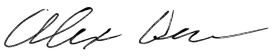
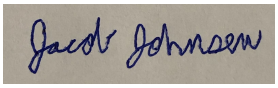
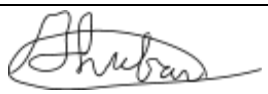
ENGG404 TEAM PROJECT FINAL TECHNICAL REPORT:

Submitted by Team #: #316

Case Study: Samsung Galaxy Note 7 Battery Faults:
Samsung Electronics, Battery susceptible to overheat and explosion due to design flaw, Various locations around the world, 2016.

Date submitted: 2019/12/05

Team Members	Student #s	Signatures
Alex Deans	1467345	
Nathan Durocher	1508587	
Jacob Johnsen	1460997	
Meng Xiao	1466737	
Ghufran Noor	1463491	

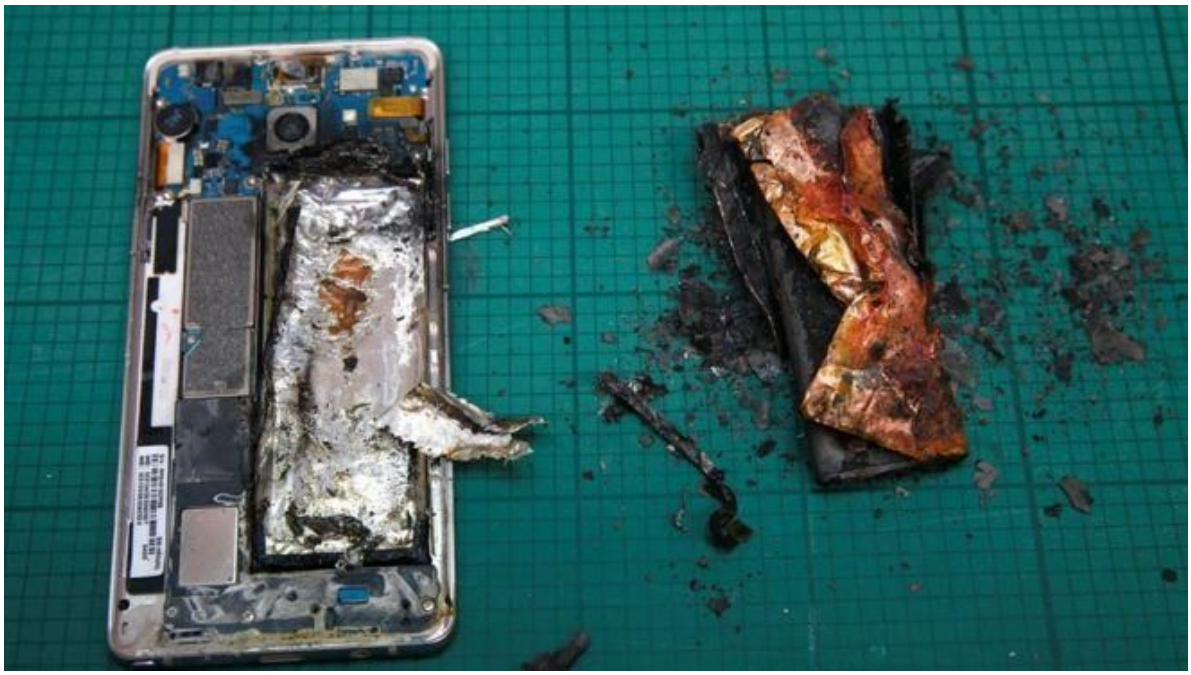


TABLE OF CONTENTS

EXECUTIVE SUMMARY

Incident Description and Losses:

On August 2, 2016, Samsung announced its latest flagship model, the Galaxy Note 7. It was officially released on August 19 in 10 major markets. The first report of a Galaxy Note 7 exploding appeared in the news on August 24, after which there were more reported incidents of the Galaxy Note 7 exploding or catching on fire. On September 2, Samsung announced a global voluntary recall and replacement of the Note 7; however, reports showed that the replaced Note 7 still showed the same battery failures. In response to the new incidents, Samsung had to stop sales and exchanges of the Note 7 and issued a second global recall on October 10. The next day, Samsung announced that it would permanently abandon the production of the Note 7 and start an investigation. The official investigation report was released on January 23, claiming that the battery design flaws and manufacturing defects were the causes of the incidents.

The total injuries caused by overheating or explosions was unknown. The disposal of recalled Note 7 devices will pose minor impact to the environment. The total impact on Samsung's assets includes the cost to recall all Note 7 devices which was estimated to be $5.3 billion [2]. Disposal cost is approximately $134 million. The lost sales for the Galaxy Note 7 was estimated to be $17 billion, and the number of units that had been manufactured but that Samsung could no longer sell was 19 million [10], equivalent to $171 million lost. There were also costs associated with device disposal or refurbishment, customer compensation, incident investigation, and lawsuits. Stock price and market shares of Samsung Electronics also shrunk. The loss of reputation, credibility, and loyal customers caused long-term effect to Samsung Electronics. All issues listed above, resulted in many lost hours of production and development due to the total time allocated for resolving the Note 7 defects.

Context and Purpose:

Samsung Electronics is one of the world's largest manufacturers of mobile phones and smartphones. Samsung released its Android smartphone Galaxy series in 2009, followed by the release of the Galaxy Note series. Up to 2016 Q1, just before the incident, Samsung Electronics was the largest global smartphone vendor. The device involved in this incident was the Samsung Galaxy Note 7 which was released on August 19, 2016.

With the intention of entering the smartphone market, ABC Conglomerate is conducting an incident investigation on the Samsung Galaxy Note 7 battery failures. Samsung's incident caused losses in various foundational elements including: people, environment, assets and production (PEAP). In attempts to be a proactive company, we will be conducting a root cause analysis in order to determine the latent causes underlying the loss incident. Also, a business case analysis of the incident and report the findings in the form of recommendations for management. Included in the report will be the impacts and challenges associated with implementing the recommendations. The ultimate goal of the investigation is to find the latent cause of the loss incident and learn from Samsung's mistakes to improve our own risk assessment and risk management system.

Root Cause Analysis:

The scope of the analysis covers the incidents due to both the initial design flaw which leads to overheating in the Galaxy Note 7 devices and the manufacturing flaw in the replacement device.

However, other design flaws in the Galaxy Note 7 which did not contribute to the device short circuit/overheating are not in our scope of discussion.

The root cause analysis includes all of Samsung's battery design, manufacturing, processes, engineering and management and how they contribute to the overheating of the batteries. Initially, the main flaw was in the battery casing design and upon discovery of the issue their action to reconcile, did not work since the second replacement battery manufacturer also had production flaws causing similar overheating problems. Battery issues, along with risk assessment, product testing, employee competency and training were all analyzed in the breakdown. The first battery manufacturer failed because the casing around the battery cell was too small, resulting in excess pressure on the upper right corner of the battery and displacement of the negative electrodes. The deflected negative electrodes produced short circuits and thus generated the heat that lead to the explosion. This flaw is attributed to both poor design specifications and a deficiency in quality control which stem from a lack of engineering design experience and errors in the review process. The second battery manufacturer showed failure in their welding process. Abnormalities on the surface of one of the battery layers did not allow for sufficient space and isolation for the negative tab. This lack of space created contact between the positive and negative tabs of the battery resulting in shortage and overheating much like the first manufacturer. Insufficient research in the welding process and assembly of the prototype batteries exposes issues in their risk assessment process and product review.

Latent Causes:

#	Latent Cause	RMSE
1	Management did not promote the importance of following the design requirements and a safety culture in design process	1) Management Leadership, Commitment and Accountability. 7) Design, construction, and start-up
2	Management did not see the need to review the design specifications	7) Design, construction, and start-up
3	Management did not see the need to review the training process	1) Management Leadership, Commitment and Accountability.
4	Management did not think training was necessary	9) Employee Competency and Training.
5	Management did not put effort into promoting the importance of the review processes	1) Management Leadership, Commitment and Accountability.
6	Management did not think review processes were necessary	6) Program Evaluation and Continuous Improvement.
7	Management did not see the need for more senior engineers	6) Program Evaluation and Continuous Improvement.
8	Management did not promote a safety culture	1) Management Leadership, Commitment and Accountability.

