2016

Continuous Manufacturing Performance Improvement: An Investigation of Overall Equipment Effectiveness as a Valid Shop Floor Performance Evaluation Tool

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Abstract

As part of a Lean Manufacturing journey, much research looks at Overall Equipment Effectiveness (OEE) elements and how they can be utilized individually and as a system working together. These elements include availability, performance, and quality. Availability can be addressed as part of a Total Productive Maintenance (TPM) program. Performance is examined through understanding the impact of cycle time, standards, set-up reduction, and productivity of employees. The Quality element is examined through scrap factors and waste due to producing non-conforming material. Developing a thorough Quality plan incorporating systems like Total Quality Management helps create structure for measurement and evaluation.

Though much research focuses on the elements, an underlying component critical to the success of each area is often overlooked. That component is the manpower or employee, which supports the integration and sustainability of OEE. The purpose of this research is to examine how OEE can impact the performance of the manufacturing area and understand if it is a reasonable tool for everyday use on the shop floor by employees. In addition to use by employees, do all levels of management and support areas consider OEE a valuable tool? This research will attempt to answer a couple basic questions:

1. Does it provide information that is useful to drive Continuous Improvement for operators, managers, and the business in general?

2. What elements of OEE are most beneficial to upper management, supervisors, operators, and maintenance teams?

Research was conducted through a survey that exams existing system data collection, online investigation, as well as internal questionnaires and experience within the current organization.

The survey found that availability, performance, and quality elements of OEE are valid shop floor measurement tools. Wage and salary employees can utilize TrakSys, a software package that collects data on OEE to drive continuous improvement opportunities in all areas of OEE. It also found that open, continuous communication supports advancement of ideas and progress towards company goals and objectives. Further research, auditing, and surveys can gather additional information that can be utilized to generate new and innovative ways to measure and track performance. TrakSys/OEE metrics yield results that drive sustained, continuous improvement.

CONTINUOUS MANUFACTURING PERFORMANCE IMPROVEMENT: AN INVESTIGATION OF OVERALL EQUIPMENT EFFECTIVENESS AS A VALID SHOP FLOOR PERFORMANCE EVALUATION TOOL

Technology Research Paper

A Research Proposal for Presentation
To the Graduate Faculty of
the Department of Technology
University of Northern Iowa

In Partial Fulfillment of the requirements for
The Non-Thesis Master of Arts Degree

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June 13, 2016

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7/27/2016

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7/27/16

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TABLE OF CONTENTS

TABLE OF FIGURES

Abstract

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Introduction

Introduction

Businesses today must continuously strive to improve in order to remain competitive in the ever-changing global market. Manufacturing businesses look to utilize metrics to help easily evaluate the performance of the entire enterprise. Overall Equipment Effectiveness (OEE) is a performance measure used to evaluate the availability, performance, and quality executed by machines/processes in a manufacturing, factory setting. These three factors are independently calculated, then multiplied to generate a percentage value for upper management to utilize in decision making. OEE can help provide a high level assessment to gauge the health of an organization's performance. A concern that arises is whether OEE is an effective tool for shop floor salary and wage employees to guide improvement efforts. Can manufacturing operations utilize this tool to make rapid, real-time, improvement decisions?

Statement of Problem

The problem that is presented for the research in this study is to see if there is a work cultural acceptance by wage and salary staff for the use of overall equipment effectiveness as a shop floor tool to drive continuous improvement efforts.

Purpose of the Study

An objective for many businesses is to quickly assess deficiencies in machine availability, employee performance, and quality defects impacting customers. All of these negatively hurt profitability for the company. The purpose for doing this research is to better understand what factors of overall equipment effectiveness can and are being utilized by operations departments to improve the business. Does this tool provide useful

information that can direct teams in improvement idea generation? The intent of this research would be to examine the elements of OEE and their application in a manufacturing setting. The three elements of OEE would be evaluated for effectiveness and ready acceptance by employees and salary support staff. Research would also help determine improvements to the OEE system and metrics needed for improvement to be successful.

Research Questions

This research paper will organize this information to compare OEE elements to conventional measures of performance. The research will also examine wage and salary shop floor employee perceptions of OEE and conventional metrics for evaluating performance and continuous improvement activities. The research should also provide some potential direction for improvement opportunities to achieve company objectives.

The research questions to be considered are:

1. Does OEE provide performance information of value to drive continuous improvement activities?
2. Do wage and salary employees consider OEE an effective metric to gauge performance?
3. Can incorporation of OEE into an overall lean manufacturing strategy be sustained and utilized at a shop floor level?

Background

Literature Review

The need for this study is based on the following factors: optimal equipment utilization, whole system performance, real-time performance measures, substantial cost

savings and profitability, and continuous improvement opportunity identification. Much research has been conducted and analyzed surrounding OEE over the last couple decades. Aspects include the understanding of OEE versus Overall Process Efficiency (OPE), how performance measures like cycle time and productivity impact output, and finally quality and scrap impacts to the system output.

According to Muchiri and Pintelon (2008), OEE is often the base metric that industries derive other measurements. Terms like overall factory effectiveness (OFE), overall plant effectiveness (OPE), overall throughput effectiveness (OTE), and total equipment effectiveness performance (TEEP) have been developed to encompass additional measures to fit their particular industrial requirements. Their research argued that one can't look at individual machine or cell performance through OEE, but that the entire system or process must be evaluated. The alternative measures focus more on whole system performance versus equipment specific utilization and are more suited to overall system improvement efforts.

In order to better understand OEE, literature review was conducted focusing on the three components of OEE. This includes:

1. Availability – Is the machine/cell available to produce parts?
2. Performance Efficiency – Are the machine and manpower running at optimal cycle time and minimal non-value add?
3. Quality – Is the process capable and reliable to consistently produce quality parts with minimal scrap?

Each of these components contributes to the overall performance of the business, but can it be measured, evaluated, and executed at the shop floor level?

Availability

According to Vorne Industries Inc. (2011), Overall Equipment Effectiveness is calculated by multiplying availability by performance efficiency by quality rate. Availability focuses on maximizing utilization of equipment. Research done by Dogra, Sharma, Sachideva, and Dureja (2011) suggests that developing a Total Productive Maintenance (TPM) program through Lean Manufacturing practices is a key strategy to assist in process improvement. Their research focuses on how a structured maintenance approach to maximizing machine uptime helps ensure the overall health and success of the organization.

Braglia, Frosolini, & Zammori's research (2009) also examined OEE, but looked at the entire manufacturing line (OEEML). "Throughput and equipment utilization have been traditionally adopted as the standard way to assess the performance of manufacturing equipment, mainly because of their simplicity. However, when machines operate jointly in a manufacturing line, OEE alone is not sufficient to improve the performance of the system as a whole." Therefore, more robust measures that work well with many applications may be needed to fully assess a system's performance and determine optimal equipment performance levels. Their research recognized the importance of TPM to support machine availability, but also identified the limitation of OEE in that it often only focused on the individual equipment.

Performance Efficiency

According to Vorne Industries Inc. (2011), Performance Efficiency is calculated by (Ideal Cycle Time x Total Pieces) / Operating Time. It focuses on understanding the impact of cycle time, standards, set-up reduction, and productivity of employees. Where

availability focused on machine performance, performance efficiency looks at the process effectiveness.

Research performed by Naveen and Babu (2014) focused on productivity improvements in manufacturing through the use of industrial engineering tools. Their work focused on identifying bottlenecks, reducing cycle time and takt time, and reducing tool change over times to calculate overall machine efficiency. The use of standard tools, methodology, and procedures provide a structured approach to process improvement. This has been an effective approach throughout manufacturing industry.

Another impact to productivity includes worker fatigue. Use of industrial engineering tools and calculations can help factor in this delay to standard cycle times. Research performed by Al-Shayea, El-Tamimi, Al-Saleh, and Al-Yami (2011) focused on the use of a Productivity Improvement Model (PIM). This model derived calculations for a variety of allowances, including a relaxation allowance. These allowances provide the worker opportunity to recover from physiological and psychological effects while carrying out their work.

Both research works (Al-Shayea, El-Tamimi, Al-Slaeh, & Al-Yami, 2011;Naveen & Babu, 2014) provide fundamental industry practices to manage and calculate process efficiency. This research supports the performance efficiency element of OEE.

Quality

Quality focuses whether good or defective parts are being made, which results in lost output. This is calculated by (Good Pieces x Ideal Cycle Time) / Planned Production Time. (Vorne Industries Inc., 2013)

Typical quality plans include methods to identify and measure scrap factors and waste due to producing non-conforming material. Developing a quality plan/strategy through systems like Total Quality Management (TQM) is common in many manufacturing businesses.

