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THE EFFECT OF PROJECT COMMUNICA-  
TION AND PROJECT PERFORMANCE:  
The Role of Detailed Gantt Chart in  
Substation Construction Project

Technology and Communication

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## TIIVISTELMÄ

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Tämän tutkimuksen tavoitteena on selvittää Gantt-kaavio -tyyppisen aikataulun vaikutus projektin kommunikaation ja projektin suorituskyvyn. Projektinhallinnan alan tieteellisessä kirjallisuudessa aikataulu näyttäytyy tärkeänä tekijänä osana projektinhallintaa. Kirjallisuudesta ei löydy kattavasti selvyyttä, mikä on aikataulun rooli projektikommunikaatiossa ja mikä on sen vaikutus projektikommunikaation ja projektin suorituskyvyn välillä.

Tutkielma on tehty yksittäisenä tapaustutkimuksena. Tutkimuksen ohessa luodaan kattava Gantt kaavio -tyyppinen aikataulu, jota käytetään projektin suunnitteluun, seurantaan, hallintaan ja kommunikointityökaluna. Tutkimusmenetelminä käytettiin kirjallisuuskatsausta teoriaosuudessa ja haastatteluja empiirisessä osiossa. Teoriaosuudessa käydään Gantt kaavio -tyyppisen aikataulun historiaa, nykytilaa, sen hyviä ja huonoja puolia ja sen tyypillistä rakennetta. Lisäksi perehdytään projektin kommunikaation ja suorituskyvyn perusteisiin. Näiden aiheosa-alueiden riippuvuudet pyritään selittämään auki. Teoriaosuuden pohjalta muodostetaan kysymykset, jotka esitetään haastattelutilanteessa haastateltaville. Tutkielmaan valikoitui neljä eri haastateltavaa tapausyrityksestä, joiden vastaukset peilautuvat pääosin luodun aikataulun pohjalle.

Tutkimuksen mukaan Gantt kaavio -tyyppisen aikataulun käytöllä on myönteisiä vaikutuksia projektikommunikaatioon: Ganttin kaavio vähentää väärinymmärryksiä, lisää kommunikaatiota ja luo keskustelupohjan rationaaliselle päätöksenteolle. Ganttin kaavion käyttäminen tuo projektille kasvanutta suorituskykyä tehokkaamman kommunikaation kautta.

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Avainsanat	Gantt Chart, aikataulu, projektin suorituskyky, projektikommunikaatio
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## ABSTRACT

Author	Peetu Vasankari
Title	The Effect of Project Communication and Project Performance: The Role of Detailed Gantt Chart in Sub-station Construction Project
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The objective of this study is to study the impact of Gantt Chart-type time schedule on project communication and on project performance. Literature notes time schedules as an important part of project management, but there are few studies available on what is the role of time schedule on project communication, and what is its impact between project communication and project performance.

The study is a single case study. A real-life case project from the case company was studied to create a Gantt Chart time schedule on. The research methods used were literature review in the theoretical part of the study and interviews in the empirical part. In the literature review Gantt Chart, communication and performance in projects are studied. The interdependencies of these factors are intended to be demonstrated. Based on the literature review questions were formulated, and four interviewees were interviewed.

Based on the study, the use of Gantt chart time schedule has a role on project communication: the use of Gantt chart reduces misunderstandings, increases communication, and creates a communication base for rational decision making, thus increasing project performance through more efficient communication.

Keywords Gantt Chart, time schedule, project performance, project communication

# CONTENTS

ACKNOWLEDGEMENTS

TIIIVISTELMÄ

ABSTRACT

LIST OF ABBREVIATIONS

LIST OF FIGURES AND TABLES

1	INTRODUCTION .....	10
1.1	Research Problem .....	11
1.2	Research Gap .....	11
1.3	Research Objectives.....	12
1.4	Research Questions .....	12
1.5	Research Methodology .....	13
1.5.1	Case Study .....	14
1.5.2	Single Case Study .....	14
1.5.3	Data Collection .....	16
1.5.4	Analyzing Data.....	17
1.5.5	Reliability and Validity in Case Study Research .....	17
1.5.6	Reporting the Findings .....	19
1.6	Structure of Thesis .....	19
2	LITERATURE REVIEW.....	21
2.1	Projects and Project Management .....	21
2.1.1	Projects.....	21
2.1.2	Project Management .....	22
2.2	Scheduling Methods in Project Management .....	24
2.2.1	PERT.....	25
2.2.2	Gantt Charts .....	28
2.3	Project Communication .....	30
2.3.1	Basic Communication Model and Communication Method.....	32
2.3.2	Tools for Effective Communication.....	34
2.4	Project Performance .....	34

2.4.1	Earned Value Management .....	35
2.4.2	Key Performance Indicators .....	38
2.5	Relationship of Time Schedule, Communication, and Project Performance .....	38
2.5.1	Time Schedule .....	38
2.5.2	Communication and Performance .....	39
3	RESEARCH APPROACH .....	43
3.1	Data Collection and Sampling .....	43
3.2	Findings from the Interviews .....	44
3.2.1	Interviewee A .....	44
3.2.2	Analysis of Interview A .....	47
3.2.3	Interviewee B .....	49
3.2.4	Analysis of Interview B .....	51
3.2.5	Interviewee C .....	53
3.2.6	Analysis of Interview C .....	56
3.2.7	Interviewee D .....	58
3.2.8	Analysis of Interview D .....	60
3.2.9	Summary of the Interviews .....	62
4	CONCLUSIONS AND DISCUSSION .....	66
4.1	Theoretical Contribution .....	66
4.2	Practical Implications .....	67
4.3	Limitations and Further Research .....	68
	REFERENCES .....	69

## APPENDICES

## **LIST OF ABBREVIATIONS**

CPI	Cost Performance Index
EVM	Earned Value Management
GC	Gantt chart
ICB	Individual Competence Baseline
IPMA	International Project Management Association
PM	Project Management
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
RQ	Research Question
SPI	Schedule Performance Index
TS	Time Schedule
WBS	Work Breakdown Structure

## LIST OF FIGURES AND TABLES

<b>Figure 1.</b>	Iterative process of qualitative research	p. 13
<b>Figure 2.</b>	Stage Model of Qualitative Content Analysis	p. 17
<b>Figure 3.</b>	Project Management Process Groups	p. 22
<b>Figure 4.</b>	Example of overlapping project phases	p. 24
<b>Figure 5.</b>	Process Group Interaction	p. 24
<b>Figure 6.</b>	Conversion from bar chart to PERT	p. 27
<b>Figure 7.</b>	Example Picture of Gantt Chart	p. 29
<b>Figure 8.</b>	Basic Communication Model	p. 32
<b>Figure 9.</b>	Example of S-Curve	p. 37
<b>Figure 10.</b>	Communication Triangle	p. 40
<b>Figure 11.</b>	Communication Triangle with barriers	p. 40
<b>Table 1.</b>	Choice of number and type of case studies	p.15
<b>Table 2.</b>	Structure of Thesis	p.20
<b>Table 3.</b>	Summary of interviewees	p.44
<b>Table 4.</b>	Summary of time schedule impact on communication.	P.62

## **LIST OF APPENDICES**

**APPENDIX 1.** Interview Questions

# 1 INTRODUCTION

The early creations of Gantt chart dates to around the First World War as to be used for a production planning tool. During the 1950s and 1960s large scale production was seen too complex for the Gantt chart to track and therefore, their popularity in production planning went down. It was not until the development of computers which revived Gantt charts and led them to be utilised in project management (Wilson, 2003).

Project management literature acknowledges Gantt Charts as being a simple, useful, and practical tool of project management (Geraldi 2004; Wilson, 2003). A survey conducted with 750 project managers, the Gantt chart was ranked 4<sup>th</sup> out of 70 tools used most for managing projects (Besner & Hobbs, 2008). Time schedule is also noted as a critical success factor (CSF) for project management. (Pinto, J.K. and Prescott, J. (1988). In the guide to the project management body of knowledge project schedule management has a dedicated knowledge area (PMBOK 2017).

It is argued that the issues to achieve large scale project goals are related to keeping the planned time schedule or budget and the root cause to slip in these topics are communication related such as ignorance of what other project teams are doing, diverse views on the project objectives, poor project planning and scheduling (Hameri, 1997). The same thoughts are complemented by Koskinen (2004) stating that over half of the project management problems result, either wholly or partly, from poor communication.

According to Chiocchio (2007), project teams are formed to work together to ensure successful project completion and “working together” equals to high quality communication, in specific, communication regarding tasks and coordination. Chiocchio continues to argue that communication technology can influence project performance since it provides possibilities for people to think in new ways, pay attention to different things, communicate, and work together differently, but also to do completely new things. He also notes that when tasks are complex, it is essential to exchange information, receive feedback and to coordinate

information in high velocity. This is emphasized in group decision making, where the issue to be resolved needs to be easily understood, and alternatives in relation to that specific issue are to be compared and upon that information the correct alternative is to be chosen.

Ranking time schedules as one of the most important tools the project personnel have access to, it is yet to be shown in literature how using time schedule has effect on project communication and project performance. This thesis aims to demonstrate how developing a realistic and detailed time schedule effects project communication and project performance on substation project delivered in Finland.

### **1.1 Research Problem**

In the case company Gantt charts have been used in high voltage substation projects on a level which is not considered to be detailed enough to provide a realistic tracking nor dynamic scheduling on activity level, but more as a tool to support in scheduling the most critical activities on a high level. This approach is also known as a milestone chart. The company is interested in developing and implementing time schedule in greater detail for project use to follow the project status in more detail, and to see how the use of time schedule affects project communication and project performance. Another aspect is educational: having a detailed time schedule may prove to be an effective tool when teaching project personnel how different tasks intertwine between different project phases and overall growing the knowledge of time schedules amongst project team members.

### **1.2 Research Gap**

Given all the literature written and practical utilisation of Gantt charts throughout the decades, there are no studies to found by the author on how the Gantt chart affects project performance or project communication.

Literature on project communication has been and is to date a subject that has been extensively studied (BG Zulch, 2014), and while time schedules are

mentioned as being important part of project communication (Plowman & Diffendal, 2020), it has not been studied what is the role of the Gantt chart on project communication. Another obvious gap is having no studies made on how the use of detailed time schedule affects project performance through project communication.

### **1.3 Research Objectives**

The objective of this thesis is to ascertain whether establishing a detailed and realistic project time schedule, i.e., the Gantt chart, used as a project management tool has an impact on project performance through improved communication.

Additionally, as part of this thesis a Gantt chart will be created for a real-life project for the case company's 400 kilovolt sub-station expansion project in northern Finland. In utilizing this Gantt chart in everyday project use, data is gathered from key project stakeholders: project manager, lead design engineer, design engineer and site manager. Ultimately, through interviews the results shall be reviewed and compared to reviewed literature. Lastly, if seen beneficiary, there is an interest in generating a time schedule template from the initially developed Gantt chart. This template could serve as a standardized starting point in generating project specific time schedule for different types of sub-station projects.

### **1.4 Research Questions**

As there is a gap in project management literature to clearly indicate what is the role of Gantt chart to project communication and what impact the Gantt chart brings on the relationship between project communication and project performance, two questions are constructed as follows:

Q1: What is the role of detailed Gantt chart time schedule on project communication?

Q2: How does the use of detailed Gantt chart time schedule impact the relationship between project communication and project performance?



### **1.5.1 Case Study**

“Case study research designs or approaches can be based on their function, characteristics, or disciplinary perspective. One’s selection of a research design is determined by how well it allows full investigation of a particular research question.” Designs of case studies include exploratory, explanatory, and descriptive. (Dawson, Algozzine 2006).

Exploratory designs seek to define research questions of a subsequent study or to determine the feasibility of research procedures. These designs are often a prelude to additional research efforts and involve fieldwork and information collection prior to the definition of a research question. Explanatory designs seek to establish cause-and-effect relationships. Their primary purpose is to determine how events occur and which ones may influence particular outcomes. Descriptive designs attempt to present a complete description of a phenomenon within its context (Dawson, 2006). Based on this classification the design of this thesis is exploratory.

### **1.5.2 Single Case Study**

This thesis is a single case study i.e., the selected company representing the case whereas the interviewees are of the same company, allowing for greater depth. Table 1 presents the choice of selecting the number of case study for research purposes.

**Table 1.** Choice of number and type of case studies (Yin, 1994)

Choice	Advantages	Disadvantages
Single cases	Greater depth	Limits on the generalizability of conclusions drawn. Biases such as misjudging the representativeness of a single event and exaggerating easily available data
Multiple cases	Augment external validity, help guard against observer bias	More resource needed, less depth per case
Retrospective cases	Allow collection of data on historical events	May be difficult to determine cause and effect, participants may not recall important events
Longitudinal cases	Overcome the problems of retrospective cases	Have long elapsed time and thus may be difficult to do

Yin (2003) further defines reasons for using single case study, as follows:

**Case is critical** – to strengthen, widen or to challenge theory.

**Case is unique or extreme** – To produce important information.

**Case is typical or representative** – To capture conditions of a common situation, to produce information about human or institution experiences.

**Case is revealing** – Earlier scientific research on the case has not been possible, produces a remarkable study.

**Case is longitudinal** – Case is researched from many points of views at a given time, produces information how case may change during given period.

