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Honest indicators

- How to effectively measure and develop processes indicators in a manufacturing environment

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PREFACE

This Master Thesis corresponds to 30 ECT and was performed during the late spring and summer 2014. It constitutes my final studies to a Master in Industrial Engineering and Management at Lund University Faculty of Engineering. The thesis was made in collaboration with Tetra Pak Packaging Material (TPPM) in Lund.

First I would like to thank my supervisor at Tetra Pack Nicklas Hall for helping me and supporting me with this thesis. Secondly I would like to thank Helene Nilsson at Tetra Pak for helping me locate all the bugs in the support system and being patient with me when bugs magically reappeared in the system.

I would also like to thank all the staff at TPPM Lund who took time to answer all my questions, gave me support and feedback.

Finally I would like to thank my supervisor at Lund University, Jan-Eric Ståhl, for his expertise and his time throughout this project.

Writing this Thesis have been a learning experience and I feel that all my studies throughout my five year at Lund University have contributed to the final work.

Lund, August 2014

Carl Agmén

ABBREVIATIONS

CSF	–	Critical Success Factors
TPPM	–	Tetra Pak Packaging Material (Lund)
JiPM	–	Japan Institute of Preventative Maintenance
WCM	–	World Class Manufacturing

Abstract

Title Honest Indicator
- *How to effectively measure and develop processes indicators in a manufacturing environment*

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Purpose The purpose of this Master Thesis is understand how Tetra Pack Packaging Material in Lund can extract useful information from the data gathered by performance indicators and be assured that they are measuring the right things. A support system for the indicator management was also developed as part of the Master Thesis.

Methodology The Master Thesis where carried out as an Action Study as there were a problem to solve. Data were collected by interviews, literature review and observations.

Conclusions To ensure that the indicators really are a tool for improvement it is vital to fully understand your processes. The indicators should measure what each

process stakeholders find most important and focus on the indirect parts of the process that improves the output. It is important not to have too many indicators as it clouds the view and to maintain the indicators to make sure they are still relevant.

Keywords Key Performance Indicators, Lean Production, Processes

Contents

Preface 4

Abbreviations 6

1 Introduction 11
1.1 Tetra Pak 11
1.1.1 Tetra Pak Packaging Material 11
1.2 Background 12
1.3 Purpose and research question 13
1.4 Scope and delimitations 13
1.5 Structure of the thesis 13

2 Methodology 14
2.1 Scientific approach 14
2.1.1 Research Characteristics 14
2.1.2 Theoretical frameworks 14
2.2 Research methods 14
2.2.1 Survey 14
2.2.2 Case study 15
2.2.3 Experiment 15
2.2.4 Action Study 15
2.3 Data collection 15
2.3.1 Interviews 15
2.3.2 Observations 16
2.3.3 Literature review 17
2.4 Trustworthiness 17
2.4.1 Reliability 17
2.4.2 Validity 17
2.5 Project structure 18
2.5.1 Choice of method 18

3 Frame of reference 19
3.1 Definitions 19
3.1.1 Performance indicators 19
3.1.2 Process 19
3.1.3 Critical success factor 19
3.2 LEAN Production 20
3.2.1 Kaizen 20
3.3 Developing new performance indicators 21
3.3.1 Frameworks 22
3.4 Maintaining performance indicators 24
3.4.1 Handling large amounts of performance indicators 24
3.5 Prioritizing 25

4 Empirical studies 26
4.1 Organisation 26
4.2 World Class Manufacturing 26
4.3 Performance measurement system today 27
4.3.1 Observations 27

4.3.2 Interviews 29

5 Support system 31

5.1 Background 31
5.2 Design 31
5.3 Result 32

6 Conclusion 34

6.1 Performance indicator system 34
6.1.1 Process for develop new indicators 34
6.1.2 Process for maintaining indicators 36
6.1.3 Prioritization and handling large amounts of indicators 38

7 Discussion 38

References 40

Table of Figures 42

1 Introduction

1.1 Tetra Pak

Tetra Pak was founded 1951 as one of the first packaging companies for liquid milk. Today the company have expanded into packaging for other liquid foods, food processing and plant engineering. Tetra Pak have over 23 000 employees all over the world and about 78 000 000 000 litres of liquid foods where delivered in Tetra Paks packages. (Tetra Pak, 2013)

1.1.1 Tetra Pak Packaging Material

Tetra Pak Packaging Material Lund AB (TPPM) is a company in the Tetra Pak group responsible for producing packaging material, located in Lund, Sweden. The plant has about 250 employees where 75 % are blue collars and 25 % are white collars. The packaging material is produced in a roll feed system and is categorised as a process industry. TPPM converts the paper board into the packaging material that goes into the filling machines. The Lund factory is the most complex of all Tetra Paks factories and produces over 700 different product combination of packaging material. To obtain this high degree of effectiveness TPPM have worked intensively with a LEAN-philosophy called World Class Manufacturing and is certified by Japan Institute of Preventative maintenance. The certifications system has five levels and currently TPPM is at the second level. All the levels have clearly defined targets of what a plant needs to achieve to move up to the next level. TPPM have worked with the WCM-concept since 2002 and Tetra Pak provides assistants from a central organisation within Tetra Pak to those at Tetra Pak that uses WCM. (Tetra Pack Packaging Material Lund AB, 2013)

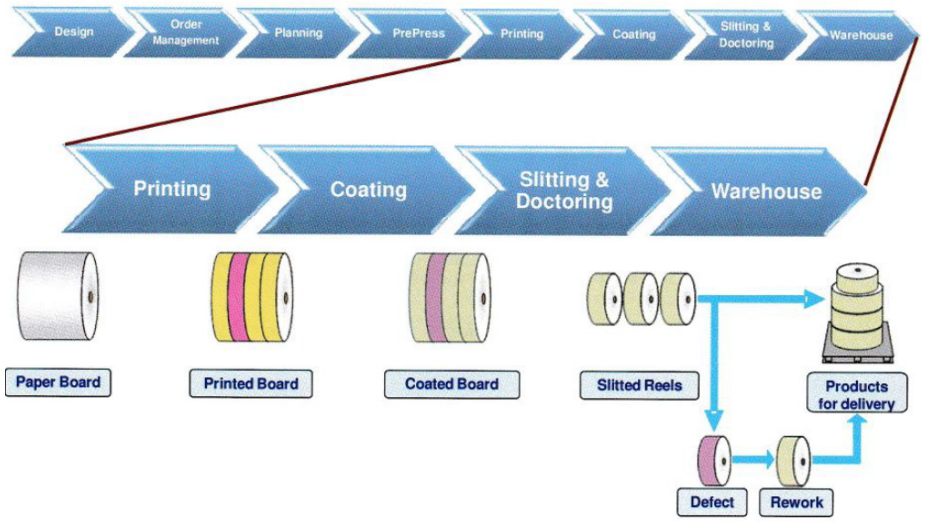

Figure 1 - Factory process TTPM.

Figure 2 - Packaging material construction.

