

# Lithium-ion battery



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## **Introduction**

This course work is related to a new type of Lithium-ion battery developing by a company. This new product (battery) based on Nanotechnology. Nanotechnology has great anticipate in production of laptop batteries. This kind of battery have many overcomes on traditional or commercial batteries. The new technology has great efficiency as well. It allows the battery to be recharged in 5 minutes for its 80% capacity, consumes less time for recharging, another good feature of this technology are improves the battery life to 20 hrs instead of normal 3 hours, similarly using this technology a new battery could be developed that will power a family car for 500 miles and yet be recharged in less than 10 minutes. Majority of well known companies follow a process when producing a new product in the market, and they also required discussing various approaches before producing new product in the market , that how a product could sustain successfully in the market. A detailed discussion about R&D, Managing Innovation, ISO standard and Six Sigma is the part of this course, because most of new companies using these standards. For a new company to stay in the market in the presence of competitors it need to innovate and come up with new approaches and ideas, the others competitors they don't follow the new ideas could literally survive in the market .

## **Background**

The first lithium-ion battery was introduced in 1991 for commercial purposes [1], with the growth of electronic devices at that time also increases the demand for lithium-ion batteries, particularly for notebook, computer (laptop) and cellular phones. The weight and capacity of battery reduced

with engineering techniques. It was achieved with manufacturing process and the introduction of new separator, cathodes and anodes materials.

The most popular manufacturing company (Wee-Energizer) was introduced batteries for laptop in 2002. Their current partners are Dell, HP and Apple are also the leading laptop and computers manufacturing companies in the world. Wee-Energizer used for the first time novel application ‘ nanotech’ for new battery. Novel application has the capability to be recharged up to 80 percent and is capable of holding a very high charge density. The nanotechnology will improve the battery life for a laptop to extend from 3 hours to 20 hours. A recent feasibility shows that the battery could be developed to produce power for a family car for 500 miles and yet to be recharged in less than minutes. The company currently manufactures the lithium-ion batteries known as ‘ Nanobattery ‘ at its manufacturing facility in Taiwan and ships the products directly to laptop manufactures like Dell, Hp and Apple etc clients .

### **Technology Plan**

#### **Managing Innovation**

Managing innovation is the process of adding something new, enhance the invention and recharging. The company will be developing the Nanobattery because of technology driven solution. Adopting this solution will increase the funding of the company or it will boost up the business opportunities to spread business venues related to their business products and brands. The performance of this new type of battery will be very effective and more efficient as compared to the previous one, offer adapting Technology driven solution. Innovation contributes in several ways [2]. For example research

proofs provides strong correlation between market performance and new products when new products properly managed and advertised possible to retain the market shares and attract people. A mature and well established product not just comes with low price bus also from a variety of non-price factors like design, customization and quality.

The novel application of nanotech to battery will provide high performance and it will allow higher density. It will not just improve the performance and efficiency, but it will also reduce the capacity or size o the battery the size of battery will become smaller in size, reducing the size of these high density batteries are for the purpose appropriate battery casing to accommodate within battery casing.

### **Types of Innovation:**

There are three types of Innovation which includes Disruptive Innovation, Open Innovation, Closed Innovation, a detailed provided each of them, it will specify which is best suited to our current scenario.

Disruptive Innovation: Disrupt the market by introducing new product in the market which is not expected in the current market, since it has low price then other products available in the market, example of disruptive innovation is mp3 players and usb etc.

**Open Innovation:** Open Innovation is the type of Innovation which specify that the company does not rely on the R&D department and the research conducted by R&D department, but also allow to purchase new technology and material from outside domain and utilized them to create new innovative technology.

**Closed Innovation:** Closed Innovation is the type of innovation, it works reverse of Open Innovation, the companies and an organization relies on their own R&D departments and their research. Large corporate companies have their own large R&D department.

Following are the four main categories of process innovation:

a. **Product innovation:** define changes in products and services which an organization offer

b. **Process innovation:** changes in the way they are created.

c.

Figure 1.

d. **Paradigm innovation:** changes in the underlying mental model which frame what the organization does. The following show the managing innovation process.

The R&D department could innovate further the existing technology, the R&D department and the people working within this department monitor the technology and monitor as well for further learning and investment in the same area. “ The company will follow the interactive model to develop this idea and links together the technology-push and market pull model, it emphasis that innovation occurs as the result of interaction of the market place the science base and the organization capabilities”[3].

**Innovation as knowledge management process**

It is very important to know the process of innovation, because innovation is the core of business. Two main terminologies can be defined within innovation process which represents the structure of an organization. The two terminologies are “ technology push” (R&D to market) and “ market full”( from market to R&D). The following figure 1. 2 represents the innovation process.