Based on the above literature, it can be reasoned that a single case study is a correct method to be used: the case is critical, unique, representative, and revealing. This study widens the theory, produces information around the topic that has not been researched earlier.

### **1.5.3 Data Collection**

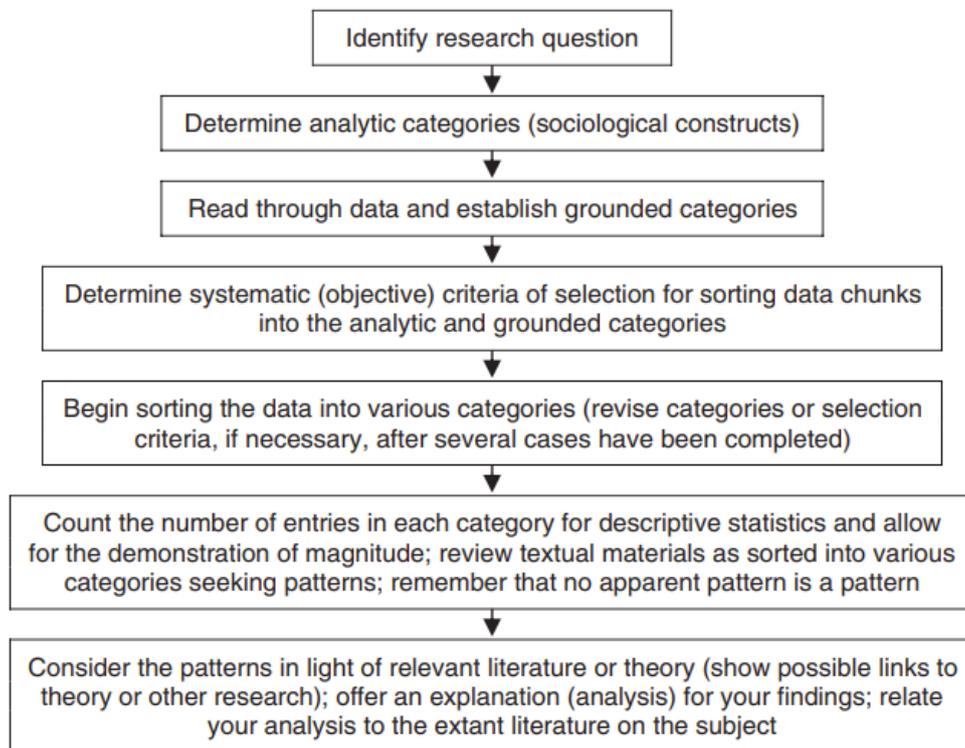
Data collection is needed to gather the information that will address the fundamental research question. Common modes of qualitative data gathering include interviews, focus groups and participants observation. Most common mode is interview and is typically used in phenomenological research where first-person description of experience is recorded. Interviews can be unstructured or semi-structured, where unstructured refers to an interview conducted in a conversational style, whereas semi-structured interviews are more focused and formal, normally having a list of questions (Fossey et al, 2002).

Multiple key considerations are to be considered when planning sampling, appropriateness, and adequacy, i.e., participants providing data must be those who can support the study the best, and the information sources to be adequate (people, events, places) to support to address the research question and to develop full awareness of the phenomenon being studied. To enhance the appropriateness and adequacy of sampling alternative strategies for sampling may be used to fully extract the data until a saturation is achieved (Fossey et al, 2002). For the interview, the researcher should develop an interview guide which includes open-ended questions to be asked by the interviewees, tailored to gain insights to

study's fundamental research question. The best way to record the interviews is to use an electronic recorder, with the permission of the interviewee. (Dawson, 2006).

#### 1.5.4 Analyzing Data

Once data is collected, it is then analyzed, a process of reviewing and interpreting to describe and explain the phenomena. An effective system or a model to compare different parts of data is needed to gain understanding of different themes within the data to help the researchers to be effective with the analyzing of data (Fossey et al, 2002). An example of a stage model is shown below in Figure 2.



**Figure 2.** Stage Model of Qualitative Content Analysis (Dawson, 2006).

#### 1.5.5 Reliability and Validity in Case Study Research

To assess the validity of qualitative study, it is argued that the best method is to evaluate it against its own aims, accurate and objective measurement, and the generalizability of the findings to a population beyond the study. Meaning that “reliability and validity of methods used is important to evaluate the accuracy and

objectivity of the measurements. Generalizability of the findings depends on the representativeness of the sample and replicability of the data collection” (Fossey et al, 2002).

Following terms are widely accepted as a standard to evaluate the criteria and validity of a qualitative research study:

**Credibility** The confidence that can be placed in the truth of the research findings. Credibility establishes whether the research findings represent plausible information drawn from the participants’ original data and is a correct interpretation of the participants’ original views.

**Transferability** The degree to which the results of qualitative research can be transferred to other contexts or settings with other respondents. The researcher facilitates the transferability judgment by a potential user through thick description.

**Dependability** The stability of findings over time. Dependability involves participants’ evaluation of the findings, interpretation, and recommendations of the study such that all are supported by the data as received from participants of the study. **Confirmability** The degree to which the findings of the research study could be confirmed by other researchers.

**Confirmability** is concerned with establishing that data and interpretations of the findings are not figments of the inquirer’s imagination, but clearly derived from the data.

**Reflexivity** The process of critical self-reflection about oneself as researcher (own biases, preferences, preconceptions), and the research relationship (relationship to the respondent, and how the relationship affects participant’s answers to questions) (Korstjens & Albine, 2018).

When considering different project phases in substation construction projects, it is natural to divide the project into three phases: engineering, procurement, and site construction. All phases were represented in the interviews to gather phase

specific information but to also achieve holistic view of the TS. The interviewees were selected for their contribution towards developing the TS, but also because they gave input towards the schedule when it was to be updated as the project progressed. The interviewer was familiar with the company, but also with the interviewees, a factor which can have a positive effect to establish a relaxed session leading to open discussion.

### **1.5.6 Reporting the Findings**

Reporting the findings is the last step in qualitative research. Given that there is no standardized format for writing case study research reports, some components are to be found in most reports (Dawson, 2006). The report should project the literature related to the topic and explain how the literature informs the research question. The report needs to include a description of the methods and design used, but also to address the appropriateness and adequacy of the research. Ultimately the research must be trustworthy and transparent (Fossey et al, 2002). The report should be descriptive and include participant statements which illustrate significant findings (Dawson, 2006).

## **1.6 Structure of Thesis**

This thesis is structured in four chapters as illustrated in Table 2. Chapter 1 explains the background and motivation for this study, along with research objective and research questions. In chapter 2 the literature review of project management, project communication, project performance and Gantt charts are being studied. Chapter 3 explains the research approach of this study and contains the interview, analysis of the interviews and the findings from the interviews. Chapter 4 is for the conclusion and discussion – the theoretical and practical implications are being discussed, along with suggestions and the limitations of the thesis.

**Table 2.** Structure of Thesis.

<b>Chapter &amp; Topic</b>	<b>Sub-Chapters</b>	<b>Description</b>	<b>Research method</b>
<b>Chapter 1 – Introduction</b>	1.1-1.6	Background, research objective and questions	
<b>Chapter 2 – Literature review</b>	2.1-2.5	Theoretical concept of project management, project communication and performance. Introduction to Gantt charts	Literature research
<b>Chapter 3 – Research Approach</b>	3.1-3.2	Data collection, interview citations and analysis	Empirical research
<b>Chapter 4 – Conclusion and Discussion</b>	4.1-4.3	Theoretical and practical contribution. Conclusion	Synthesis between literature and interviews

## **2 LITERATURE REVIEW**

### **2.1 Projects and Project Management**

#### **2.1.1 Projects**

Projects have been undertaken throughout the history of humankind. The Pyramids of Giza, Great Wall of China, and Coliseum are examples of projects conducted before there was project management as we know it today. It was not until the 1950's when organizations started to utilize tools and techniques for complex projects. Followed by the increasing interest and need in project management, both IPMA (International Project Management Association) and PMI (Project Management Institute) were developed in the 1960's; IPMA in 1965 geographically covering Europe, Asia, and Arab countries, whereas PMI was founded 1969 mainly focused on America. PMBOK (The Project Management Body of Knowledge) is published by PMI. The PMBOK includes processes and knowledge areas generally accepted by project management practitioners as best practices in the field of project management (Seymour & Hussein, 2014).

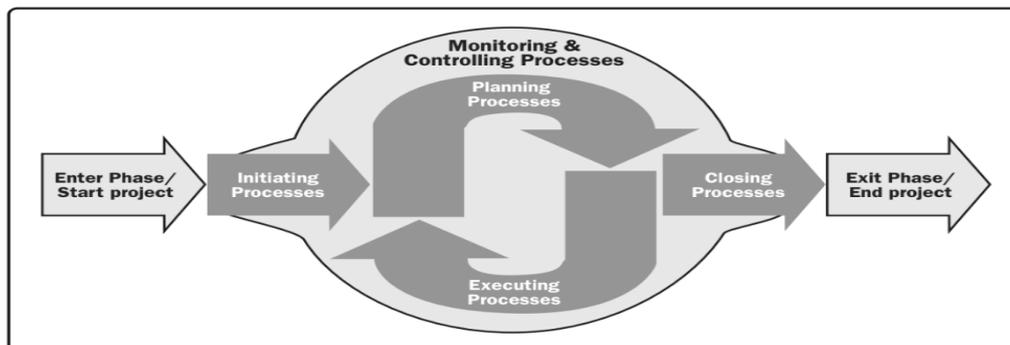
A project definition by IPMA: "A project is a unique, temporary, multidisciplinary and organized endeavor to realize agreed deliverables within predefined requirements and constraints" (IPMA ICB, 2015), whereas PMI defines a project as "a temporary endeavor undertaken to create a unique product, service, or result" (PMBOK 2017). The most interesting definition in the opinion of the author, keeping the topic of the thesis in mind, is the one made famous by Juran. "Project is a problem scheduled for solution" (Hameri, 1997).

It is safe to Conclude that projects indeed are unique by nature i.e., scope, budget, quality, environment, time factor, stakeholders, all vary from project to project and therefore, require project management to ultimately enable organizations to execute projects effectively and efficiently.

### 2.1.2 Project Management

Project Management, on the other hand, is at its core, “concerned with creating an environment where people can work together to achieve a mutual objective, in order to deliver successful projects on time and on budget” (Seymour et al 2014), with “the application of knowledge, skills, tools and techniques to project activities to meet the project requirement” (PMBOK 2017) or to “provide a greater likelihood of achieving the goals and ensures efficient use of resources, satisfying the differing needs of the project’s stakeholders” as performed throughout the various project lifecycles. (IPMA ICB, 2015). Project management definition by Kerzner (2017): “Using project management methodologies is a business strategy allowing companies to maximize the project’s value to the organization. The methodologies must evolve and be “tweaked” to accommodate a company’s changing focus or direction. It is almost a mind-set, a way that reshapes entire organizational processes: sales and marketing, product design, planning, deployment, recruitment, finance, and operations support. It presents a radical cultural shift for many organizations. As industries and companies change, so must their methodologies. If not, they are losing the point.”

To further compose project management concept into smaller packages, PMI groups project management into five groups: initiating, planning, executing, monitoring & controlling, and closing, as seen in Figure 3. It is worth noticing that monitoring & controlling process has been illustrated to take place in all other process groups due to integrative nature of project management. (PMBOK 2013).



**Figure 3.** Project management process groups.

The definition and authorization of a new project takes place in initiating process group; the scope is defined, and financial resources are committed. The key purpose of this process group is to align the stakeholders' expectations with the project's purpose, give them visibility about the scope and objectives, show how their participation in the project and its associated phases can ensure that their expectations are achieved.

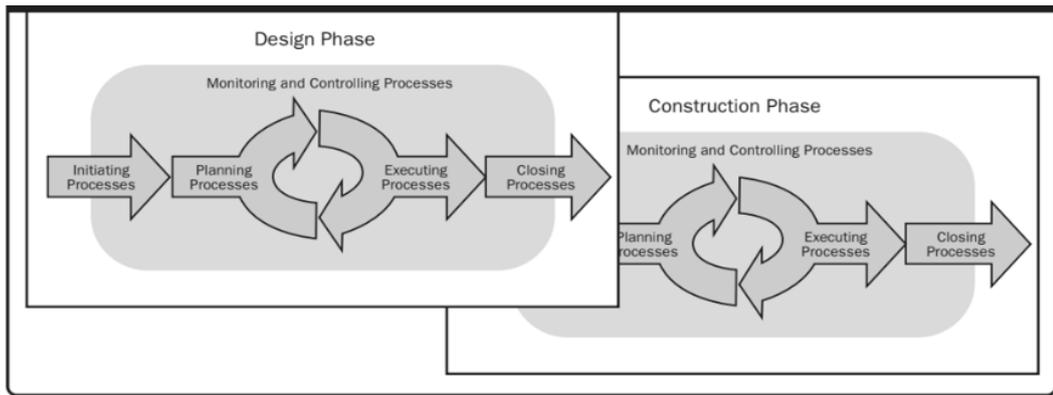
Addressing the total scope of the effort, defining objectives, and establishing a course of action to attain those objectives takes place in a planning process group. The planning process group's advantage comes in determining the strategy and tactics to successfully complete the project. According to PMBOK, the creation of Work Breakdown Structure (WBS) takes place in the planning process group. The creation of WBS work as a basis for creating a time schedule further down the processes. WBS is a representation of the whole project scope, decomposed into smaller, manageable packages.

