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## **MOTOR-GANIZER: MOTOR INVENTORY MANAGEMENT SYSTEM**

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### Abstract

Motor-ganizer is a system intended for the inventory management of electric-driven motors of United Pulp and Paper Co., Inc. This is to handle the account of 920 motors recorded on the system and to include those units subject for repairs and others for spare. This system focuses on the movement and identifying the motors if installed, stand-by, spare, under repair or later on declared as scrap.

Further, it also aims to cover the information, especially for those with lost name plates, to fast-track in identifying the motor unit. Having such data on the system that can be accessible not just by supervisors will be much aid for the plant operation and maintenance.

Concerns with economic benefits were also highlighted on this research. Records of total repair costs based on issued Purchase orders by Procurement will be reflected and updated. With this heads-up for the management, this can support life span assessment of the unit or later request for replacement and acquisition of brand new ones instead.

The general perspective of this study in developing an inventory management system of electric-driven-motors for United Pulp and Paper Co., Inc. (UPPC) has been evaluated effective for further utilization.

The Motor-ganizer is of great help to the company's motor retrieval, location, and maintenance. Moreover, it can provide all the crucial pieces of information about the motor—both confidential and basic which are of great contribution to the company's economic development and operation efficiency.

With the reliability of the system, the records of the company are safe and secure, distribution process is well managed, errors are minimized, and reports generated for management are accurate thereby increasing the profit margin.

The study is open for further improvement or application for other related manufacturing plants for technical evaluation of motor management.

## Introduction

Manufacturing is a vast medium to tackle in terms of engineering. It is a system where all bright ideas are placed and developed to further enhance the integration of sciences, production, maintenance and engineering and financial matters. Manufacturing system focuses on turning specified raw materials into a more economic by-product that meets the demand of the market. The law of supply and demand will come along.

Developing and maintaining a manufacturing plant is never as easy as snapping the fingers. Every detail of the organization needs a keen attention to implement and function well as it represents vital parts of the structure to perform accordingly as designed. Achieving the optimization of the equipment, procedures, reliability and availability of the machines are factors to be considered along the process. A system, as defined, requires interdependence among the integrated elements of the organization.

Paper manufacturing plant is a meek system with thoughts that it just depends on soft raw materials with dominant fibers mixed with water processing it as convenient as possible and turning it again to equivalent item called 'paper'. In a way it seems a YES. But the process and details along the way realistically is a NO. The external view of the system often looks ordinary which actually requires in depth understanding appreciating every complicated principle in each fragment of the process. Hence, maintenance of these personas of the manufacturing and process requires more of engineering technicalities.

Preventive maintenance of every machine, acting as bones of the structural system, is the very specific matter to tackle and later sending its message to other parts of the process in order for the system to function on its highest scale. Hundreds of electric motors in this pre-determined system are evidently a concern. Monitoring the capacities and critical specifications, locations, its functions and including its maintenance works are not jokes to handle. Keeping track of

these particulars are relevantly a factor to be considered to further address the capability of the entire system in order to limit the possibility of breakdowns or worse plant-wide shut down.

Currently, the motors are present everywhere with hardly accessible list while others even have lost name plates and proper identification. This leads to longer time in seeking for replacement or spare unit/s. With that, loss time covering the productivity of the plant is hereby affected.

The research has been keen on details of feedbacks on handling motors plant wide. It has been a common hurdle during breakdowns of such units and it normally takes time to replace and at the first place locate the spare motor if any. This agony should not be left behind as every hour of delay always mean inventory cost are running out of the management fund bucket. The professional inclination of the researcher put the chances to study further the problem that exist. Having hundreds of motors required to be monitored has chances of getting out of the loop kept unmonitored. If physically aware on the location, the specifications are out of reach. Motor plates are either lost or not visible for electricians to be recognized. Professionals concerned have to measure every now and then to match the unit to its probable location and installation area. Others are not properly turned-over particularly for some common spare which are left unattended during personnel turn-over through the years.