Figure 1. 2

**Product Lifecycle Management Analysis**

**PLM (Project Lifecycle Management) is the process of managing used for entire lifecycle of a product from its conception, designing and manufacturing, to service and disposal. This method PLM is adopted this product, this process will continue whereby the process ends, this method will start with raw material extraction will collect from Disposal Recycling, company will convert into manufacturing product than the product will be finally delivered to the other partner companies under transportation phase. The three popular terms are used in this process ‘ cradle to cradle’ as opposed to ‘ cradle to gate’ where the process stops once than the product will leave the company, the final term ‘ cradle to grave’ where the process stops once the product reaches its end life**

**a. Conceive**

**b. Design and Develop**

**c. Realise**

**d. Service**

**e. End of Life**

**Phase 1: (Conceive) will be specified the basic function and data requirements, system boundaries and goals and objectives. In the current scenario the core function of new battery as to improve the battery life for laptop up to 20 hours, congenital batteries are limited to 3 hours, the aim of this project is, the battery should be able to recharge 80 percent of its capacity in five minutes.**

**\* Performance: the performance of battery depends on the size of laptop screen, performance of battery is related to the size, battery performance should not drop below 20 hours for 20” screen**

**\* Project Risk Management: the primary part of this project is to identify the risk that is related to your current project, risk management is also focus on the future of project as well. The expected risk that are involved to this project are;**

**\* The company required new equipments, machines and instrument to assemble the product; the company will losses many in the start of this operation.**

**\* If there is any fault in the current product (battery), like it overheat or no functioning properly, it will impact on the end user side.**

**\* If the demand for the product reduced, it will impact on the sale of the product**

**\* However it is very important to identify the risk at the beginning, risk that involved to the project. The following areas to be identify before starting the proposed project.**

- **Insufficient or unreliable data**
- **Lack of preparation**
- **Lack of resources**
- **Lack of control**

### **Mitigation:**

**Some project they have unforeseen problems and those problems neither eliminate or nor reduce to reasonable level, mitigation is the process which address these kind of issues in the project, it also avoid and reduce the impact of risk on the project. Mitigation should be adopt by the company to avoid these kind problems and risk that are associated to the project, to avoid such risk with mitigation actions which include;**

**The company should reduce the expenses for instruments, machines and assembly process to a quality third party partner, the company can also save fund that spending on new machines, equipment and machineries.**

**The risk associated with battery of overcharging or discharging would resolve through mitigation process. This phase will pass through a proper testing to check the temperature regularly that the required temperature should not exceed from 30 degree centigrade, if it exceed from 30 degree centigrade the battery will not be usable.**

**The cost of new battery should not very high. The company should split current market of laptop and new technology devices like cellular phones and electrical vehicles. The company should meet new clients point out the benefits of having a lighter with for more capacity an ordinary laptop battery.**

**The company should have backup for power if the current power supplier failure**

**The delivery of the new product (battery) should not delay**

### **Process Model**

**The following figure is the example of process model of a product, the process model includes, Raw materials, Inventory, manufacturing, assembly, quality assurance, collecting and distribution.**

**Raw materials: An unprocessed natural product used in manufacture, to be collected from supplier.**

**Inventory:** availability of product (batteries) in stock, storing of material in warehouse.

**Manufacture:** manufacturing components that made new battery

**Assembly:** joint working of components and offering a single product or more

**Quality assurance:** specify the quality of product and ensure that the battery working properly accordingly to the proposed design.

**Transportation:** delivery of product to the end users or clients

The above steps defines the process of product from raw material to the end user, quality assurance will specify that the product working properly and according to the desired of end user. Quality assurance and assembly will work together for the final shape of battery.

### **Phase 2:(Designing and Development)**

In the design phase the battery would tested through various real-time applications and software, like CAD (Computer Aided Manufacturing), flow charts will also use to demonstrate the designing phase or designing of product, proper documentation will be constructed in the this phase. Different simulation software like OPNET, METLAB and etc will measure the performance of battery in this phase, based on this performance battery management will approve the production of battery, the following methodologies are using in the design phase.

**DFM (Design for Manufacture )**

**DEF (Design for Environmental )**

**DFA**

**DFSS**

**DFM:** Design for Manufacture specify some various factors and they play vital role for success and popularity in the market, those factors are manufacturing process, cost of product (battery) in the current market , quality of battery and customer satisfaction.