1.2 Background

The ever increasing amounts of data collected by enterprises are creating new challenges to the management and steering based on the data. Going from lack of data to too much data puts higher demand on the management to assure the legitimacy of what the performance measurements are claiming to measure. TPPM in Lund has come a considerable way in working with their performance indicators but they have now come to a point where they

measure so much that it is getting difficult to manage all performance indicators in a reliable way.

1.3 Purpose and research question

The purpose of the thesis is to understand how companies and organisations can extract useful information from the data and assure that they are measuring the right things.

The analysis should take a holistic view and will look at both developing new performance indicators and maintaining them.

The main question is broken down to three sub questions that TPPM wanted studied:

- How to construct a performance indicator to show a truthful picture of reality?
- How to prioritize between performance indicators?
- How to handle large amounts of performance indicators?

1.4 Scope and delimitations

The scope of this thesis is to provide TPPM Lund with guidelines and process on how to tackle the questions asked. A support system to handle the performance indicators will also be developed and implemented.

The thesis have the following delimitations:

- This thesis will only look at TPPM Lund and not Tetra Pak as a whole.
- As TPPM already have a functioning performance indicator management system for performance indicators this thesis will not try to find a completely new system or discuss how to build a performance indicator management system from scratch.
- No new performance indicators will be developed and suggested.
- No prioritization of the current performance indicators will be made.

1.5 Structure of the thesis

The thesis will begin with a chapter of different research methodology to set a foundation on how to proceed with the study. After that a frame of reference will be set and the empirical studies presented. The support system will be presented and the conclusion be drawn on what TPPM should do to improve their work with performance indicators. Lastly the thesis will be discussed in how well it answered the research questions and how applicable it is in general.

2 Methodology

2.1 Scientific approach

2.1.1 Research Characteristics

Choice of research method is based on the objectives and the characteristics of the research task. The general purpose of a task can be the following: (Höst, et al., 2006, p. 29)

- *Descriptive studies* try to find out and describe how something is working or is executed.
- *Exploratory studies* try to gain a deeper understanding about how something is working or executed.
- *Explanatory studies* try to find cause and affect relationships and explains for how things are working or is executed.
- *Improving/normative studies* try to find a solution to an identified problem.

A study can consist of a number of sub-studies, which can have different purpose.

2.1.2 Theoretical frameworks

When conducting research one must decide what theoretical framework to use. There are three main approaches for reasoning; deductive, inductive and abductive. These are used for different reasons. Deductive and inductive approaches are mainly used for developing new theory while the abductive approach is used for testing or evaluating a theory.

- *Inductive approach* commence by studying existing theoretical knowledge from research made by others, often a literature review. The knowledge is then used for comparison with real-life observations and finally new theoretical conclusions are drawn.
- *Deductive approach*
- *Abductive approach*

2.2 Research methods

There are mainly four different research methods for the applied areas of science. These are described in the following sections.

2.2.1 Survey

A survey is a question sampling with purpose to describe or explain a phenomenon. This makes surveys appropriate for describe what the study should focus on to fix the most

critical issue. To identify these problems the survey must find the appropriate population to study. If the population is small the whole population might be studied but if the population is large it is impractical to study the whole population. There for a sample of the population must be chosen. To get a representative sample a random-based sample method must be used: (Höst, et al., 2006, pp. 31-33)

- *Random sample* – A subset of the sample frame chosen by random number generation.
- *Systematic sample* – A systematic subset is chosen, i.e. every n:th person.
- *Stratified sample* – The sample frame is dived into different categories and a sample is chosen from each category.
- *Full range* – The full sample frame is chosen.

A survey cannot be altered after it has started, that renders the purpose of the survey void.

2.2.2 Case study

When the purpose of a study is to get an in-depth understanding of the subject a case study is appropriate. It is suitable for studying how working tasks are executed in organisation. It is important to remember that a case study does not yield a statistically significant result, since the cases are not chosen with a random-based sample method.

A case study can be changed during the study due to its flexible design. Data are mostly quantitative, and the most commonly techniques are interviews and archive analysis. (Höst, et al., 2006, pp. 33-35)

2.2.3 Experiment

To find the cause-and-effect relationship of different phenomena's experiments are used. To get the most accurate result a systematically experimental design should be used. Experiments are of the type fix design. (Höst, et al., 2006, pp. 36-38)

2.2.4 Action Study

If the purpose of the study is to improve the studied subject during the study it is called an action study. The action study usually starts with an observation of the phenomena or situation to clarify the problem, usually through a survey or a case study. The next step is to develop a solution for the problem and the last step is to evaluate the solution in its context. The action study is often iterative in its nature. (Höst, et al., 2006, p. 39)

2.3 Data collection

2.3.1 Interviews

When collecting data through interviews there are three different types; structured, semi-structured and unstructured. (Höst, et al., 2006, pp. 89-92)

Unstructured Interviews – An unstructured interview is based upon an interview guide but the formulations and the order the questions are asked in is not static. The interview can focus on the areas the interviewed has the deepest knowledge in and feel most secure in answering. It is important to remember to try to at least cover minimum of all the areas that are planned to be explored even though the interviewed might not be comfortable to talk about them. This type of interview is of a qualitative nature.

Semi-structured Interviews – In the semi-structured interview there is a mix of open questions and structured questions with fixed answers. It is important to separate the fixed questions from the open questions and always ask the fixed questions in the same way.

Structured Interviews – In the structured interview all the questions are predetermined and the interviewer have control over the interview. The structured interview is basically an oral survey.

Table 1 - Overview of the different interview types.

	Open	**Semi structured**	**Structured**
Goal	The individuals experience of the quality of the phenomena	The individuals experience of quantities and qualities	The interviewer seeks knowledge about relationships between concepts, and connections
Structure	Interview guide, flexible questioning	Mixed flexible and structured questions and answers	Structured questions and answers
Purpose	Exploratory	Explanatory/Descriptive	Explanatory/Descriptive

The different types of interviews can be combined in a study. It can be useful to start with a open interview to get the base for a more structured interview later on in the study. It is also possible to do the other way around, to follow up a structured interview with an open interview to interviewers that answered in a peculiar way.

The interview should be divided into four different phases:

- *Context* – It is important for the subject to understand why they are being interviewed and therefore the interviewer need to shortly explain the context of the interview.
- *Preliminary questions* – To put the subject into context some preliminary neutral questions are needed. Such as position and years of experience.
- *Main questions* – The main questions should be asked in a logical order.
- *Summation* – Summarize the interview for the subject to ensure that there are no misunderstandings and explain what will happen next.

2.3.2 Observations

To study a phenomena or a cause of events direct observation is a useful tool. Observation mean that the data is collected through technical aides or personal senses. An observer can have different levels of interaction with the subject and the subject can also have different level of knowledge if it is being observed.

Table 2 - Four categories of observation.