The executing process group consists of completing the work defined to satisfy the project specifications. It involves people and resources coordination, stakeholder management and integration, and performing the activities of the project.

Key benefit of monitoring & controlling process group is the project performance measuring and analyzing it at certain frequency by tracking and reviewing project activities against project baseline.

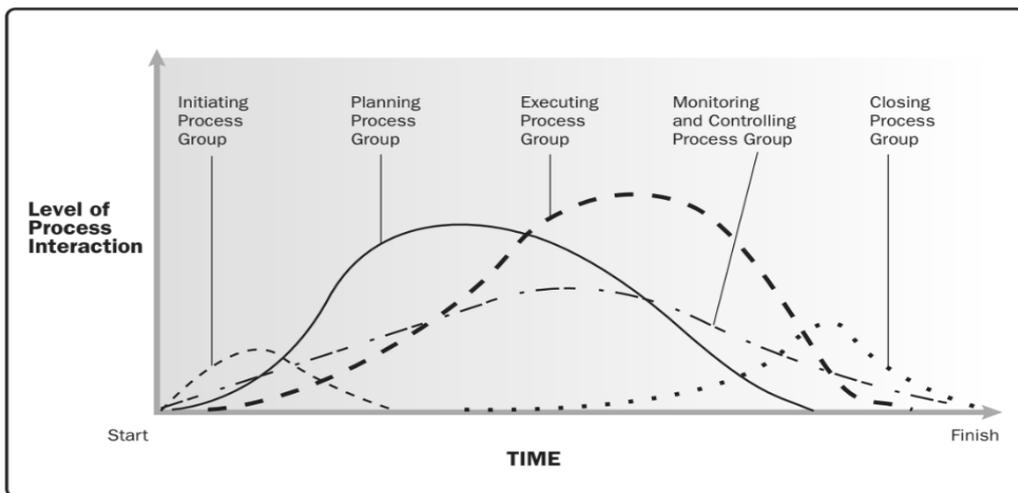
The purpose of the closing process group is formally and orthodoxly to conclude a project or project phase by verifying that all processes are completed within other process groups.

Project management processes are independent of project phases, i.e., there is an overlap of project phases as illustrated in Figure 4.



**Figure 4.** Example of overlapping project phases.

Project management processes overlap by nature and require a different amount of effort and resources along the project life cycle, as illustrated in Figure 5.



**Figure 5.** Process groups interaction in a phase or project.

## 2.2 Scheduling Methods in Project Management

Time as a concept can be phrased in many ways, for example:

“Time is the indefinite continued progress of existence and events in the past, present, and future regarded as a whole” (Oxford Dictionaries). Or “the dimension of the physical universe that orders the sequence of events at a given place” (McGraw-Hill Encyclopaedia of Science and Technology).

Based on above, the author would like to point out that time, as a factor, enables human beings to do or not to do something. Given that time enables us to look back in time, act in the present or plan the future, it is quite self-explanatory why time schedules were created in the first place.

Time schedules in general come in many shapes and forms. In everyday life and in the simplest forms time schedules can be found everywhere; business opening hours, public transportation schedules, broadcast timetables, or weekly work schedules for students. Although above examples can be considered as time schedules, in project use time schedules have been around since the First World war where Gantt charts were used in (Marsh, 1975; Seymour et al 2014).

From the literature review it can be concluded that many of the techniques attempting to illustrate or analyze required resources and durations within projects were created in the 1950's, for example PERT (Program Evaluations and Review Technique) and CPM (Critical Path Method), or were implemented to project use in a slightly new format, as were the case with Gantt chart (Geraldi, 2004). Development of these scheduling tools took place with the development of other project management tools and techniques during 1950's (Seymour et al 2014). Other scheduling techniques include, for example Graphical Evaluation and Review Technique (GERT), Precedence Diagram Method (PDM) and Critical Path Method (CPM) (Kerzner, 2009). Amongst many scheduling techniques or tools this thesis is specifically concentrating on the Gantt chart. Some methods are hereby mentioned, and shortly explained since they can be used in conjunction with Gantt charts, such as PERT.

### **2.2.1 PERT**

PERT is a scheduling technique based on statistics and probabilities developed in 1958 for the USA navy project called Polaris (Seymour et al 2014; Ashadi, Husin & Guntorojati, 2022). In the early 1960s, the Navy ruled basic requirements for PERT:

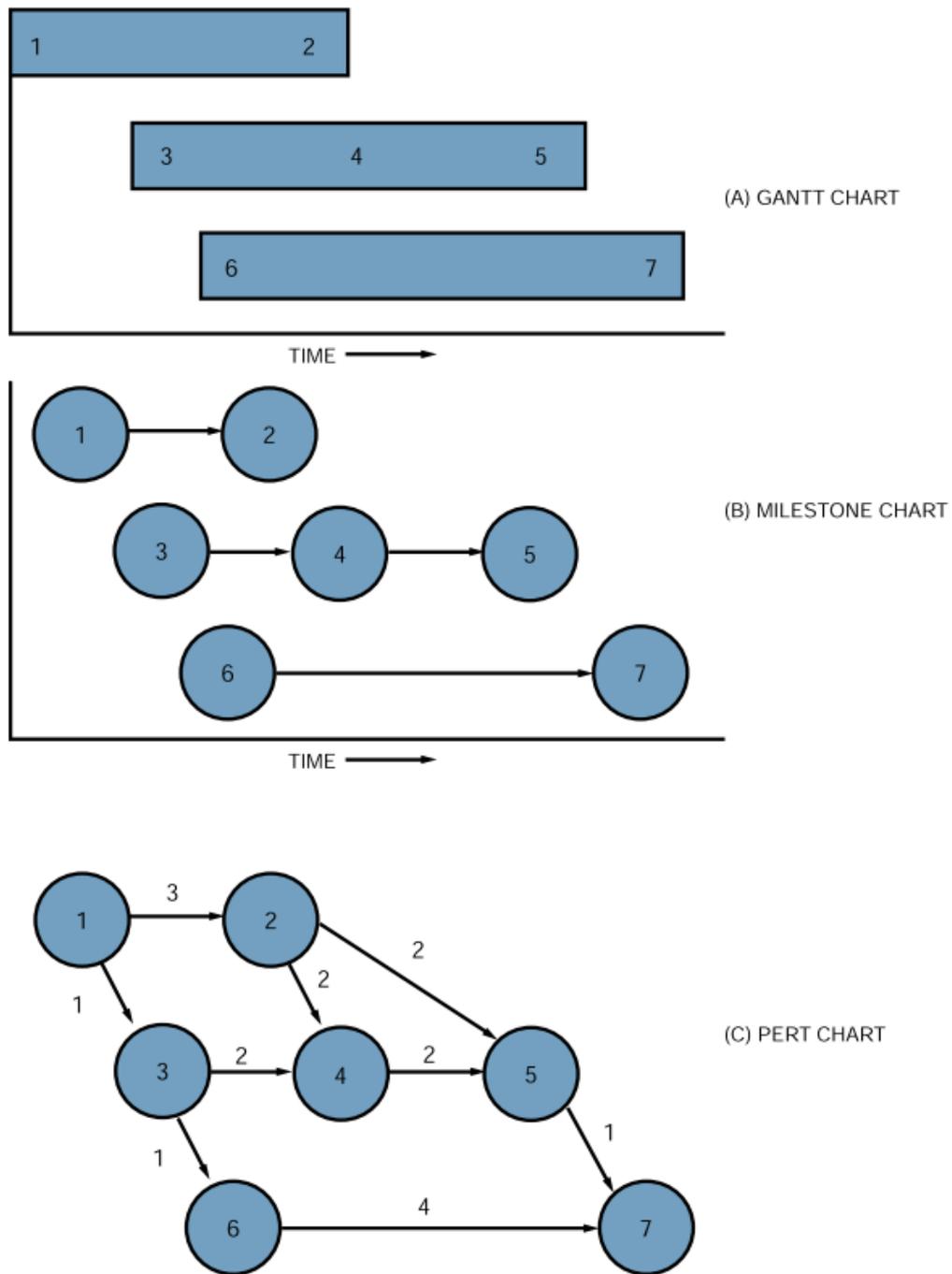
- All the individual tasks to complete a program must be clear enough to be put down in a network, which comprises events and activities i.e., follow the WBS.
- Events and activities must be sequenced on the network under a highly logical set of ground rules that allow the determination of critical and sub-critical paths. Networks may have more than one hundred events, but not fewer than ten.
- Time estimates must be made for each activity on a three-way basis. Optimistic, most likely, and pessimistic elapsed-time figures are estimated by the person(s) most familiar with the activity.
- Critical path and slack time are computed.

PERT has advantages over other planning methods through the creation of networks and analyzing the critical paths. These reveal interdependencies and problems not obvious with other planning methods. Kerzner (2009) points out that PERT is mostly suitable for large projects due to being time and labor intensive.

As laid out above per the Navy's specification, PERT includes the following formula:

$$E = (O + 4 * M + P) / 6,$$

where E is the estimated duration for a task, O is Optimistic duration, M is duration that is Most probable for the task and P is for the Pessimistic duration. For example, task A is estimated to take at least 3 days (Optimistic), should be done in 5 days (Most probably), and maximum 8 days (Pessimistic), or in formula  $(3 + 4 * 5 + 8) / 6 = 5.16$  days (Prayitno et al, 2020). This duration can be used for estimating duration for an activity in Gantt chart, or for network scheduling purposes. To understand better how PERT network is constructed, below simplified conversion from Gantt chart to PERT is made, as shown in Figure 6.



**Figure 6.** Conversion from bar chart to PERT chart. Kerzner (2009)

The above figure gives way to the fact that during the development of PERT, Gantt charts were also rising in popularity, and the best of both worlds were used in combination (Geraldi, 2004).

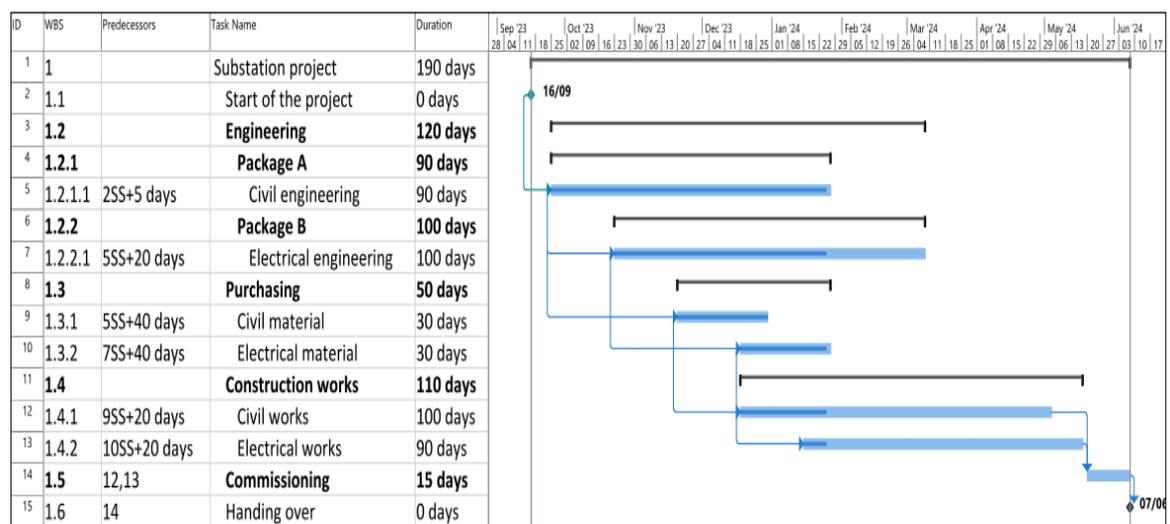
### 2.2.2 Gantt Charts

Henry Gantt (1861-1919) was an American engineer, best known for developing the Gantt chart, but also considered to have significantly contributed towards the development of project management in its early days. Henry Gantt originally designed the Gantt chart as a production planning tool, from where it was subsequently iterated to be used with projects as a time schedule where the benefits of breaking a large project into smaller activities and having dependencies between them served the projects and project managers of that time. (Seymour et al 2014; Wilson, 2003). Although the Gantt chart is named after Henry Gantt, the first known time schedule with a similar bar chart layout than in the Gantt chart was developed in Poland by Karol Adamiecki in 1886 named Harmonogram. Similarly, as first designated purpose of the Gantt chart, Harmonogram was also used as a production planning tool. Adamiecki's published Harmonogram to wider audience in 1903 and finally an article of the same, though it was only published in Polish and Russian, therefore not reaching western audience. By that that time the Gantt chart was already somewhat popularized in the western world (Marsh, 1975; Seymour et al, 2014).

