Hochschule Aalen

Beethovenstraße 1

73430 Aalen

Germany

Timm Meier, Christian Nguyen, Ines Wegelin

Smart Factory

Key Performance Indicator

Contents

List of Figures

Acronyms

CSF   Critical Success Factor

EFQM European Foundation for Quality Management

FTE   Full Time Equivalent

ISO   International Organization for Standardization

KPI   Key Performance Indicator

OEE   Overall Equipment Effectiveness

PI   Performance Indicator

RI   Result Indicator

VPN   Virtual Private Network

1 Topic and Introduction

Key Performance Indicators are becoming more essential in the manufacturing industry and help those to develop important metrics leading to the success of companies. With the possibility to quantify different company standards like quality, efficiency or productivity, companies can be more effective in finding the issues regarding production. With the international standard ISO 22400, there is a „set of Key Performance Indicators (KPIs) to evaluate the performance of manufacturing operation" (Zhu et al., 2017, S. 1) and can establish more overview in finding the right KPIs for the desired case.[1] In order to determine whether your company is on the right path or not, KPIs help to understand if certain goals can be achieved or not and what causes the deficiencies.[2] But not only will KPIs identify the problems but also provide the opportunity to improve the metrics to exceed the actual expectations.[3] This is mostly to be seen on dashboards, which allow a visualisation of all metrics on a single display. The clear comprehension of the graphics is crucial to ensure that employees, from the shop floor to the company level, can easily grasp the information.[4]

In terms of our project in Smart Factory, the task was to convey the topics around the usage and purposes of KPIs to students who may have never heard of this topic. For that, we created a presentation with roughly 70 slides explaining multiple areas tied to these metrics. We started the presentation with a case study to introduce the topic of KPIs. The case study was about the airline British Airways, which has the problem of delayed planes leading to higher costs and unsatisfied customers. To prevent this from always happening, implementing metrics to monitor these datas can enhance time management and aid in decision-making. It involves determining whether to risk a more significant delay or proceed without waiting, such as in the case of passengers who did not make it to the plane on time.[5] After the case study, students should brainstorm on what possible solutions there were to diminish delays and other issues causing higher costs and maintenance. After collecting insights from the students, the transition to KPIs in connection with manufacturing will be made. A proper introduction of explaining the purposes of KPIs will follow as well as a short subchapter about critical success factors, which have

---

[1] cf. Zhu et al., 2017.
[2] cf. Bhatti et al., 2013.
[3] cf. Lindberg et al., 2015.
[4] cf. Tokola et al., 2016.
[5] cf. Parmenter, 2007.

a major influence on the selection of KPIs. After that, characteristics in addition to the selection of the critical success factors and KPIs will be elaborated before getting to the most important manufacturing metrics. Here, some will be selected for the final case study which should help the students to a better understanding of reading KPI graphs and transfer their theoretical gained knowledge to a practical situation. The selected KPIs will be described in detail including all information needed. The most crucial point on the slides of the selected manufacturing metrics, will be the formula from which the students should explore the dependency of those metrics to each other. Not to be neglected, should be the visualisations of metrics on a dashboard for which there are examples to help distinguish the advantages of those dashboards.

2 Project Management

In order to obtain a structure on how to perform the project, we included project management tools to get a better overview and divide tasks.

