CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Research methodology is the systematic process which involves identifying the problem, collecting facts/data, analyzing data and drawing conclusions. The research methodology enables the researcher to arrive at the solutions towards the problem concerned or drawing certain generalization for some theoretical formulation. This chapter focuses on the research methodology used for the present study. The background of the problem is critically analyzed and all the major research paradigms are explored. Finally, suitable research method was finalized. The chapter also provides a detailed portrayal of the company in which the research study was conducted.

3.2 RESEARCH DESIGN

In the present study, descriptive design is used, taking into consideration the nature of this research work. Descriptive research is defined as a design to explain the characteristics of the variables per se. A descriptive study is normally employed in situations where it is necessary to describe and interpret “what is” kind of problems. It is concerned with conditions or relationships that exist, opinions that are held, processes that are going on, effects that are evident, or trends that are developing.
The research utilizes the case study approach to gain a detailed understanding of the various processes in the new product development management system in Caterpillar India Private Limited. A detailed study has been undertaken at each stage of the new product development process. As a part of the study, a structured survey instrument has been developed to gather information from the customers to improve the design of the products.

3.3 NPD TOOLS

Several tools have been utilized in the New Product Development (NPD) Management process. The purpose of the tools is to verify the NPD process discipline, analyze proto and pilot build data, setting and following the timeline, conduct production studies. Some of the tools used are given below.

- NPD Workflow
- NPD Dashboard
- Process Conformance Index (PCI)
- Requirements Management Index (RMI)
- Advanced Product Quality Planning (APQP) Conformance Index
- Prediction Evaluation Reliability Growth (PERG) Analysis
- Reflection Analysis

3.3.1 NPD Workflow

The NPD workflow is the detailed representation of the stages of work process in the new product development management system. The
workflow shown in Figure 3.1 has five major stages of operations namely, program strategy, concept, develop, pilot and production. Each stage of the workflow has a certain number of gateways which further provide additional details about the sub-processes in each stage. A detailed description of the NPD workflow process is given in chapter 4.

![Figure 3.1 NPD Workflow](image)

- **Consists of eight phases**
  - **Strategy** → Launch Review
  - **Concept – Define** → Gateway 1
  - **Concept – Measure** → Gateway 2
  - **Concept - Explore** → Gateway 3
  - **Develop - Design** → Gateway 4
  - **Develop - Verify** → Gateway 5
  - **Pilot** → Gateway 6
  - **Production** → Gateway 7

- Each phase is followed by a Gateway review

**Figure 3.1 NPD Workflow**

### 3.3.2 NPD Dashboard

NPD Dashboards are used to provide a more detailed look into the state of an item in their NPD workflow process. Generally a customized tool is created to monitor the status of the workflows and the items in them. By viewing the dashboards, the user can review an item or item set to see what step in the workflow process the item is in, and how long it has been in that
step. In addition, the dashboard can enable the user to move the item on to the
next step, given the appropriate permissions. The reporting and time tracking
of item states that is captured in the dashboard can also be used to do analysis
of the workflow process to identify bottlenecks.

3.3.3 Process Conformance Index (PCI)

Process Conformance is to ensure the adherence of process
requirements stated for a particular function. Process Conformance helps the
understanding of what to be done and how it should be done.

3.3.4 Requirements Management Index (RMI)

Requirement Management Index helps to identification of customer
key requirements. The VOC and VOB collected from customers are narrowed
down to top 10 to 20 key requirements. This also identifies requirements that
are not met and actions that needs to be taken.

3.3.5 Advanced Product Quality Planning (APQP) Conformance
Index

Advanced Product Quality Planning (APQP) is a structured method
for defining and executing the actions necessary to ensure satisfaction of the
needs of the customer. The goal of APQP is to facilitate communication with
all persons involved in a programme and ensure that all required steps are
completed on time, at acceptable cost and quality levels.

