Motor vehicle industry - Rework costs analysis

The sooner an error is detected and fixed, the smaller is the financial impact.

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Whitepaper

1 Introduction

Every manufacturing company's main goal is to ensure the quality of their products and to keep their consumers safe and satisfied. However, sometimes the manufacturing process fails, leading to field claims and the most feared consequence: product recalls.

In the 1st semester of 2019, 283 recalls of motor vehicles were made in the European market[(0)]. This includes mainly car manufacturers, but also buses, motorcycles among others.

Not all field claims end in a recall. In the best case these could be isolated cases but still they could end up in serious injuries for the final users and a colossal cost for the manufacturer. In an interview with the Plant Manager of a German car manufacturer (name reserved), he said that they had three field claims in 2018 which, according to his experience in several plant from around the world, this is about the yearly average.

In the case of car manufacturers, it is a fact that they spend extraordinary amounts of money fixing warranty issues. We can bring the example of the total accruals in US during 2016 for these kind of issues: USD 10.3 Billion[(2)].

From the 283 cases, we have taken 10 examples where Error Proofing solutions could have avoided the issue completely or at least minimize the impact. Let us analyse some facts from the selected cases:

- Number of products affected: **278,032 vehicles**
- Problem origin:
  - Missing or loose tightening
  - Wrong part assembled
  - Incorrect assembly process
  - Defective parts

When analysing the sources of these issues, we have found that the biggest portion are directly or indirectly related to the **production process complexity**. According to a study carried out in the US, the amount of options for each model is one of the main root causes which leads to field claims: *when as few as four extra options are added on the production line, it can lead to two extra recalls -- the equivalent of USD 46.2 Million in additional costs to automakers over the same seven-year period.*[(1)]

We have analysed some of the potential cost sources, some of which are easier to measure than others. It is important to mention that the costs can vary depending on the region, country, product, brand, etc. therefore we have taken some representative figures based on our own experience in the field.

2 Cost analysis and their sources

On top of the field claims and recall costs, we will also analyse *the costs related to detecting and repairing the problems before the products leave the manufacturing facility*. These have a smaller financial impact compared to field claims of any kind, but still are big enough for the vehicle manufacturers to take actions.

These costs might be hard to grasp and assign to a specific model, plant of manufacturing process. We will try to bring this numbers down to specific costs.

2.1 Field claims and recalls

- **Legal consequences:** The US government can fine per affected vehicle (up to USD 21,000 in one of our examples), and this without calculating the individual legal actions from the final users
- **Brand image & revenue reduction:** who wants to buy a product which is known to have serious safety issues?
- **Repair costs** (operating costs)**:**
  - o Communication, training
  - o Engineering
  - o Labour
    - Disassembly and reassembly of the area where the failure is
    - Mostly done in overtime (double the cost!)
  - o Material
    - Replacement parts

Facts (data from US)

- Warranty accruals (2016): USD 10.3 Billion
- Vehicles produced (2016): 12.1 Million
- Estimated **repair costs** of a recall per vehicle(1): **USD/vehicle 200**
- **Total cost of a recall per vehicle:** USD 10.3 Billion / 12.1 Million vehicles = **USD/vehicle 850** or its equivalent EUR/vehicle 760

2.2 Problem detection and repair within the manufacturing facility

- **Opportunity cost:** Each product that is not released on time is a product that might not be sold. Many times, only delays in delivery are generated but occasionally it could lead to cancellation of orders.
- **Operating costs:**
  - **Detection cost:**
    - "4 Eyes principle": This means to have a 2nd or even a 3rd (6 eyes) operator to check the critical operation before it leave the plant
    - Numerous check points: this generates unnecessary inefficiencies
  - **Repair cost:**
    - *Logistics:*
      Movement of products and a place needed to keep them while repairing
      (think about 1000 cars, many times manufactures need to rent special locations to do the rework)
    - *Engineering:*
      Planning, designing and managing the execution of the rework process consumes an extraordinary amount of engineering resources.
    - *Labour:*
      - Depending on the number of products that can be done in overtime (double the cost!)
      - Disassembly and reassembly of the area where the failure is
      - Unrelated quality issues could appear as normally these rework processes are not standard and do not use the same tools as in the main line.
    - *Material:*
      - Replacement parts
      - Scrap material

Facts (yearly average) [3]

- **7.6 vehicles every 100** of the plant production has assembly defects related to:
  - Missing or loose tightening
  - Wrong part assembled
  - Incorrect assembly process
  - Defective parts
- Detection: 10 min/vehicle
- Repair: 10 min/vehicle
- Labour cost reference
  - Operator: USD/h 30
  - Engineering: USD/h 60
- **Total estimated rework cost** (adding material and logistic costs)**: USD/vehicle reworked 20**
- **Total rework cost per vehicle produced:** 7.6% x USD/vehicle 20 = **USD/vehicle produced 1.52**

3 Conclusion

Citing the US study [1]:

> *The bottom line is that complexity causing variety on an assembly line requires commensurate levels of excess capacity to manufacture good quality products. Three former GM executives have attested to the eracity of these findings.*

On simpler terms:
Competitive market → high variety of product models and variants → increased complexity in production → increased amount of assembly defects → increased amount of recalls