9	Management prioritizing reputation over safety (not enough time was given for design review, competition with other companies)	1) Management Leadership, Commitment and Accountability.
10	Specifications given to manufactures were not reviewed	6) Program Evaluation and Continuous Improvement.
11	Management did not select manufacture with right competencies	10) Contractor Competency and Integration.
12	Management did not see the need for improving the training program	6) Program Evaluation and Continuous Improvement.
13	Management did not see the need for training (install the electrode)	9) Employee Competency and Training.
14	Management prioritizing restoring company reputation over safety (no action was taken to address the flaws in replacement devices)	1) Management Leadership, Commitment and Accountability.
15	Inadequate risk assessment process	2) Risk Assessment and Management of Risks.
16	Company prioritized the replacement of devices	1) Management Leadership, Commitment and Accountability.
17	Testing process (for new manufacturing process) was not reviewed	6) Program Evaluation and Continuous Improvement.
18	Management did not understand the risk of having inadequate/obsolete researching method	2) Risk Assessment and Management of Risks.
19	Management did not see the need of researching or improving the existing method	6) Program Evaluation and Continuous Improvement.
20	Management did not ensure that the factory has an appropriate safety culture	10) Contractor Competency and Integration.
21	Auditing for contractor competency was inadequate	6) Program Evaluation and Continuous Improvement.
22	Samsung did not monitor the process in a proactive way	8) Operations and Maintenance.
23	Management did not ask for feedback from factories to ensure that clear instructions were given	6) Program Evaluation and Continuous Improvement.
24	Company prioritized the replacement of devices	1) Management Leadership, Commitment and Accountability.
25	Testing process was not reviewed	6) Program Evaluation and Continuous Improvement.
26	Prioritized restoring their reputation over due diligence, lack of safety culture	5) Incident Reporting, Investigation, Analysis and Actions.
27	The MOC work process was not followed	4) Management of change.

Key Recommendations and Alignment to Elements:

Rank	Recommendation	Gain Index	Effort Index	Total Score	Nature of Fix	Latent Cause Addressed	Applicable RME
1	**Recommendation #3:** Create and formalize a procedure for manufacture selection, including safety culture in the selection criteria.	4	22	88	Solution is not technology	1. Company prioritized the replacement of devices 2. Testing process was not reviewed Samsung did not monitor the process in a proactive way 3. Management did not ask for feedback from factories to ensure that clear instructions were given 4. Management did not ensure that the factory has adequate safety culture 5. Auditing for contractor competency was inadequate	1, 6, 8, 10
2	**Recommendation #1:** Have senior engineers and managers visit the contractor facilities and make sure there is no ambiguity in the given instruction/specifications.	4	20	80	Solution is not technology	1. Management did not ask for feedback from factories to ensure that clear instructions were given 2. Samsung did not monitor the (manufacturing) process in a proactive way	1, 6, 7, 8, 10
3	**Recommendation #4:** Implement a program which reviews the device testing process of future products being produced by Samsung	4	18	64	Solution is not technology	1. Company prioritized the replacement of devices 2. Testing process was not reviewed Samsung did not monitor the process in a proactive way 3. Management did not ask for feedback from factories to ensure that clear instructions were given 4. Management did not ensure that the factory has adequate safety culture 5. Auditing for contractor competency was inadequate	1, 2, 6
4	**Recommendation #2:** Create and Implement a comprehensive training program for all engineers	4	15	60	Solution is not technology	1. Management did not think review processes were necessary 2. Management prioritizing reputation over safety (not enough time was given for design review, competition with other companies) 3. Management did not understand the risk of having inadequate/obsolete researching method 4. Testing process (for new manufacturing process) was not reviewed 5. Management did not see the need of researching or improving the existing method	1, 7, 9

Business Case Analysis:

	Top Two Recommendations
Cost Avoidance of a Loss Incident	$ 327,300,000,000
Initial Costs of Improvements	$ 60,000
On-going Costs of Improvements per Year	$ 750,000
Life of Project	30 years
Total Cost of Improvements	$ 810,000
Annual Risk Exposure without Improvements	$10,910,000,000
Annual Risk Exposure with Improvements	$ 327,300,000
Gross Benefit	$ 10,582,700,000
Net Benefit	**$10,581,890,000**

The comprehensive solution falls into the “Low hanging fruit” quadrant. The combination of the two recommendations not only address the basic cause but also the latent cause behind the loss incident. ABC Conglomerate should review and improve the existing project based on the top two recommendations listed above since the cost in improving the current project is significantly less than the cost of a loss incident similar to the Samsung Galaxy 7 battery failure. Other factors, like losses that cannot be quantified, changes in the on-going cost, and variable project lifespan can be further analysed to provide a sound basis of decision making.

Issues with Implementation and Next Steps:

Issues with implementation regarding the power of leaders to influence behaviour are discussed regarding Recommendation #1 - having senior engineers and managers visit the contractor facilities and make sure there is no ambiguity in the given instructions or specifications. Two challenges with implementing this recommendation are having Samsung senior engineers and management gain the respect of the contractors so that they can view them as leaders, and have the safety lessons and culture that are imparted by the senior engineers and management propagate throughout the organization, instead of only influencing the small sample of workers that interact with Samsung during their visits.

To reduce the risk of similar loss incidents from occurring, ABC Conglomerate proposes that management enforces the implementation of several of the key recommendations of the report. Recommendations, #1 and #3 are the suggested choice based upon their gain index values. Carrying out these recommendations will prevent the risk of errors in the manufacturing process by providing a framework for initial and on-going business with third-parties. By creating an interdisciplinary group and a small budget, new processes can be created to provide a proactive solution to prevent similar loss incidents.

CHAPTERS:

Chapter 1: Incident Description and Losses:

Incident Description:
On August 2, 2016, Samsung announced its latest flagship model Galaxy Note 7 as a successor to the previous model, Galaxy Note 5, in the Galaxy Note Series. It was officially released on August 19 in 10 major markets including South Korea, Canada, the US and China.

On August 24, the first case of a Galaxy Note 7 explosion was reported in South Korea. After that there were more incidents of the Galaxy Note 7 exploding or catching on fire reported across several countries including the US and China. Users claimed that their Note 7 overheated or exploded either during or just after charging. It is unknown if there were any injuries caused by the exploding Note 7. On August 31, It was reported that shipments of Galaxy Note 7 were being temporarily delayed since additional quality inspection was conducted.

On September 2, Samsung claimed that they were aware of 35 cases of Note 7 devices overheating or igniting and they are conducting a thorough inspection of their suppliers. At the same time, they announced a global voluntary recall and replacement of the Note 7. Customers were offered refunds or replacements of their phones, but not all Galaxy Note 7 holders were aware of the fire and explosion hazard. A few days after the voluntary recall was announced, a 28 year old man in Florida reported that his Note 7 exploded when he was shopping in a Costco in Palm Beach Gardens. The phone burned directly through his pants, resulting in a second-degree burn on his right thigh.

By September 15, there were 92 reports of batteries overheating in the U.S, including 26 reports of burns and 55 reports of property damage[1]. The US Consumer Product Safety Commission (CPSC) had to issue a nationwide recall of approximately 1 million Note 7 devices purchased before september 15. The CPSC claimed that the Note 7 poses to be a fire hazard or serious burn hazard to consumers.

Furthermore, reports showed that the replaced Note 7 still showed the same battery failures. A replacement Note 7 device caught on fire on a Southwest Airline flight from Louisville, Kentucky to Baltimore, Maryland on October 5. Smoke was reported in the cabin before take-off and the plane was evacuated. Later reports indicated that a Note 7 device was the cause. According to the phone owner, this device was purchased on September 21, which was when Samsung started selling new versions of the Note 7. They said that there was a black square on the packaging of the device, which indicates that the device was the “safe” replacement model. Whereas, Samsungs claimed there was no evidence that this incident was related to the new Note 7. After this incident, several major airlines banned the Note 7 over potential fire risk.