Motors are the backbone of the plant. It keeps the pulp move from one point to another with such application of blowers and pumps. Any chance that come the unavailability of unit/s means stoppage of the plant. It is not just loss of a few pesos but hundred thousand pesos and even millions in some cases. Having figures of estimated 15,000Php per ton, with expected 440 meter per minute converting it into hour of shutdown represents a value which is not easy to earn caused by just a motor being clearly not specified where it is when needed. With such information on hand, the researcher clearly wanted to establish the reality check how the proposed study will matter much.

The researcher is keen in evaluating the inventory management of the motor units of the plant as this is one of the exposures on the existing job assignment. As an Electrical Engineer by profession, the researcher understands the need for improving this aspect in maintenance management. The study is very timely to be developed as the number of motor units are increasing along with projects newly implemented and further expansion as expected.

## Research Problem

The general perspective of this study is: To develop an inventory management system of electric-driven-motors for United Pulp and Paper Co., Inc. (UPPC).

Specifically, the study will find answers to the following questions:

1. How may the inventory management system can be described in terms of

1. 1.1 content,
  2. 1.2 information of motors,
  2. 1.3 reports generated,
  3. 1.4 user-friendly interface and
  4. 1.5 maintenance planning and interpretation?
2. What is the level of inventory control and stock management of the system in terms of
    - 2.1 data of each motor unit,
    - 2.2 historical repair works of each unit and
    - 2.3 repair, recondition and rewinding costs (external works)?
  3. What is the significant time improvement of replacement/locating the spare or alternative motor with the inventory system?

## [Integrated Review of Relevant Literatures and Studies](#)

The present study was conceptualized on basic principles of maintenance engineering, electric-driven motors, monitoring and inventory management leading it to a programming aspect in order to form the inventory system.

Due to factors of complexity, size and range of scope, including costs that vary hand on hand, today's maintenance practices are market driven, Billions of dollars (and pesos) so to speak are spent on equipment maintenance worldwide. Maintenance organizations are faced with same problems confronting manufacturing management a competitive end product in general.

Historically, the typical size of a plant maintenance ranges from 5-10 per centum of the organization. The tendency to decrease the personnel in an aspect of technology enhancement and automation, proportionally results to higher demand to maintain these high-valued machines. Maintenance team as a dynamic part of the system builds idea to be controllable in terms of preventive rather than corrective maintenances (Niegel, 1994). The need of a good planning of equipment maintenance is increasing as industry strives to become competitive.

Comprehensive systems are recognized by most companies in modern time as this has been shared by Dunlop at the year 1990.

Setting up objectives, planning, executing and controlling the maintenance function falls under a relative matter of system approach. An isolated function related to one another is a considerable fact. The maintenance function coordinates its activities like production, sales, and other external performing groups. Maintenance can be considered as a combination of acting

forces carried out in an orderly manner for the repair, service of any part of the system or component of any equipment.

Venkataraman (2013) introduces the concepts of repairs and maintenance in a relative dimension of predictive and proactive repair. He further relates the principles of human resource management on a typical organization. 'Design for Maintenance' is a highlight on the study hereby specified. DOM as a concept on identifying mean time to repair, mean down time and mean time between failures. Several conditioning monitoring techniques are discussed in full on motor conditioning aspect. Total Productive Maintenance is hereby an extended study to evaluate the overall equipment effectiveness (OEE).

Preventive maintenance on once facility can be totally different approach for the other. Individuality of the machine is key point not to treat them same all though out as they perform better (or worse) than they are expected based on standard or rated efficiency.