Research conducted by Sadikoglu and Olcay (2014), examined how TQM practices could impact various performance measures. The reasons for its use and barriers in a manufacturing setting were also discussed. Reasons to implement TQM practices included improvement of customer satisfaction, productivity, capacity, and employee performance. Their results concluded that TQM practices overall improve the performance measures. Successful training improves operational performance, employee performance, and customer results. They also concluded that effective strategic quality planning efforts improve employee performance and social responsibility of the firm. (Sadikoglu & Olcay, 2014)

Calculation Tools

Finally, many research articles and publications also suggest that new measures and methods need to be developed to better understand equipment utilization and the system performance beyond the equipment level. Several refer to the use of software for real time collection and analysis of the information. Muthiah, Huang, & Mahadevan (2008), suggest that productivity and performance gains to entire production systems are necessary for companies to remain competitive and profitable in today's ever-changing market. Companies are looking for the most cost effective ways to improve their performance and identification of their problem areas to target. Their work suggests the use of Overall Throughput Effectiveness (OTE) metric be used to automate the factory

level monitoring. They utilized a software package called SIMPRO to run algorithms to quantitatively identify bottlenecks and opportunities for improvement for the entire process versus at the machine level..

Additionally, research by Singh, Shah, Gohil, and Shah (2013), recognized that hardware and software developments could ease the calculation and monitoring process for OEE. Their research utilized Visual Basic to develop software that could easily record and display equipment information for analysis. They concluded that the standard manual calculation of OEE was time consuming and tedious. This resulted in demanding operators' time to input data and reducing their productivity. Use of software helps counteract the time loss and operator interruption.

Definition of Terms

In order to clarify some talking points within the paper, here are definitions of some common terminology used:

- Lean Manufacturing – Lean manufacturing involves never ending efforts to eliminate or reduce 'muda' (Japanese for waste or any activity that consumes resources without adding value) in design, manufacturing, distribution, and customer service processes. (BusinessDictionary.com, lean manufacturing, 2015)

- OEE (Overall Equipment Effectiveness) - Framework for measuring the efficiency and effectiveness of a process, by breaking it down into three constituent components (the OEE Factors) (Vorne Industries, 2011). All of these factors/elements support the optimal use of our machines, materials, methods, and manpower. The three factors/elements are:
    - Availability focuses on how much time a machine is available to produce parts. This is generally calculated by Operating Time / Planned Production Time.
    - Performance focuses on how well the machine and manpower utilized during the available time and more specifically when it is running. This is calculated by (Ideal Cycle Time x Total Pieces) / Operating Time.
    - Quality focuses whether good or defective parts are being made, which results in lost output. This is calculated by (Good Pieces x Ideal Cycle Time) / Planned Production Time.

  - When you multiply these together, you get an OEE value. (Vorne Industries Inc., 2013)

- TPM (Total Productive Maintenance) – Methodology designed to ensure that every machine in a production process always performs its required task and its output rate is never disrupted. (BusinessDictionary.com, Total Productive Maintenance, 2015)

- TrakSys – Software that monitors and tracks equipment utilization provided by Parsec Automation Corporation.

- Productivity - A measure of the efficiency of a person, machine, factory, system, etc., in converting inputs into useful outputs. (BusinessDictionary.com, Productivity, 2015)

- Efficiency - The comparison of what is actually produced or performed with what can be achieved with the same consumption of resources (money, time, labor, etc.). It is an important factor in determination of productivity. (BusinessDictionary.com, Efficiency, 2015)

- Downtime –
  - a time during a regular working period when an employee is not actively productive.
  - an interval during which a machine is not productive, as during repair, malfunction, maintenance (Dictionary.com, 2015)

- Root Cause Analysis – "Root Cause Analysis is a process or procedure that helps guide people to discover and understand the initiating causes of a problem, with the goal of determining missing or inadequately applied controls that will prevent recurrence." (RootCause.com, 2013)

Method of Study / Methodology

Method of Study

People are a key component to the improvement of business metrics and performance. Companies need engaged employees to achieve greater levels of success. Through the literature review and class instruction, a set of research questions were developed to help evaluate the current perceptions of employees, at all levels within the business, as to the current effectiveness of an existing OEE system. In order to better

understand the impact and use of overall equipment effectiveness measures to drive continuous improvement activities, this paper includes:

- Define some basic terminology used in this paper.
- Discuss the conventional metrics used to measure areas of performance.
- Discuss the elements of OEE.
- Explore different types of tools used to measure the elements of OEE.
- Develop and conduct a survey of wage and salary employees to understand current perceptions of OEE and its' effectiveness in the organization.
- Summarize the research

Participants

The participants for this study include employees of the business and can include wage and salary positions. The criterion for participation is that the participants be an employee at the place of business where the study is being conducted. All employees are eligible to participate. The intent is to examine the perspectives of employees on use and effectiveness of current OEE software and applications in their respective areas of the business. The questions are designed to provide feedback on existing processes and systems. All participation is voluntary and anonymous. The design and administration of the survey mitigate exposure and knowledge of the participants. At any time, the participants can cease or not answer any questions they feel may cause undue influence. IRB approval was obtained for questioning participants. (See Appendix A)

Instruments

The instrument for this study is a personally constructed survey questionnaire (See Appendix B) developed from literature review, class lecture, textbook, class assignments, and personal experience. The survey was designed by the researcher to examine the views of overall equipment effectiveness (OEE)/TrakSys and its' ability to be an effective tool to use in continuous improvement of the organization. The survey

questions were developed based on the three elements of OEE and also include communication and perceptions of managements' commitment to its use on the shop floor to drive improvement efforts. It can also be used to evaluate the current health and performance of the individual equipment and processes. Sections of the survey target the Availability, Performance Efficiency, Quality, and communication needs for employees and supervisors. Each section was chosen to understand knowledge and experience about the participants relative to OEE including:

A. Section 1: TrakSys/Overall Equipment Effectiveness (OEE) – Knowledge and understanding of the existing software and tracking systems
B. Section 2: Elements of TrakSys/Overall Equipment Effectiveness (OEE) – Understanding of Availability, Performance Efficiency, and Quality rate
C. Section 3: Managements' Commitment and Communication of TrakSys/Overall Equipment Effectiveness (OEE) – Are upper levels of management and support areas committed and effectively communicating the application of OEE

The overall purpose is to gather information about what is or isn't working with the current set of tools and to develop a better understanding of what could possibly be changed to improve its' effectiveness for future use or to discontinue all or a portion of its' use altogether.

The results will be evaluated, examined, and shared with all production areas upon completion of the study. The results are intended to be used by the operating teams for reference and possibly guide improvement idea generation.

Procedure and Time Frame

The research is conducted through a survey. The sample questions for this survey were developed based on literature review, personal experience, and information provided in class lecture. Investigation in the literature was done through internet

searches, reading of additional articles, and previous investigation in pursuit of the author's master degree.

The survey was constructed utilizing Microsoft Excel® for sorting and graphing purposes. The survey was introduced to the participants by the author in an actual face-to-face presentation at the participants' places of work. The intent of this was to clarify any questions and to avoid variation in the response method in order to improve validity. The surveys were left with the employees to allow them to answer based on their comfort zone and in their own privacy in an effort to get more detailed, accurate, and in-depth responses. Survey data was collected on an on-going basis, allowing participants the freedom and time necessary to answer on their terms. The responses were recorded by the author, raw data collected in an Microsoft Excel® form (See Appendix C), and are discussed in the analysis and findings section.

Costs and budgetary needs for this research were minimal. A few basic materials needed to document and record the responses were all that were required. No investment, other than time, was required to conduct the surveys.

Overall time-frame for this research was defined by the researcher and internal work project schedule. The timeline for this research is limited to the tentative project timeframe of mid-June 2016. Six separate interactions were made with the various participants to distribute the survey and communication of intent. A simple Gantt chart was developed in Microsoft Project® to track tasks and timeframes to keep the entire project on schedule. (See Appendix D)

Analysis Plan

The analysis plan for this study attempts to specifically answer the research questions. The questions and rankings for the survey were designed to answer the research questions. The results are graphed using Microsoft Excel®.

1. *Does OEE provide performance information of value to drive continuous improvement activities?*

To answer question 1, information was gathered from participants if they use TrakSys/OEE to drive continuous improvement ideas. Sections 1 and 2 of the survey questionnaire cover this topic (See Appendix A).