Besides developing the Gantt chart, Gantt patented twelve inventions and had made several presentations in the American Society of Mechanical Engineers, and gave lectures at Stevens, Columbia, Harvard, and Yale. He also published over 150 titles and three major books "Works, Wages and Profits", "Industrial Leadership" and "Organizing for Work" (Geraldi, 2004). Seymour and Hussein (2014) stated that, Henry Gantt is one of the forefathers of project management and while some may disagree with this, many would at least agree that he has had significantly contributed to early project management development.

Early version of the Gantt chart was concerned with production planning where repetitive tasks were monitored. This first version of the Gantt chart was not about planning the future, but about monitoring realized production where the principle was to manage schedule based on quantities. The idea was to monitor and reduce idle time in turn to increase personal accountability of workers (Geraldi, 2004).

The Gantt chart as known today is a visual presentation of a project WBS where each work package, i.e., task, is vertically inserted. Each task will be set with estimated duration and needed resources, and dependencies will be assigned between tasks. This is the major difference between the first version of the Gantt chart and today's Gantt chart, on which the schedule management is not based on quantities as opposed to the first version, but on time. Tasks will be graphically presented as bars over time. The Gantt chart can include important dates inserted as duration of zero days to give presentation of milestones and tasks or milestones can have deadlines. The progress for each task, and for the project, can be followed by updating the actual completion of a task where the task bar will be proportionally filled based on the actual completion of a work done so far (Pankaja, 2005), as shown in below Figure 7.



**Figure 7.** Example Picture of Gantt Chart

Gantt charts are still in use today and are considered a vital tool in a project manager's toolkit. In a survey conducted with 750 project managers, Gantt chart ranked fourth out of seventy tools used most for managing projects (Besner et al. 2008).

The development of scheduling software has enabled the user to modify the visuals of the schedule and to benefit from the use of PERT and critical path methods and the use of earned value management (EVM) (Geraldi, 2004). In a study where

the Gantt chart was compared between flow-line charts and 4D BIM (Building Information Modelling) software, Gantt chart was ranked the best in terms of visual representation and ease of use. (Rolfsen & Merschbrock, 2016). According to Geraldi (2004), GC's visual representation of important milestones, deadlines, tasks dependencies and durations etc. may add value to the project.

The Gantt chart does not come without drawbacks. Rolfsen (2016) mentioned that challenges emerged in complex projects where many activities would need to be scheduled, making the appearance of the GC messy. Geraldi's paper (2004) mentioned that activities which are circular, meaning they may undergo number of iterations until the desired state for that activity is achieved, cannot be adequately represented in GC since it is impossible know beforehand the number of iterations needed, thus creating issue in planning, and managing the schedule.

It is to be also noted that developing a realistic and transparent Gantt chart takes great effort from project stakeholders in early phase of the project (Ahuja and Thiruvengadam, 2004). During the initial planning phase, it might be difficult or almost impossible to know exactly when each activity shall take its place, what might be the duration of it or what might be sufficient resource or cost for one (Dvir, 2003). However, as argued by Ahuja et al (2004), time schedule estimation is possible for any construction project. It may not be exact but will result in a satisfactory view of the total project duration. While Geraldi (2004) recognizes the importance of planning, she argues that there is a need to understand the mechanisms of GC; what is planned, is expected to be executed similarly down the line. This may give a false feeling of how the project will be done, yet there is always uncertainty or changes.

### **2.3 Project Communication**

Word *communication* comes from Latin word *communicare* which means to make common. When communicating, a mutual understanding is created through the transmission of meaning from one person to another or many people, whether verbally or non-verbally (Zulch, 2014).

Whereas communication has been referred as the lifeblood of a project and it can be seen as a foundation for integrating cornerstone areas of a project such as time, scope, and cost still the lack of communication is often listed as an area where improvement is needed (Zulch, 2014; Čulo, 2010). In a project when one needs information from, or needs to send information to, there is a need, or better, a reason to communicate. A report made by PMI in this regard, warrants this reason with valid key take aways:

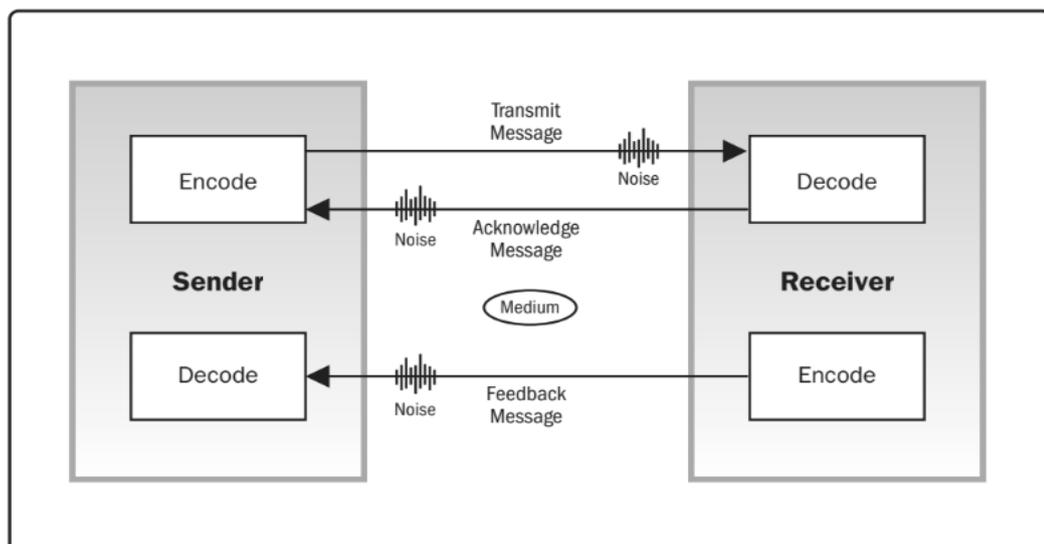
- The most crucial success factor in project management is effective communications with all stakeholders.
- Effective communications led to more successful projects, allowing organizations to become high performers.
- Effective communications are associated with a 17 percent increase in finishing projects within budget.
- Companies that have highly effective communications practices are 1.7 times more likely to outperform their peers financially.
- On average, two in five projects do not meet their original goals and business intent, and one-half of those unsuccessful projects are related to ineffective communications. (PMI, 2013-2)

Communication in projects is a key factor for team performance, successful project completion, and effective project management (Chiocchio, 2007). As project progresses, project management activities require constant effort and constant communication between project stakeholders to exchange information. Poor communication can affect project performance negatively, conversely improved communication can affect project performance positively. Open communication lines between project stakeholders are the best way to avoid projects to escalate into arbitration or litigation (Zulch, 2014).

### 2.3.1 Basic Communication Model and Communication Method

To have a closer look on a process of communication a Basic Communication Model as described by PMI (2013) breaks down sequential steps in communication:

- **Encoding** is the step where ideas, thoughts by the sender are translated into language.
- Sender shall **transmit the message** using communication channel, also known as medium. Depending on several factors such as the medium, technology, cultural difference, lack of background information and so on, the transmission of the message, intended content, quality etc. may be compromised. Collectively these factors are termed as noise.
- The receiver shall **decode** the message back into thoughts or ideas.
- The receiver may **acknowledge** upon receiving the message, although this does not mean agreement or comprehension of the message.
- By **feedback/response** the received, decoded, and understood message is then processed by the receiver by encoding thoughts or ideas into a message and is then transmitted back to sender.



**Figure 8.** Basic Communication Model.

As a continuation from PMI, the following communication methods have been constructed: interactive communication, push communication and pull communication.

- Interactive communication is multidirectional exchange of information which takes place between two or more parties.
- Push communication is information sent to recipients in need of this information. This ensures that information is being distributed but does not guarantee that information reached its destination, nor does it guarantee that information was understood by the recipient. Push communication includes emails, memos, reports etc.
- Pull communication requires the recipients to access the information on their own. Pull communication includes databases, e-learning etc. (PMBOK 2013).

Cervone (2014) uses terms active and passive communication methods. He states that active communication methods, such as face-to-face, meetings, video conferences and telephone calls are usually more engaging than passive ones. Passive communication methods may include ways of communicating such as emails, memos etc. He makes a point that advantage of passive communication is obvious when one can fetch the information when suitable timewise.

To establish efficient communication in projects, it is necessary to create a communication plan to identify different communication scenarios. Zulch (2014) has laid out the framework for such a plan in the following way:

- Who (sender & receiver)
- What (content and format of information)
- When (schedule)
- Feedback (To ensure that information was received and understood)
- Filing (Archiving)
- How (means of communication)

Having a communication plan is crucial, especially for large projects with many stakeholders to ensure clear communication methods and responsibilities.

### **2.3.2 Tools for Effective Communication**

In the case of understanding the Gantt chart as a project management tool, specifically a communication tool, it could be said that it communicates in a visual way (Plowman and Diffendal, 2020). In a survey where the effectiveness of a communication methods was studied, visual communication ranked fourth out of five given areas (Zulch, 2014). However, as Koskinen (2004) states, different knowledge areas need different communication media and environments to be effective, meaning it is important to utilize correct tools and ways of communicating to support the topic in hand. Ziek and Andersson (2015) continued explaining that tools, as an instruments for communication, enable certain sort of communication and that the more tools used by project managers, the more successful the project team will be i.e. tools enable the conditions for success.

Chiocchio (2007) continues to argue that communication technology can influence project performance since it provides possibilities for people to think in new ways, help them to pay attention to different things, communicate and work together differently, but also to do completely new things. He also notes that when tasks are complex, it is essential to exchange information, receive feedback and to coordinate information in high velocity. This is emphasized in group decision making, where the issue to be resolved needs to be easily understood, and alternatives in relation to that specific issue are to be compared and upon that information the correct alternative is to be chosen. Ziek and Andersson (2015) continue to argue that it is necessary to develop the project team behaviour in the area of communication.

## **2.4 Project Performance**

While the success of a project depends on different areas of project performance and on the expected results of a specific project and the project condition, project performance focuses on the measured or tangible outcomes of a project

(Jitpaiboon, Smith & Gu, 2019) such as timely performance, cost performance, quality performance and safety targets. (Digehsara, Rezazadeh and Soleimani, 2018).

Similar findings are also made by Toor and Ogunlana (2008) state that as projects are unique by nature with varying expectations from stakeholders when it comes to defining successful project thereby also the perception of success may also vary. Moon (2019) continues arguing that project performance measurement criteria can be different from project to project.

While measurement criteria may differ from project to project, organizations are challenged with measuring and evaluating their performance. Generally, performance equals efficiency, in addition to flexibility, creativity and continuous improvement. Traditional performance evaluation tools have proved not to serve their purpose in the world of constantly changing performance variables, instead researchers are developing improved approaches to assess performance (Digehsara et al, 2018).

#### **2.4.1 Earned Value Management**

One of the proven and most popular techniques is earned value management (EVM), a method consistently used in project management to quantitatively track project schedule performance and/or cost performance (Moon, 2019). EVM introduces a use of performance baseline against which actual performance can be measured during the project, providing early indications of varying project performance to highlight the need for eventual corrective action (Vandevoorde & Vanhoucke, 2006).

For the project team to assess project performance and progress, EVM integrates a scope baseline with a cost baseline along with a schedule baseline to establish a performance measurement baseline. Three key values are developed and monitored for each WBS:

1. Planned Value (PV) is the authorized budget planned and assigned for each WBS. At each point of performance measuring, PV illustrates the value of physical work which should have been done so far.
2. Earned value (EV) is a measurement of work performed so far, expressed in terms of the budget authorized for that work. EV is often used to calculate the percent complete of a project. EV cannot be greater than PV.
3. Actual Cost (AC) is the total cost incurred in accomplishing the work that EV measures. AC does not have an upper limit, rather it will illustrate how much is spent to achieve EV.

To establish full potential of EVM, two more variables are monitored:

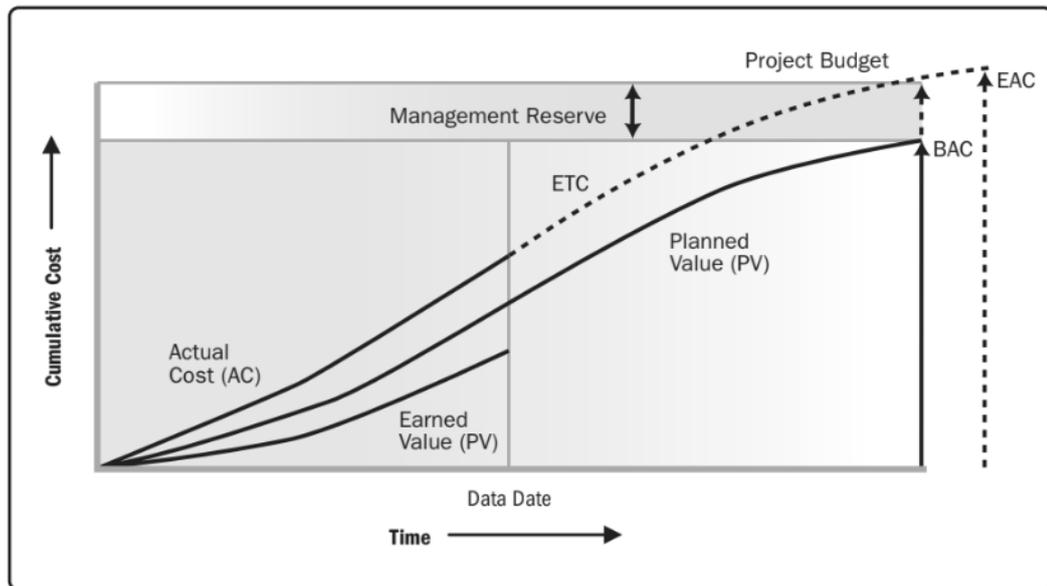
1. Schedule Variance (SV) measures the schedule performance of a project taking into consideration the difference between EV and PV. Practically it illustrates whether in a given point the project schedule is ahead or behind planned delivery. Equation:  $SV=EV-PV$ .
2. Cost Variance (CV) measures the cost performance of a project taking into consideration the difference between EV and AC. CV is particularly critical because it indicates the relationship of physical performance to the costs spent. Equation:  $CS= EV - AC$

The SV and CV values can be converted to efficiency indicators to reflect the cost and schedule performance, useful to determine project status.