	Knowledge about being observed	
Interaction	*High*	*Low*
High	Observed participants	Total participants
Low	Participant observer	Total observers

- *Observed participants* – An observing participant tries to get as involved in the group as possible. The group is well aware that they are being observed. The data collection can be carried out by keeping a journal.
- *Total participants* – A total participants tries to get as involved in the observed group as possible without reviling that the group is being observed. The data collection can be carried out by keeping a journal.
- *Participant observer* – A participant observer does not get involved in the activities but the subjects know the observers presence. The data collection can be carried out by interviews or just using the observers' senses.
- *Total observer* – The goal of the total observer is to be unnoticed. The observation is preferable carried out by camera or tape recorder.

When choosing what way to observe it is important to consider the risk of the observation rendering void because of the subjects knowing of the observer and ethical aspects.

2.3.3 Literature review

Literature review is an iterative process that is the basis of all research. The literature review should progress throughout the study. In the beginning of the study a literature review is an efficient way to get a deeper understanding of the subject. Once the study progresses and the objectives become clearer a more focused literature review can be done. After the study is done the results can be compared to other results with a literature review.

2.4 Trustworthiness

2.4.1 Reliability

Reliability is very important in scientific research, to ensure the reliability it is important to be thorough in the data collection and the analyses. When conducting a study one should always as themselves if the material is reviewed and by whom. They should question if the research methodology is reliable, if the results has been certified or have led to recognition and been referred to in other reliable circumstances. It is also important to document the research method so other people can evaluate the research. (Höst, et al., 2006, pp. 42-42)

2.4.2 Validity

Validity considers the connection between what is measured and what is intended to be measured. To increase validity triangulation is often used, which means that the same object is studied with different methods. Limitations and threats toward the validity must be presented in an open and clear way. (Höst, et al., 2006, pp. 41-42)

2.5 Project structure

2.5.1 Choice of method

As TPPM have identified several problems with their current management system and tools for their performance indicators this thesis will be an *Improving Study* and this leads to that the natural way of working is through an *Action study*. To set a frame of a *Literature review* will be made. To get a more in-depth insight into how TPPM is working with their performance indicators today several *semi-structured interviews* will be carried out and *observations* made during management steering meetings. The interview forms will be based on information gained from the literature study. From the data collected appropriate measures will be analyses to counter the problems and finally suggestions and prototypes will be made to offer a solution to the problem.

3 Frame of reference

3.1 Definitions

3.1.1 Performance indicators

Performance indicators are a way of "distilling" large amounts of data collected by organisations. As the organisations and processes become more and more complex, data management becomes increasingly difficult. Using indicators provides the following three basics functions: (Franceschini, et al., 2007, p. 10)

- *Control.* Enable managers and workers to evaluate and control the performance of the resources they are responsible for.
- *Communication.* Indicators communicate performance to stakeholders, managers and internal worker. Poorly developed or implemented indicators can lead to confusion in the organisation.
- *Improvement.* Indicators help identifying gaps between performance and expectation.

3.1.2 Process

The definition of a process is not as simple as it first seems to be. The basic definition is: (Ljungberg & Larsson, 2001)

> "A process is a chain of linked activities that transform an input to create an output"

That definition is strictly mechanical as is does not take into account the many uncertainness that exists in a process. It builds upon a view that a process is a closed system where it is possible to control all the variables. Especially when it comes to processes that takes into account human interaction it not a suitable definition. A more universal definition of what a process is:

> "A process is a repetitive use of a network of activities in a predefined order that use information and resources to transform input to output, from identification to satisfying demand."

3.1.3 Critical success factor

A critical success factor is something that is vital for an organisation to achieve its mission. The critical success factors should derive from the overall strategy of the organisation and is a more concrete way of measuring how well the strategy is going. An easy way to determine what critical success factors influence an organisation is to ask "Why would the customer choose us". There can be many answers to that question but is important that there is not too many critical success factors, a suitable number is between five and eight. (Parmenter, 2007)

3.2 LEAN Production

LEAN production was first coined as an expression in 1990, but the concept of lean production have existed longer than that. The first person to point out the importance of a "lean manufacturing" was Henry Ford. Who already at the beginning of the 20th century understood the value of creating a continuous flow throughout the manufacturing process, standardised working tasks and eliminated waste. The system developed by Ford and others of that era were perfect for mass production of standardised products but not very flexible. As each worker had their own highly specialised task to perform it was a simple task to measure their performance, you just had to use a stop watch. (Ståhl, 2012)

Mass production worked great in the western hemisphere where there were an abundance of workers and it was relatively easy to find capital to by new specialised machinery. In Japan were none of these two important factors for mass production existed in any large numbers Kiichiro Toyoda, the founder of Toyota Motor Company, developed his own production philosophy that would become known as Lean production. In 1937 Toyoda coined the expression "Just in Time" (JIT) which means that a plant should have the right material, at the right time, at the right place, and in the exact amount without the need for an inventory. This is the first of many philosophies and tools that have come to define what Lean Production means today. (Ståhl, 2012)

There are several different definitions today of what LEAN production really is and what is most important to focus on but one thing they all have in common is the need for adequate systems to follow up and manage the different systems and tools. (Ståhl, 2012)

3.2.1 Kaizen

One of the more common tools and philosophies in LEAN is Kaizen, Japanese for improvement. The Kaizen philosophy dictates that an organisation should work with continuous improvements. One way of ensuring that is to work with PDCA-cycles. PDCA stands for: (ISO, 2008)

- **P** (Plan) – Establish objectives and processes to reach the desired output and target.
- **D (**Do) – Execute the plan and collect data.
- **C (**Check) – Study the results and compare against expected results.
- **A (**Act) – If any deviations is found between expected results and actual results analyse the root cause and take corrective actions.

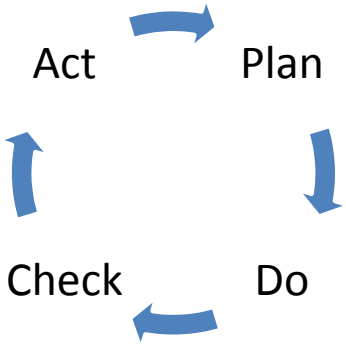

Figure 3 - PDCA-cycle.

The PDCA-cycle is iterative in its nature and for it to work properly it is important to accurately check the desired results.

3.3 Developing new performance indicators

Even after a new performance management system have been implemented in an organisation new performance indicators have to be developed to meet the ever changing needs and strategies. It is important to remember that every performance indicator should have some sort of action or counter measure attached to it. There is no use to measure something just because it is possible. The most important part of developing new indicators is to truly know the process that the indicators will measure. A good way of illustrating what happens in a process is to do a process map where all processes and sub processes are mapped out. (Ljungberg & Larsson, 2001)

Another problem with performance indicators is that they often are based on historic data and do give an organisation the tools the react and counter any future problem. It is not possible to measure anything in the future but it is possible to indirectly measure what will happen in the future by analysing what factors are important for an organisation to achieve success. This can for example be that if a well-trained machine operators will correlate to a higher customer satisfaction due to higher quality of the finished product, it is more important to try measure and improve how well trained the operator is than how many claims the plant receives due to lack of quality. (Ljungberg & Larsson, 2001)

Even if you have all the necessary information as process maps, customer demands and organisational targets it is not easy to determine what really should be measured. A more concrete seven step method for determining what to measure will be presented below: (Ljungberg & Larsson, 2001)

1. *Compile requirements* – By compiling all demands that different interests have on a process it is easy to identify requirements stated several different interests.