2. *Do wage and salary employees consider OEE an effective metric to gauge performance?*

Question 2 analysis plan required questions pertaining to participants' knowledge and use of OEE and the three elements. Analysis of Section 1 and 2 questions provides understanding of how much employees use TrakSys/OEE in their daily work activities. Along with these, participants were asked for specific feedback for ways to improve the use of TrakSys/OEE.

3. *Can incorporation of OEE into an overall lean manufacturing strategy be sustained and utilized at a shop floor level?*

Finally, question 3 is answered from feedback in Section 3 of the survey. Section 3 evaluates the communication and commitment from management in supporting the use of TrakSys/OEE. The survey collects information on how employees perceive their managers' approach to effectively communicating business and continuous improvement activities.

Assumptions

The following assumptions are made in the pursuit of this study:

1. Data collected will be the result of participants answering honestly to the best of their ability.
2. Data collection results will be specific to the "normal" or "average" work conditions encountered by the participants.

Limitations

1. Data may be limited by failure to understand or misinterpretation of the questions.
2. Length of questionnaire adjusted to keep as short as possible to collect pertinent information. A lengthier questionnaire may provide additional information for further research.
3. Restricted to a certain group of participants (employees at the place of business) based on project assignment.
4. Time constraint available for the study restricted to mid-June based on project definition.

Analysis and Findings

Over one hundred surveys were distributed for this study. At the point of writing this paper, forty-six total responses were received and responses were documented for analysis. Section 1 of the survey was designed to capture general information and knowledge of the participants concerning TrakSys/Overall Equipment Effectiveness and how the information is used and communicated. Section 2 was designed for a more in depth examination of the three elements of OEE, how the information is utilized, and what methods are used to communicate current use and application. Section 3 examines ranking information that is important to employees and perceptions of importance by

managers. It was designed to identify potential gaps in communication between employees and their management.

General Survey Analysis

At the time of writing this paper, forty-six respondents completed survey information for less than 46% response rate. Of the forty-six responses, the following chart (Figure 1) shows the percentage of how familiar the participants are with the elements of OEE. 60.9% of the participants were familiar with TrakSys/OEE and its use within the company. There is a distinct percentage difference between the equipment availability (TPM) understanding versus the performance and quality elements. There is a 73.9% familiarity with TPM, compared to 28.3% performance, and 13% quality familiarity in relation to OEE and its use within the company.

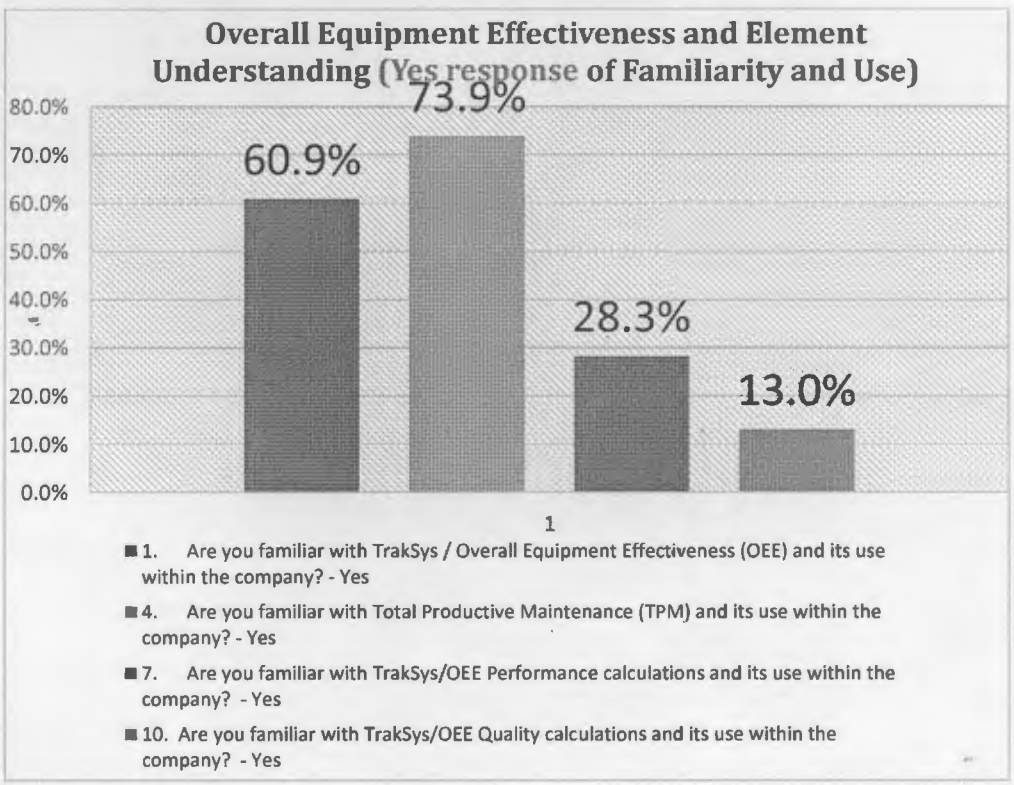

Figure 1 – Familiarity with OEE and Elements

Of the 60.9% (22 participants) familiar with TrakSys/OEE, the following chart (Figure 2) breaks down what aspects are being utilized by number of responses. Figure 3 shows the percentage of utilization based on the twenty-two responses.