1. Schedule Performance Index (SPI) is a measure of schedule efficiency expressed as the ratio of earned value to planned value. An SPI value less than 1.0 indicates less work was completed than was planned and conversely value greater than 1.0 indicated more work was done than initially planned. Equation:  $SPI = EV/PV$
2. Cost Performance Index (CPI) is a measure of the cost efficiency for the work completed, expressed as the ratio of earned value to actual cost. Considered to be the most critical EVM metric where value less than 1.0

indicates a cost overrun for work completed and a value greater than 1.0 cost underrun for work completed. Equation:  $CPI = EV/AC$  (PMBOK 2013).

PV, EV, and AC can be reported based on project need for example by typical S-curve chart.



**Figure 10.** Earned value, Planned Value and Actual Costs (PMBOK 5<sup>th</sup> edition)

While EVM is widely used it has its downsides. Vandevorde et al (2006) note that SPI values occurred after halfway through project delivery may have biased figures and have produced alternative methods in forecasting project outcome. Moon (2019) notes that there are various notable articles on improving accuracy of SPI but concludes that many of them are overly complex mathematically speaking, and not suitable for practitioners use. Moon's article is about improving the predictability of project performance using Laney U chart to track SPI to provide a simpler way of working for project managers to track SPI and concludes that using Laney U chart brings many added benefits instead going the traditional way of calculating SPI .

Other critic against measuring project performance with traditional measures on construction projects i.e. time, cost and quality, has been made by stating that their findings on the matter support the idea bringing other criteria on the table

to measure, such as safety, efficient use of resources, effectiveness and satisfaction of stakeholders, implying that the construction industry is moving away from the traditional quantitative performance measurement to a mix of quantitative and qualitative performance measures (Toor et al 2010).

#### **2.4.2 Key Performance Indicators**

Key Performance Indicators (KPI's) indicate the health of an organization, provide information how the organization can create value for the company and customers, and give feedback on where corrective actions are needed to implement to address possible issues. (Saib, 2020). Furthermore, KPI's provide a valuable information on the performance of construction tasks, projects, and companies. (Ali, Al-Sulaihi, Al-Gahtani, 2013). KPI's give easy to comprehend presentation to compare planned and actual performance in terms of effectiveness, efficiency, and quality (Toor et al 2010).

To further refine the definition of KPI, Kerzner makes a separation between the term "metric" and KPI. According to him, the term "metric" is generic, whereas KPI is specific. He also conforms other authors on the matter that for more than four decades only KPI's were time and cost. He makes interesting point on KPI's being critical components of earlier mentioned EVM system, saying that terms such "cost variance", "schedule variance", SPI and CPI are KPI's, if used correctly, but are seldom referred as one. He continues stating that what is KPI and is not, must be defined by project by project (Kerzner, 2017).

### **2.5 Relationship of Time Schedule, Communication, and Project Performance**

#### **2.5.1 Time Schedule**

Based on the PMI's Project Management Process Group and Knowledge Area mapping, the actual development of time schedule takes place in the planning process group (PMBOK 2015). It is suggested that planning a project is particularly important and a better project outcome will be achieved with reduced risk, when more effort on planning is allocated. Conversely, lack of planning will lead to failed

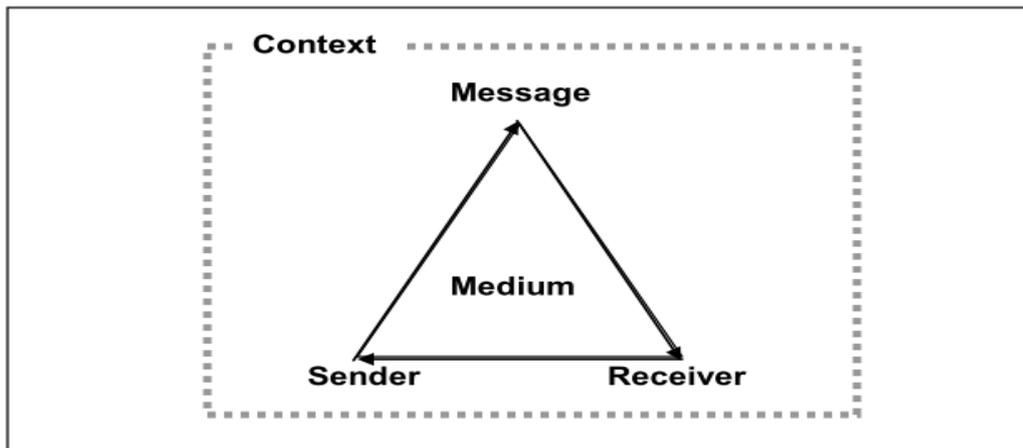
projects. (Serrador & Turner, 2015). Dvir, Raz, Shenhar (2003) goes to add that while there are some claims that too much planning could hinder the creativity of a project team, there is no argument that at least minimum level of planning is needed. They continue, that while planning does not guarantee project success, lack of planning will probably lead to a failed project.

All the above strongly suggest that planning should be done as per the project's needs: scope, cost, complexity etc. and least to a minimum. As stated in the literature review, creation of the WBS is where the project is composed into manageable packages and those packages works as a basis for creating a time schedule, which will further introduce the variables of needed resources, task interdependencies, durations of each task etc. This work is usually a shared effort of project team members working in coalition by communicating with each other, sharing thoughts, and providing expert judgement on their own field of expertise towards a common goal: a well-planned project time schedule where all the aspects have been considered to provide a mean for following project performance during its life cycle. Interestingly enough, whereas planning is cited being major contributor to project performance (Setiawan, Hansen & Fujiono, 2021), no studies were found by the author on the subject of how using the Gantt Chart could affect the project performance. Plowman & Diffendal (2020) argue that the time schedule is one of the most powerful tools at hand for project team members to communicate the project details. They explain that having a detailed project schedule could communicate tasks, planned and actual start and end dates, durations, dependencies, resources, and other detailed information. According to them, the time schedule is the place where the pieces of project information are gathered.

### **2.5.2 Communication and Performance**

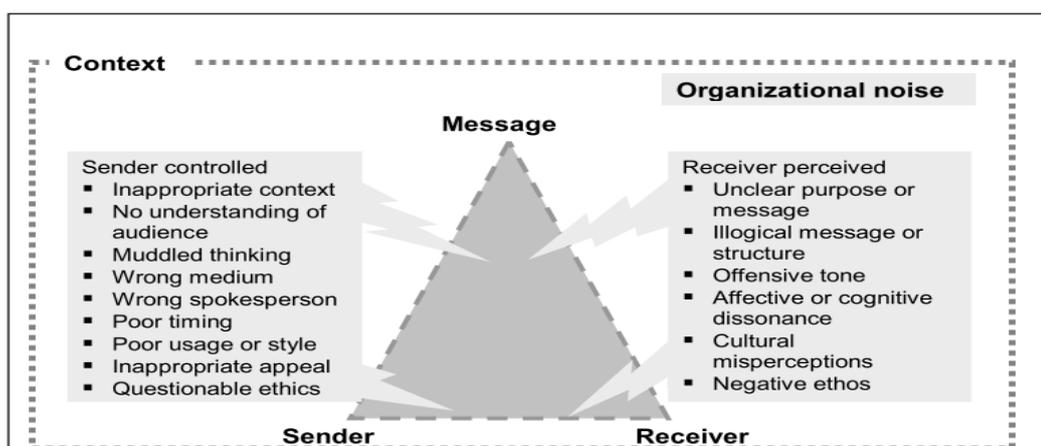
Even though it is argued that the project manager is the focal point and single most significant factor affecting project communication, project team members also need to be active in communication. The team members need to understand project goals, objectives, and outcomes of the project. Ultimately this means that the vision of the project must be clearly communicated (Cervone, 2014).

When it comes to ensuring that the vision of the project is clearly communicated, it is important to understand the barriers which can curtail effective communication. As opposed to the model explained in chapter 2.3.1 Barret (2006) introduces the communication model at its simplest form, as shown in below Figure 11.



**Figure 11.** Communication Triangle.

This triangle is a representation of a situation which could be considered being the ideal situation in the world of communication: no unwanted noise, misunderstandings or similar issues exist. On the other hand, she demonstrates what are the barriers hindering effective communication as shown below in Figure 12.



**Figure 12.** Communication Triangle with barriers.

As illustrated, there are many variables affecting communication. Barrett (2006) adds that understanding how these barriers impact the outcome of a message is the foundation of effective communication.

Chiocchio (2007) notes that when tasks are complex, it is essential to exchange information, receive feedback and to coordinate information in high velocity. This is emphasized in group decision making, where the issue to be resolved needs to be easily understood, and alternatives in relation to that specific issue are to be compared and upon that information the correct alternative is to be chosen. All above suggest that to communicate effectively communication must be clear and understandable. According to Koskinen (2004), an attitude towards learning to understand other project team member, as well as regular communication is needed to minimize communication problems in project activities.

Depending on the source, about 40-65% of humans can be categorized as “visual learners” meaning that this group of people learn new skills best by having visual feed to support teaching (Clarke, Flaherty & Yankey, 2006 ; Bradford, William, 2004). While Raiyn (2016) has studied how visual tools in teaching affect learning and adoption of new skills with children, the articles author could find more suited to complement this thesis, dates to 1951. The experiment by MacNeice (1951) gives some insight on the how the Gantt chart relates to production planning: 300 management students were given with a complex production planning task where students were asked to intuitively resolve the task, only 1% could achieve this. With the help of the Gantt chart all the students resolved the task with success within 15 minutes. Other similar studies were not found, specifically studying how the visual presentation of the Gantt chart or similar tool in general could help in understanding and communicating the project entity or task interdependencies etc. or what kind of impact it could have on the project performance.

There is a clear correlation between effective communication and project performance (Setiawan et al. 2021) and ultimately better performance can lead to higher project success. By representing project activities in visual format i.e., the Gantt chart and using the Gantt chart as a communication tool could result in reduced

noise, having less misunderstandings and overcoming communication barriers etc. and therefore, improve project communication which ultimately could lead to improved project performance.

### **3 RESEARCH APPROACH**

#### **3.1 Data Collection and Sampling**

The interviews were divided into four sections, first starting with general questions regarding time schedules to help loosen the interview environment, then continuing to case specific questions about the use of time schedule in the case project, project communication and lastly project performance. All interviews were conducted face to face, interviewed in Finnish language and the sessions were held in two separate sessions, geographically and timewise. Interviews took 30-40 minutes to conduct. The interviews were recorded and transcribed to ensure reliability and validity. The transcript texts were written in Finnish and then translated to English, done by the author. The interviews were grouped by themes and analyzed one by one.

The first interview was done with interviewee A (Site Manager) at the case project substation in Northern Finland, where a quiet meeting room was booked for the interview. The last three interviews (B, C and D) were held at the company headquarters in Pori, Finland, in a quiet meeting room. The interviewees were selected for their contribution towards developing the GC, but also because they gave input towards the schedule when it was to be updated as the project progressed. The interviewees also represent the main disciplines found in the project, design, procurement and site construction. The project manager contributed to the contractual matters implemented in the schedule, such as milestones, deadlines, and other significant contractual matters. The project manager also gave input to the schedule for the procurement phase. The lead design engineer and design engineer gave their contribution on the design related tasks in the schedule and the site manager contributed to the site activities on the schedule. The author was the person responsible for developing the schedule, and managing the schedule based on the input from the interviewees, respectively.

**Table 3.** Summary of Interviewees

Work Position (As of December 2023)	Name	Work Experience in substation project	Work experience in project management	Date of the interview
Site Manager	A	5 years	5 years	21.11.2023
Lead Design Engineer	B	20 years	20 years	4.12.2023
Project Manager	C	10 years	10 years	4.12.2023
Design Engineer	D	4 years	4 years	4.12.2023

### 3.2 Findings from the Interviews

The following chapter introduces the findings from the interviews, analyses them and finally a summary of the interviews is presented. The interviews are presented in the order of the interviewing date. The structure of the interviews is in line with Appendix 1, interview questions.