2. *Relate requirements to the right component* – After all requirements have been identified and compiled it is important to relate the different requirements to the

different components in a process. A requirement can relate to several components. By doing this through visualisations on a process map it is easy to see if a component lacks requirements in the process.

3. *Identify indirect requirements* – Not all requirements can be directly related to a specific component in a process, often a requirement necessitates some sort of indirect requirement to be met. For example a restaurant guest demands that the food is served hot, this indirectly means that the food should be served directly from stove. It is better to measure how many tables are served directly from the stove rather than the temperature of each plate. By identifying indirect requirements it is possible to have more proactive indicators that focus more on steering than just control.

4. *Express requirements that are needed to measure the internal effectiveness of process* – Efficiency is often expressed as a quote between the results of a process and the resources it took to achieve the results. To measure the efficiency of the process it is important to identify the relationship between results and resources and express it as a requirement.

5. *Express the requirements in measurable terms* – It is first in this stage that all requirements have to be measurable in some way. The reason why it is done as number five is that too much time can be put into be able to identify how to measure requirements that will sorted away in later stages. It is not needed to exactly define how each requirement should be measured but requirements like "high quality" and "flexible" should be quantified in some way.

6. *Determine correlated properties for indirect requirements* – Sometimes it is impossible to quantify or measure indirect requirements. To get around this try to identify correlated properties for a requirement. A basic example can be that instead of measuring the occurrences of something it can be possible to measure the absence of the same thing. It is almost always better to measure roughly the right thing than not measure at all or measure something exactly but is irrelevant.

7. *Determine measurements and sorts of measurements* – The last stage is to exactly determine what to measure and the sort of measurement each requirement require. It is also a last chance ask yourself if there is a balance of requirements in the different components in the process. The decision of what type of measurement to use for each measure is not an exact science and the results should not be over interpreted. Some requirements can be related to more than one type of measurement.

3.3.1 Frameworks

There are many different frameworks for developing and validating if new performance indicator really is up to the task. In this section there will be a short presentation of some of the more relevant.

SMART test (Training Resources and Data Exchange (TRADE), 1995, p. 54)

The SMART test is a quick way to test the quality of the performance measurement. All bullet points should be fulfilled for the measurement to be implemented.

- **S** (*Specific*): is the measure clear and focused, so it avoids misinterpretation? It should include measurement assumptions and definitions, and should be easily interpreted.
- **M** (*Measurable*): can the measure be quantified and compared to other data? It should allow for meaningful statistical analysis.
- **A** (*Attainable*): is the measure achievable, reasonable, and credible under expected conditions?
- **R** (*Realistic*): does the measure fit into the organization's constraints? Is it cost-effective?
- **T** (*Timely*): is the measurement doable within the given time frame?

The "Three Criteria" test (Franceschini, et al., 2007, p. 169)
Another test to which performance indicators should be subjected includes the satisfaction of three broad criteria:

- *Strategic Criteria* – do the measures enable strategic planning and then drive the deployment of the actions required to achieve objectives and strategies? Do the measures align behaviour and initiatives with strategy, and focus the organization on its priorities?
- *Quantitative Criteria* – do the measures provide a clear understanding of progress toward objectives and strategy as well as the current status, rate of improvement, and probability of achievement? Do the measures identify gaps between current status and performance aspirations, thereby highlighting improvement opportunities?
- *Qualitative Criteria* – are the measures perceived as valuable by the organization and the people involved with the indicators?

Characteristics of Effective KPIs (Eckerson, 2006)

Effective KPIs often exhibit the following 12 characteristics:

1. *Aligned* – KPIs are always aligned with corporate strategy and objectives.
2. *Owned* – Every KPI is "owned" by an individual or group on the business side who is accountable for its outcome.
3. *Predictive* – KPIs measure drivers of business value. Thus, they are leading indicators of performance desired by the organization.
4. *Actionable* – KPIs are populated with timely, actionable data so users can intervene to improve performance before it is too late.
5. *Few in number* – KPIs should focus users on a few high-value tasks, not scatter their attention and energy on too many things.
6. *Easy to understand* – KPIs should be straightforward and easy to understand, not based on complex indexes that users do not know how to influence directly.
7. *Balanced and linked* – KPIs should balance and reinforce each other, not undermine each other and sub optimize processes.
8. *Trigger changes* – The act of measuring a KPI should trigger a chain reaction of positive changes in the organization, especially when the CEO monitors it.

9. *Standardized* – KPIs are based on standard definitions, rules and calculations so they can be integrated across dashboards throughout the organization.
10. *Context driven* – KPIs put performance in context by applying targets and thresholds to performance so users can gauge their progress over time.
11. *Reinforced with incentives* – Organizations can magnify the impact of KPIs by attaching compensation or incentives to them. However, they should do this cautiously, applying incentives only too well understood and stable KPIs.
12. *Relevant* – KPIs gradually lose their impact over time, so they must be periodically reviewed and refreshed.

3.4 Maintaining performance indicators

For any performance management system it is vital that all performance indicators are being maintained. This should be done at least once per year to ensure the validity of all indicators. There are four tasks that should be done each year to maintain the performance indicators on an organisational level: (Parmenter, 2007)

Task 1. *Review organization-wide CSFs at least annually* – The environment that organisations operates in changes so rapidly that the requirements for survival changes rapidly. It is essential to review the CSFs to ensure that they are still valid in the current environment.

Task 2. *Hold a one-day focus group revisiting the performance measures* – The focus group should consist of a cross-section of the staff. The objective of the focus group is to revisit the performance measures used during the year to learn from experience and enhance the value gained from using performance measures.

Task 3. *Maintain the stakeholder consultation* – Ensure that consultations with stakeholders continues to be included in the performance review process. The stakeholders will provide feedback as to whether there are any needs for improvements to strategies or CSF

Task 4. *Allow team performance measures to adapt* – It is crucial that the employees affected by the performance indicators in their work sees them as valuable, useful and worthwhile. They need to have a sense of ownership of performance measures. Team performance must be adapted as required to maintain their relevance and use

3.4.1 Handling large amounts of performance indicators

An organisation should never have too many performance indicators as this only clouds the view on how well the organisation is performing. However a complex organisation need to have different levels of performance indicators to have a complete picture of the performance. Different researches suggest different amounts of performance indicators. On the highest organisational wide level the number of performance indicators should be around 10, preferably fewer. According to Parmenter there are three different levels of performance indicators: (Parmenter, 2007)

Key result indicator – Tells you how you have done in a perspective.
Performance indicator – Tells you what do.
Key performance indicators – Tells you what to increase performance drastically.

The rule 10/80/10 – should apply to all organisations. It means that an organisation should have 10 Key results indicators, 80 Performance indicators and 10 Key Performance indicators.