According to Bannister (2007), whenever the cost of a repair is calculated, it is broken down typically into two specific components – parts and labor. "Machine down, waiting for parts." This is a familiar statement stated every maintenance works likely pressed in a maintenance environment designed for pressures. Unfortunately, parts unavailability leads longer shutdown maintenance works. Another problem associated with Maintenance is the developing of the tendency to overstock low-turnover items. Bulk orders is another factor we can consider in ordering to avoid stock-out. But this

scheme increases the stock inventory costs. The set-up and continued management of these types of partnership with maintenance have a great impact on availability, reliability and cost management

Motor as unit that transform mechanical energy to velocity energy, the complex machine present in the plant has been the focus of this study. Lippman and Albert also establish a study last 2007 that covers design and performance characteristics of a compact electric-motor spinning disc aerosol generator. This sums up the idea of technically of the subject matter of this study. The team composed of Chan (2005) extends effort to study the motion control of an electric vehicle primarily moved by its fundamental unit of independently-driven in-wheel motors. The search for inputs in motors studies are widely accepted and even Bitar and Al Jabi (2014) shared the study of induction motors in electric cars by presenting the performance of these units. The information being shared focused on analyses of the motor units in designing and presenting that the concepts of efficiency of motors are relevantly acceptable.

[Kathir, Balakrishnan](#) and [Sakthivel](#) presented a power quality perspective last 2012 that pertains about the detection of rotor fault in an induction motor. This supports the need for the study to monitor performance of the electric-driven motors of the concerned paper mill/plant. Analysis

of the motors is then used by ANSYS software which results to present the steady-state performance of the units being investigated.

Preventive maintenance is synonymous to maintenance that is performed on a scheduled basis an insisting point of Niedel (1994). If a preventive maintenance is effective, regular work assignment, evaluation of figures, assembly performance, standard values, erratic and variable changes on the system and level of effective routines are evaluated accordingly. Historical Information is vital to further check and balance the performance capability of every unit on the system. Preventive Maintenance record cards are normally provided in order to monitor the ups and down of every unit. Priority in terms of criticality and emergency case are tedious work to be done. Sorting alone on a room of records remembering the functional location of the documents is the first challenge to consider.

Postulated here is that Inventory System software is no doubt an indispensable tool in doing business. This has been a mainstream for the reason that persons engaged in any sort of business want to stay in the game, more so stay ahead with competitors. This system also acts as some sort of an eye that ensures that everything flows smoothly and without aggravation.

The Inventory System software is a stand-alone tool. Thus, it is very much able to operate without control from another system that makes it self-contained and independent. With this, decision makers will more likely benefit the most. The Inventory System will allow them, the clients to analyze and study the sales and distribution system of the company and anticipate accurately the issues which could arise therein. It is an Inventory System that ensures that the right volume of the precise products on hand and will be made available at no time.

Having such system also answers vital questions in relation to the following:

- a.) How much should be allotted for distribution on a particular day? And
- b.) How much will be available (product/supply/good) for tomorrow or the next day?

The Inventory System will thus tell everybody concerned especially the stakeholders that x number of x material are needed within a specific number of days. With these data presented, if the inventory is enough, work can proceed right away. Moreover, the Inventory System makes sure that information needed and will be available soonest saving effort and time for both the employees and the stakeholders.

An Inventory System no needs to be computer-based. Even a manual style of keeping track of the flow of various goods or products in and out of the company may also be deemed some sort of an Inventory System. This type of an Inventory System is more frequent and exercised the most in very small businesses whose main bodies are not genuinely inclined and interested to technology moreover to tools which need to be employed through the aid of technology or

when such things are unavailable to the business' geographic location. With all the development and changes existent today, computerized Inventory System is still seen as a significant key concept on doing business. This is primarily because simply relying on crude and rudimentary methods may be counterproductive and inefficacious at the same time. It may be tedious, consuming most of the employee's time. It may also be more prone to human error which may soon result to unsolicited lapses. In this case, the objective of having an Inventory System no matter how simple may be defeated. In fact, slip-ups can entail additional cost, lost revenue, redundancy, and worst customer dissatisfaction.

In this study, the researchers focused on the inflow and outflow of motors, number of stocks available, and income of the said business the researchers are referring at. The researchers provided an Inventory System that ensures that the right volume of the right motor units are on hand and available. With this, expected distribution on a particular day was also deemed significant.