2.1 Magic Triangle

Our project commenced on October 26th with our initial meeting, during which we initiated the development of the magic triangle tailored to our specific project. Our primary focus, in line with our objectives, was to outline the structure of our presentation. The resources at our disposal included a workload allocation of 90 hours per person and access to relevant literature through the VPN of Hochschule Aalen. Regarding our appointments, we had a biweekly meeting with our stakeholder Prof. Dr.-Ing. Nicole Stricker and a weekly meeting within the group. As we approached the conclusion, there were slight modifications to the magic triangle. The goal has not been modified throughout the process and the focus relied on the development of the presentation with the topic of key performance indicators. Instead, the resources altered. With the documentation of our workload, the arrangement of 90h exceeded about 15h which caused the triangle to be shifted to the left. The appointments with our stakeholder as well as our weekly meetings did not vary.
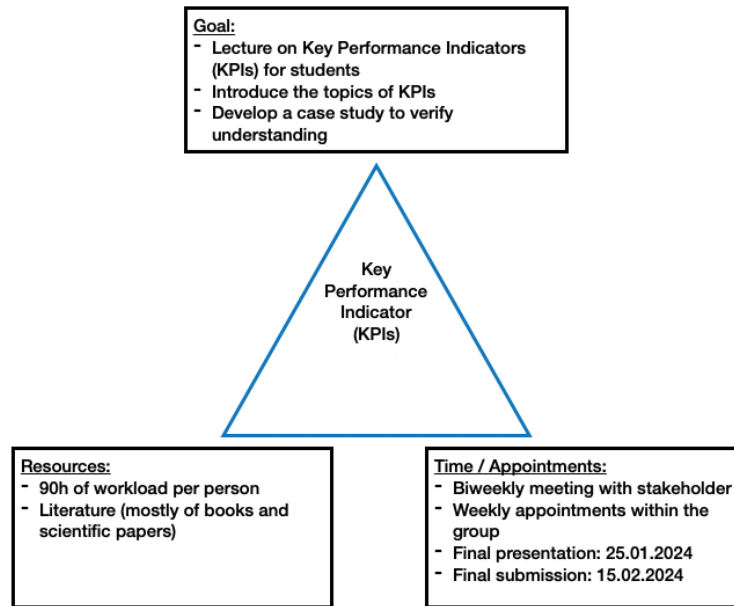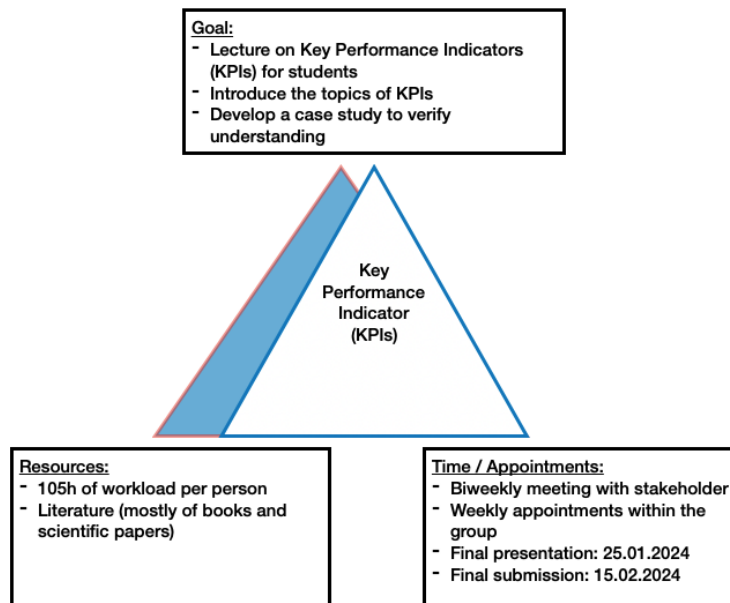
Figure 1: Magic Triangle (02.11.2023)

Figure 2: Magic Triangle (19.01.2024)

2.2 Gantt Chart

Additionally to the magic triangle, we developed a Gantt Chart in order to manage and distribute tasks. For that, we set the initial start of the project on the 19th of October, 2023 and the end date on the 19th of January 2024.

Gantt Chart

PROJECT NAME		START DATE	END DATE	% of PROGRESS
Key Performance Indicator		19-Oct	19-Jan	100 %
PROJECT MANAGER				
Christian Nguyen				

| TASKS	RESPONSIBLE	START	CHART DATA Do Not Alter	END	DAYS	STATUS
PROJECT START DATE		19.10.23				
Kick-Off	Christian Nguyen	26.10.23		26.10.23	1d	Complete
Agree on Objectives	Christian Nguyen	26.10.23		26.10.23	1d	Complete
Literature Review	Team	27.10.23		01.11.23	6d	Complete
Documenting Literature	Christian Nguyen	02.11.23		05.11.23	4d	Complete
Case Study British Airways	Christian Nguyen	02.11.23		03.11.23	2d	Complete
Introduction Slide	Ines Wegelin	02.11.23		05.11.23	4d	Complete
Critical Success Factors	Timm Meier	07.11.23		11.11.23	5d	Complete
Selection of CSFs	Timm Meier	08.11.23		12.11.23	5d	Complete
Characteristics of KPIs	Christian Nguyen	15.11.23		17.11.23	3d	Complete
Fundamentals of KPIs	Ines Wegelin	15.11.23		24.11.23	10d	Complete
Selection and Dependency of KPIs	Christian Nguyen	20.11.23		25.11.23	6d	Complete
Important Manufacturing KPIs	Christian Nguyen	30.11.23		15.12.23	16d	Complete
Visualisation of KPIs	Christian Nguyen	08.12.23		10.12.23	3d	Complete
Developing Case Study	Ines Wegelin	02.01.24		10.01.24	9d	Complete
Merging Slides	Timm Meier	11.01.24		11.01.24	1d	Complete
PROJECT END DATE				19.01.24		
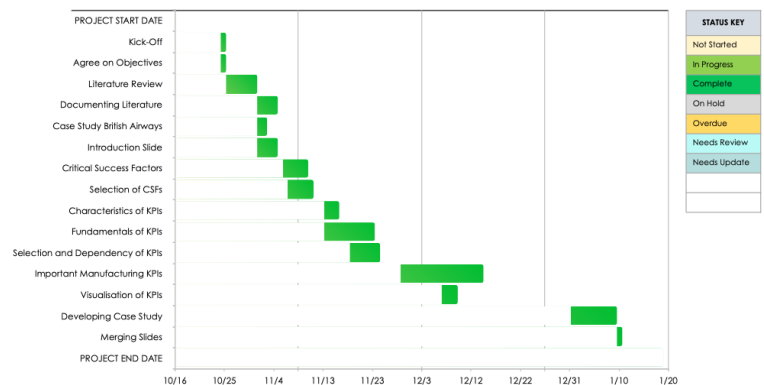
Figure 3: Gantt Chart