3.5 Prioritizing

Even if all indicators should be considered important there sometimes comes situations where an organisation need to prioritize between the different performances indicators. According to Ståhl one way of prioritizing and categorise different indicators is the following framework with three different levels: (Ståhl, 2014)

First level:
1. Is directly cost related, used in the cost calculation.
2. Is indirectly related to the cost calculation, have a clear influence in the cost but cannot be used directly in the cost calculation.
3. Can be tied to the cost but cannot be expressed in monetary terms.
4. Cannot be tied to the cost in any way.

Second level:
1. Direct measurable and direct verifiable.
2. Indirectly measurable and indirectly verifiable.
3. Estimated measure, not verifiable.

Third level:
1. Objective
2. Subjective

By using this framework a organisation can produce a prioritizing map of all the indicators where the indicators directly tied to costs that are directly measurable and objective are the most important to focus on in a situation where there is a need for prioritizing.

This framework can also be used when deciding which indictors to keep and not if an organisations feels that it has too many. It is better to keep indicators that you are sure of and can be directly cost-related.

4 Empirical studies

4.1 Organisation

TPPM is organised into a matrix organisation where almost everybody have a roll both in the line organisation and in the pillar organisation. The line organisation is based on the main processes in the factory. The pillar organisation is based on the WCM-concept and can be found in the next section.

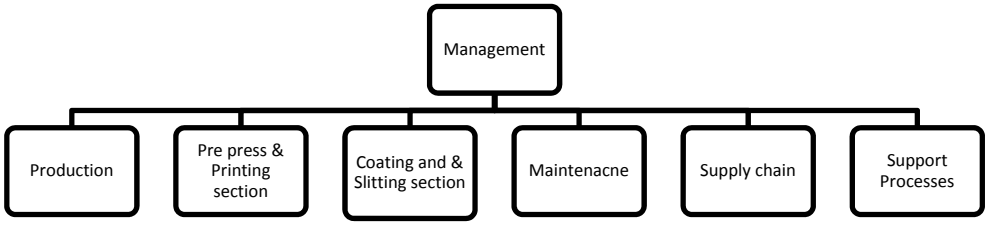

Figure 4 - Line organisation TPPM.

4.2 World Class Manufacturing

Tetra Pak Lund has adopted a lean manufacturing principle called World Class Manufacturing (WCM). This principle is based on the philosophy called Total Productive Maintenance (TPM) and was developed in Japan in the 1980s. TPPM have over the years used Japan Institute for Preventive Maintenance (JiPM) as a certification agency to make sure that the plant is working actively on improving itself.

The WCM-work is organised into a structure that can be seen as a temple. The Education & Training, the Safety & Health and the Environment pillars can be seen as the foundation of the temple as it is the foundation of the organisation and the Cost Management pillar can be seen as the top of the temple as it supports all the pillars with cost intelligence, governs the results and helps with prioritization.

To administer and educate the pillars in WCM TPPM have established a WCM office in the plant. The staff there does not do the WCM work for the pillar, they provide the tools for the pillars such as support systems and team trackers.

Figure 5 - Illustration of the WCM structure at TPPM.

4.3 Performance measurement system today

4.3.1 Observations

The pillars are responsible for developing their own performance indicators and keeping them up to date through the provided systems.

The indicators are being followed up with different frequencies. There are two types of management meetings where selected indicators are being monitored, the weekly steering committee meeting where short term actions is being decided and the quarterly follow-up meeting where more long-term actions is decided. Apart from this there are daily management meetings to discuss any deviations for the past 24 h production and the different pillars have meeting each week where they follow-up on their pillar indicators.

4.3.1.1 Tetra Paks definition of indicators

Tetra Pak are using four levels of indicators, they are defined as following:

KMI – Key Management Indicators

- Quantified indicators based on the critical success factors for summarizing the organizational performance.
- High level performance measurements.

KPI - Key Performance Indicators

- A set of indicators summarizing KAIZEN outcomes measured by performance variables in terms of PQCDSME with contribution to one or more KMIs.

PI – *Performance Indicators*

- Performance variables affecting KPIs.
- Several PIs can support a single KPI.

KAI – *Key Activity Indicators*

- Indicator of activities done to support KPIs or PIs.

The lowest level of indicators is the KAIs. They differ from the rest of the indicators in the way that they do not measure the current status of the plant but instead the activities that have been identified as crucial for reaching the goals for the rest of the indicators.

At Tetra Pak all indicators derive from the identified critical success factors for Tetra Pak. Organizations have different critical success factors for their operations. All performance indicators should derive from these at the highest level. A critical success factor is something that drives the strategy forward. A simple way of determine what a critical success factor is to ask yourself *"Why would the consumer choose us?*" the answers are the critical success factors.

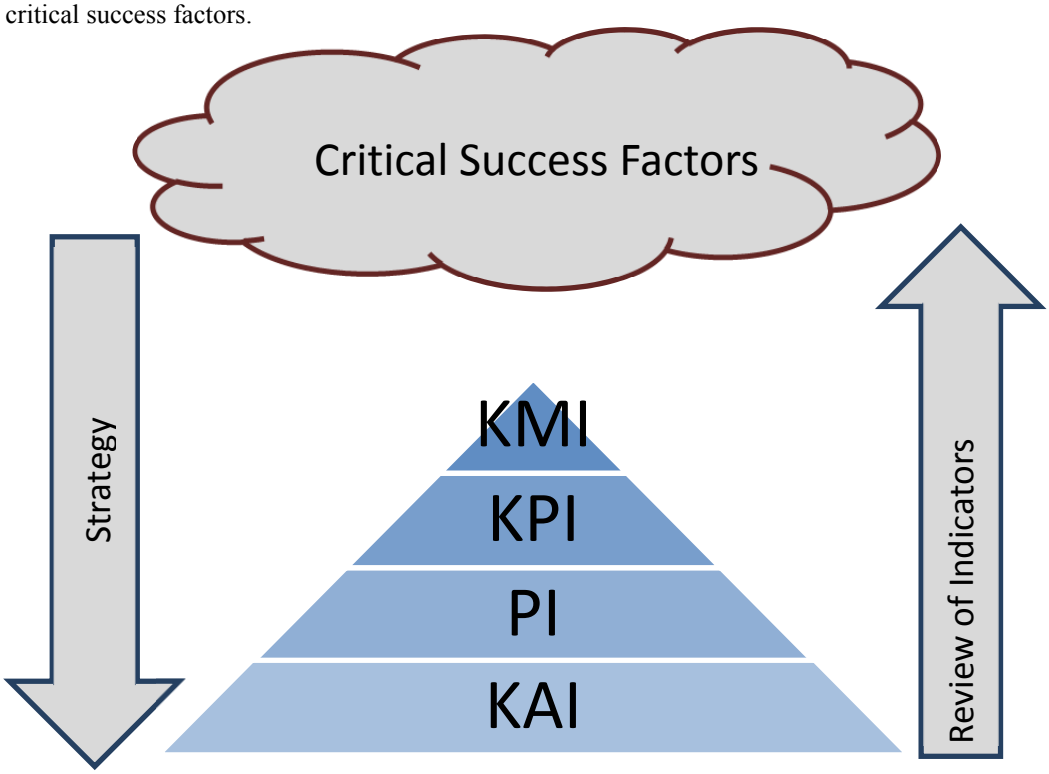

Figure 6 - Overview of Indicators according to Tetra Pak.