Furthermore, related studies reviewed in this section were of great help and assistance in pursuing this research which sought to create and innovate a system that will provide an efficient Inventory System that will make the target users easily recognize and tally their sales.

The previous studies that had been particularly focused on this subject matter are presented as follows leading to the optimum opportunity to develop the idea of this research.

On projects done by Engineers Karen Jose and Axill Fidelino at UPPC in 2012 and 2013 respectively, motor inventory was vital as well as crucial in the development of the company. In the said company – sectional project, the two supervisors mentioned and gathered all the needed data and pieces of information to produce an inventory system. The said sectional project collected the following records (a) size of motor, (b) pictures of the actual motor and, (c) ticker that includes the motor specs, also they assigned an alphanumeric tag for each motor.

On one hand the sectional project's target that leads to its advantage was to lessen the downtime due to spare recovery on warehouse and its replacement for the broken motor. On the other hand, the project also had loop holes and drawbacks (a) the excel file was not centralized, thus the access was exclusive, (b) the data for each motor file may not be accessed fully with mere excel, other tab or applications must be visited as well (pictures), (c) the excel file was not maximized, for a reason that it was not fully updated, (d) due to the position rotation, the file was neither maintained nor updated.

## Methodology

A systematic inquiry evolving on gathering of facts as per application of allied sciences is the key point method established on this study commonly known as applied research. Data are analyzed and evaluated in order to develop an innovation or improvement of the pre-existing system. Practical problems are to be addressed associated with identifying the best solution to fit the objective. Identifying every challenges and develop an innovation or improvement from the findings.

The conceptual design of this study is Integrated Definition [IDEF] that were used to further organize the analysis of the provided data. The Integrated Definition  $\emptyset$  [IDEF $\emptyset$ ] used to model the decisions, actions and activities in the modular design of the training unit. The whole project life cycle stages be depicted using IDEF0. The design was done in the AutoCAD Software environment created by Autodesk. The design subdivided into modules to provide the details of various components as well as the general dimensions. Tag names and/or numbers were used to identify the different components present.

The study integrated the collective information on hand of various job functions. It can present the basic and vital information of each unit of the electric-driven motors. Historical data of the reconditioning and/or rewinding works are presented along with the costs that come along. Service providers of each maintenance repairs are also presented. Interviews and panel coordination meeting are being done. These information showcased gave greater impact on the performance evaluation of each motor. On this point, correlated schedule of monitoring were evaluated accordingly. Functional locations are also expected including image of each unit for proper identification. Inventory Management for that purpose is being satisfied.

The respondents of the study are the key functions involved in the maintenance of motors. Eight (8) managers, ten (10) supervisors along with eight (8) electricians and four (4) other end-users assessed the system.

The subject of this study were developed by applying the stratified random sampling. In this technique, maintenance and managers were randomly represented among the almost 400 plant personnel affected by cases of plant shutdowns. Going down to the level of the most exposed workforce on motors, randomly selected engineers and electricians of the Electrical and Instrument Maintenance Section. Average-mean computation were applied for the analysis and interpretation.

Working on the most tedious part which includes much data of the motor-units, electronic data processing were greatly applied. Microsoft Word and Excel were utilized on the organization of the information. Listing, classifying and sorting will be empowered. For info with incomplete data, actual site inspection of the name plates or measurement of the vital dimensions done.

Likert scale has been directly used for the analysis of the statistics. The levels of acceptance on the end-users are evaluated using the following scales.

<i>Range of Weight Scale Mean</i>	<i>Interpretation</i>
4.51 - 5.0	Very Satisfied
3.51 – 4.50	Satisfied
2.51 – 3.50	Almost Satisfied
1.51 – 2.50	Dissatisfied
1.0 – 1.50	Very dissatisfied

## **Research Instrument**

Data gathering instruments are necessary in this study. Retrieval of information from different sources are required and deemed required and considered by the researcher. Direct observation as initially considered from the job function since the researcher handles repair works when he is still on the Procurement department. The inputs and concerns raised then are observed to be vital in establishing this study.