**DEF:** Design for Environment, it specify that the new battery would be environmental friendly and should not harmful for environment. DEF also using the “ cradle to cradle” approach, the new proposed battery should re-usable when it complete their first lifecycle or expire. Therefore ongoing testing to be required before it entered to the implementation phase as earlier mentioned that this process to be done through different software and simulation.

### **Phase 3: (Implementation)**

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**The implementation to be started when designing phase is complete, in the implementation phase the company start manufacturing of battery after validation. In this phase the product is ready for clients, also sales in the market, implementation phase based on Marketing Activities, Distribution, Manufacturing method and Supply Chain Management.**

**Manufacturing Methods: (Lean, Six sigma, etc) will be used for optimise of laptop battery production.**

**o Lean Manufacturing: is a model that the value or the size of product would be optimised reduced and less anything that are not required to the end users.**

**o Six Sigma: is business strategy or model would be adopted for manufacturing process of batteries, six sigma improve the quality of product (battery) and remove any defects from the product Due to adopting this strategy the final shape or condition will present with good condition and free of defects.**

**Marketing Activities: Marketing activities specify that the materials to be distributed to the market, support packages also improve the marketing activities, like proper training to be arranged for the technical staff. An annual or quarterly magazine to be published for general and further future information about product.**

**Distribution: Moving a service from producer to consumer in certain sectors, either through direct channel or indirect channel [5]. In the distribution section an organization or company pack products properly then distributor sells to retailers or agents and finally retailers also called (resellers) who sells to end users.**

#### **Phase 4: (Services)**

**Services is the fourth phase of PLM, in this phase the repair and maintenance information about laptop battery must be update, on the base of customer experience will specify that the performance of battery is good, normal, medium or not good, a survey will conduct to gather information from end users and customer and feedback to the phase 1 that the customers are satisfy, in case of failure of its design or manufacturing, phase 2 and phase 3 will be reviewed.**

#### **Phase 5: (End of Life)**

#### **Figure 1. 5 End of Life (Modified Life cycle)**

#### **Six Sigma (Business Strategy)**

**The six Sigma business strategy approach will be adopted for this project. Six Sigma improves the process and solve the problems, it is a very important and effective business strategy using by various companies. Six Sigma are also eliminates the causes of errors and defects or failures in business process, it reduce scrap, improve quality and gain better control process and system. The six sigma approach is based on DMAIC model, each letter in this model (DMAIC) refers to a step and steps are including the following are five stages of six sigma.**

**ü Define: the define stage is the agreement on different issues like quality characteristics, goals and objectives are crucial.**

**ü Measure: Measure is the second phase of six sigma that measures and identify the root causes of the problem, also helps to confirm if the definition of the problem is correct.**

**ü Analyze: analyze can be divided into three further steps, following are the steps that are involved in the analyze phase.**

**o Measuring: is the ability to meet the customer specification.**

**o Design of experiments (DoE)**

**o Identify the root causes of errors or defects and their impacts on the business.**

**Figure 1. 6 Five Stages of Six Sigma (DMAIC)**

**ü Improve: in this stage of DMAIC model of Six Sigma, advance tools and techniques are using for design, manufacturing and assembly**

**ü Control: in this stage “ the process should be managed in order ‘ sustain the gain’ “. This will include ongoing measurements.**

**There are different six sigma advance tools uses for the improvement of business, following are the tools:**

- Quality Function Development (QFD)**
- Failure Mode and Effect Analysis (FMEA)**
- T-Test**
- Cause & Effect Matrix**
- Statistical Process Control or Control Charts**
- Design of Experiment:**

**Design of Experiment: is most important element of six sigma, design of experiment is the secret weapon of rapid growth or improvement.**

## **Critical Success Factors for Six Sigma**

**Customer Centricity:** the purpose of customer centricity is the happiness of customer about product, customer centricity is to delight the customer and the product will be measured through customer prospective.

**Voice the Customer:** customer opinion is more important regarding business point of view, it is necessary to hear from customer about the product. The voice of customer will be considered as input and that input will be translated into specific measurable elements.

**Critical to Quality (CTQ):** CTQ requirements are most important to the customer.

## **Control Charts**

### **Figure 1. 7 Control Charts**

## **Causes and Effect Matrix**

**Fishbone diagram and C&E Matrix** both are used to identify and explore the possible root causes that related to problems. C&E Matrix also help to measure the designing of experiment (DoE) phase.

## **Failure Mode Effects Analysis (FMEA)**

**FMEA** identify new procedure or identifying ways a new product, service might fail. The importance of FMEA is to identify expected errors in the process. It will prioritize the possible failure scenarios; it keeps possible failure scenarios by importance. FMEA generates a list of possible failure scenarios by importance and help the management team or technical staff to prioritize things that can cause errors in the process, it also provide an opportunity to the staff to take precaution measure to prevent or stop the failure scenarios and rectify the problem. It should be conducted at the beginning of the product lifecycle when major changes are introduce to the product, feedback will help to indicates unidentified problems in the process of product lifecycle.