4.3.2 Interviews

To understand how the performance indicator management system is function today a series of interviews were conducted with key persons in the factory. These consisted of all the pillar leaders plus the plant manager. In total 13 semi-structured interviews were done. The questionnaire upon the interviews were based upon can be found in appendix A.

4.3.2.1 Positive

TPPM have been working with indicators since 2002 and that is showing during the interviews. All the pillar leaders are using the indicators as a tool for continuous improvements and the overall level of understanding is high.

Most pillars review their indicators once a year to make sure that they are still relevant and reflecting the plant strategy. Each pillar follows up on their indictors at regular intervals to ensure that they do not deviate.

The pillars are measuring what they want to measure and not just what is possible to measure. For some pillars this has been a lengthy process with a lot of iterations in developing indicators that accurately describe how a certain process is going.

4.3.2.2 Potential Improvements

Among the pillar leaders at TPPM there was a large difference of opinion concerning whether there were too many, too few or just the right amount of indictors in place today. People stating that there were to many indictors, based it on that it was hard to get an oversight of how the plant performed and that it was too time consuming to keep track of all the indicators. The indicators sometimes felt more like a burden than a tool for improvement according to several of the interviewers and not all indicators felt relevant to the operations.

The measuring system today at TPPM Lund focuses a lot on efficiency. There were concerns during the interviews that the measuring system must also focus on productivity. For example if you can run the machines at lower speed with less personnel it might be more cost beneficial than just producing as much as possible. This however depends on production volume.

Another thing that some pillar leaders remarked was that the coordination between the pillars when issuing new performance indicators. Today pillars do not ask or coordinate with each other to ensure that new performance indicators will not affect other pillars indicators. There are also some indicators today that several pillars influence even though they do not own them. This makes controlling the indicators difficult for the responsible pillars. It can also led to unnecessary discussions between the pillars on who should improve their results to improve the overall result of the combined indicator. All pillars constantly have to prioritize when it comes to using their resources the most efficient.

When developing new indicators the pillars use their experience. There is no official process for them to follow to ensure that the new indicators are quality assured according

to Tetra Pak standards. Some indicators are perceived as not on the same level even though they are so today, one KPI can measure something general in the plant were another KPI measure something very specific and only important to a small part of the plant. On the other end is there no process for when to stop measuring certain indicators. There are indicators that always are green; some conceives these indicators as unnecessary to measure.

Indicators measuring the quality of activities carried out are also something that is missing today. It is easy to measure how many improvements tags the operators are reporting but it does not actually say something about the quality of the tags. There are however one pillar that is measuring on what level on the countermeasure ladder that their actions are being carried out on. This is to ensure that the actions are keeping a high level of quality.

The pillars are using different strategies for deciding what activities to carry out first to improve indicators. Some are choosing the activity that is saving the most money while other are choosing the one that is easiest to fix.

5 Support system

5.1 Background

An integral part of any management system is their support systems. A management system that is perceived as cumbersome and time consuming does not gain the full support from its users. (Parmenter, 2007). The support system today for TPPM consist of several large Microsoft Excel workbooks were the users had to input data in several different workbooks and places. This led to a very inflexible solution due to technical limitations only one person a time can access and input data into a workbook. As an effect of this the users sometimes had to access the workbooks from home after office hours to input their data before certain deadlines. There were also instances where the user that had the workbook open forgot to close it before they went home, effectively keeping anybody else from input data until the person returned.

Extracting data to generate graphs and tables for presentations had to be done manually and if the data came from several sources this task could be very time consuming.

The users also felt that some input of data was unnecessary as they just copied the data from one system onto another by hand.

All of these issues made the users less prone to using the system and during the interviews one of the most sought after new indicators were an indicator that measured how much time each white-collar used for administrative work.

TPPM did not want to invest in a totally new system so the system had to be built on existing software that every computer had access too. It also had to be easy to maintain and modify even for people without programming skills as TPPM don't have any dedicated IT-staff in house as many other Tetra Pak plants.

5.2 Design

After examine the programs installed on the computers a choice was made to build the system on Microsoft Access as this is a simple database program that interacts well with other Microsoft Office products. It was also decided to split the database in a front end and a back end part to make sure that a multiuser environment could be established. The back-end would contain all the data and be located on a file server. There was no need for a dedicated database server as the amount of data was not large enough and there were no need for any advance calculations or scripts running on the back end.

It was also early on clear that Microsoft Access could not alone accommodate all the needs for visualisation the support system needed. The graph module and table module in Access where very basic and could not accommodate all the needs that TPPM had for layout. To overcome this Microsoft Excel where used when generating graphs and tables.

As TPPM already had a basic system before the layout of the graphs and tables were just copied. A couple of new layouts were also devised and all the graphs and tables where standardized when it came to appearance and colours to improve visualisation.

The front-end had to be designed to be as user-friendly as possible to make the transition from the old the system to the new as simple as possible. This means that everything should be colour coded and as automated as possible, another thing was to keep the functions to a minimum so that the users did not have participate in any lengthy training in how to operate the system.

The basic functions of the system where only two:

- Report indicators
- Visualise indicators

To ensure data integrity it was decided that the users could not change the targets for the indicators during the year. The targets had to be handed over to WCM office that entered in the beginning of each year.

There also had to be some administrative functions to archive old indicators that are no longer needed. They might be needed later on but keeping them in the system only clutters it.

5.3 Result

The end result was a support system made for WCM-office based on Microsoft Access with graphs and tables generated in Microsoft Excel. The system is right now being used by two pillar in a pilot study to determine if the system is up to the specifications and is user friendly enough.

The system also includes a 40-page document with everything from user manuals to in depth technical descriptions on how to modify and add functions to the system.

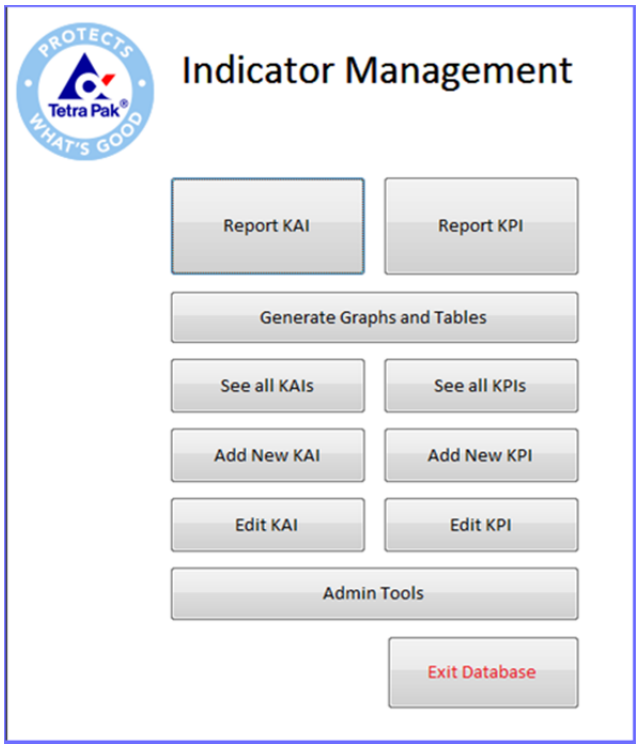

Figure 7 - Front page of support system.