#### 3.2.1 Interviewee A

In general, interviewee A felt that the biggest advantage of having a time schedule in a project is that the time schedule creates an overview of the project, if the schedule has been created up to certain level: *“if the schedule has been created to detail, it gives a one a possibility to follow up how the project is doing.”*. Conversely on the disadvantages: *“if the schedule has not been done with thought it makes the project difficult to follow. If the schedule is done well, it serves the project well, if it is not done well, it does not serve the project.”*

On a general level, the interviewee felt that the importance of having a time schedule is important, but not extremely important. *“The schedule is important, but it should not be the determinative factor in guiding the project, there are lots of different things happening in the site conditions, therefore some room should be left in the time schedule.”*

On the advantages on development of the GC, interviewee A said that: *“even the tasks are not perfectly on their “correct” order, it is important to go through all the tasks; it serves as a walkthrough of the project and may raise some things that are good to consider. It is good and recommended to do this exercise. The greater the number of participants in giving input, the better are the odds in finding the most critical factors that may affect the project.”* The interviewee did not recognize any disadvantages in the development work of a detailed GC.

When discussing the advantages of using GC on the follow-up meetings he said : *“it brings added value to project. For example, coordination of project materials from procurement to site are important to follow, as the materials drives the activities of site work.”* Regarding disadvantages of using detailed GC, he felt that: *“perhaps when a part of work has been split in too detail, and the actual work sequence differs from what was planned, it may cause the GC to be hard to read.”*

Interviewee A did not feel that the workload on developing or using the GC was a big burden. *“It took the number of hours that were resourced on the development of the schedule, roughly 10% of the working hours in a working week. On a weekly basis it takes maybe one hour to follow up and update the schedule”*

On the question of how GC supports the timely execution of a project, the site manager told that: *“project is being somewhat driven by the GC, and we did put lots of effort into creating a detailed schedule so in that sense it supports the execution. I have not come across any tasks that I had forgotten in my mind that would have been in the GC, but probably towards the end of the project there might be some tasks that were thought initially which I may forgot (without the use of GC)”*

As a continuation on how the interviewee A felt on planning the future works through GC he said that: *“it gives us time to react and prepare for upcoming works”*

Interviewee A said that it is not possible to execute a substation project without a time schedule. *“There is no way that a project could be executed on a mentality where we are to think “let’s see what we could today.”*

When asked to describe communication as a term, interviewee A said that: *“communication is general informing, interaction between stakeholders but also extra discourse.”*

On the role of project communication, interviewee A said that: *“it is about exchanging information, but also about learning about the activities of different disciplines in the project.”*

When discussing how the use of GC affects project communication, interviewee A pointed out that *“when using GC, it has raised more communication, and there is never too much communication when discussing the project execution. ...it brings added value to project.”*

Interviewee A did not feel a change about how the use of GC has affected the quality of communication, nor he did not feel any communication issues in using GC.

When asked to describe project performance as a term, interviewee A said that *“the project is executed in an effective way when it comes to resources and time usage.”*

Interviewee A said that *“there would be a lack of consideration between project parts. When an important part of the project is dismissed, it would affect the time usage and resource usage, there would be a snowball effect”*, when asked about how communication affects the project performance.

On how the use of time schedule has affected project performance, the site manager said: *“it has had positive effect, as we have walked through the project since the beginning through the time schedule, it definitely brings added valued for the project even the time schedule is never without any flaws.”*

### 3.2.2 Analysis of Interview A

Interviewee A (Site Manager) recognizes the essentiality of time schedule for project work when stating that a (substation) project could not be executed without a schedule. This supports findings by Besner as found in chapter 2.2.3.

Interviewee A describes that it is important to plan the schedule with care, even if all the tasks would not be in their “correct” places. This highlights the importance of planning as described in chapter 2.5 but also reflects Dvir’s thoughts (chapter 2.2.3) when he said that during the initial planning phase it might be difficult to know exactly every detail of each task. Interviewee A explained that a badly made schedule does not serve the project, which in turn can be connected to what Dvir stated by saying that the planning of the project should be done at least to a minimum, as found in chapter 2.5.

Interviewee A felt that when the time schedule is done with great detail, it may be difficult to read, which was also mentioned in the work by Rolfsen (chapter 2.2.3).

As written in chapter 2.2.3 “it takes great effort from project stakeholders” to develop a realist and transparent schedule. Workload wise Site Manager noticed that the development of TS took around 10% of his weekly working time. No actual records were kept during the development phase, but it could be said that 10% does not qualify as a significant effort, though, this is quite a subjective matter.

On the question of how GC supports the timely execution of a project, the site manager told that *“project is being somewhat driven by the GC, and we did put lots of effort into creating a detailed schedule so in that sense it supports the execution.”* An interesting statement here by the site manager is that he feels that project is being somewhat driven by the GC, and clearly, he does not take the GC as a guiding factor. His thoughts assimilate with Geraldi’s “warnings” described in chapter 2.2.3.

*“I have not come across any tasks that I had forgotten in my mind that would have been in the GC, but probably towards the end of the project there might be some*

*tasks that were thought initially which I may forgot (without the us if GC)*” As a continuation on how Interviewee A felt on planning the future works through GC he said that: *“it gives us time to react and prepare for upcoming works.”*

On the role of project communication, Interviewee A said that: *“it is about exchanging information, but also about learning about the activities of different disciplines in the project.”* As per literature, communication as a term can be phrased in many ways so no reflections will be made in this thesis in that sense, but Interviewee A explains it in a nutshell: it is about changing information. He felt that using a detailed GC has increased communication compared to earlier projects, where GC was not so detailed. He also said that there is never too much communication in a project. This could be an important improvement communication wise, as Čulo mentioned that lack of communication is often listed as an area of improvement, as found in chapter 2.3.

Interviewee A did not feel a change about how the use of GC has affected the quality of communication, nor he did not feel any communication issues in using GC. This may be because the interviewee could have become comfortable with the GC as a tool and with the communication in that regard. As the project had progressed one year already when the interview with Interviewee A was conducted, and many update meetings had been held, probably the way of working and communication with those meetings had become routine.

Interviewee A described that (lack of) communication would have a negative impact on project performance. This is supported by the literature discussed in chapter 2.3 with references to PMI report, Zulch and Chiocchio.

He described that a detailed GC has positively impacted project performance through the development work done with the case GC. i.e., the Site Manager is describing that increased communication during the planning phase has positively impacted project performance, which again is widely acknowledged in the literature, as written in chapter 2.3.

### 3.2.3 Interviewee B

When asking from Interviewee B on the advantages of a time schedule on a general level in projects, he pointed out that *“there is a possibility to create a schedule with resources on it, and you’re able to filter the resources by name for example, and then easily print the schedule for the person who needs to have his/her schedule to perform the work”*. On the disadvantages he said that *“creating dependencies and updating them on the other hand may show to be time consuming.”* He continued that he would like to see more integration between the tools: *“...we could give a notice to person at a certain point, saying “hey, you got a deadline for this task in one week.”* He also mentioned that: *“biggest issue is when one person is working on multiple projects, but that is not being taken into account when creating a schedule for a project.”*

Interviewee B said that the usage of time schedule on project work is especially important: *“It is very important. When we are scheduling, for example a year ahead, we simply need to have a time schedule of some sort.”*

On the case specific questions, starting with a question on if the development of detailed time schedule brings added value for the project, he said that *“the tasks on the schedule were split noticeably more than we previously have done”* and *“we were used to keep the most part of the project work in our heads, but now that the number of simultaneous projects have grown, the tasks simply need to be written down”*. On the disadvantages of creating such a schedule interviewee B said: *“the only problem is when things can be done in many ways, especially when drilling down to smaller work packages. The possibilities to make these smaller works could be done in dozens of ways, but in schedule we are locking into one path, this creates work when updating the schedule when actualized works were done in different order.”*

On the advantages of monitoring and controlling project works through detailed schedule he said that: *“the dependencies are the important thing. It gives us time to react to upcoming works.”* When discussing disadvantages, he said that *“the*

*biggest issue is keeping the schedule updated. On this project that was not an issue because we had a dedicated person to do that work for us."*

When asked about the impact on workload on each stage, development and controlling & monitoring, interviewee B said: *"It is really a project dependent matter. If we have a smallish greenfield project the impact is not that big. On the case project, which is existing site, we did an extension which means there are lot's matters which need to be scheduled... so in the case project the impact on workload was reasonable."*

When discussing whether going through upcoming works with the help of time schedule, he said: *"Yes, I think so. It is one of the most important things to do with time schedule, going through what will happen in the following weeks."*

Interviewee B continued: *"I think it would be possible to execute a project without actual time schedule, but all the information would be in the head of few people, and this would restrict the use of these personnel on other projects."*, when asked whether substation project could be executed without schedule.

Interviewee B coined the term communication as: *"I see communication as everyone knows what everybody else is doing."*

When discussing the role of communication in projects, Interviewee B said: *"On a critical project there needs to be communication on all direction."*

The role and impact of time schedule on communication was seen by Interviewee B as: *"time schedule removes unnecessary communication when different stakeholders can look the answer from the schedule. It is important to bind together, for example, the engineering and construction phases of the project. The biggest issues we have had in the past was due to not having actual schedule to be used by all project stakeholders, instead having the schedules were in our head and this led to communication issues."*

Interviewee B was not able to list disadvantages in communication when using the GC: *“No, as far as I see. Actually, it has been a very good habit to sit down once a week... I am able to keep up with the project status.”*

When asked to describe project performance as a term, Interviewee B said that *“It’s about removing unnecessary steps, to make works in correct order.”*

Interviewee B’s take on how communication affect project performance, he said: *“You are not able to put all design matters on drawings, then we need to discuss with site on how to solve the issues raising at sight”* and, *“If there is some input missing from initial stage, then this causes extra work down the line.”*

Interviewee B said that *“with time schedule you are able to get the most (effort) out of an individual.”*

#### **3.2.4 Analysis of Interview B**

Interviewee B implies that it would be possible to execute a substation project only having the time schedule in one’s mind, but also critically continues that this would only be possible with highly skilled experts and that the experts would be used only for this purpose, thus, burdening them so much that they could not do nothing else. It can be said that this would not be good practice to execute a project, as there are too many risks and disadvantages with this approach. The verdict, however, was done carefully by interviewee B with many ifs and buts. At the same time, he is a supporter of using time schedule in a conventional way, when he described that there simply is a need to have a schedule of some sort when planning the works. His thoughts can be said to be in line with literature discussed in chapter 2.2.3.

The general level advantages Interviewee B described are related to the use of the TS tool, such as assigning resources on the schedule, filtering, and printing options. This thesis does not editorialize the user experiences of the interviewees in regards TS software, or graphical user interfaces of TS software as such, but this topic was also touched on by interviewee C. It can be said that some of the interviewees

do put some value on the features of the software. On the other hand, he mentioned that managing the schedule may be cumbersome when creating dependencies and updating them as the project progresses. He proposed some enhancements to the existing software. It is quite evident that interviewee B is using the tool on all aspects and had a good understanding of the capabilities and limitations of the tool, however these points are not being analyzed here further as they are not part of the scope of this work.

The Lead design engineer described that the development of detailed schedule reduces the risk of forgetting activities from the project but stated that extra work will be done when work packages (in this case numerous design documents) are being created at document level, the planned work order may differ from the actualized order. This is acknowledged in literature review in chapter 2.2.3 regarding design work not following the traditional waterfall approach, instead loops of work may be done during the design phase, or the work order may differ from what was initially planned.

As a contrast on the general disadvantages related to dependencies, Interviewee B described that GC enables proactive planning of future works through activities which are linked together, where the downside is keeping the schedule updated. When a schedule is made in a way that dependencies are used to create a dynamic schedule, where moving a task upstream moves the tasks downstream automatically, this should create ease of use for the end user. As the interviewee is working on design related work, this can explain the frustration with the linked tasks. As explained earlier, design work does not necessarily follow the waterfall approach, thus creating extra work when moving tasks back and forth or trying to rectify the issue with some other workaround to reflect on going situation.

Interviewee B explained that the workload put into developing or updating the schedule is project dependent. He felt that the workload in the case project was reasonable.

According to Interviewee B, one of the most important things TS can provide to him is to scrutinize upcoming works. As Interviewee B manages a group of designer personnel working simultaneously on different design documents, he uses TS to communicate late, ongoing, and upcoming works between the designers and project managers.

When it comes to communication, he described that communication must be present in all directions in a project as it enables everyone to be aware of what anyone else is doing. This reflects the importance of communication, as found in the literature review in 2.3.

Interviewee B explained that previously they had had communication issues due to not creating a concrete and transparent TS for the project personnel use. He explained that the use of TS in the case project has removed unnecessary communication. He was not able to name communication issues in using GC in the case project. This could be for the same reason as with Interviewee A, and the fact that interviewee B has the longest experience in using the GC, particularly the same software (for twenty years) as for the case project.

Interviewee B described the same as Interviewee A regarding how communication affects performance. He explained that with the use of GC you can get the most (effort) out of an individual. This all comes down to the use of milestones, deadlines, clearly indicated tasks and so forth.