Interview is another key factor to be considered as an instrument in data acquisition. Direct and indirect personnel involves in handling motor units are sources of key information. These are from maintenance and production sectors of the plant. This allowed the researcher to have level up input from those affected by motor breakdowns.

Survey technique also used by the researcher to hear the necessary performance evaluation of the end-users. As found on Appendix F where managers, supervisors and electricians are selected respondents.

## **Results and Discussion**

### **Inventory Management System**

The prior inventory scheme holds number of information about each motor but it failed to meet the reports and history standards needed to fully distinguish and identify each unit. The reports and history cited contain pieces of information such as but not limited to: damage/s, repair/s, cost, Return of Investment (RoI) data, Purchase Order (PO) and Purchase Reference (PR).

Likewise, all the said flaws of the previous inventory scheme were taken into consideration in the new Inventory System. In which, sufficient pieces of information were maximized for better retrieval and maintenance purposes in the shortest period of time.

Due to the issue of comparing and contrasting the current with the existing project, the researcher arrived to conduct a survey. Personnel especially those coming from the Maintenance Department who are engaged with the motors were asked and interviewed about the previous motor inventory.

*Content.* The Paper Mill Motor Inventory Management dashboard where you can see the breakdown of the total motors of the company. It is separated as installed motors, spare motors, scrap, stand-by and motors on the internal and external repair. Also the summary of motors by area of the company and recent activity of the user were displayed.

The System Login is restricted with the following facility. There will be a limited view for each system administrator.

Administrator – they handle the whole program.

Supervisor – they can view, see cost and edit motor specifications.

Electrician – they can view and edit motor specification

System Users has two categories: the system registry where users register and the users list that displays all the registered users. Only admin can view this category. Database, Import database to upload a file in .csv format the software required a format(see Appendices How to use Motor-ganizer). Export Database to download a file in .xlsx, .xls and .csv format for printed reports.

*Information of Motors.* Motor inventory has three categories: motor lists, inventory and location. Motor lists display All motor, AC motors and DC motor it has a view mode where it displays the information like pictures, files, location history and repair history of the motors and edit mode function. For the Inventory you can add new motor, the users should fill-up the required fields, upload picture and files. For the Location it displays the available location on the company and also can add a location for future expansion.

*Reports Generated.* The respondents deemed accepted the result of the system. The incoming reports from repair, recon and rewinding works are to be improved. Having highlighted the benefit of available data on hand, pictures of each unit are for future improvement for proper identification.

## **Table 1**

*Frequency Distribution and Descriptive Measures of Inventory Management System*

1. How is the inventory management system can be presented in terms of:	5	4	3	2	1	Mean	Descriptive Interpretation
1.1 Content	15	11	4	0	0	4.37	Satisfied
1.2 Information of Motors	15	15	0	0	0	4.50	Satisfied
1.3 Reports generated	0	8	22	0	0	3.27	Almost Satisfied
1.4 User-friendly interface	4	15	11	0	0	3.77	Satisfied
1.5 Maintenance planning and interpretation (preventive & corrective)	15	11	4	0	0	4.37	Satisfied
<b>Total Mean</b>						<b>4.06</b>	<b>Satisfied</b>

*User-friendly Interface.* The survey focused on the presentation of the system's content and objective of information availability. The respondents are still looking for more since some data are yet provided as of the study is presented. An option in password protection is recommended accordingly. Delete function were actually handled as archive for tracking purposes.

*Maintenance Planning and Interpretation.* The aspects of planning repair maintenances are now capable to refer on the system report of the program.

The benefit of the study is for the faster accessibility of the motor units. But since few motors moved, repaired and spare as of the presentation of the system, more scenarios will seek the most benefit of such. But as of the minor instances happened, it is seen the greater benefit of the system compared when it is not yet available. Therefore, the system is still recommendable as per the respondents' feedback.