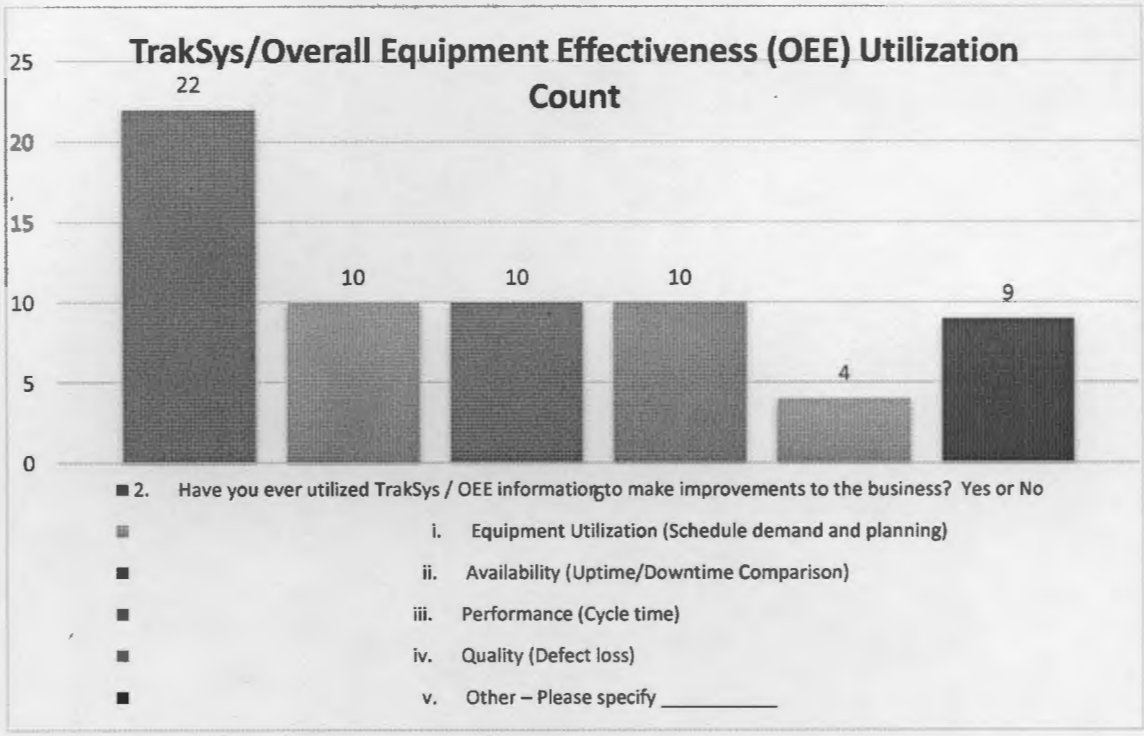

Figure 2 - Count of TrakSys/OEE Utilization

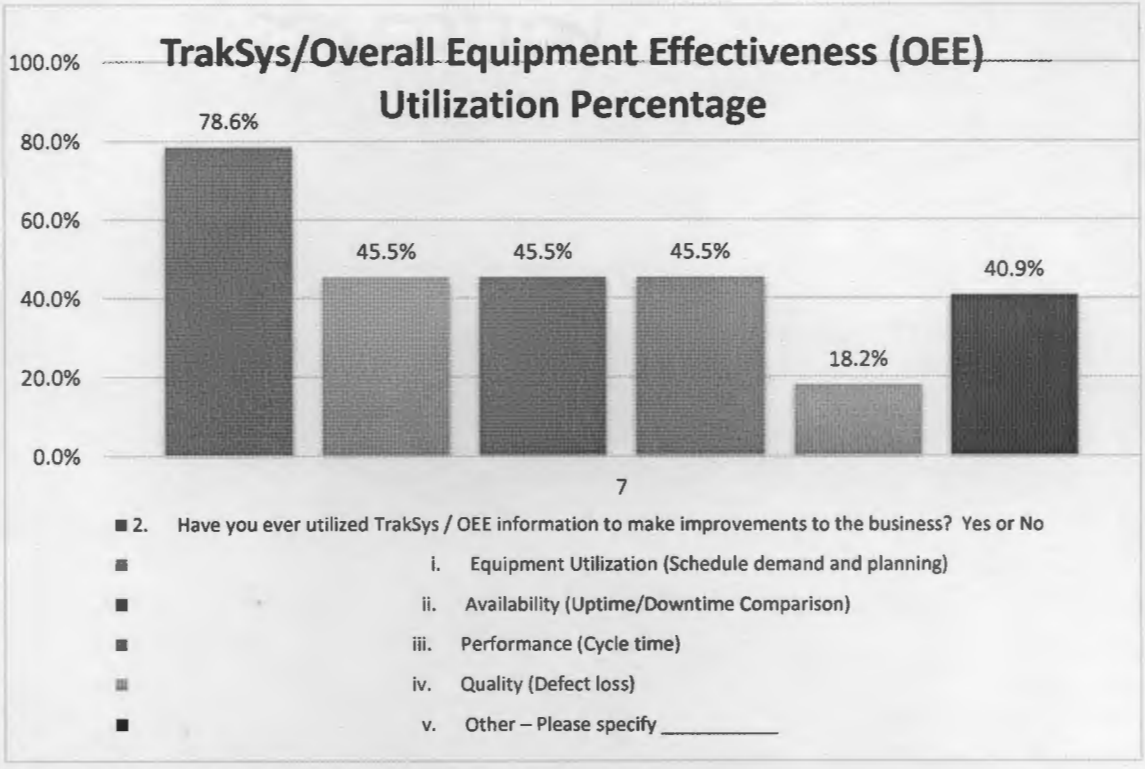

Figure 3 - Percentage of TrakSys/OEE Utilization

The survey response reflects an equal percentage of understanding of equipment utilization, availability, and performance. There was a marked decrease in how quality is tied to OEE at an 18.2%. Of the nine responses to "Other," most of these would fall into the Availability category.

Research Question Analysis

In this section, the data will be examined in reference to addressing the research questions.

1. *Does OEE provide performance information of value to drive continuous improvement activities?*

The survey collected information for overall understanding of TrakSys/OEE and specifically the individual contributing elements. Questions two, five, eight, and eleven asks participants if they utilize each aspect to make improvements to the business.

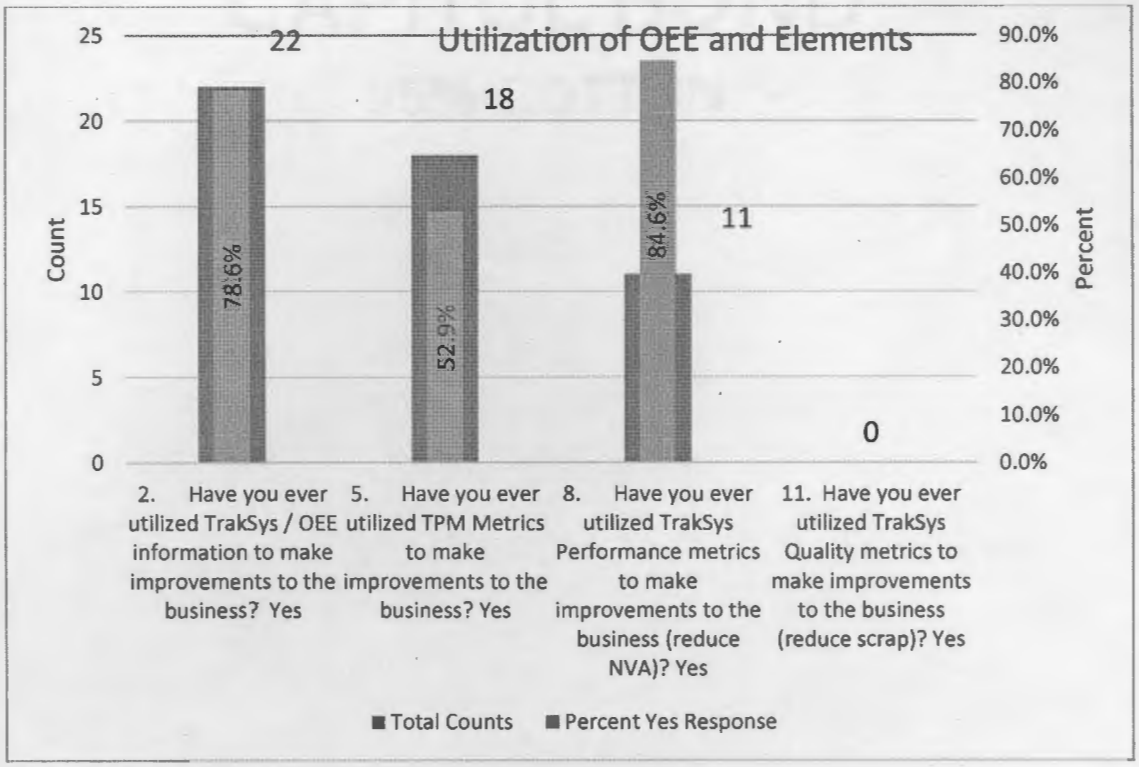

Figure 4 - OEE and Element Utilization

Figure 4 displays the results on how much the information is utilized. The counts are based on 46 overall responses. The percentages are based on the individual count responses for each category. 22 out of 28 responses have utilize TrakSys/OEE for 78.6%, 18 out of 34 for TPM, 11 out of 13 for Performance Non-Value Add, and 0 utilization for Quality metrics.

2. *Do wage and salary employees consider OEE an effective metric to gauge performance?*

For this question, participants were asked questions if they had regular communications and which methods were used. These questions targeted feedback from employees and managers'/supervisors' on what forms of meetings and communications they utilize frequently discussing the topics of OEE. The use and frequency of communication avenues would show the level of activity in which the metrics were utilized to gauge

performance. The interaction between wage employees, salary support functions, supervisors, and management can help predict the effectiveness of the metrics. Figures 5 and 6 show the responses to regular communication of OEE and each element, along with the communication avenues being used.