In the following days, there was accumulated evidence that the replacement devices were also susceptible to overheating and explosion. On October 10, 2016, Samsung announced to stop sales and exchanges of the Note 7 and issued a second global recall. The next day, Samsung announced that it would permanently abandon the production of the Note 7 and start an investigation.

In December 2016, Samsung announced its intention to disable the functionality of any unreturned Note 7 via software patches. On January 9, 2017, Samsung released a software update limiting the battery capacity of Note 7 to 15%. An official investigation report was released on January 23. The report indicates that the battery was the cause of the Galaxy Note 7 incidents. There was a design flaw in the battery and these batteries also suffered from a manufacturing defect in the welding process. In addition, a number of batteries were missing insulation tape.

On March 2017, Samsung released another software update to completely block the device from charging, putting an end to the incidents; however, Samsung still had to face multiple lawsuits against them for the injuries and damages caused by the Note 7.

Losses:

People:

- Unknown total number of people injured
- The explosion of the device caused burn to its owners. One reported second-degree burn caused by Note 7 explosion.
- It was reported that owners of Note 7 hospitalized with acute bronchitis due to smoke inhalation.
- Before issuing the first recall by US Consumer Product Safety Commission, Samsung receives 92 reports of batteries overheating in the U.S, including 26 reports of burns [1].

Environment:

- The impact on the environment is minimized since the reusable parts from the recalled Galaxy Note 7 are refurbished as the Galaxy Note Fan Edition.
- The disposal of the Note 7 batteries will impose a minor negative effect on the environment.

Assets:

- The total cost of the recall of all Note 7 devices was estimated to be $5.3 billion [2].
- Lost sales for the 19 million Galaxy Note 7 devices was estimated to be $17 billion [3].
- Disposal cost is approximately $1.6 trillion won ($134 million), for 4 million Note 7 devices to be safely disposed [3].
- Samsung Electronics share were dropped by 6.3 percent to 1,476,000 won each after the first recall [4]
- Loss of marked shares to other competitors like Apple and Google. Samsung's market share in phone sales shrunk from 35% to 17% from August to December 2016 [5]
- Cost of customer compensation.
- Cost of investigation of the incidents.
- Lawsuits in the US and South Korea involving injuries and property damages.
- Loss of its reputation, credibility and loyal customers.

Production:

- The production of Note 7 is permanently ceased.
- The production lines have to be adjusted for other devices.

- Lost close to 1 million man-hours that were spent on manufacturing 19 million devices that were never sold [10]. Equivalent to $171 million lost.

Chapter 2: Context and Purpose:

Context:

Samsung Electronics is a South Korean multinational electronics company under Samsung Group. It is one of the world's largest manufacturers of consumer electronics and semiconductors. It is also a major manufacturer of mobile phones and smartphones. Smartphones came into the consumer market in the late 90s, and it gained popularity with the introduction of iPhone by Apple in 2007 [6]. iPhone revolutionized the industry by providing consumers with user-friendly interface and various digital contents. After that, the first Android smartphone HTC Dream was released in 2008. Samsung releases its first Android smartphone Galaxy series in 2009, followed by the release of the Galaxy Note series characterized by larger screen and stylus pen. Up to 2016Q1,just before the incident, Samsung Electronics was the largest global smartphone vendor and took 23.3% [7] market share and the main competitors of Samsung Electronics were Apple and Huawei.

The device involved in this incident was Samsung Galaxy Note 7 which was released in August 19, 2016. The Note 7 was designed by Samsung Electronics. It was an improvement on their past design of Galaxy Note 6. Before a device can be put into mass production, prototypes were made and reviewed by various people to select the best design. After the best design was selected, several tests were performed on the prototype device to make sure that the quality and other parameters meet the requirements. If the prototype meets all the requirements, the device can then be put into mass production. Different components of the device will be manufactured separately. Some components are manufactured in-house, while some other components(e.g. batteries, camera, memories, etc.) are outsourced in order to lower the production cost. The batteries of Note 7 were manufactured by Samsung SDI affiliate and Amperex Technology Ltd.

Smartphones are generally safe, but there are some minor risks using a smartphone. Since it is an electronic device, it might be susceptible to short circuit or thermal runaway. Especially when the device is too old or mechanically damaged. Inadequate design might also cause similar problems, but those kinds of problems rarely happen since prototypes are usually tested for design flaws and safety issues.

Purpose:

ABC Conglomerate is currently in the planning stages of breaking into the smartphone market and developing its own Android based smartphones. In order to compete with current flagship smartphones, senior management at ABC has drawn specific attention to safety issue of phone design, pointing to the incident of Samsung Galaxy Note 7 in 2016 as an example of the consequences that may occur as a result of company making poor design decisions and its defective risk management system.

By the request of senior management, this document will serve as a critical investigation into the latent causes associated with the Samsung Note 7 battery failures. Through the investigation, we will analyze the incident from the first reported failure in August, 2016 through to Samsung's end of production in October, 2016 and the results of their own investigation in January, 2017. By looking into Samsung's internal structure and actions we will perform a root cause analysis of the incident to discover the underlying issues in their risk management system and the latent cause of the loss incident. Along with the root cause analysis, a business case analysis will be completed and key findings will be reported as recommendation and the challenges associated with implementing them. As a part of the initiative within ABC conglomerate to be a proactive company, the purpose of the investigation is to identify issues in risk management systems of similar companies to provide ABC conglomerate with a solution to prevent the possibility of a similar loss incident and to improve our own risk management system based on the latent causes found by RCA.

Chapter 3: Root Cause Analysis – Discussion:

Scope and Boundaries:

Our scope includes all aspects of the Samsung Galaxy Note 7 battery design, manufacturing, processes, engineering and management and how each plays a role in the overheating/exploding of the batteries. The initial case was due to flaws in the battery casing design; however, the situation did not relieve when a second replacement battery manufacturer also had production flaw leading to the exact same overheating problems. Our analysis includes a thorough breakdown of both battery issues, as well as well as the lack in risk assessment, product testing, employee competency and training. The scope of the analysis covers the incidents due to both the initial design flaw which leads to overheating in the Galaxy Note 7 devices and the manufacturing flaw in the replacement device. However, other design flaws in the Galaxy Note 7 which did not contribute to the device short circuit/overheating is not in our scope of discussion.

Key Latent Cause #1:

The first of two battery manufacturers showed failure due to the casing around the battery cell being too tight. Resultant pressure in the upper right corner of the battery caused displacement of the negative electrodes. Battery cell pouches were manufactured too small, thus objectifying the cell to insupportable pressure. Once the pressure had deflected the negative electrodes, short circuits were created generating excess heat. Their manufacturing of inadequately sized cell pouches are a result of both poor design specifications and a lack in quality control. Having both a push for engineers to implement designs and miscalculating the space needed for the electrode were underlying factors giving rise to the failure.These engineering design flaws slipped through production because of both a lack of engineering design experience and errors in the review process, ultimately leading to Samsung implementing a new safety check system to ensure that a similar situation does not arise.

Key Latent Cause #2:

The second battery manufacturer had their own separate cause of failure attributed to abnormalities in the welding process. Deformities on the surface of the positive tab along with defective insulating tape did not allow for sufficient space and isolating for the negative tab. Burrs created from the welding process were responsible for contact between the negative and positive tabs of the lithium battery. In the same way that the first manufacturer had shortages between the negative electrodes, this positive and negative contact created shortages resulting in a build up of unwanted heat. The high temperature of the battery caused melting of both the battery itself and the phone case. Inadequate research in the welding process and assembly of the prototype batteries shows that not only did management miss the need to improve manufacturing methods, but it also exposes flaws in their risk assessment process.The same can be said on the side of device testing since not only was the device testing processed not reviewed, but additionally, insufficient time was given to properly test the replacement batteries from the second manufacturer.