### **3.2.5 Interviewee C**

In general advantages of GC, Interviewee C said that: *“you are able to insert various built-in columns with different data in them. ...Creation of dependencies is a good feature...I can print out a document that looks like it is a proper time schedule.”* When asked about disadvantages, he said: *“the view of the tool may be confusing when there are lots of tasks in it, of course, one is able to modify the view.”*

When discussing the importance of the GC for project work, he said: *"it is very important when defining milestones. With time schedule we can plan the needed resources for each work package"*

On the advantages on development of the GC, Interviewee C said that *"I feel it brings added value to project. The matter which brings the most value is the fact that we think through the tasks how we do them, listing tasks so we remember to do it. It is a supporting tool for project planning."* Disadvantages according to Interviewee C are the needed labor to build a schedule but also keeping the schedule up to date: *"it takes effort (to create), and it is prone to changes because it is so detailed and therefore laborious to update."*

When asked about the advantages of GC in use, the project manager said that *"I would say that when updating tasks up to date, it may bring up some new (unnoticed) scenarios. Another thing is that when we update the GC, we learn new things and we can use those learning on the upcoming projects."* On the disadvantages, he said that the same thing is around than with the development of the GC, it is laborious.

Interviewee C said that *"it is quite laborious because you need to think through the matters multiple times, but we did start this schedule from a scratch."* He did not feel that the actual use takes a lot of time, when asked about how he feels the development and the use of GC has affected his workload.

Interviewee C felt that planning the future works with time schedule is extremely important: *"I feel that it is extremely important so that we can plan and assure that the basis and resources for the works are available."*

When asked if he thinks that it is possible to execute a substation project without a schedule, he replied: *"No, we need at least some sort of a schedule, because we have deadlines. The schedule could be quite simple if we are working with highly skilled labor, but if there are personnel doing the project for the first time it is a different story. I think this is valid for all projects, a schedule of some sort is always needed."* He added that *"if we want a successful project, the schedule must be at*

*least satisfactory... without a schedule, you cannot deliver a successful project... you could deliver a project (without a schedule), but it will probably fail."*

Interviewee C coined the term communication as *"it is exchange of information between project personnel about project related matters."*

When asked about the role of communication in a project, he said: *"communication is necessary, there must be communication to exchange information but also so that we could work together, after all, projects are a team game. The more open the communication is, the better result we can deliver (as in project) ... things, either good or bad, must be shared."*

The project manager said that *"it (GC) shows the tasks at hand, and gives a visual presentation of the project, where we are, and what are the upcoming works"* when asked about the role of GC in the case project.

Interviewee C pointed out that GC brings added value for the project: *"it brings added value to the project by means of concreteness."* When asked what type of added value, he replied: *"for example, deadlines, the duration of tasks, the impact of the tasks on project related matters. It can prioritize the matter which is being communicated. It helps to prioritize things."*

The Project manager pointed out that come communication issues when using the GC: *"We could prioritize wrong things when developing the schedule."*

When asked how he would describe the term project performance, he said: *"...it is how smart we do the things, how efficiently we do the things and what is the quality of the work done."*

Interviewee C felt that the communication has a significant impact on the project performance *"it has a big impact."* When asked how the lack of communication could affect the project he said: *"the schedule could slip, we could have work performances at the same time... the prioritizing could be wrong and there might be important things which could be left undone."*

When discussing how the GC affects project performance, he said: *“enormously. With the schedule we can execute the project in the most efficient way. Without a schedule the project cannot be efficient. This has of course an impact to the financial figures of the project.”*

### **3.2.6 Analysis of Interview C**

The Project manager explains that it would not be possible to execute (substation) project without a TS since all projects have milestone(s). He continues to explain that the complexity of the schedule could depend on the project personnel skill level. He argues that if a successful project is the goal, then the TS should at least be at a satisfactory level, and that a project could be delivered without a schedule, but it would probably fail. Interestingly Dvir also reckons this is the case, as found in chapter 2.5. Interviewee C clearly recognizes the importance of having a schedule as does Besner, referred to in chapter 2.2.3.

The Project manager embraces the importance of having a software that is flexible in terms of modifying the view as one pleases, and as other have stated he may time to time feel that the view may get clutter if many tasks are being shown at the same time, in line with the literature (chapter 2.2.3). He also mentioned that TS plays an important role in defining milestones and planning resources. As mentioned in the analysis of Interviewee B, this thesis does not editorialize the user experiences of the interviewees in regards TS software, or graphical user interfaces of TS software.

He continues to explain about case specific advantages in the development phase: thinking through each activity, listing it to the GC. This resonates with the importance of planning as found in the literature in chapter 2.5. As for the downsides he mentioned that TS could come laborious to update as it is so detailed.

The Project manager explained that as the time schedule for the case project was started from scratch, it required quite much of an effort. This is explained by the fact that the project manager worked intensively with the development of the

schedule and can be said to be in line with literature as described by Ahuja (chapter 2.2.3).

As for the timely execution, he explained that GC enables him to plan and assure the needed resources for the future works. Clearly the project manager uses the GC for executing these sorts of activities and it seems to support him in doing so, when communicating these matters with relevant stakeholders.

For Interviewee C, the existence of communication is essential. He described that communication is about information exchange, which enables individuals to work together as a team. He stressed the importance of sharing information, whether good or bad. The Project manager's thoughts are alike with those presented in chapter 2.3.

According to Interviewee C, GC impacts project communication through visualization of the project. This is an interesting comment as the author was not able to source literature around the subject of how visual tools affect project communication. He continues to add that GC brings concreteness to the quality of communication by illustrating what are the deadlines, duration of tasks and how activities are related to each other. He believes that GC, by communicating this way, could help in prioritizing ongoing project matters. On the contrary, he identifies a risk that it can be possible to prioritize wrong matters i.e., discussing matters that are not as important.

Interviewee C explained that poor communication can have a negative effect on project performance. This is in line with Setiawan et al. as found in chapter 2.5.

He felt that when using GC, the project is executed in the most efficient way possible. As the author could not find literature to back this statement, this resonates on what Interviewee B said about GC is the key to get the most out of an individual by setting clear milestones and communicating the tasks at hand.

### 3.2.7 Interviewee D

Interviewee D pointed out that *“the more precise the time schedule has been created, the better the work can be done in a controlled way. There might be a lack of prioritizing of tasks.”* On the disadvantages he replied: *“In general, I don’t see drawbacks in using time schedules.”*

When asked about the importance of time schedule on project use, Interviewee D said: *“...time schedule is one of the main elements, on which a successful project can be delivered, in any case the importance should not be underestimated.”*

On a question regarding the added value through development of GC, Interviewee D commented: *“The benefit from creating a detailed schedule will be obtained in the following projects.”* On the other hand, he felt that the downside is the effort needed to develop the schedule: *“substations as a project (type) are so specific, it takes unbelievable number of tasks, which are intertwined, and need to consider, so the time management is... (time consuming). No project manager has the time to create such a schedule themselves from nothing.”*

The design engineer said that *“we can analyze whether we are missing important inputs from a work package or if another work package is better to do in a different sequence. We can identify the important work phases”*, when discussing what benefits GC could bring on a project. He noted that *“the time consumed on managing the schedule is an effort alone, but I believe the achieved benefit is greater than the effort we put in it.”*

Interviewee D did not feel the development of the schedule too time consuming: *“I would like to think that the development part of the schedule will iterate in the following projects. On a general note, I see that if you do something today that could help you in the next project, you gladly take the time to do those things. I did not feel it took that much time.”*

When asked how the design engineer perceived the achieved benefit of GC, he commented: *“I think it was beneficial. This was quite a large project and therefore*

*time-consuming. Now that everything was scheduled (on this project) I was able to work with other projects at the same time."*

He believed it would not be possible to execute a substation project without a schedule: *"You need to have at least a schedule with bullet points at for the milestones and objectives with penalties, to start with. Without a schedule it is impossible to deliver on time."*

He described the term communication as: *"communication is about discussing how things are going, are the things in schedule, when they are ready, what are the ramifications on tasks. In general, interaction between project personnel."*

He stated that *"a successful project requires strong communication between project personnel. Everything culminates in communication"*, when discussing the role of communication on a project.

When asked how the time schedule impact project communication, he pointed out that *"before using detailed time schedule, the communication happened in the project meetings. Now when we are following the work packages split in smaller efforts, we are discussing whether we can do this, and if we could do this faster etc. We followed intensely what topics and tasks are about to be done, these things and topics are now coming from the time schedule, they are more precise, and we don't forget anything, when compared to a discussion between project personnel."*

Interviewee D commented: *"I think it brings precision. We have better understanding when works are split into smaller packages, we can discuss based on logical thinking, rather than a feel-based discussion. This also emphasizes the fact that when a junior level worker starts a new work, he/she would not underestimate the amount of time needed for that performance"*, when discussing on how the GC affects the quality of communication.

When asked if he had encountered any communication issues in using Gc, interviewee D said that *"...when something is done enough, and it will be continued later, but the works after that task can still progress even it is not done fully, this*

*as a design engineer is clear for me, but in the schedule, it is difficult to interpret. Per se I don't feel communication issues as such, usually there were no topics left open."*

Interviewee D described the term performance as: *"performance illustrated the entity where efficiency and schedule and budget are coming together as we planned."*

On how communication impacts performance he said: *"if there would not be communication the project would be hard to steer, the personnel would not have clear idea what is happening in the project."*

Interviewee D commented on the question how time schedule affects project performance: *"The benefit comes from the timely execution, which relates back to time schedule. It gives a person the possibility to maneuver between projects."*

### **3.2.8 Analysis of Interview D**

Interviewee D shared the thoughts of other interviewees regarding the essentiality and importance of TS in project use by explaining that without a schedule it would not be possible to deliver the schedule on time. He continued saying that the TS is one of the main elements of on which a project can be delivered and that the importance of TS should not be underestimated.

The design engineer explained that the more details the GC has, the better the work can be done in a controlled way. It seems that GC brings structure for project work in way of listing the works to be done. He joined the majority in saying that there are no general drawbacks in using time schedules.

Interviewee D explained that the added value of developing a detailed GC will be obtained in the future projects by learning how the earlier projects are schedule wise. Even though projects by nature are unique, similar types of projects often share a lot in common; therefore, this is a key point and should be considered as a mandatory practice if applicable. He mentioned the same downside as others, the needed effort to develop the schedule and to keep the schedule up to date

but believed that the gained benefit is bigger than the effort put in the schedule development. As Interviewee D also represented the design department, he also mentioned the same as the Lead design engineer regarding the complexity of working with design documents with waterfall approach.

Interviewee D did not feel the GC affected his workload that much. Again, this is a subjective matter and depends on the role of an individual working on the GC.

The design engineer explained that he was able to work on multiple projects simultaneously in a controlled way when one of the largest projects he had at a time was scheduled to be detailed.

Interviewee D stated that a successful project requires strong communication, and that communication is where everything culminates on. His thoughts are in line with the literature found in chapters 2.3 and 2.5.

Interviewee D explained that having GC in project communication brings benefits, for example, the discussion on tasks is not that feel-based but instead based on hard logic. This indicates that using GC may affect communication positively, by removing unwanted noise as mentioned in the literature by Barret (chapter 2.5). This could also mean that by using GC as a communication platform information is exchanged in high velocity, as noted by Chiocchio (chapter 2.5).

Interviewee D described that with poor communication the project would be affected by factors which could hinder the project performance, again resonating with the literature as found in chapter 2.5.

He commented that GC affects project performance by giving guidance when each activity should take place, this gives one a possibility to manage his/her work as seen best. It seems that GC supports timely execution of project activities, and therefore, may affect project performance.

### 3.2.9 Summary of the Interviews

Key findings from the interviews have been summarized in Table 2. All four emphasize the importance of TS in planning, whereas Interviewee B also mentioned managing of TS is likewise important. All interviewees explained TS having an impact on communication and that impact was positive.

**Table 3.** Summary of GC time schedule impact on communication.

Interviewee	Importance of GC: Planning(P), Managing(M)	Effect of GC on communication: Increase quality or quantity (lqt, lqn), Prioritizes(Pri), Visual(V)	Effect of GC on communication: Positive (Po)
A	P	lqt	Po
B	P, M	Pri	Po
C	P	V	Po
D	P	lqn	Po

All four interviewees were like-minded on the essentiality of having a time schedule when delivering substation projects. Generally, they mentioned that GC is an important tool to plan the projects, but also to follow-up project progress and to manage project deadlines. On the other hand, two out of four interviewees mentioned no major drawbacks, whereas one mentioned possible cluttered view and one explained the fact that TS does not serve the project if it is not planned up to a certain level.

Three out of four interviewees pointed out the importance of planning during the development phase of GC, which indicates that they value the planning of project. The importance of planning is mentioned in the literature review in chapter 2.5. One interviewee explained that the added value of developing GC comes on during

the future projects through lessons learned. Two out of four mentioned that development of the GC is laborious.

All the interviewees explained that the biggest benefit from using the GC comes from the coordination of the tasks or planning the future works. This implies that GC works as a planning and communication tool, used either inside a department or beyond department limits, depending on the task at hand. On the downside one interviewee mentioned that the view may become cluttered when there are many tasks. Three out of four mentioned that the GC is laborious to use, even though when asked regarding the workload directly, no one specifically mentioned the use i.e., updating the schedule takes great effort, but three out of four mentioned that the development of the schedule is quite laborious, as presented by Ahuja chapter (2.2.3).