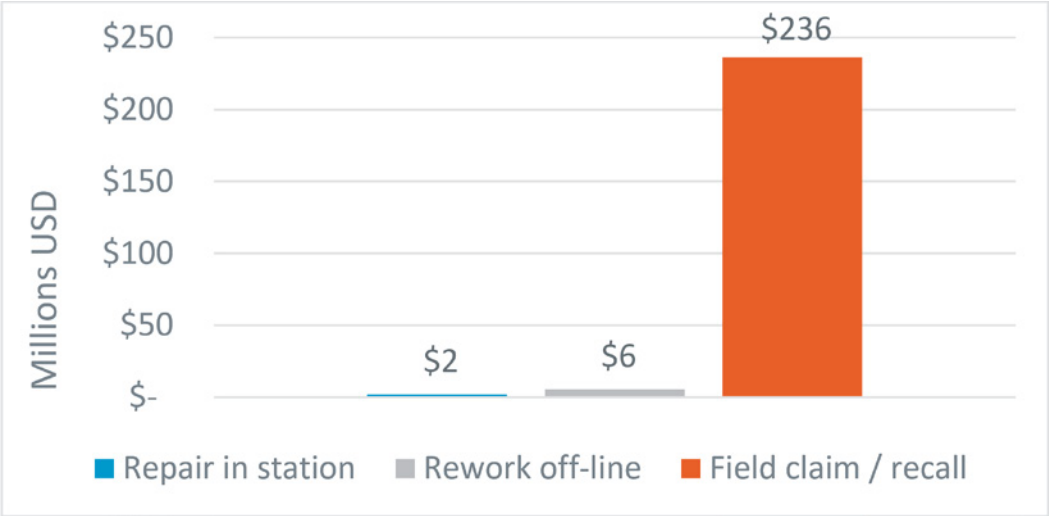
The manufacturers can't deal with all the factors affecting this chain, but they can implement Error Proofing measures **to avoid that the complexity in the production lead to defects**, which if not detected in time, could end in field claims or recalls.

Once again, let us take the 278,032 vehicles of our 10 examples from this 1st semester of 2019 in the light of the mentioned costs:

- **Estimated recall cost:** USD 850 x 278,032 = **USD 236.3 Million**
- **Estimated detection and repair costs:** USD 20 x 278,032 = **USD 5.5 Million**

The picture is clear: **"the later an error is recognized and repaired; the bigger is the financial impact"**

On our example, this looks as follows:



4 Sources

[0] European Commission Safety Gate

[1] Shah, Rachna and Ball, George and Netessine, Serguei, Plant Operations and Product Recalls in the Automotive Industry: An Empirical Investigation (January 21, 2016).
INSEAD Working Paper No. 2016/01/TOM.
Available at SSRN: https://ssrn.com/abstract=2356315 or http://dx.doi.org/10.2139/ssrn.2356315

The data set included information about production at 32 plants, 80 unique models and a sample size of 232 car model years.

[2] Alix Partners

[3] Production data from German automotive manufacturer quality reports

5 Appendix

5.1 Recall details

Details on the mentioned 10 cases from the 1st semester of 2019

Manufacturer	Model	Recall code	Issue description	Prevention	# of units	Date	Link
Volvo	XC60, S90	R19931	Possible missing screw connection on the front seat rails.	Error Proofing: Operator guidance	2297	20.03.2019	Link
Chrysler	RAM 1500	V04	Loose Ground Causing Power Steering Assist Loss	Error Proofing: Tool interlock	159740	24.01.2019	Link
Ferrari	458, 488, F12		Due to possible defect of the control unit, vehicle's airbags and/or the safety belt pre-tensioners could activate inadvertently.	Error Proofing: Part documentation Can't be prevented but the amount of vehicles can be reduced	~500	05.07.2019	Link
Nissan	NV300	PN9B3	The hand brake cable stopper may be incorrectly installed. The safety belt anchor bolts on certain vehicles may have been insufficiently tightened.	Error Proofing: Process control	~1000	15.07.2019	Link
Porsche	Boxster, Cayman, 911	AKA4	Injuries Airbag sensors may have been inadequately installed. This may lead to reduced protection in the event of an accident in which the restraint system is activated.	Error Proofing: Operator guidance	417	06.03.2019	Link
Mercedes-Benz	Vito	VS2HA FEDER	The springs on the rear axle are inadequate for the vehicle type.	Error Proofing: part verification	~100	08.07.2019	Link
Otokar	Territo (Bus)		The suspension system nuts have been insufficiently tightened.	Error Proofing: Operator guidance, tools interlock	~50	15.05.2019	Link

5.1 Recall details

Manufacturer	Model	Recall code	Issue description	Prevention	# of units	Date	Link
Dodge	Charger	U37	The front driveshaft universal joint may seize or fracture causing the shaft to detach from the vehicle.	Error Proofing: Process control	13928	05.08.2018	Link
Dacia	Logan	0D0X	Possible insufficient tightening torque of the lower steering column fixing bracket screws. This may result in vertical movements of the steering wheel, impairing vehicle's steering control	Error Proofing: Tool interlock	~100000	10.05.2019	Link

5.2 Additional calculations

Assumptions:

- Recall cost per vehicle: 200$
- Engineering cost: 60$/h
- Operator costs: 30$/h

Assembly defects in vehicle production	Costs inside the factory					Outside the factory		
	Engineering	Labor: 10 min per vehicle		Material	Total			
# of products affected		Detection	Rework			Recall operative cost	Brand image and revenue impact	Total
1	$ -	$ 5,00	$ 5,00	$ 10,00	$ 20,00	$ 200	$ 650	$ 850
10	$ 60,00	$ 50,00	$ 50,00	$ 100,00	$ 260,00	$ 2.000	$ 6.500	$ 8.500
100	$ 240,00	$ 500,00	$ 500,00	$ 1.000,00	$ 2.240,00	$ 20.000	$ 65.000	$ 85.000
1000	$ 2.400,00	$ 5.000,00	$ 5.000,00	$ 10.000,00	$ 22.400,00	$ 200.000	$ 650.000	$ 850.000
278032	$ 2.400,00	$ 1.390.160,00	$ 1.390.160,00	$ 2.780.320,00	$ 5.563.040,00	$ 55.606.400	$ 180.720.800	$ 236.327.200

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