Chapter 4: Application of the Cause and Effect Model – Discussion:

Immediate Causes:

Substandard Conditions:

- Defective Equipment
    - Short circuit within the phone battery due to defective electrode
        - Flaws in the Note 7 design led to defective equipment of which included the negative electrode of the battery. This is due to the electrode being too large for the designed battery pouch, leading to short circuiting of the device.
    - Defective insulating table within the phone battery
        - The insulating tape that protects the electrodes within the battery was penetrated or missed in the production process. This contributed to the cases where the phone failed due to battery issues.

Substandard Work Practices:

- Failure to Follow Established Procedures
    - Change in manufacturing procedure introducing new flaws
        - During the relaunch of the Galaxy Note 7 after the initial recall, additional flaws were introduced to the device. New procedures were introduced as a quick fix instead of following established procedures in past products.
    - Improper installation of battery components
        - Workers installed the battery components incorrectly during the manufacturing process due to not adhering to proper work procedures.

Basic Causes:

Engineering Design Factors:

- Inadequate Technical Design
    - Inadequate Galaxy Note 7 battery design
        - Multiple flaws in the technical design of the Galaxy Note 7 including: inadequate space allocated for the negative electrode within the battery pouch and inadequate research into the welding process resulting in high welding burrs penetrating the insulation tape.

- Inadequate Standards, Specifications and/or Design Criteria
    - Incomplete manufacturing specifications given to manufacturer
        - Incomplete manufacturing specifications were given to the manufacturer by Samsung in regards to installation of the insulating tape within the phone battery.
- Inadequate Assessment of Operational Readiness
    - Samsung management did not assess operational readiness in the relaunch of the Galaxy Note 7
        - Samsung did not follow proper due diligence in testing the relaunched Galaxy Note 7 devices before sending them out to customers. Operations was not prepared in monitoring the manufacturing process in a proactive fashion.
- Inadequate Evaluation and/or Documentation of Change
    - Inadequate documentation of change in manufacturing process lead to new flaws in relaunch of device
        - The new process that were used in relaunching the Galaxy Note 7 were not studied and testing properly. The change in procedures from the old device to the relaunched version led to additional manufacturing flaws being introduced.
- Inadequate Inherently Safe Design
    - Phone design not designed inherently safe to allow for smaller design
        - Concessions were made to the safety of the device in order to keep it small and compact. This includes the small battery pouch designed to house the battery electrodes which contributed in the short circuiting of the device.

Job Factors:

- Inadequate Job Procedures
    - Inadequate job procedures in manufacturing of the Galaxy Note 7
        - Inadequate job procedures relating to the manufacturing of the Galaxy Note 7 led to multiple device defects. Improper welding of the positive electrode burrs resulted in high burrs that penetrated the insulation tape of the battery.
- Error-Inducing Conditions
    - Lack of senior staff leading to overloaded workers
        - The inherently unsafe design of the battery was not caught by senior engineering staff that were to review design specifications. This may be due to overloaded senior staff who were placed into this error-inducing condition by staffing issues.
- Incompatible Goals
    - Samsung executives pushing the release of the phone instead of safety culture
        - The initial launch and subsequent relaunch of the Galaxy Note 7 was pushed instead of additional device testing and due diligence. Many flaws/defects were not caught due to the goal of a fast product release which is incompatible with safety culture/goals.
- Inadequate Training
    - Inadequate training of manufacturing contractors

        - Inadequate training of the contracted companies in charge of manufacturing the Galaxy Note 7 devices could be responsible for the manufacturing defects found. Additional training could have prevented the high burrs of the positive electrode penetrating the insulation tape within the battery.
    - Inadequate training of design staff
        - Flaws in the battery design (inadequate space for the negative electrode and the welding burrs on the positive electrode being too close to the insulation tape) could have been avoided in the design staff were trained properly to avoid these flaws in the design.
- Inadequate Communication
    - Inadequate communication between senior staff and workers
        - Communication issues between senior staff reviewing the battery design and engineers designing the battery may have allowed design flaws to reach the final product that could have been prevented with better communication during the review process.

Personal Factors:

- Physical or Physiological Stress
    - Senior engineers overloaded with work
        - Physical and physiological stress due to overwork may have allowed senior staff reviewing the phone design to miss the flaws present in the final product.

- Lack of Knowledge / Lack of Skill
    - Lack of battery design experience/skill
        - A lack of design experience or skill may be the cause of the design flaws being present in the first place. Workers more experienced in battery design may have been able to design a phone with the small space requirements without introducing the flaws present in the initial launch and relaunch of the Note 7.

Latent Causes (weaknesses in Management System Elements):

- RMSE #1 Management, Leadership, Commitment and Accountability:
    - Samsung management did not see the need to review training processes
        - They felt their training process was adequate. Management had no insight that there was defiecies in the system.
    - Samsung management did not put effort into promoting the importance of review process
        - Assumptions were about the competency level of employees. They though senior management would be accountable.
    - Upper management did not promote a safety culture
        - Senior engineer was responsible for completing the review but management was not accountable for ensuring it was done.
    - Samsung executives priozited company reputation and profits over safety
        - They were under pressure to release the device at a certain date to keep up with competition. They were also under pressure to replace the first round of defective devices.

- RMSE #2 Risk Assessment and Management of Risks
    - Inadequate risk assessment process for recognizing hardware defects
        - Risk of hardware defects was not accounted for. Testing measures did not reflect all potential hazards.

- RMSE #4 Management of Change
    - Management of Change process not followed in production of new models
        - Information was not communicated as it was thought to be common knowledge for manufacturers. Switching to the second manufacturer corners were cut.

- RMSE #5 Incident Reporting, Investigation, Analysis and Actions
    - Lack of incident investigation, analysis and action taken when flaws were found in the first shipment of devices
        - Flaws were found but due to company reputation and other factors the devices were shipped before proper action was taken.

- RMSE #6 Program Evaluation and Continuous Improvement
    - Manufacturing specifications were not reviewed for continuous improvement
        - Battery design specifications were given to manufacturers before proper review was complete. Wrong specifications were followed by the manufacturer.
    - Training programs were not evaluated for continuous improvement
        - Current employee training seemed sufficient; however, no review for improvement was made or evaluated.
    - Device testing procedures were not evaluated and continually improved
        - No need was seen to have provided an up-to-date testing procedure resulting in outdated policies/steps.

- RMSE #7 Design, construction, and start-up
    - Management did not promote the importance of following the design requirements and a design safety culture. Management did not see the need for reviewing the design specifications.
        - Management did not actively promote a safety culture in the design stage.

- RMSE #8 Operations and Maintenance
    - Samsung did not monitor products as they were produced to ensure they meet operating standards.
        - Samsung wasn’t proactive and didn’t inspect or have operations in place to catch the defects.

- RMSE #9 Employee Competency and Training
    - Samsung management did not ensure that workers were trained properly
        - Management didn’t provide proper and sufficient training programs to workers helping them to work appropriately.

- RMSE #10 Contractor Competency and Integration
    - Contractors were not properly trained and/or knowledgable
        - Contractor management did not carry out adequate training on their end. Additionally, checks to ensure contractor competency were not in place.
    - Contractors did not have a proper safety culture
        - Contractor management didn't place enough value on safety and therefore a proper safety culture was not integrated or relayed throughout the employees.