3 Results

The results of the project are documented in a presentation. The presentation is based on several aspects of key performance indicators. To collect the students, a case study is provided at the beginning, which shows the importance of KPIs. The presentation includes several exercises to enhance a better understanding. Furthermore, the properties and the selection of the right KPIs will be discussed in order to achieve a specifically set goal. In general, there is the 10/80/10 rule, which states that with a company of 500 FTEs, the limit should be 10 KPIs, 80 RIs and 10 KRIs[6]. After, the seven fundamental modules of KPIs are explained showing the importance for the success of implementing these metrics. The selection of KPIs depends on various factors, there is no pattern for the right choice, but it depends on the purpose, background, objectives and other factors. Accordingly, the key figures must be chosen in such way that a dependency can be distinguished. Examples for methods of choosing KPIs are the balanced scorecard method, the critical few method and the EFQM-method using different categories to select the desired indicators. In order to clarify the most important production key figures, the ones important for manufacturing such as OEE, performance, quality and availability are discussed. Formulas as well as other informations can be found to enhance a better understanding in terms of dependencies and purposes of those metrics. There are different tools and softwares for KPIs and their visualisation providing an overview which are also

---

[6]cf. Parmenter, 2007, p.13 f.

being presented. Video material about companies developing those dashboards should bring the concept of visualisation closer. To summarise the topic, a case study was developed to also verify the comprehension about the most important manufacturing key performance indicators. For that, the students need to compare different graphs of collected datas by the KPIs and check on dependency to distinguish the point of error.

4 Conclusion

As discussed, our task was to bring the topic around key performance indicators closer to fellow students. For that, we had to study the topics about the metrics first using the input from the lectures of Smart Factory, the workshop about KPIs as well as self-studies through literature. The slides we designed and developed will be used in the following year and enhance the understanding of important metrics in manufacturing. With the creation of this presentation it not only allowed us to get a superficial view on KPIs but also with the implementation of self-designed exercises, case study and visualisations, it fostered a deeper understanding of the subject matter.

5 Lessons Learned

This project let us learned that a proper project management is to be done in order to achieve a structured project. A regular meeting with the stakeholder also helped us being motivated throughout the semester and showing our process determining whether we are on the right path or not. Also, we learned about the importance about KPIs. Before the project some of us may have heared about those metrics but in total, we could not arrange the importance of those. The use of these indicators are crucial for the success of companies in different categories such as medical, financial but also manufactural. The experiencing of developing a case study not only will enhance the comprehension of the dependency of KPIs for our fellow students but also helped us enormously. It requires us to grasp the relationships among different KPIs and gain practical skills in working with data to create a strong case study. This hands-on experience enhances both our theoretical understanding and practical abilities in analysing and interpreting datasets.

Literature

Bhatti, M. I., Awan, H. M., and Razaq, Z. (Nov. 2013). "The Key Performance Indicators (KPIs) and their impact on overall organizational performance". In: *Quality & Quantity* 48.6, pp. 3127–3143. DOI: `10.1007/s11135-013-9945-y`. URL: `https://doi.org/10.1007/s11135-013-9945-y`.

Lindberg, C., Tan, S., Yan, J., and Starfelt, F. (Aug. 2015). "Key performance indicators improve industrial performance". In: *Energy Procedia* 75, pp. 1785–1790. DOI: `10.1016/j.egypro.2015.07.474`. URL: `https://doi.org/10.1016/j.egypro.2015.07.474`.

Parmenter, D. (Jan. 2007). *Key performance Indicators: Developing, implementing, and using winning KPIs*. URL: `http://cds.cern.ch/record/1169634`.

Tokola, H., Gröger, C., Järvenpää, E., and Niemi, E. (Jan. 2016). "Designing manufacturing dashboards on the basis of a key performance indicator survey". In: *Procedia CIRP* 57, pp. 619–624. DOI: `10.1016/j.procir.2016.11.107`. URL: `https://doi.org/10.1016/j.procir.2016.11.107`.

Zhu, L., Johnsson, C., Mejvik, J., Varisco, M., and Schiraldi, M. M. (Dec. 2017). "Key performance indicators for manufacturing operations management in the process industry". In: *Institute of Electrical and Electronics Engineers*. DOI: `10.1109/ieem.2017.8290036`. URL: `https://doi.org/10.1109/ieem.2017.8290036`.

Statutory Declaration

Hereby we, the individuals listed below, declare that we have independently authored the present work, that we have not previously submitted it as an examination performance at any other university or in any other course of study, and that we have not used sources or aids other than those specified. All passages in the work that have been taken literally or paraphrased from publications or other external expressions are clearly identified as such.

Ort, Datum: Aalen, 25 January 2024

Unterschrift:

Unterschrift:

Unterschrift: