data, COGQ is 22 ~ 50 times cheaper / lower than COPQ. So, investment for COGQ could safeguard much more compare to the losses of COPQ.

VI. Recommendations

In the present scenario of Pakistani automobile industry, there is a genuine need of having effective COQ program and as a starter; PAF (Prevention – Appraisal – Failure) model of COQ is appropriate tool.

Organizations need to create a process at their workplaces that takes Cost of Quality data and could turn this data into actions to reduce Cost of Poor Quality.

The current study is small scale exploratory research; another detailed study will be more beneficial with relatively larger sample size. This study covers organizations in the southern part of Pakistan only, generalization for whole automobile industry in Pakistan would be invalid and therefore a country-wide study may be carried out.

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