Chapter 5: Key Recommendations:

A list all possible risk reduction solutions that address that latent cause:

#	Latent Cause	RMSE	Solution
1	Management did not promote the importance of following the design requirements and a safety culture in design process	1) Management Leadership, Commitment and Accountability. 7) Design, construction, and start-up	-Make safety a value in the company rather than a priority -Implement design review program to make sure design specifications are followed
2	Management did not see the need of reviewing the design specifications	7) Design, construction, and start-up	-Make safety a value in the company rather than a priority
3	Management did not see the need to review the training process	1) Management Leadership, Commitment and Accountability.	-Improve existing battery design training program -Make safety a value in the company rather than a priority
4	Management did not think training was necessary	9) Employee Competency and Training.	-Create and implement a comprehensive and mandatory training program for cell phone design
5	Management did not put effort in promoting the importance of review processes	1) Management Leadership, Commitment and Accountability.	-Make sure every senior engineer understands the importance of review process -Make safety a value in the company rather than a priority
6	Management did not think review processes were necessary	6) Program Evaluation and Continuous Improvement.	-implement a comprehensive senior review process for cell phone design
7	Management did not see the need for more senior engineers	6) Program Evaluation and Continuous Improvement.	-Hire more senior engineers -Allocate workload more efficient and reasonable

8	Management did not promote a safety culture	1) Management Leadership, Commitment and Accountability.	-Make safety a value in the company rather than a priority
9	Management prioritizing reputation over safety (not enough time was given for design review, competition with other companies)	1) Management Leadership, Commitment and Accountability.	-Review all existing designs to make sure they are safe -Make safety a value in the company rather than a priority
10	Specifications given to manufactures were not reviewed	6) Program Evaluation and Continuous Improvement.	-Implement sound review programs for specifications given to manufacturers
11	Management did not select manufacture with right competencies	10) Contractor Competency and Integration.	-Create and formalize a procedure for manufacture selection, including safety culture in the selection criteria -Review and audit all current manufactures to make sure they meet the criteria
12	Management did not see the need for improving the training program	6) Program Evaluation and Continuous Improvement.	-Improve the current training programs for device assembly, also implement post-training evaluation program
13	Management did not see the need for training (install the electrode)	9) Employee Competency and Training.	-Create and implement training programs for device assembly, also implement post-training evaluation program
14	Management prioritizing restoring company reputation over safety (no action was taken to address the flaws in replacement devices)	1) Management Leadership, Commitment and Accountability.	-Redesign the replacement devices to eliminate any potential risks due to design flaws -Make safety a value in the company rather than a priority
15	Inadequate risk Assessment process	2) Risk Assessment and Management of Risks.	-implement comprehensive incident investigation and risk assessment program
16	Company prioritized the replacement of devices	1) Management Leadership, Commitment and Accountability.	-Make safety a value in the company rather than a priority
17	Testing process (for new manufacturing process) was not reviewed	6) Program Evaluation and Continuous Improvement.	-review all existing test process, have senior engineers and technicians involved in the review process -Implement comprehensive review program for new manufacturing process
18	Management did not understand the risk of having inadequate/obsolete researching method	2) Risk Assessment and Management of Risks.	-Improve the current researching method for the welding process -Create a sound risk assessment program for new manufacturing process

19	Management did not see the need of researching or improving the existing method	6) Program Evaluation and Continuous Improvement.	-Improve or find alternatives for the current welding process
20	Management did not ensure that the factory have a safety culture	10) Contractor Competency and Integration.	-Create and formalize a procedure for manufacture selection, including safety culture in the selection criteria -Review and audit all current manufactures to make sure they meet the criteria
21	Auditing for contractor competency was inadequate	6) Program Evaluation and Continuous Improvement.	-Review and audit all current manufactures to make sure they meet the criteria -Create and implement sound contractor auditing program
22	Samsung did not monitor the process in a proactive way	8) Operations and Maintenance.	- Have senior management and engineers check the manufacture process regularly - Auditing the manufacture process
23	Management did not ask for feedback from factories to ensure that clear instructions were given	6) Program Evaluation and Continuous Improvement.	-Have senior engineers and managers visit the contractor facilities and make sure there is no ambiguity in the given instruction/specifications
24	Company prioritized the replacement of devices	1) Management Leadership, Commitment and Accountability.	-Make safety a value in the company rather than a priority
25	Testing process was not reviewed	6) Program Evaluation and Continuous Improvement.	-Implement test process review program
26	Prioritized restoring their reputation over due diligence, Lack of safety culture	5) Incident Reporting, Investigation, Analysis and Actions.	- Make safety a value in the company rather than a priority
27	The MOC work process was not followed	4) Management of change.	- Implement a sound MOC work process for design - Implement a sound MOC process for manufacture changes

Gain Index Criteria and Effort Index Criteria from the textbook:

Gain Index	Gain Index Criteria (any one of or combination of)
4	● Addresses latent causes. ● Eliminates hazards or has the greatest reduction in risk levels. ● Eliminates initiating events.
3	● Addresses basic causes.

	● Reduces risk levels to a lesser extent than “4”. ● Prevents incident by eliminating subsequent condition splits. ● Eliminates impact in overall PEAP despite having an event.
2	● Addresses immediate causes. ● Reduces risk levels to a lesser extent than “3’. ● Minimizes impact significantly in overall PEAP (i.e., mitigates the ● consequence of an incident).
1	● Minimizes impact slightly in overall PEAP (i.e., mitigates the consequence of an incident). ● Does not address any cause. ● Reduces risk levels to a lesser extent than “2” or not at all.

Gain index score /4 (No math required).

Effort Index	**1 (High effort)**	**2**	**3**	**4 (Low effort)**
Practicability	Challenging / develop new technology	Apply complex technology	Apply simple technology	Solution is not technology
Initial Cost	> $2M	$1M - $2M	$0.1M - $1M	< $100k
On-Going Costs (per year)	> $100k	$10k - $100k	< $10k	No on-going cost
Timeline	> 1 Year	< 1 Year	< 3 Months	Immediately
Duration	> 3 Months	1-3 Months	< 1 Month	< 1 Week
Frequency	Once per month	Once per quarter	Once per year	One time

Effort index score /24 (Add score of 1-4 for each of the 6 categories).
Total score = Gain Index * Effort Index

The top four recommendations are listed below:

Recommendation #1: Have senior engineers and managers visit the contractor facilities and make sure there is no ambiguity in the given instruction/specifications. Have senior management and engineers check the manufacture process regularly.
Description : Processes will be created to ensure proper communication is provided to third party manufacturers and other subcontractors about all aspects of design and scope of work.

<table>
<tr><td colspan="3">Senior staff will be required to visit and meet with third parties at their facilities to verify any confusion or unfamiliarities with the proposed work.</td></tr>
<tr><td colspan="3">Deliverable actions:
- Deliverable #1: Provide new processes for senior staff during third-party involvement.
- Deliverable #2: Create list of common areas of miscommunication as probing questions during visits.
- Deliverable #3: Create list of general processes that senior engineers can observe/check during visits to make sure that all critical processes comply with instructions/standard.
- Deliverable #4: Have senior engineers visiting the contractor facilities twice per year to check for their compliance with standard. Additional phone calls/internet meetings can be arranged monthly.</td></tr>
<tr><td>Gain index:</td><td colspan="2">4
This recommendation will address the latent causes aligned with RMSE #1, #6, #7, #8 and #10. It will also eliminate the possibility of having defective insulation tape in the replaced devices.</td></tr>
<tr><td rowspan="5">Effort index:</td><td colspan="2">20</td></tr>
<tr><td>Practicability</td><td>4 - Solution is not technology</td></tr>
<tr><td>Initial Cost</td><td>4 - $0.1M - $1M
Design and review the visiting procedure by senior engineers and managers will cost approximately $10,000.
Communicate the visiting procedure with contractors and subcontractors takes $5,000. A small team of senior engineer will be selected and trained for visiting contractor facilities. Training cost $1,000 per person for 10 senior employees. Total cost 25k.</td></tr>
<tr><td>On-Going Costs (per year)</td><td>2 - $10k - $100k
A small team of senior staff will be traveling for a few extra days a year. Multiple contractor facilities will be visited by the same team. 10 staff x 2 trips per year at $1,000 [9] per person per trip. Total cost 20k per year.</td></tr>
<tr><td>Timeline</td><td>4 - Immediate
Once in place, trips can be planned with minimal effort</td></tr>
<tr><td></td><td>Duration</td><td>3 - <3 Months</td></tr>
</table>

		Development of procedures need to be reviewed a few times before being put in place to ensure they are effective. the whole process takes less than 3 month.
	Frequency	**3** - Once per year Annual review is necessary, as industry standards change and different devices are being produced, the testing program will need to be adjusted accordingly.
Total score:	**80** "Low Hanging Fruit"	
Nature of fix:	**Permanent one time fix**	
Latent cause addressed:	- Management did not ask for feedback from factories to ensure that clear instructions were given - Samsung did not monitor the (manufacturing) process in a proactive way	
RMSE:	#1 Management Leadership, Commitment and Accountability. #6 Program Evaluation and Continuous Improvement. #7 Design, construction, and start-up. #8 Operations and Maintenance. #10 Contractor Competency and Integration.	