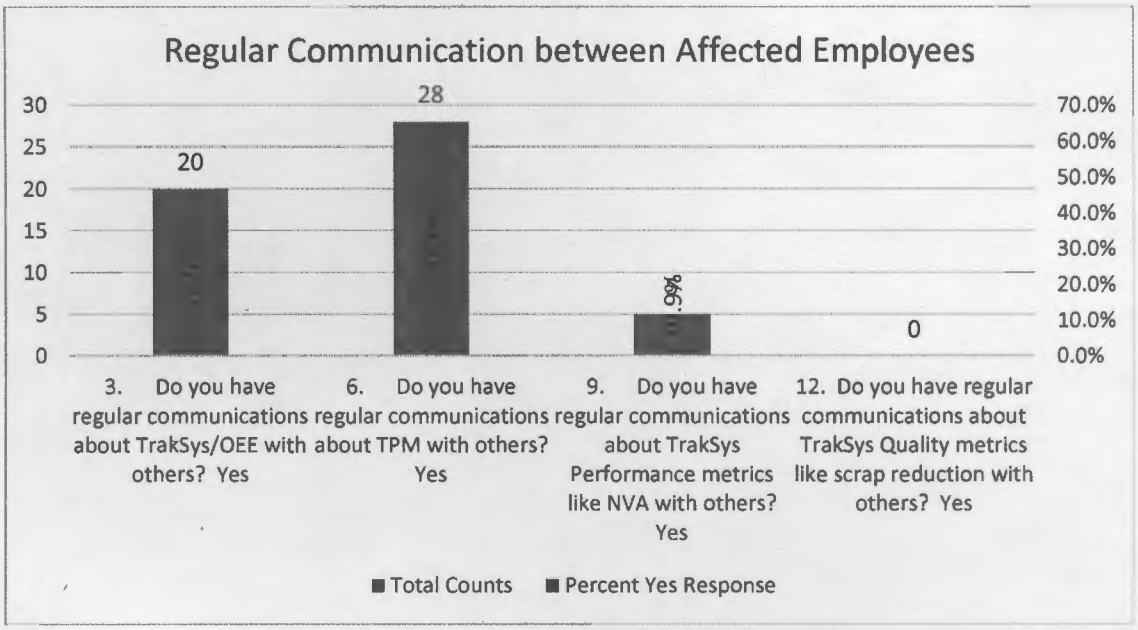

Figure 5 - TrakSys/OEE Discussion

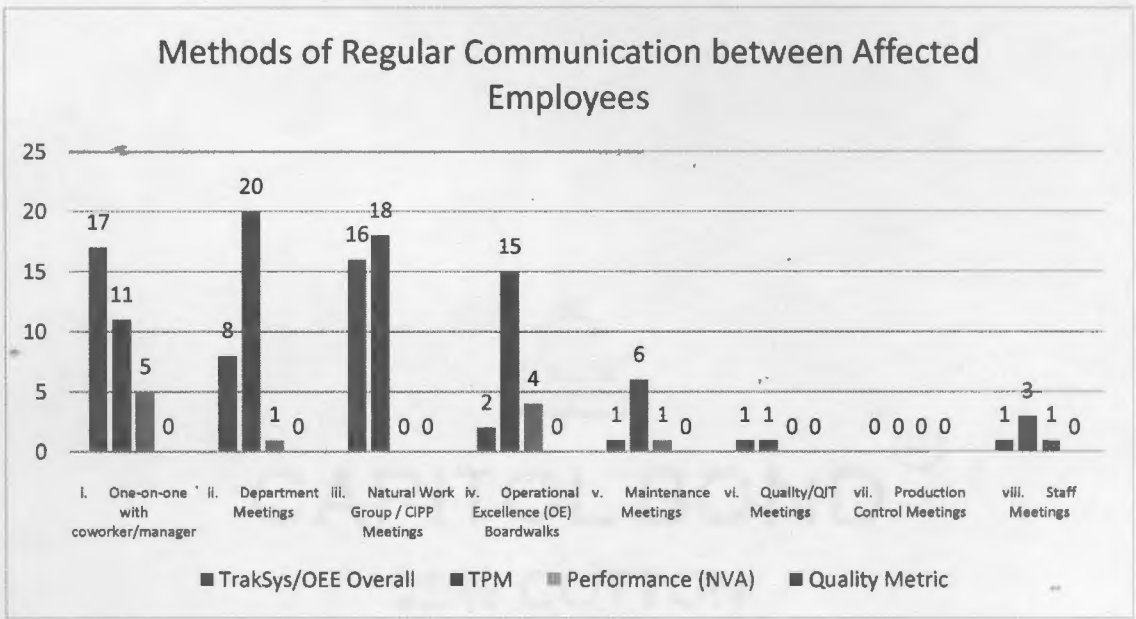

Figure 6 - Communication Methods Count

Communication through standard, established, department meetings and Natural Work Group (NWG) meetings are the most common avenues used to discuss OEE. Communication of TrakSys and maintenance TPM are more frequent than discussion of Performance (NVA) and Quality metrics. Of note is that there is zero recognition of quality communication through any of the proposed methods.

3. *Can incorporation of OEE into an overall lean manufacturing strategy be sustained and utilized at a shop floor level?*

For this questions in section 3 were analyzed. These questions were structured to capture how well managers communicate with their employees about information that employees find valuable. This includes views of shop floor employees, along with middle management and salary support roles. Questions were also asked to determine how well managers perceive that their employees are supporting the TrakSys/OEE use in every day decision making.

Figure 7 shows how employees view management's support of TrakSys/OEE usage overall and each individual element. It also includes the average for each area.

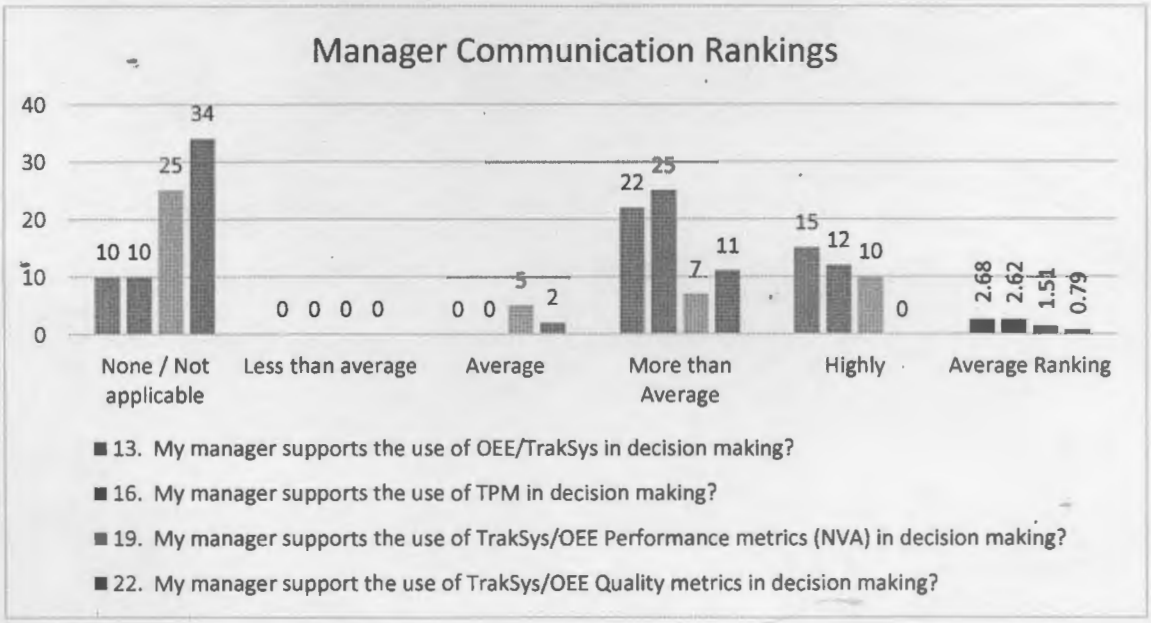

Figure 7 - Management Support

Figure 8 shows how management views employees' support of TrakSys/OEE usage overall and each individual element. It also includes the average for each area.

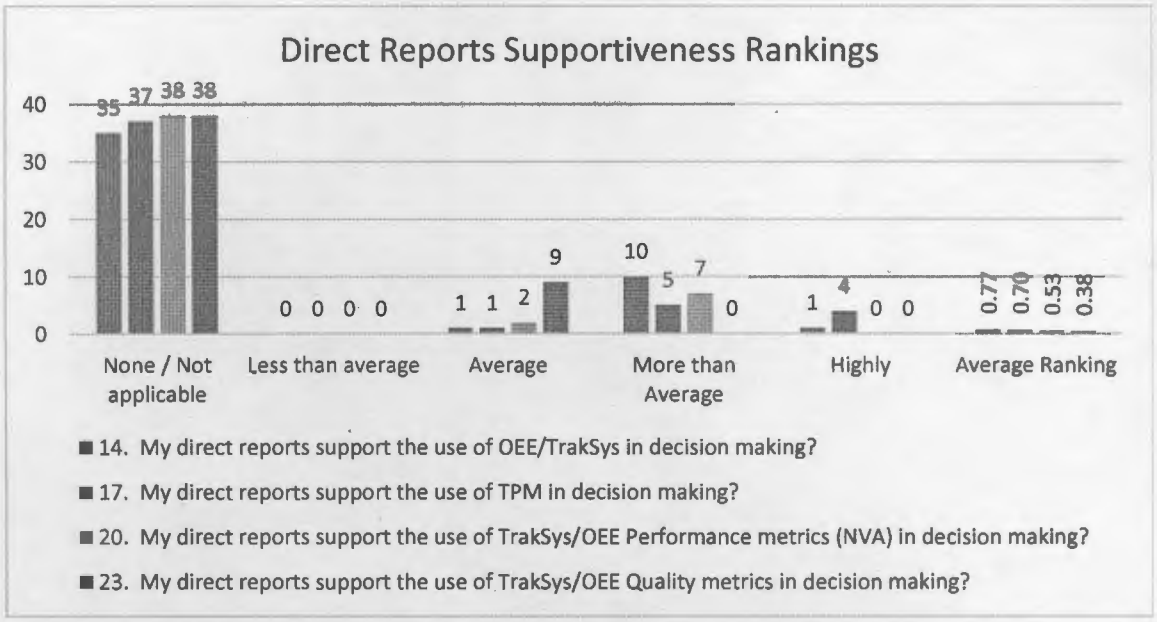

Figure 8 - Direct Report Support

Manager communication and support, according to employees, ranks above average to highly in almost every category. Direct report supportiveness tends to rank average to above average in the categories. Averages show highest results in overall TrakSys/OEE and TPM support, while performance and quality averages rank the lowest.