## **FMEA Advantages**

- ü FMEA gather information or collect information and prevent future problems in product manufacturing.
- ü The process potential FMEA minimises late changes and associated cost.
- ü The processes of FMEA encourage users and increase end user satisfaction about business product.
- ü The process potential FMEA also increase company reputation and the company image.

ü **The process potential FMEA also improve the quality, reliability and safety of a product or process.**

ü **It also reduce the potential for warranty concern**

### **ISO Standards**

**Additional measure to be taken by the company for international standard quality and further improvement of batteries is called ISO (International Standard Organization). ISO is “ the organization for standardization (organization international de normalization) widely known is ISO”. The ISO is worldwide accepted stamp or certificate, all registered companies will follow ISO standardization for production of products, and the products will be labelled or stamped with ISO benchmark, which sends a positive message to the general public about quality assurance about the product. As per ISO rules Proper documentation to be mentioned about the products.. The company will follow the ISO 9001: 2000 for the production of batteries. ISO standard will required during designing, development and manufacturing phases because ISO standard specify the quality assurance of products. As earlier mentioned proper documentation and customer complains will be recorded to eliminate any defect and improvement of Laptop battery as per customer desires. HR department or technical staff will produce an annual or quarterly report to the management; management will take decisions to address the existing problems with batteries as well as suggest further enhancement. Following are the different standards (ISO 9000, ISO 14000) of ISO, the company will follow the ISO 14000, ISO 14000 is uses for environmental management. The ISO standards and there function is:**

### **ISO 9000 Standards**

**ISO 9000 and 14000 are popular and well known standard. The ISO 9000 standard is most common series for “ Quality Management System” has relation to the company’s requirements for Designing and, Manufacturing and Developing of business products, following are the main three Quality Management Systems standard.**

**IOS 9000: Define Fundamentals and vocabulary**

**ISO 9001: Define Requirements**

**ISO 9004: Define Methods and Procedure for performance and improvement of business products**

**ISO 9001 Standard:** Contains a bunch of rules and procedures, company will follow this standard for maintaining business record for battery production, it is an effective procedure for monitoring and verification, it facilitates the companies for the purpose of consistent and improvement of business products. It also finds error and defect in the product and those errors to eliminate by proper and effective procedure when it is required. ISO 9001 standard is good practice for the quality system and also provides a framework to the companies, this process adopted by various companies for further improvement of their business products. Due to its better Quality Management System the defect ratio or percentage will be reduced from the business product, this process also plays a role for the customer satisfaction regarding business products.

#### **ISO 9001 Drawbacks.**

Despite various advantages of ISO 9001 has some drawbacks as well, following are the drawbacks of ISO 9001.

This standard provides only a framework and process for the customer satisfaction.

ISO 9001 will not tell you that the problems away or disappear by itself.

There is no specific way or procedure to identify that the current product doesn't require further improvement and does not tell you how to improve the quality.

Does not impose a significant overhead, unless no quality control procedures in place.

#### **ISO 14000 Standards**

ISO 14000 is ISO standard that addresses “ Environmental Management” which minimizes the harmful impact on the environment [7]. During the manufacturing and production of some sort of things produce harmful gases which highly impact our surrounding indirectly or indirectly. The company will adopt this standard for manufacturing of battery, because it is less harmful for the environment. ISO 14000 standard is best ISO standard for environmental management system, which also includes an audit programme.

#### **ISO 14000 Essentials (Features of ISO 14000 Family )**

The two familiar ISO 14000 family standards are ISO 14001: 2004 and ISO 14004: 2004, both standards are effective for Environmental Management System (EMS).

#### **ISO 14001: 2004 Standard:**

**As mentioned above that both standard deals with EMS, ISO 14001: 2004 specifically provides the requirements for EMS (Environmental Management System, once the requirements meet to ISO 14001: 2004 standard provides capability to an organization to achieve the following:**

- ü An organization will have the ability to identified and control the environmental impact of its activities, products or services.**
- ü An organization or company will improve its environmental performance consistently.**
- ü “ Implement a systematic approach to setting environmental objective and targets to achieving these and to demonstrating that they have been achieving”[8].**
- ü This standard will provide assurance to the management of the an organization or company that the process is in control, and activities which impact on environment**
- ü They provide assurance to the company, organization workers or employees that they are working for environmental responsible company, organization.**
- ü ISO 14001: 2004 provide assurance to the external stack holders such as customer and clients, the community and regularity agencies.**