Recommendation #2: Create and Implement a comprehensive training program for all engineers who are involved in the design process, emphasize the importance of a safety design and the senior engineer review process.
Description : Create and implement a mandatory training program for all engineers and other technicians in the design team. The training program will have an initial training session with repeated refresh sessions for all current engineers. Additionally, all new employees must complete the training program before they start to work in the design team. This training program will improve the technical knowledge of all engineers and promote a safety culture. Encourage the report of unrealistic and unreasonable design specification in the design training. Also emphasise the importance of a safety design and the senior engineering review process during the training.
Deliverable actions:

<table>
<tr><td colspan="3">

- Deliverable #1: Create a comprehensive training program for safety design. Have senior engineers and experts involved in the design of the technical side of the training program. Encourage the report of unrealistic and unreasonable design specification in the design training program, and emphasise the importance of a safety design and the senior engineering review process during the training.
- Deliverable #2: Review the training program. Have experienced engineers and managers review the training program to make sure its effective and properly designed.
- Deliverable #3: Have a initial training session for all engineers and technicians in the design team. After the initial training session, have repeated refresh session (once per year) for everyone in the design team. New employees must complete the initial training section before they start working in the design team.
- Deliverable #4: During the refresh section, have expert (from research team, other companies, or universities) talking about new developments (e.g. new type of batteries) and techniques (e.g. new welding process). This makes sure every engineers in the design team have up-to-date knowledge of current trends and developments.
- Deliverable #5: Ask for feedback from the engineers who participate in the training. continuously improve the training program.

</td></tr>
<tr><td>Gain index:</td><td colspan="2">4
This recommendation will address the latent causes aligned with RMSE #1, #7, and #9. It will also eliminate the initial event of having design flaws in the cell pouch.</td></tr>
<tr><td rowspan="3">Effort index:</td><td colspan="2">15</td></tr>
<tr><td>Practicability</td><td>4
Solution is not technology</td></tr>
<tr><td>Initial Cost</td><td>1 - >$2M
Design and review the training program by senior engineers and managers will cost approximately 10k.
The training program will take one day (7 hour) and will cost approximately $30 per employee. Samsung Electronics has $310k employees[8], and the IT & Mobile Division have approximately $20k employees involved in mobile phone (hardware) design. Average salary is estimated to be $60/hour. Taking into account the productivity lost during the training the total cost for the initial training is $12.6M. The total cost, including the development of the training program will cost $12.61M.</td></tr>
</table>

	On-Going Costs (per year)	**1** - >$100k Taking into account the productivity lost during the training the total cost for the annual training program is $12.6M.
	Timeline	**4** -Immediate Engineers in the design team can immediately apply the knowledge they learned from the training to their design.
	Duration	**2** -1-3 Months The development and review of the training process will take approximately 2 Months to finish. The implementation of the training program for all employees requires less than one month. Total time required is approximately 3 months.
	Frequency	**3** - Once per year
Total score:	**60** (Low Hanging Fruit)	
Nature of fix:	**Permanent on routine/on-going basis**	
Latent cause addressed:	- Management did not think training was necessary - Management did not see the need to review the training process- - Management did not put effort in promoting the importance of review processes - Management did not promote the importance of following the design requirements and a safety culture in design process	
RMSE:	#1 Management Leadership, Commitment and Accountability. #7 Design, construction, and start-up #9 Employee Competency and Training.	

Recommendation #3: Create and formalize a procedure for manufacture selection, including safety culture in the selection criteria. Review and audit all current manufactures to make sure they meet the criteria.
Description : Processes and checklist will be created to ensure that current third party manufacturers are operating at acceptable standards in safety and quality. The same system can be implemented as a formal guideline when selecting new manufactures for products.
Deliverable actions:

<table>
<tr><td colspan="3">

- Deliverable #1: Create a checklist of requirements that follow company safety values. Check the operation history of the manufacture and make sure no loss incident happened in the past five years.
- Deliverable #2: Create a checklist of quality measurements to ensure the integrity (also communication, compliance with standards) of the third party manufacturer.
- Deliverable #3: Review/audit all current third party manufacturers using the safety and quality checklist. Replace contractors that does not meet the criteria.

</td></tr>
<tr><td>Gain index:</td><td colspan="2">4
This recommendation will address the latent causes aligned with RMSE #1, #6, #8 and #10.</td></tr>
<tr><td rowspan="6">Effort index:</td><td colspan="2">22</td></tr>
<tr><td>Practicability</td><td>4 - The solution is not technology</td></tr>
<tr><td>Initial Cost</td><td>4 - <$100k
$35,000 for half a months worth of document development from a team of five specialized engineers to ensure proper and efficient checklist items.</td></tr>
<tr><td>On-Going Costs (per year)</td><td>3 - <$10k
$5,000/year as it is a set unchanged set of documents unless changes have been made.</td></tr>
<tr><td>Timeline</td><td>4 - Immediate
The checklists and auditing systems will take place as soon as possible to limit any existing risks.</td></tr>
<tr><td>Duration</td><td>3 - < 1 Month
No training required and therefore the total duration is the time spent developing the checklists which is approximately one month.</td></tr>
<tr><td>Frequency</td><td>4 - One time (unless changed due to review).</td></tr>
<tr><td>Total score:</td><td colspan="2">88 (Low hanging fruit)</td></tr>
<tr><td>Nature of fix:</td><td colspan="2">Permanent one time fix</td></tr>
<tr><td>Latent cause addressed:</td><td colspan="2">- Company prioritized the replacement of devices
- Testing process was not reviewed
- Samsung did not monitor the process in a proactive way</td></tr>
</table>

	- Management did not ask for feedback from factories to ensure that clear instructions were given - Management did not ensure that the factory has adequate safety culture - Auditing for contractor competency was inadequate
RMSE:	#1 Management Leadership, Commitment and Accountability. #6 Program Evaluation and Continuous Improvement. #8 Operations and Maintenance. #10 Contractor Competency and Integration.

Recommendation #4: Implement a program which reviews the device testing process of future products being produced by Samsung. Once a device is manufactured, additional quality control measures, and audits to ensure that these measures are being continuously used, avoiding employee complacency.		
Description: Hire an engineering consulting firm to review and produce new quality control testing procedures alongside senior Samsung engineers and technicians. Ensure that all testing processes meet relevant industry standards, removing unnecessary device tests in favour of more essential ones (keeping device testing time approximately the same as before). Add recurring annual review period where the device testing program is checked to ensure that any new industry standards are continually met.		
Deliverable actions: - Deliverable #1: Device testing program which details tests that each batch of devices must undergo before they are cleared for sale. - Deliverable #2: Annual review of program ensuring that testing is adjusted to account for any new industry standards.		
Gain index:	**4** - Addresses latent causes as well as catches immediate/basic causes that make it through the manufacturing process.	
Effort index:	**18**	
	Practicability	**4** - Solution is not technology. New program detailing quality control tests which will use testing equipment that Samsung already has in use.
	Initial Cost	**3** - $0.1M - $1M Initial cost of hiring a team of engineers from a consulting firm to create the new program. Team of 4 engineers