Summary and Conclusion

Summary

As literature review was conducted, it quickly became apparent that there is not a tremendous amount of information concerning overall equipment effectiveness from an employee engagement perspective. Most organizations and businesses have some type of continuous improvement strategy in order to achieve their goals and stay ahead of

competition. New initiatives for productivity and performance improvement are created that target specific aspects of the business like maintenance and quality programs. The question is how much employees from all ranks actually embrace and support these programs to drive continuous improvement efforts to the end results desired by the company.

From this study, it was observed that many of the participants are engaged in improvement efforts within their areas, but tend to focus more on the Total Predictive Maintenance monitoring. This is likely due to more availability of monitoring systems and the advanced development of this portion of TrakSys within the company. It was also shown that the communication of this portion of OEE was more evident and used by both wage and salary employees. Performance and quality factors were less utilized for improvement opportunities. A possible reason for this gap may be due to limited monitoring and communication of these elements of OEE. In general, comments made for possible improvements, focused on having more information available and targeting performance and quality system advancements to increase the effectiveness of OEE information on the shop floor.

Discussion - Conclusion

From the research, it would suggest that TrakSys/OEE is driving improvement efforts and supports a continuous improvement strategy. TPM practices are more prevalent and being utilized more than performance and quality aspects of OEE. Increasing the visibility and communication of methods used to help performance (NVA) identification would be of benefit to the organization. The current tie of quality to OEE

is almost non-existent according to the data. Though quality metrics and other tracking methods are used within the company, the tie to OEE is not widely known or utilized.

Communication and support of OEE also has some opportunity for development and improvement. The research would suggest that employees are aware and do receive communication from management through several meetings. Many avenues are used to convey information concerning TrakSys/OEE and employees do recognize its value. Several of the communication methods are similar in message content, so one would expect a repeated, continuous, stream of information being shared. There does appear to be a gap on how management perceives support from employees. The belief that direct reports understand and use the information to drive improvements is not as strong in rankings. Continued positive reinforcement of the value and possibilities of OEE could improve this perception. This lack of understanding may also be due to lack of auditing or surveys to receive feedback on the effectiveness of communication.

As no one can predict every person's behavior towards performance monitoring and communication, no one method can address all communication needs. Businesses and organizations have many differing objectives and purposes. This creates an ever-changing need to retarget goals for continuous improvement. Companies need to evaluate the factors that are important to their employees. Regular assessment provides an on-going way for managers, supervisors, and employees to provide their ideas on ways to improve the business. As the business and workforce matures, audits, surveys, and interviews can be applied to gain more insight. Open and effective communication between management and employees will support that the right tools are developed and utilized.

The survey would conclude that the use of TrakSys/OEE is a valuable and useful tool for everyday shop floor use. Though there are still gaps in the performance and quality elements, the ability and desire to make them more effective is shown in the data. The responses on how to improve reinforce the need for more data and information be shared. Though no specific ideas on how to do this were reported, the need and value of it are recognized and known. We need to capitalize on known effective practices and potentially benchmark our sister factories to move these areas forward.

Recommendations

This study was a good exercise to reinforce communication and focus on our most important asset; people. Much of the research was conducted throughout the researcher's career and place of business over the last 5 years. The strategy for use of OEE in our business is still a good plan. Continued development of this initiative will create an environment of more open communication allowing the business to prosper.

One recommendation would be to conduct more communication educating the employees more on how each element of OEE pertains to the calculation and the impact to them personally. The use of OEE has been around for many years within the company, but true understanding of each element may not be as thorough as needed to drive continuous improvement. Additional surveys, group meetings, and one-on-one discussions may improve understanding. Clarifying the questions and methods, along with more personal instruction with the participants, may improve reliability of the data.

Another area for recommendation to improve would be to do more research on the topic. A larger population and sample size would help with validity of data. In

addition, a larger population would increase data points to include more information on each element and possibly provide more feedback for improvement opportunities.

Overall, this research supported that the use of TrakSys/OEE is a valid, shop floor tool. Further research would help develop continued understanding and integration into the workplace. This information will be used as a benchmark for further improvement and development at my current place of work. Additional communication and education will be conducted to monitor continuous improvement and allow modifications to our strategic plans for goal improvement and employee engagement.

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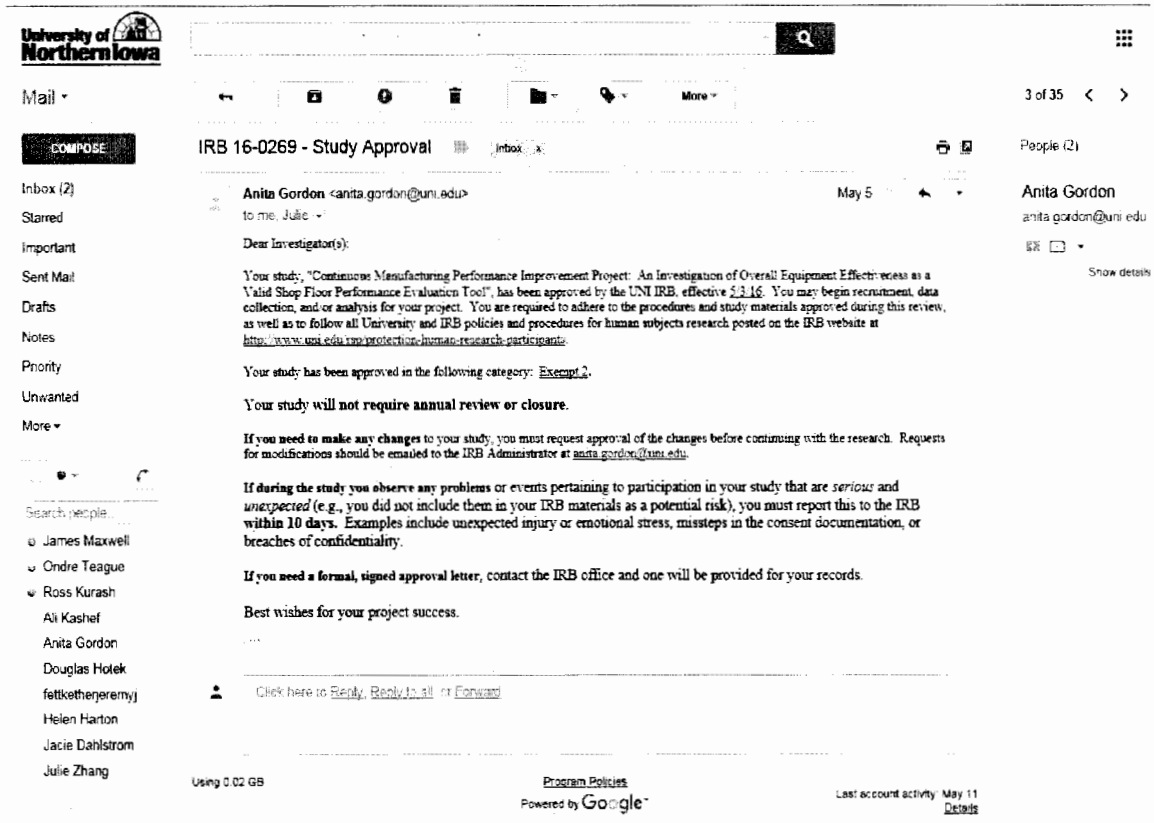
Appendix A – IRB Study Approval Email



University of Northern Iowa

Mail

COMPOSE

Inbox (2)
Starred
Important
Sent Mail
Drafts
Notes
Priority
Unwanted
More

Search people...
James Maxwell
Ondre Teague
Ross Kurash
Ali Kashef
Anita Gordon
Douglas Holek
fettkethenjeremyj
Helen Harton
Jacie Dahlstrom
Julie Zhang

More 3 of 35

IRB 16-0269 - Study Approval Inbox x

Anita Gordon <anita.gordon@uni.edu> May 5
to me, Julie

Dear Investigator(s):

Your study, "Continuous Manufacturing Performance Improvement Project: An Investigation of Overall Equipment Effectiveness as a Valid Shop Floor Performance Evaluation Tool", has been approved by the UNI IRB, effective 5.3.16. You may begin recruitment, data collection, and/or analysis for your project. You are required to adhere to the procedures and study materials approved during this review, as well as to follow all University and IRB policies and procedures for human subjects research posted on the IRB website at http://www.uni.edu/rsp/protection-human-research-participants.