**Benefits of ISO 14001 standard**

**Enhancement of environmental awareness within organization**

**Cost savings and reduction in resources usage**

**Improve compliance with legislation**

**ISO 14004: 2004 Standard:**

**Another tool of ISO 14000 is 14004: 2004 standard provides guidelines on the elements of an environmental management system and its implementation, it also discuss the principal issues that are involved.**

**Environmental Plan**

**Life Cycle Analysis**

All manufacturing products have an environmental impact throughout their life cycle such as, ( Raw material, manufacturing, distribution and final stage disposal), the aim and objectives of an environmental plan is negative impact on environment during the manufacturing to business product, the negative mean reduction of Carbon protect healthy life, and greenly. Carbon reduction policy of a single organization is not very effective, it is effective when it comes together, carbon reduction is the responsibility of all organizations, companies, public and private sectors and government agencies where they deals with Gas, Oils, and Energy etc. Lack of awareness and less attention from government agencies, public and private sectors about these issues, world now face a real threat in the form global warming. .” Our planet is warming up, and not in a good way, the last twenty years were the hottest in 400 years according to several studies”[9]. The extreme weather causes, heat waves, wildfires and strong storm due to the major changes in climate, to reduce these impacts each production companies must have plan for environment protection, changes in climate also Occurs and increases in global average air, Ocean temperatures, wide malting of snow and ice rising global average sea levels [10]. The company will implement the environmental plan during the manufacturing of battery to negate the environmental impact, the company have a set of specific goals from four environmental prospective such as Curbing climate change, conserving resources, controlling chemical substance and promoting bio-diversity. The nanobattery would be recyclable and their life to be extended to reduce the ratio of disposal, and finally the waste would recyclable. Today many companies are competing for greener environment as well as they are adopting new technology and they are trying for suitable replacement of gasoline for vehicles. As earlier mentioned the each product has an environment Impact throughout their lifecycle such as production, use, distribution and final disposal. The product lifecycle can be divided into six stages, each stage has specific goals.

- a. **Development:** company will apply technology innovation for the purpose to make it smaller product, lighter and more energy saver.
- b. **Designing:** during the manufacturing phase of battery, environmental implications will keep in mind and the product would have impressive environmental performance.
- c. **Procurement:** The material to be used for the product which less impact on the environment
- d. **Business Operation:** The overall operation will impact reduce environmental i, low gas emission and waste to achieve zero environmental footprint at all plants and offices [11].

**e. Distribution: Transportation or distribution also consumes more energy, the packaging material size would kept small in size make reduce the impact on environment, such as rail transpiration and water transport.**

**f. Take back-recycling: Company will take care when batteries come to the expiry date or disposal, company will accept the disposed battery, and finally it will be re-cycling for manufacturing.**

### **Intellectual Protection**

Intellectual protection is the process to protect ideas, invention, patenting is the best for any kind of ideas to provide protection, different technology being using by companies to protect their new product ideas, the intellectual provide copyright protection to the owner, a new technology are using for the manufacturing and development of nanobattery. Unauthorised person would not allowed to copy the subject of owner of nanobattery, legal action to be taken according to the existing law.

### **Recommendations**

With all above discussion above it would good for the company to adopt innovation process for the success of Nanobattery in the current market today.

They need to hire those labours which have good background and skills about Nanobattery manufacturing.

The company need to follow the ISO standard for standardization such as ISO 9001: 2000 and ISO 14000: 2004 for Nanobattery manufacturing and production.

The company need to more focus on the investment over new well-equipment, manufacturing instruments, packaging and assembling



Once the product introduced and stable in the market the company have to maintain the quality process of Nanobattery by applying with various techniques such as six sigma.

**Conclusion:**

The company using Nano technology for the production of laptop batteries, nano technology is new technology, it negate the implications on environment. It is necessary for all the manufacturing and production companies either they are on the private or public sectors to reduce the carbon and waste emission. The standard and reputable companies are trying and compete with each other to get greener, they are not just trying to get greener and reducing carbon by new technologies, also they are replacing with various tools and new technologies for the replacement of gasoline. Both ISO standards such as ISO 9001: 2000 and ISO 14000: 2004 are highly recommended for the production of nanobattery. Both ISO standards specifies quality management and hazardous activities and their impact on environment, a detailed environmental plan also studied in this course work, that how to reduce the impact of manufacturing and production on an environment. PLM and their five phases also analyzed for the production and manufacturing plan including Lean Management and six sigma approaches for laptop batteries. ISO standard and their benefits also discussed in this course work.

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