3.3.6 Prediction Evaluation Reliability Growth (PERG) Analysis

Reliability growth is the improvement in the reliability of a product
(i.e. component, subsystem or system) or service over a period of time due to
changes in the product design and/or the manufacturing process. Reliability growth analysis (RGA) is concerned with the quantification and assessment of parameters (or metrics) relating to the item's reliability growth over time. PERG is a graph that graphically represents both what has happened and what is expected to happen related to the reliability growth of the test (pilot) machines. Both x and y axis are log scales. Test hours on the x axis drive a repair frequency on the y axis.

3.3.7 Reflection Analysis

Reflection Analysis is an event conducted for the understanding of the effectiveness of the NPD program execution and the method of improvement of the program execution for future NPD programs based on what went well and what didn't go well. It also helps to capitalize on what went well and actions need to be taken on what didn't go well, for future generation programs.

3.4 COMPANY PROFILE – CATERPILLAR INCORPORATED

The history and origin of Caterpillar can be traced back to 1925 with the merger of the Holt Manufacturing Company and the C. L. Best Tractor Company, creating a new entity, the California based Caterpillar Tractor Co. Caterpillar Inc. has become the largest manufacturer in its industry and was ranked as number one with revenues pushing $33 billion in 2009. It was ranked at 44 in 2009 as listed in Fortune 500 companies. Caterpillar's headquarters are located in Peoria, Illinois, United States.
3.4.1 Company Specific Information

Caterpillar Inc. is the leading manufacturer of construction and mining equipments, which includes excavators, loaders, and tractors, as well as forestry, paving, and tunnelling machinery. The products also included diesel and natural gas engines, industrial gas turbines and diesel-electric locomotives. Caterpillar mainly operates in two segments: machinery and power systems, and financial products.

Machinery and power systems represent a total of construction industries, resource industries, power systems and all other segments and related corporate items and eliminations.

Financial products include the company’s financial products segment and include Cat financial and Caterpillar Insurance holdings Inc.,

A. Construction Industries

The company’s construction industries segment is responsible for supporting customers using machinery in infrastructure and building construction applications. The machine sales in this segment are made in the heavy construction, general construction, mining and quarry and aggregates markets. The construction industries product portfolio includes backhoe loaders, small wheel loaders, small track-type tractors, skid steer loaders, multi-terrain loaders, mini excavators, compact wheel loaders, select work tools, small, medium and track excavators, wheel excavators, medium wheel loaders, medium track-type tractors, track-type loaders, motor graders and pipe layers.
B. Resource Industries

The Resource Industries segment is responsible for supporting customers using machinery in mine and quarry applications. It also serves forestry, paving and tunneling customers. The Resource Industries product portfolio includes the machines and related parts, electric rope shovels, draglines, hydraulic shovels, drills, high wall miners, underground mining equipment, track-type tractors, mining trucks, electric drive mining trucks, tunnel boring equipment, wheel loaders, off-highway trucks, articulated trucks, wheel tractor scrapers, wheel dozers, compactors, select work tools, forestry products, paving products, machinery components, and electronics and control systems.

C. Power Systems

The Company’s Power Systems segment is responsible for supporting customers using reciprocating engines, turbines and related parts across industries serving electric power, industrial, petroleum and marine applications, as well as rail-related businesses. The Power Systems portfolio includes reciprocating engine powered generator sets, integrated systems used in the electric power generation industry, reciprocating engines and integrated systems and solutions for the marine and petroleum industries, reciprocating engines supplied to the industrial industry, as well as Caterpillar machinery, turbines and turbine-related services, and diesel-electric locomotives and components and other rail-related products and services.

3.4.2 Caterpillar India Private Limited (CIPL)

Caterpillar India Private Limited (CIPL) is a 100% subsidiary of Caterpillar, Inc. USA. CIPL manufactures Off Highway dump trucks, front
end loaders and backhoe loaders. These products are used in open cast mining, quarrying, irrigation, steel plants, cement plants, power plants in the field of construction and material handling.