Your study has been approved in the following category: Exempt 2.

Your study will not require annual review or closure.

If you need to make any changes to your study, you must request approval of the changes before continuing with the research. Requests for modifications should be emailed to the IRB Administrator at anita.gordon@uni.edu.

If during the study you observe any problems or events pertaining to participation in your study that are *serious* and *unexpected* (e.g., you did not include them in your IRB materials as a potential risk), you must report this to the IRB within 10 days. Examples include unexpected injury or emotional stress, missteps in the consent documentation, or breaches of confidentiality.

If you need a formal, signed approval letter, contact the IRB office and one will be provided for your records.

Best wishes for your project success.

Click here to Reply, Reply to all, or Forward

People (2)
Anita Gordon
anita.gordon@uni.edu
Show details

Using 0.02 GB
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Last account activity: May 11
Details

Appendix B - Survey Questionnaire

Section 1: TrakSys/Overall Equipment Effectiveness (OEE)

1. Are you familiar with TrakSys / Overall Equipment Effectiveness (OEE) and its use within the company? Yes or No
2. Have you ever utilized TrakSys / OEE information to make improvements to the business? Yes or No
    a. If yes, what information did you utilize from OEE to drive Continuous Improvement? (Please circle all that apply)
        i. Equipment Utilization (Schedule demand and planning)
        ii. Availability (Uptime/Downtime Comparison)
        iii. Performance (Cycle time)
        iv. Quality (Defect loss)
        v. Other – Please specify _____
3. Do you have regular communications about TrakSys/OEE with others? Yes or No
    a. If yes, what methods of communication are utilized? (Please circle all that apply)
        i. One-on-one with coworker/manager
        ii. Department Meetings

iii. Natural Work Group / CIPP Meetings
iv. Operational Excellence (OE) Boardwalks
v. Maintenance Meetings
vi. Quality/QIT Meetings
vii. Production Control Meetings
viii. Staff Meetings

Section 2: Elements of TrakSys/Overall Equipment Effectiveness (OEE)

One element of TrakSys/OEE is equipment Availability. It is a comparison of Uptime/Downtime for equipment. Total Productive Maintenance (TPM) is a tool used by maintenance and operations to evaluate equipment availability and target improvement.

4. Are you familiar with Total Productive Maintenance (TPM) and its use within the company? Yes or No
5. Have you ever utilized TPM Metrics to make improvements to the business? Yes or No
    a. If yes, what information did you utilize from TPM to drive Continuous Improvement? (Please circle all that apply)
        i. Equipment downtime
        ii. Cost of repair
        iii. Duration of downtime
        iv. Frequency of downtime situations
        v. Other – Please Specify _____
6. Do you have regular communications about TPM with others? Yes or No
    a. If yes, what methods of communication are utilized? (Please circle all that apply)
        i. One-on-one with coworker/manager
        ii. Department Meetings
        iii. Natural Work Group / CIPP Meetings
        iv. Operational Excellence (OE) Boardwalks
        v. Maintenance Meetings
        vi. Quality/QIT Meetings
        vii. Production Control Meetings
        viii. Staff Meetings

A second element of TrakSys/OEE is Performance. It is a comparison of actual cycle time to cost standards (theoretical, optimal cycle time). Traditional methods of measuring this are productivity (output / input) or Continuous Improvement Pay Plan (CIPP) performance. Performance metrics target reducing Non-Value Add (NVA) impacts to the process.

7. Are you familiar with TrakSys/OEE Performance calculations and its use within the company? Yes or No
8. Have you ever utilized TrakSys Performance metrics to make improvements to the business (reduce NVA)? Yes or No

   a. If yes, what information did you utilize from TrakSys Performance metrics to drive Continuous Improvement? (Please circle all that apply)
      i. Lost time for NVA activities (material handling, set-up)
      ii. Process improvement (cost)
      iii. Program / Tooling improvement (cost)
      iv. Cycle time reduction (duration)
      v. Frequency of NVA activities
      vi. Other – Please Specify _____
9. Do you have regular communications about TrakSys Performance metrics like NVA with others? Yes or No
   a. If yes, what methods of communication are utilized? (Please circle all that apply)
      i. One-on-one with coworker/manager
      ii. Department Meetings
      iii. Natural Work Group / CIPP Meetings
      iv. Operational Excellence (OE) Boardwalks
      v. Maintenance Meetings
      vi. Quality/QIT Meetings
      vii. Production Control Meetings
      viii. Staff Meetings

The third element of TrakSys/OEE is Quality. It is a comparison of actual conforming parts produced divided by total parts produced (conforming plus non-conforming). Non-Conforming or scrap parts reduce the amount of output produced during a given time period. Traditional methods of measuring this are Scrap $/Output Hours or PPM (parts per million) scrap rates, often discussed in Quality Improvement Teams (QIT) or Natural Work Group (NWG) meetings.

10. Are you familiar with TrakSys/OEE Quality calculations and its use within the company? Yes or No
11. Have you ever utilized TrakSys Quality metrics to make improvements to the business (reduce scrap)? Yes or No
   a. If yes, what information did you utilize from TrakSys Performance metrics to drive Continuous Improvement? (Please circle all that apply)
      i. Lost time due to scrap
      ii. Scrap costs
      iii. Duration of scrap event
      iv. Scrap Frequency
      v. Other – Please Specify _____
12. Do you have regular communications about TrakSys Quality metrics like scrap reduction with others? Yes or No
   b. If yes, what methods of communication are utilized? (Please circle all that apply)
      i. One-on-one with coworker/manager

ii. Department Meetings
iii. Natural Work Group / CIPP Meetings
iv. Operational Excellence (OE) Boardwalks
v. Maintenance Meetings
vi. Quality/QIT Meetings
vii. Production Control Meetings
viii. Staff Meetings

Section 3: Managements' Commitment and Communication of TrakSys/Overall Equipment Effectiveness (OEE)

Please select the ranking that best describes your view of the question:

13. My manager supports the use of OEE/TrakSys in decision making?

Ranking				
None / Not applicable	Less than average	Average	More than Average	Highly

14. My direct reports support the use of OEE/TrakSys in decision making?

Ranking				
None / Not applicable	Less than average	Average	More than Average	Highly

15. Do you have any suggestions to improve the use OEE/TrakSys?

16. My manager supports the use of TPM in decision making?

Ranking				
None / Not applicable	Less than average	Average	More than Average	Highly

17. My direct reports support the use of TPM in decision making?

Ranking				
None / Not applicable	Less than average	Average	More than Average	Highly

18. Do you have any suggestions to improve the use of TPM?

19. My manager supports the use of TrakSys/OEE Performance metrics (NVA) in decision making?

Ranking				
None / Not applicable	Less than average	Average	More than Average	Highly

20. My direct reports support the use of TrakSys/OEE Performance metrics (NVA) in decision making?

Ranking				
None / Not applicable	Less than average	Average	More than Average	Highly

21. Do you have any suggestions to improve the use of TrakSys/OEE Performance metrics (NVA)?

22. My manager supports the use of TrakSys/OEE Quality metrics in decision making?

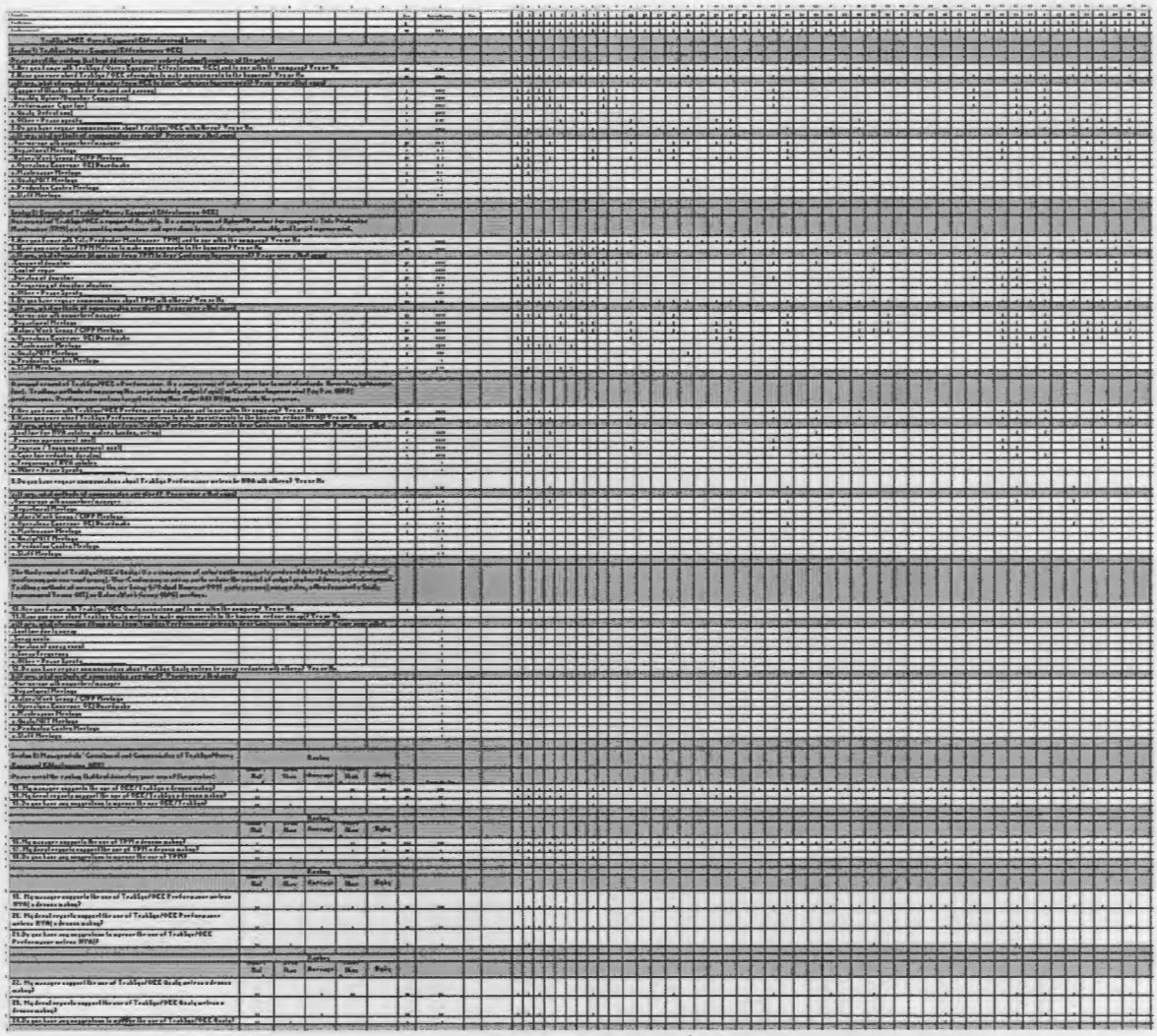
Ranking				
None / Not applicable	Less than average	Average	More than Average	Highly

23. My direct reports support the use of TrakSys/OEE Quality metrics in decision making?

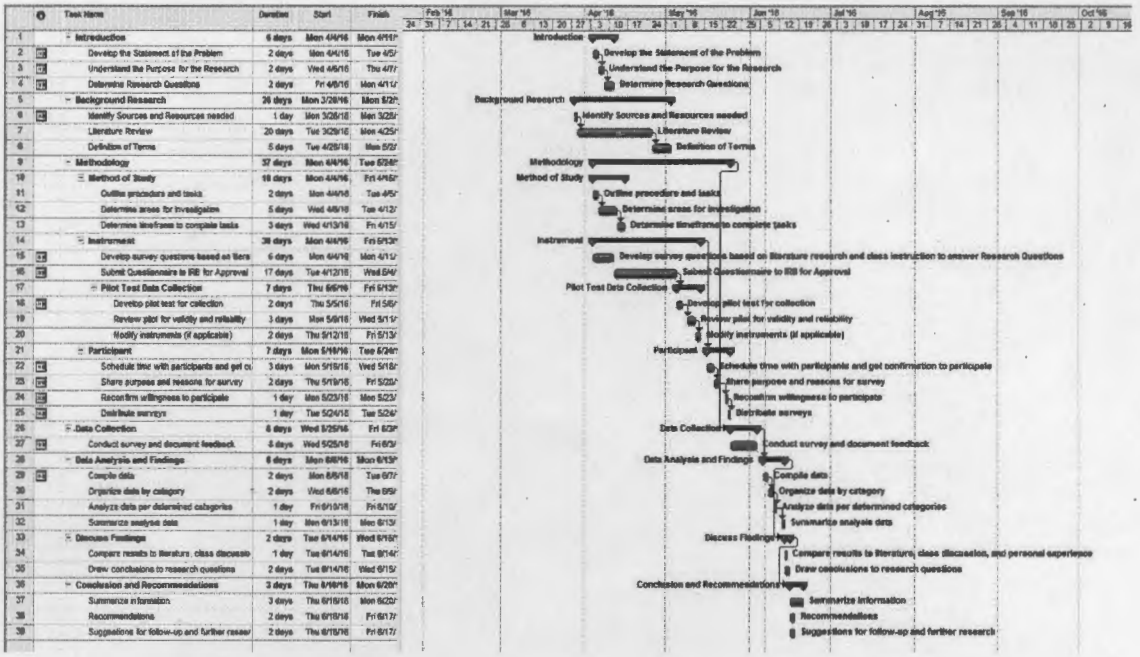
Ranking				
None / Not applicable	Less than average	Average	More than Average	Highly

24. Do you have any suggestions to improve the use of TrakSys/OEE Quality?

Appendix C - Survey Data Collection Form for Raw Data



Appendix D - Gantt Tasks and Time Table



	Task Name	Duration	Start	Finish
1	Introduction	6 days	Mon 4/4/16	Mon 4/11/
2	Develop the Statement of the Problem	2 days	Mon 4/4/16	Tue 4/5/
3	Understand the Purpose for the Research	2 days	Wed 4/6/16	Thu 4/7/
4	Determine Research Questions	2 days	Fri 4/8/16	Mon 4/11/
5	Background Research	26 days	Mon 3/28/16	Mon 5/2/
6	Identify Sources and Resources needed	1 day	Mon 3/28/16	Mon 3/28/
7	Literature Review	20 days	Tue 3/29/16	Mon 4/25/
8	Definition of Terms	5 days	Tue 4/26/16	Mon 5/2/
9	Methodology	37 days	Mon 4/4/16	Tue 5/24/
10	Method of Study	18 days	Mon 4/4/16	Fri 4/15/
11	Outline procedure and tasks	2 days	Mon 4/4/16	Tue 4/5/
12	Determine areas for investigation	5 days	Wed 4/6/16	Tue 4/12/
13	Determine timeframe to complete tasks	3 days	Wed 4/13/16	Fri 4/15/
14	Instrument	36 days	Mon 4/4/16	Fri 5/13/
15	Develop survey questions based on lite	6 days	Mon 4/4/16	Mon 4/11/
16	Submit Questionnaire to IRB for Approval	17 days	Tue 4/12/16	Wed 5/4/
17	Pilot Test Data Collection	7 days	Thu 5/5/16	Fri 5/13/
18	Develop pilot test for collection	2 days	Thu 5/5/16	Fri 5/6/
19	Review pilot for validity and reliability	3 days	Mon 5/9/16	Wed 5/11/
20	Modify instruments (if applicable)	2 days	Thu 5/12/16	Fri 5/13/
21	Participant	7 days	Mon 5/16/16	Tue 5/24/
22	Schedule time with participants and get co	3 days	Mon 5/16/16	Wed 5/18/
23	Share purpose and reasons for survey	2 days	Thu 5/19/16	Fri 5/20/
24	Reconfirm willingness to participate	1 day	Mon 5/23/16	Mon 5/23/
25	Distribute surveys	1 day	Tue 5/24/16	Tue 5/24/
26	Data Collection	6 days	Wed 5/25/16	Fri 6/3/
27	Conduct survey and document feedback	6 days	Wed 5/25/16	Fri 6/3/
28	Data Analysis and Findings	6 days	Mon 6/6/16	Mon 6/13/
29	Compile data	2 days	Mon 6/6/16	Tue 6/7/
30	Organize data by category	2 days	Wed 6/8/16	Thu 6/9/
31	Analyze data per determined categories	1 day	Fri 6/10/16	Fri 6/10/
32	Summarize analysis data	1 day	Mon 6/13/16	Mon 6/13/
33	Discuss Findings	2 days	Tue 6/14/16	Wed 6/15/
34	Compare results to literature, class discussio	1 day	Tue 6/14/16	Tue 6/14/
35	Draw conclusions to research questions	2 days	Tue 6/14/16	Wed 6/15/
36	Conclusion and Recommendations	3 days	Thu 6/16/16	Mon 6/20/
37	Summarize information	3 days	Thu 6/16/16	Mon 6/20/
38	Recommendations	2 days	Thu 6/16/16	Fri 6/17/
39	Suggestions for follow-up and further resear	2 days	Thu 6/16/16	Fri 6/17/