6 Conclusion

6.1 Performance indicator system

TPPM have been working with TPM for over 10 years. This reflects in the way they work with indicators in the organisation. They have a functioning performance indicator system that just need a bit of fine tuning to work even better. During the interviews with the different pillar leaders it became clear that there is no laid out process for developing new and maintain indicators for the different pillars. A predefined process would be a helpful tool for the pillars in their yearly review of the performance indicators not to overlook or forget anything important. There were also some problem with communication between the pillars, a process where that stage is include can give the pillar some incentive to communicate more.

6.1.1 Process for develop new indicators

As need for a new indicator arises for any reason, a suggested process have been developed for aiding the pillars in doing so:

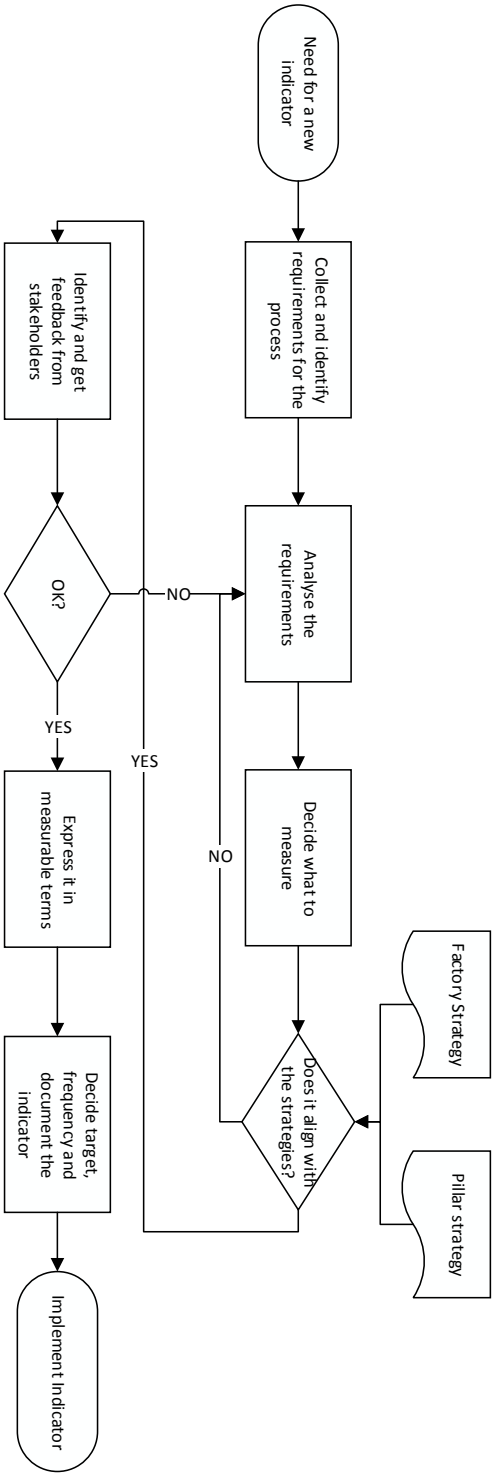

Figure 8 - Process for developing new indicators.

1. The input of the process is the perceived need for a new indicator. It can be that the current indicator is not up to task, the strategy have change so there is a new need to measure something that have not been measure before or there is a whole new process.
2. The first and most important step is to have a clear picture of the process. This step is not added here as it should already been accomplished. What is important when measuring a process is to understand what requirements there is on the process, they can be both direct and indirect. All requirements should be connected to a component in the process. Doing this by drawing the process on a whit board is a great way of visualising to aid in the effort.
3. Analyse the requirements and see if it possible to combine several requirements or find requirements that can combine several others. It is also important in this step to prioritize among the requirements to find the requirements that really tells you how the process is doing. Another thing to remember is that for a proactive measurement it is important to understand what makes a process function, find correlations between things to measure and the output of the process.
4. Come to a conclusion on what to measure. It is not important on deciding all the details for the indicator, such as metric or frequencies. But it should be clear on what you are measuring.
5. Check if the indicator is aligned with the strategy, both the overall factory strategy and the local pillar strategy. If not, return to step 2.
6. Identify all stakeholders for the process. It can everything be from the machine operators, the process that utilise the output to the management. Get feedback from them if they think the indicator is valid for the process. If not, return to step 2.
7. Express the indicator in measurable terms.
8. Decide how often to measure the indicator, what target to set and last but not least. Document the details of the indicator, why it has been chosen, how to calculate it etc. It is important to do this for several reasons, such as inter-pillar understanding, new employees, the top management and other.
9. The output of this process is implementation of a new indicator. Remember not to only add indicators but also to remove them when they are not needed.

6.1.2 Process for maintaining indicators

Each indicator should be overseen at least each year to verify that it should still be followed. From the literature and observations at TPPM a suggest process for doing so is being presented below. Get feedback from them