		specialized in the testing / quality control for 8 weeks at $200/hr would cost $256 000. Additional cost of involving Samsung engineers and technicians in the range of $50 000.
	On-Going Costs (per year)	**2** - $10k - $100k Smaller team of consultants to do an annual review and bring the current program up to new standards. Team of 2 engineers for 2 weeks at $200/hr would cost $32 000. Additional cost sending out updated program < $10 000.
	Timeline	**4** - Immediately Once the new program has been finalized, it is able to be implemented immediately. As there is no new technology being implemented, quality control testers will be able to use the new program without additional training (it is only what they are looking for / testing that is changed, not how tests a
	Duration	**2** - 1-3 Months Consulting firm will take at least two weeks to review current Samsung testing procedures, a month to write and revise the new device testing procedures, and another two weeks to review these test procedures with Samsung senior engineering and technicians.
	Frequency	**3** - Once per year Annual review is necessary, as industry standards change and different devices are being produced, the testing program will need to be adjusted accordingly.
Total score:	**64** (Low hanging fruit)	
Nature of fix:	Immediate fix that can remain permanent with an annual review.	
Latent cause addressed:	- Management did not think review processes were necessary - Management prioritizing reputation over safety (not enough time was given for design review, competition with other companies) - Management did not understand the risk of having inadequate/obsolete researching method - Testing process (for new manufacturing process) was not reviewed - Management did not see the need of researching or improving the existing method	
RMSE:	#1 Management Leadership, Commitment and Accountability.	

	#2 Risk Assessment and Management of Risks. #6 Program Evaluation and Continuous Improvement.

Summary and Ranks of Recommandations:

Rank	Recommendation	Gain Index	Effort Index	Total Score	Nature of Fix	Latent Cause Addressed	Applicable RME
1	**Recommendation #3:** Create and formalize a procedure for manufacture selection, including safety culture in the selection criteria.	4	22	88	Solution is not technology	1. Company prioritized the replacement of devices 2. Testing process was not reviewed Samsung did not monitor the process in a proactive way 3. Management did not ask for feedback from factories to ensure that clear instructions were given 4. Management did not ensure that the factory has adequate safety culture 5. Auditing for contractor competency was inadequate	1, 6, 8, 10
2	**Recommendation #1:** Have senior engineers and managers visit the contractor facilities and make sure there is no ambiguity in the given instruction/specifications.	4	20	80	Solution is not technology	1. Management did not ask for feedback from factories to ensure that clear instructions were given 2. Samsung did not monitor the (manufacturing) process in a proactive way	1, 6, 7, 8, 10
3	**Recommendation #4:** Implement a program which reviews the device testing process of future products being produced by Samsung	4	18	64	Solution is not technology	1. Company prioritized the replacement of devices 2. Testing process was not reviewed Samsung did not monitor the process in a proactive way 3. Management did not ask for feedback from factories to ensure that clear instructions were given 4. Management did not ensure that the factory has adequate safety culture 5. Auditing for contractor competency was inadequate	1, 2, 6
4	**Recommendation #2:** Create and Implement a comprehensive training program for all engineers	4	15	60	Solution is not technology	1. Management did not think review processes were necessary 2. Management prioritizing reputation over safety (not enough time was given for design review, competition with other companies) 3. Management did not understand the risk of having inadequate/obsolete researching method 4. Testing process (for new manufacturing process) was not reviewed 5. Management did not see the need of researching or improving the existing method	1, 7, 9

Chapter 6: Business Case Analysis:

	Top Two Recommendations
Cost Avoidance of a Loss Incident	$ 327,300,000,000
Initial Costs of Improvements	$ 60,000
On-going Costs of Improvements per Year	$ 750,000
Life of Project	30 years
Total Cost of Improvements	$ 810,000
Annual Risk Exposure without Improvements	$10,910,000,000
Annual Risk Exposure with Improvements	$ 327,300,000
Gross Benefit	$ 10,582,700,000
Net Benefit	**$10,581,890,000**

Quadrant

The top two recommendations are creating and formalizing a procedure for manufacture selection, including safety culture in the selection criteria, and having senior engineers and managers visit the contractor facilities to make sure there is no ambiguity in the given instruction/specifications. Both recommendations falls into the “Low hanging fruit quadrant”.

Referring to the complex Effort vs. Gain Tool, the comprehensive solution is not technical so the practicability of the solution is graded a 4 out of 4. The initial cost of the project is $60,000 which is below $100k (4), and the on-going cost is $750,000 per year which is greater than $100k (1). Once the project is implemented successfully, the risk of loss incident can be reduced immediately (4) and the planning phase is expected to be less than 3 months (2). Annual visiting trip is required (3). Summing this all up, the combined effort index is 18. The top two recommendations both address the latent cause aligned with RMSEs. The total score of the comprehensive recommendation is 72 which falls into the “Low hanging fruit quadrant”.

Conclusion

Based on the financial analysis and the complex Effort vs. Gain analysis, the comprehensive recommendation is highly cost effective (positive net gain) and falls in the “low hanging fruit” quadrant. Thus, the investment in such a risk reduction program is justified. The combination of the two recommendations not only address the basic cause but also the latent cause behind the loss incident. In addition, by implementing the top two recommendations, the safety culture in the company can be promoted. The ABC Conglomerate should review and improve the existing project based the the top two recommendations listed above since the cost in improving the current project is significantly less than the cost of a loss incident similar to the Samsung Galaxy 7 battery failure.

Factors to Consider

Since this method is only a preliminary assessment regarding the loss incident and is not a sound basis on which to make final decisions, there are some unknown factors which need to be considered during the business case analysis. We calculated the cost-of-avoidance of loss incidents based on the lost in PEAP from published data by the company and the media. The actual loss due to the incident might be higher than the estimated value. Since this loss incident not only affected the sales of the Galaxy Series smartphones, but also other consumer electronic devices/appliances produced by Samsung Electronics. In addition, the long term effects like the loss of reputation, credibility, and loyal customers is hard to estimate. By taking into account those side factors, the results of the business analysis will be more sound.

Another factor to consider is the changes in on-going cost. The salaries engineers and managers are subjected to changed during the 30-year project lifespan. Hence the annual cost of the risk reduction project is also subject to changes. The salaries for senior engineers/managers and the travel costs are all estimated by using the average salaries/travel cost of 2018/2019 and assuming no changes over the project life span. Moreover, The opportunity cost that the loss of potential gain from other alternatives is not taken into account. More in depth study of different recommendations must be carried out to provide a sound basis for decision making.

The expected lifespan of the risk reduction project is 30 years. This number is chosen because the current expectation rate of a major loss incident is one in 30 years or more. But in the consumer electronics industry, new generations of products are released very often (generally less than one or two years), so the project (Galaxy Series Smartphone) lifespan could be less than 30 years, which might affect the net benefit.

Chapter 7: Issues with Implementation

Key Recommendation and Implementation Topic:

The key recommendation that will be discussed in this section is Recommendation #1: Have senior engineers and managers visit the contractor facilities and make sure there is no ambiguity in the given instructions or specifications. The general topic that has been selected to apply to this recommendation is The Power of Leaders to Influence Behaviour. This topic centers around the influence that leaders have in a workplace, and the role that leaders play in shaping the behaviour of team members within a workplace as well as the overall culture of an organization. This topic is applicable to Recommendation #1 since having senior engineers and managers visit the contractor facilities allows for two fold. Not only does it ensure that procedures are being followed properly, but also holds the manufacturer accountable for the quality of their goods or services they are providing.

Implementation Challenge #1:

The first challenge that may be encountered in implementing Recommendation #1 regarding the topic of leaders influencing behaviour is having the contractors gain respect and view the visiting senior engineers and managers as leadership figures. The interface between two organizations can provide an additional layer of friction that impedes the senior engineer's and management's influence of the behaviours of the contractors. Understanding how both respect and proper role modelling is formed is an important part to this challenge.

Implementation Challenge #2:

The second challenge that may be encountered in implementing Recommendation #1 is ensuring that the standard imparted to the contractors, by the visiting leadership, propagates throughout the organization. As it is not possible to interact individually with every member of a large organization, especially when the interaction is at the interface between two different organizations, the quality standards and culture imparted by company leadership will need to be passed on within the contractors themselves. Understanding what drives behaviours in a workplace plays a vital role in this challenge.