CIPL erstwhile named Hindustan Motors Limited – Earthmoving Equipment Division was started in 1971 at Thiruvallur by C.K. Birla Group of companies. CIPL had initial agreement with Terex Division of General Motors, USA, for manufacturing Off-Highway machines in the Thiruvallur factory. The products manufactured in the factory were to cater to the needs of the Indian mining and construction industries.

CIPL had entered a Licence Agreement with Caterpillar Inc. USA in 1984 to manufacture and sell mining and construction equipments in the name of Hindustan to Indian markets. New ranges of products were introduced under the licence of Caterpillar.

Caterpillar acquired CIPL as a fully owned subsidiary of Caterpillar Inc. in 2001 to manufacture and sell off-highway machines to India and Emerging markets. 80% of the products manufactured at CIPL is exported to South East Asian countries, China, Russia, Africa and Middle East counties. Around 200 million US Dollar investments were made to enhance the capacity of the factory to manufacture 2200 trucks, 2500 hydraulic excavators and 500 loaders. CIPL is equipped to manufacture and support sub-assemblies and products to other factories in Thailand, Russia and Australia.

The first CAT branded product, 424 backhoe loader, was launched in 2003 and the export of Hindustan off-highway trucks began in 2005. Caterpillar branded off-highway trucks were started to be manufactured from 2006 onwards opening the export market at CIPL.
CIPL adopted the process of 6 Sigma in 2002 in all manufacturing and support processes to improve the process efficiency and manufacturing capability. In 2006, Caterpillar Production System was launched in CIPL to enhance the manufacturing capability of CIPL by identifying and eliminating wastes in manufacturing processes and being lean in manufacturing operations.

CIPL launched the 773E off-highway truck model in 2010 to production after following rigorous New Product Development Management process. 770G and 772G new generation off-highway trucks were launched at CIPL in 2012 well in ahead of its mother factory in USA. CIPL added 320D2 Hydraulic Excavator to its product portfolio in 2013, thereby opening a wide construction equipment demand in the Indian market. CIPL added a Hammer Work Tool Assembly plant for manufacturing Hammer assemblies for backhoe loaders and hydraulic excavators.

CIPL factory performance has seen an exponential improvement over the last 6 years. CIPL has won the Caterpillar Chairman’s Award for Safety for 6 consequent years. 5-fold improvement in Quality clearly explains the robust quality processes being followed at CIPL to ensure quality and reliability of the machines produced. CIPL has an history of 100% meeting the customer expectations on delivery of products, thereby proving to be Agile in manufacturing. The efficiency has seen a 3-fold increase in the past 4 years thereby making the factory cost effective and becoming lean.

The success of CIPL in manufacturing excellence is predominantly due to the effective collaboration and concurrent product and process development that happened with various process partners which include
Engineering and Product Group divisions, Purchasing and Procurement divisions and Logistics and Supply Chain divisions.

3.5 PRODUCT OVERVIEW

In 1963, Caterpillar introduced a revolutionary off-road truck 769 to cater to the needs of mining and heavy construction industries. Several modifications were made to the original design and an enhanced product with added technological features was developed and introduced as 770G/772G variants of off-highway trucks. 770G/772G Off-highway Truck was purposely built for the rigors of mining and heavy construction.

With the growing prospects in the emerging market and to establish Caterpillar’s worldwide market leadership Off-Highway Truck group needs to launch a worldwide platform for the 770G/772G to address both emerging market and developed market needs by providing the customers with the best value proposition at a fair price. To address the pricing sensitivities in emerging markets it would be beneficial to leverage the lower cost of producing the emerging markets offering at the CIPL plant. The study scope addresses key customer, business, and regulatory requirements by delivering content that creates value, generating stakeholder wealth and benefits.
770G variant of off-highway truck as shown in Figure 3.2 has maximum tonnage capacity of 40 tonnes (40T).

Figure 3.2  770G – 40T Off-highway Truck
772G variant of off-highway truck as shown in Figure 3.3 has maximum tonnage capacity of 50 Tonnes (50T).

Figure 3.3 772G – 50T Off-highway Truck