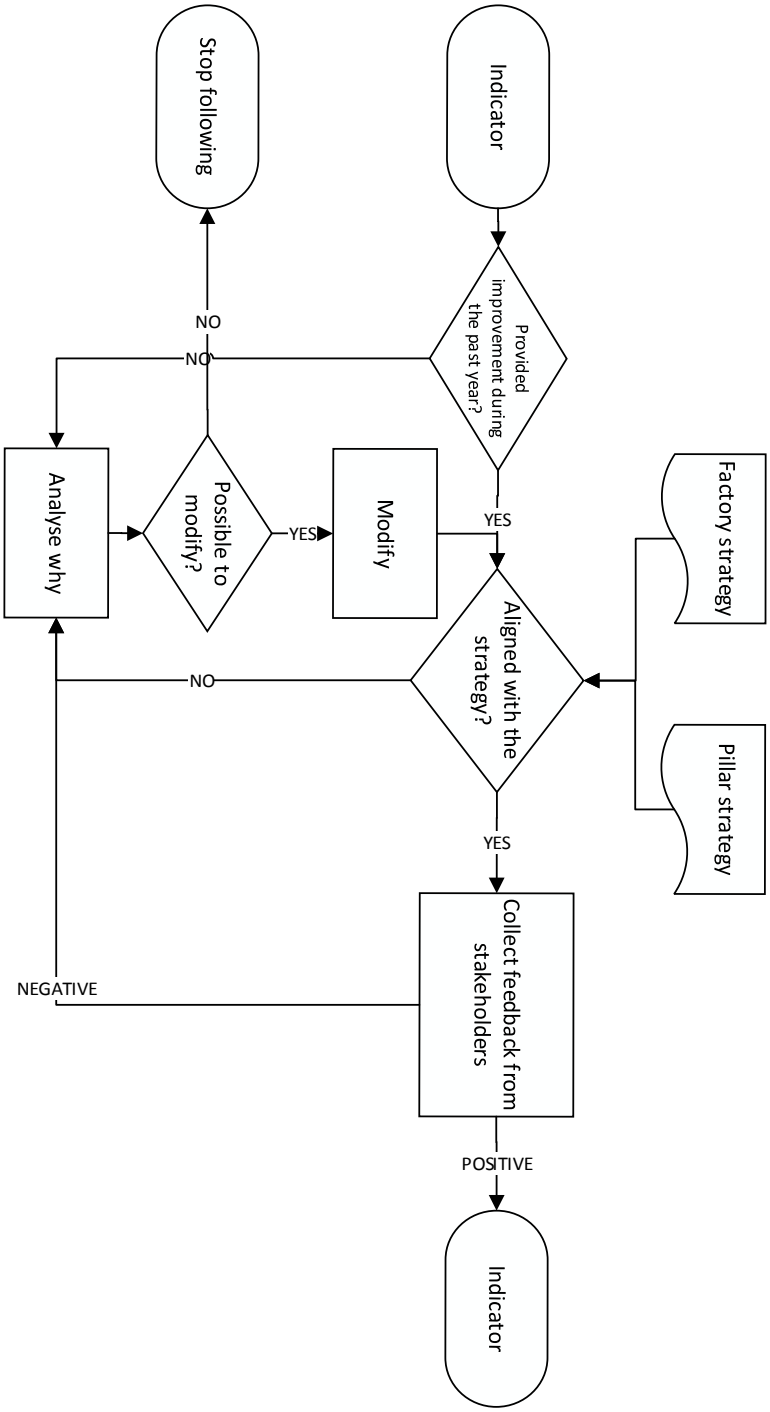

Figure 9 - Process for maintaining indicators.

1. The first thing to decide is if the indicator have helped in provide improvement during the year. Sometimes an indicator can still be green even though the problem still accurse. If that happens the indicator should be analysed to see why it is not providing the tool for improvement as was intended. After the analysis decide if it is possible to modify the indicator in any way to help reach the target. If not stop following the indicator.
2. The second phase is to see if the indictor still is aligned with the strategies, both the overall factory strategy as well as the more detailed pillar strategy. Is the indicator still important to measure? If not analyse why and try to modify the indicator. If not, stop following it.
3. The last step is to collect feedback from all the stakeholders of the indicator. It can be the process after what the indicator is measuring or other stakeholders that are relying on that the indicator is improving. If the feedback is positive keep the indicator as it is. If not, analyse the feedback, see if there is anything to modify to able to keep using it. If it is not possible to modify it to meet the requirements of the stakeholders, stop measuring it.

6.1.3 Prioritization and handling large amounts of indicators

There really is no good way of handling large amounts of indicators according to the literature. An organisation should never have too many indicators, this will only lead to lack of focus and misalignment with the strategy. If an organisation feels that they have too many indicators they really need to ask themselves if all indicators are necessary to support the critical success factors.

There can however be the case with TPPM were one department is in charge with supporting the other departments with their performance indicators and it means a lot of administration for the department. Then an adequate support system is vital for the department to not be buried in work. Such a system were provided to TPPM as one part of the thesis.

7 Discussion

One of the more important aspects when it comes to developing new indicators is the aspect of ownership and that the user of the indicators feel that they are relevant for their work. Therefor it is best to let the pillars at TPPM decide themselves what they to measure. As one of the more important part of the best practice presented in this thesis is ownership TPPM should stop using indicators that span over processes controlled by different pillars. The framework and suggested process in this thesis can one of the tools that assists in doing so. There are a lot of different ways out there to measure and develop indicators and there is no single right way of doing it. As mentioned in the literature:

> "The task of construction a performance measurement systems is more of an art than an exact science."

By using the tools provided by the thesis TPPM can intensify their continuous improvement cycle by ensuring that what they measure really is what they should measure. This comes especially true on a pillar level where the development and maintenance of indicator often is based on the members of pillars experience. The processes suggested in this thesis are not only applicable for TPPM or just in a production environment. The process works just as well in a sales environment or in the finical world.

TPPM should also increase their willingness to prioritize and decrease the number of indicators they are using today as using as many as they do today leads to lack of focus. Even the new support system is not a cure for using too many indicators as it only lessens the administrative burden.

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INTERVIEWS:

Anders Olsson, S&H pillar leader, 24/3 2014

Andreas Ekholm, PM pillar leader, 20/3 2014

Christer Andersson, SC pillar leader, 27/3 2014

Erik Hallgren, Cost pillar leader, 17/3 2014

Lars Granholm, AM pillar leader, 27/3 2014

Magnus Johnsson, Plant manager, 21/3 2014

Maria Engdahl, Env pillar leader18/3 2014

Martin Toft, Cost pillar leader, 18/3 2014

Mikael Öberg, E&T pillar leader, 19/3 2014

Nicklas Hall, Office pillar leader, 31/3 2014

Sofia Gustavsson, Q pillar leader, 18/3 2014

TABLE OF FIGURES

Figure 1 - Factory process TTPM. 12
Figure 2 - Packaging material construction. 12
Figure 3 - PDCA-cycle. 21
Figure 4 - Line organisation TPPM. 26
Figure 5 - Illustration of the WCM structure at TPPM. 27
Figure 6 - Overview of Indicators according to Tetra Pak. 28
Figure 7 - Front page of support system. 33
Figure 8 - Process for developing new indicators. 35
Figure 9 - Process for maintaining indicators. 37

Appendix A

Questionnaire

General questions

- How do you work with performance indicators in the pillar?
- What do they tell you?
    - How do you handle deviation?
- How do you convey the vision and strategy targets for the indicators throughout the pillar?
- How do you handle changes in the followed indicators that negatively effects the indicators you are responsible for?
- Do TPPM follow to many or too few indicators?
- Do it exist any indicators that sub optimize the process in your opinion?
- Are there any indicators that you miss?
- Are the indicators based on what you want to measure or what you can measure?
- When are you satisfied with the targets for each indictor?
- What possible problems do your performance management system have today?
- What mechanisms do you have in the pillar to identify deviations in the indicators before they arise?
- Are all your indicators measured in quantified terms?
    - How do you quantify immaterial measurements?
- How do focus on improving the right indicator?
    - The one that is simplest to improve?
    - The one that saves most money?

Developing and maintaining indicators

- How do you develop and maintain indicators today?
    - Do you only add or do you ever remove indicators?
- What stakeholders do you consult when you develop new indicators?
    - Do you consult the machine operators what is important to control and measure for the production to function well?
    - Do you consult the operative managers what is important to control and measure, so that both the tasks of his superiors and subordinates can function unimpeded?
- Do you analyse how your indicators might affect other departments or pillars?
- How do minimize the risk for sub optimisation between departments when you develop new indicators?
- What factors do you take into consideration when developing new indicators?
- Do you have any process for developing new indicators in you pillar?