Chapter 8: Next Steps

As ABC Conglomerate will be entering the smartphone industry soon, there are a few ideas we would like to put forward. To prevent a similar loss incident from occurring, our group proposes that management strongly considers implementing any or all of the key recommendations of the report. Of the recommendations, #1 and #3 would be the preferred choice if a limited selection is made. The major benefit of recommendation #3 is that by creating a formal audit process for third party selection, the risk introduced by these groups would be limited. Also there would an assurance within the company that the third party's safety culture and values align with ABC Conglomerate. This process is formatted so that once implemented there would be negligible ongoing costs. Additionally, recommendation #1 furthers the idea of fluidity between ABC Conglomerate and third parties. This will prevent a similar incident because there will be a reduced risk of errors in the manufacturing process through discrepancies of instruction.

Without implementation of any or all of the recommendations previously described, the potential for similar battery/device failures increases. Furthermore, by not learning from Samsung's previous errors, ABC conglomerate would not be fulfilling its due diligence in providing safe consumer products; thus, not adhering to our own corporate values and programs. The combination of recommendations #1 and #3 form an umbrella approach to working with third parties. This includes not only a formal audit of the third party, but also ensures that ongoing check-ins through senior leadership are carried out to guarantee procedures do not deviate from set standards. Through assembly of a diverse group whom have experience in dealing with third parties and the allocation of a small budget, new processes can be created to provide a proactive solution to prevent similar loss incidents.

References:

[1] United States Consumer Product Safety Commission, “Samsung Recall Galaxy Note7 Smartphones Due to Serious Fire and Burn Hazards”. September, 2016. [Online]. Available: https://www.cpsc.gov/Recalls/2016/Samsung-Recalls-Galaxy-Note7-Smartphones

[2] Associated Press, “Samsung Galaxy Note 7 recall to cost at least $5.3 billion”. October, 2016. [Online]. Available: https://www.latimes.com/business/technology/la-fi-tn-samsung-recall-20161014-snap-story.html

[3] K. Carlon, “Samsung permanently discontinues the Galaxy Note 7, $17 billion in sales lost”. October, 2016. [Online]. Available: https://www.androidauthority.com/samsung-galaxy-note-7-permanently-discontinued-721283/

[4] S. Y. Lee, “Samsung Stock Plunges Amid Massive Galaxy Note 7 Recall”. September, 2016. [Online]. Available: https://time.com/4487359/samsung-galaxy-note-7-recall-stock/

[5] A. Pressman, “Samsung Smartphone Sales Plummeted Worldwide Due to Galaxy Note 7”. January, 2017. [Online]. Available: https://fortune.com/2017/01/31/samsung-galaxy-note-7-recall-apple/

[6] A. Holst, “Smartphones industry: Statistics & Facts”. August, 2018. [Online]. Available: https://www.statista.com/topics/840/smartphones/

[7] Counterpoint, “Global Smartphone Share: 2016 Q1 – 2017 Q3”. November, 2017. [Online]. Available: https://www.counterpointresearch.com/global-smartphone-share-2016-q1-2017-q3/

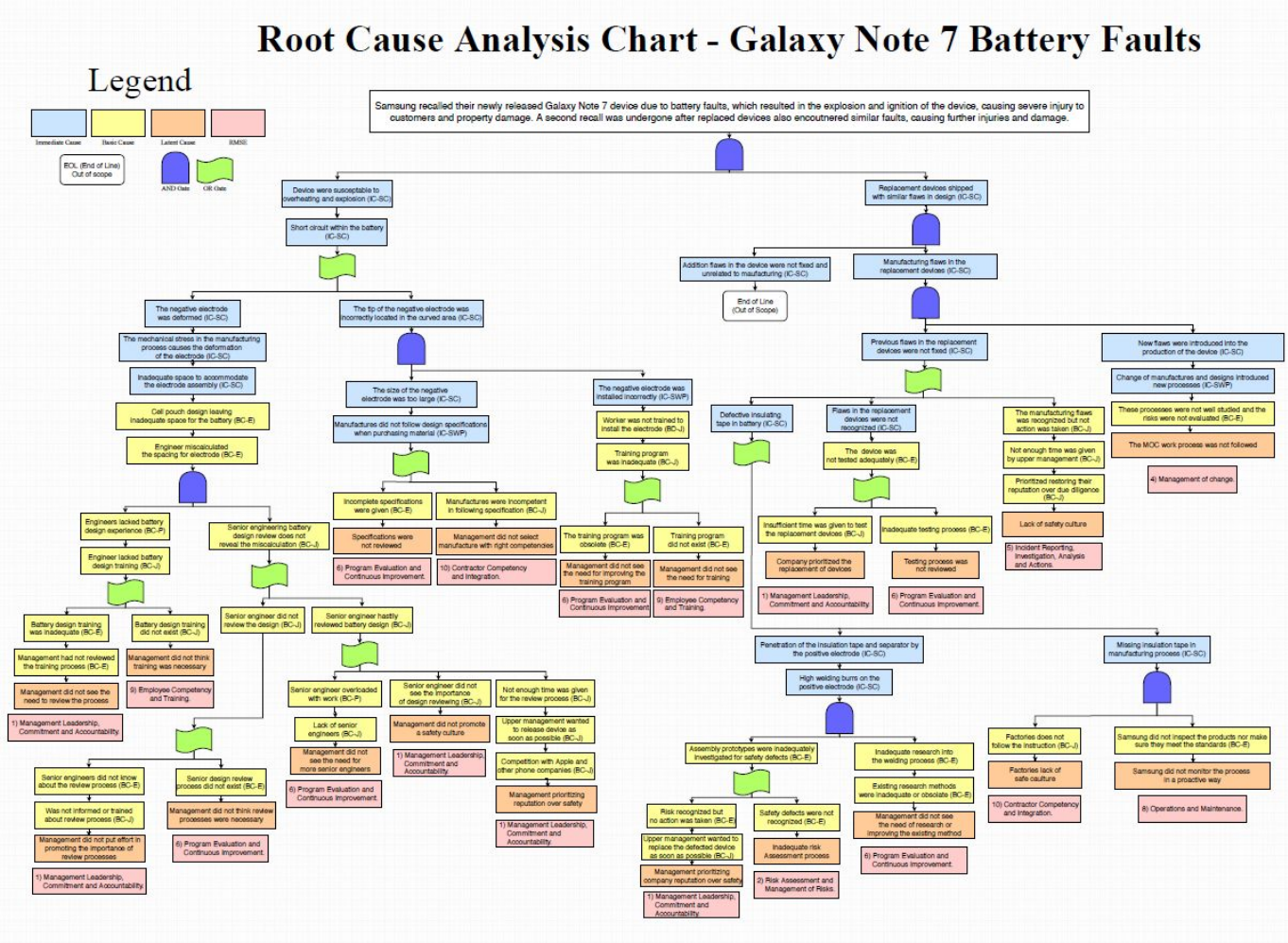
[8] S. Liu. “Number of Samsung Electronics employees worldwide from 2009 to 2018 (in 1,000s)”. August, 2019. [Online]. Available: https://www.statista.com/statistics/236919/number-of-samsung-electronics-employees-worldwide/

[9] S. Lock. “ Average domestic business trip cost in the United States from 3rd quarter of 2013 to 3rd quarter of 2018 (in U.S. dollars)”. January, 2019. [Online]. Available: https://www.statista.com/statistics/675026/average-domestic-business-trip-cost-us/

[10] Barboza, David. “An IPhone's Journey, From the Factory Floor to the Retail Store.” *The New York Times*, The New York Times, 29 Dec. 2016, https://www.nytimes.com/2016/12/29/technology/iphone-china-apple-stores.html.

Appendix A: Root Cause Analysis – Chart:

Progress Report RCA Chart



Final Report RCA Chart