. A month for evaluating the competency of the program is allotted. Since information that were inputted are existing data on hand and just collated to present as per objective, no much waiting time were required. New data are readily editable as another objective of the program to be used. Section Managers, Supervisors and Electrician & Technicians are desired to evaluate the program on the best capability it can present.

As per recommendation later of the evaluators on their most credible capability as benefactors of this study, this were recommended for further use. Performance and Duty as per objective of the study will be evaluated constantly and be updated accordingly.

## **Level of Inventory Control and Stock Management**

*Data of each motor unit.* Details provided for every motor are incorporated in the system. Vital information are provided from kilowatt (kW) power rating, voltage, frequency and even dimensions for installation.

All data provided are editable using administrator role. With these data on the system, level of inventory system and identify of each motor are established.

*Historical Repair of each unit.* The main objective of the system is to categorically compile all repair history of each motor.

Repair motors has two categories internal or inhouse repair, that takes place inside the company and External repair,that take place outside the company with their service provider. Internal repair fields should be filled first before repair inhouse and also displays the some details of the motors. In external repair the purchase reference should be filled first before repairing the equipment and the purchase order should be filled before completing the repair and for the test report files can be uploaded.

*Repair, Recondition and Rewinding costs.* One of the information that the researcher aimed to develop is the total cost incurred for the repair cost of each unit. With the availability of the system, this is hereby well established. Total repair costs are reflected on the individual motor view including Purchase Orders (PO) for reference. Historical repairs to see previous and ongoing repair jobs for every unit. Repair History including all incurred repair costs presented below each motor.

**Table 2**

*Frequency and Descriptive Measures on Inventory control*

2. What is the level of stock management of the system in terms of:	5	4	3	2	1	Ave.	Descriptive Interpretation	
2.1 Data of each motor unit	26	4	0	0	0	4.87	Very Satisfied	
2.2 Historical repair works of each unit	26	4	0	0	0	4.87	Very Satisfied	
2.3 Repair, recondition and rewinding costs (external works)	7	15	8	0	0	3.97	Satisfied	
						<b>Total Mean</b>	<b>4.57</b>	<b>Very Satisfied</b>

**Significant Time Improvement of Replacing/ Locating Motor**

The retrieval of the motors are exponentially improving since the system has been implemented. Current Location shows the entered information from the supervisor latest area installed or spare. This part can also presents if the motor is under repair (internal or external)

Location and warehouse are recommended to be improved as the management will be establishing a common central warehouse for the stacking. Another area allocated for the scrap to be improved.

Report has system logs where the history of the user log ins and out are recorded.

Motor Location where the history or movements of motor is recorded.

References where to add references such as pricing reference. It reads .pdf, .doc, .xlsx, .xls, and .csv.

The table below summarizes the result and inputs of the respondents.

**Table 3**

*Descriptive measures on locating the motor*

	5	4	3	2	1	Ave.	Verbal Interpretation
3. Presentation of significant time of replacement/locating the motor.	0	11	19	0	0	3.37	Almost Satisfied

## Conclusions

The study weights all the factors we may consider. With the earlier assumptions, it is hereby accepted and considered that the inventory system is accepted and beneficial to the plant retrieval of motors including records of downtime and causes of repairs. This also includes cost that has economic consideration therefore. It can be further conclude that keeping an inventory of motors contributes to the plant productivity for easy access of information. The capability to search any motor will help much in identifying a unit for direct or alternate replacement.

All of this initiative gave awareness to the managers, supervisors and electricians on aftermath of movement therefore they have now basis for the analysis of evaluating the life and operation of motors.

## Recommendations

The study exerts best effort to offer most of the point of interests. Even though, factor to improve are hereby presented.

### 1. Additional display (Frame size and Speed)

Most of the presentations are text and numerals. With that, it is requested to present dimensions of the motors in an improve option like images in .jpg format for visual presentation.

### 2. Organize warehouse and Additional Racks

Since dealing with small and big motors require space, it is then presented and approved for future expansion to allocate a central motor warehouse to keep-track the objective in recording the ins and outs of the motors.

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