Three interviewees explained that having a GC in project use supports the planning of future works and provides time to react on upcoming works whereas one added that having a GC enables him to concentrate on multiple projects in a controlled manner.

The author wanted to ask how the interviewees see communication as a term, to establish a clear baseline on which to build further conclusions. Although the interviewees described communication differently, as a summary it can be said that all four see communication as an exchange of information.

All four interviewees explained that the role of communication for project work is essential. One described that the role of communication is to enable information exchange between project stakeholders, whereas two interviewees explained that communication is a must for project work as it enables teamwork, while the last one concretized the importance of communication by stating that everything culminates in communication. The findings from the interviews support the view of Zulch (chapter 2.3).

When discussing how the use of GC has affected project communication, there was no clear consensus. One interviewee explained how the use of GC has

increased communication, whereas one interviewee described how it has removed unnecessary communication, by guiding the discussion on the activities which matter the most. One interviewee pointed out how the GC establish a visual representation of the project, thus enabling stakeholders to discuss project status and the last one highlighted the importance of GC providing a list of activities to be done, so nothing is forgotten.

There was dispersion in the responses regarding the question about how GC has affected the quality of communication. The site manager felt there was no effect of any kind, whereas the lead design engineer thought the habit of updating the GC once a week is good practice. The Project manager pointed out that when communicating with GC, there is more concreteness in the communication, enabled by the visual presentation of the tasks, milestones, durations etc. He explained this would help in prioritizing the activities. On the other hand, he explained that during the development of the schedule the discussion could get carried away and thus end up prioritizing wrong things, this could negatively affect the quality of communication. The design engineer mentioned that there is a better understanding of the works when they are composed in smaller packages, which in turn can reduce misunderstandings. As a downside, he pointed out the earlier mentioned difficulties with design related work being not able to work flawlessly with waterfall type time schedules. This may cause frustration when updating activities to correspond to the actual situation.

All four interviewees were of the same opinion, that lack of communication has a negative effect on project performance. Three out of four mentioned that poor communication can have a negative effect on resource management, whereas one explained that projects would become hard to steer without communication. Findings from research support the literature discussed in chapter 2.3.

There is unanimity between interviewees when it comes to describing how GC effect project performance. All were indicating that there is a positive correlation between the use of GC and project performance. The site manager explained that the increase in performance comes through the development of the GC i.e.,

planning the works, as found in chapter 2.5. One interviewee explained that with the support of GC one could increase the performance of his/her work by meeting the given deadlines, whereas the design engineer explained that the use of GC enhances the timely execution of the activities. The project manager explained that with the GC the project would be executed in the most efficient way. The design engineer noted that the use of GC could give a person the possibility to also maneuver between projects.

## **4 CONCLUSIONS AND DISCUSSION**

### **4.1 Theoretical Contribution**

#### **Q1: What is the role of detailed Gantt chart time schedule on project communication?**

As written in chapter 2.3, communication has been referred as the lifeblood of a project and it can be seen as a foundation for integrating cornerstone areas of a project such as time, scope, and cost (Zulch, 2014). As discussed in chapter 2.5, Plowman & Diffendal (2020) argues that time schedule is the place where the pieces of project information are gathered. Depending on the intended use of time schedule, it can include beforementioned cornerstone areas time, scope, and cost, but also resources, for example. According to Ziek's et al (2015), as found in chapter 2.3.1., time schedule can be seen as a communication tool which enables project team to communicate certain project items.

Based on the interviews and literature, it can be said that the role of time schedule on project communication is to enable higher efficiency in project communication.

#### **Q2: How does the use of detailed Gantt chart time schedule impact the relationship between project communication and project performance?**

The findings from the interviews suggest that using a Gantt chart time schedule as a communication tool enables higher efficiency in project communication. Based on the findings from the interviews, time schedule may:

- Increase communication in all project phases.
- Reduce misunderstandings by providing visual presentation of the project and its activities.
- Reduce misunderstandings by composing activities in smaller work packages.
- Help to prioritize and rationalize communication.

As there is a correlation between effective communication and project performance (Setiawan et al 2021), it can be said that the impact of the detailed Gantt chart time schedule on the relationship between project communication and project performance is positive.

#### **4.2 Practical Implications**

On a high level, substation projects are no different than most construction projects. They are time-bound with multiple milestones where different departments inside and outside the project organization depend on each other. This naturally calls for a tool, which can demonstrate the project time schedule in an understandable way, including task dependencies, durations and more.

Based on the literature and findings from the interviews, following suggestions for implications are introduced. Firstly, continuing the development of the time schedule based on the case project TS is recommended as an attempt to gain more experience from projects with varying scope to establish the best possible version of time schedule for each project type. This naturally leads to increased communication between project stakeholders on each project, which supports project planning, thus increasing the odds for a better performing project teams and ultimately leading to more successful projects. Secondly, it is suggested to consider a use of a different scheduling tool for engineering and design works, which require a tool capable of handling activities which may reiterate multiple times. This would enhance the communication and ease up the monitoring of engineering activities.

As it has been suggested in the literature review, it is necessary to develop the project team behaviour in the area of communication and project management tools positively support this development. It is recommended to implement active use of time schedule for projects formerly known for not to take advantage of such a tool in project management works.

### **4.3 Limitations and Further Research**

The limitations of this study are discussed herein. The major limitation, in the eyes of a wider interpretation of this study, is the sample size. Keeping in mind the topic of this thesis, and the wide popularity of time schedules, specifically Gantt charts, the study represents a fraction of the construction industry as it was conducted for the case company, for a single project in Finland and the data was withdrawn from four company representatives from the same subdivision organization (sub-stations). Although the sample size was limited, there were visible patterns in the answers from the interviewees in key questions; therefore, a bigger sample size might not provide much additional data.

It is also to be noted that the software used for the case project was Microsoft Project Professional and the number of activities in the schedule was around 1700. The lifespan of the project is around one and a half years, and the project value is circa 12 000 000 euros. The project type and size are a limiting factor. It is also to be kept in mind that this study served for internal development project, so internal focus is present. Finally, it is to be noted that the development and use of the case project TS was done virtually, due to the project team members locating geographically around Finland.

As existing literature was not able to provide sufficient rationale why we need time schedules in project work, other than it is a “best practice” this thesis provided some insight into theory by trying to explain how the GC impact project communication and ultimately project performance. The studies around Gantt charts are not that popular and keeping in mind the approach on this study i.e., what is the impact of GC between communication and performance, it is yet to be studied how the improper use of GC could hinder the project performance.

## REFERENCES

Ahuja, V. and Thiruvengadam, V. (2004). "Project scheduling and monitoring: current research status". *Construction Innovation*, Vol. 4 No. 1, pp. 19-31.

Amin Ahmadi Digehsara , Hassan Rezazadeh, and Mohamad Soleimani (2018). Performance evaluation of project management system based on combination of EFQM and QFD. *Journal of Project Management*, Volume 3 Issue 4 pp. 171-182.

Barrett, D. J. (2006). "Leadership Communication: A Communication Approach for Senior-Lever Managers." *Handbook of Business Strategy Emerald Group Publishing*, pp.385-390.

Besner, C. & Hobbs, B. (2008). "Project management practice, generic or contextual: a reality check." *Project Management Journal*, Volume 39(1), pp. 16–33.

Bradford, William C., (2004). "Reaching the Visual Learner." *Teaching Property Through Art* (September 1, 2011). *The Law Teacher* Vol. 11.

Busetto, Loraine & Wick, Wolfgang & Gumbinger, Christoph. (2020). "How to use and assess qualitative research methods." *Neurological Research and Practice*. 2. 14. [10.1186/s42466-020-00059-z](https://doi.org/10.1186/s42466-020-00059-z).

Cervone Frank, H. (2014). "Effective communication for project success." *OCLC systems & services*, 06 May 2014, Vol. 30, Issue 2, pp. 74 – 77

Chiocchio, F. (2007). Project Team Performance: A Study of Electronic Task and Coordination Communication. *Project Management Journal*, 38(1), pp. 97–109. <https://doi-org.ezproxy.puv.fi/10.1177/875697280703800110>

Clarke, I., Flaherty, T. B., & Yankey, M. (2006). "Teaching the Visual Learner: The Use of Visual Summaries in Marketing Education." *Journal of Marketing Education*, 28(3), pp. 218–226. <https://doi.org/10.1177/0273475306291466>

Čulo, K. I Skendrović, V. (2010). "Communication management is critical for project success." *Informatologia*, 43 (3), pp. 228-235.

Dawson R. Hancock, Bob Algozzine (2006). "Doing case study research: a practical guide for beginning researchers."

Dvir Dov, Tzvi Raz, Aaron J. Shenhar (2003). "An empirical analysis of the relationship between project planning and project success." *International Journal of Project Management*, Volume 21, Issue 2, 2003, pp. 89-95, ISSN 0263-7863, [https://doi.org/10.1016/S0263-7863\(02\)00012-1](https://doi.org/10.1016/S0263-7863(02)00012-1)

Fossey E, Harvey C, Mcdermott F, Davidson L., (2002). "Understanding and Evaluating Qualitative Research." *Australian & New Zealand Journal of Psychiatry*. Issue 36(6), pp. 717-732. doi:10.1046/j.1440-1614.2002.01100.x

Geraldi, J. & Lechter T. (2012). "Gantt charts revisited." *International Journal of Managing Project in Business*, Vol 5, No. 4, 2012, pp. 578-594

Hameri, A.-P. (1997). "Project management in a long-term and global one-of-a-kind project." *International Journal of Project Management*, 15(3), 151–157. [https://doi.org/10.1016/S0263-7863\(96\)00051-8](https://doi.org/10.1016/S0263-7863(96)00051-8)

IPMA ICB (2015). "Individual Competence Baseline." *International Project Management Association*

Jitpaiboon, T., Smith, S. M., & Gu, Q. (2019). "Critical Success Factors Affecting Project Performance: An Analysis of Tools, Practices, and Managerial Support." *Project Management Journal*, 50(3), 271–287. <https://doi-org.ezproxy.puv.fi/10.1177/8756972819833545>

Kerzner, Harold (2009). "Project Management, A Systems Approach to Planning, Scheduling, and Controlling." 10<sup>th</sup> edition.

Kerzner, Harold (2017). "Project management metrics, KPIs, and dashboards: a guide to measuring and monitoring project performance." third edition.

Koskinen, Kaj U. (2004) "Knowledge management to improve project communication and implementation." *Project Management Institute* Vol. 35, No. 1, pp. 13-19.

c "Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing." *European Journal of General Practice*, 24:1, 120-124, DOI: 10.1080/13814788.2017.1375092

MacNeice, E.H, (1951). "Production forecasting, planning, and control" pp. 177-180 [https://openlibrary.org/account/login?redirect=/books/OL6221014M/Production\\_forecasting\\_planning\\_and\\_control./borrow?action=borrow](https://openlibrary.org/account/login?redirect=/books/OL6221014M/Production_forecasting_planning_and_control./borrow?action=borrow) Accessed 25.9.2023

Marsh, Edward R. (1975). "The Harmonogram of Karol Adamiecki." *The Academy of Management Journal*, vol. 18, no. 2, pp. 358–64. JSTOR, <https://doi.org/10.2307/255537>. Accessed 6 Apr. 2023.

McGraw, Hill. (2009). "Encyclopedia of Science and Technology"

Moon, Jayet. (2019). "An Investigation into the Use of Laney U Chart as a Visual Schedule Tracker to Graphically Monitor the Schedule Performance Index." *Journal of Engineering, Project, and Production Management*. 10. Pp. 35-41. 10.2478/jeppm-2020-0005.

Oxford Dictionaries. <https://web.archive.org/web/20120704084938/http://oxforddictionaries.com/definition/time>

Pankaja, P. K. (2005). "Effective use of Gantt chart for managing large scale projects: A publication of the American association of cost engineers." *Cost Engineering*, 47(7), 14-21. Retrieved from <https://www.proquest.com/scholarly-journals/effective-use-gantt-chart-managing-large-scale/docview/220442584/se-2>

Pinto, J.K. and Prescott, J. (1988). "Variations in critical success factors over the stages in the project life cycle." *Journal of Management*, Vol. 14 No. 1, pp. 5-18

Plowman, Connie & Diffendal, Jill (2020). "Project Communications: A Critical Factor for Project Success." ProQuest Ebook Central, <https://ebookcentral-proquest-com.ezproxy.puv.fi/lib/vamklibrary-ebooks/detail.action?docID=6270021>. Accessed 26.9.2023

PMI (2013). "A Guide to the Project Management Body of Knowledge: Pmbok Guide 5<sup>th</sup> edition." Project Management Institute.

PMI (2017). "A Guide to the Project Management Body of Knowledge: Pmbok Guide 6<sup>th</sup> edition." Project Management Institute.

Prayitno E. et al (2020). "Use Case Points (UCP) with 3 Point in Program Evaluation and Review Technique (PERT) to Estimate Effort Software." *Journal of Physics: Conference Series*, Volume 1641, 1641 012008.

Project Management Institute, Inc. (2013). *The Essential Role of Communications*. <https://www.pmi.org/-/media/pmi/documents/public/pdf/learning/thought-leadership/pulse/the-essential-role-of-communications.pdf?rev=e1f0e9144b3a456fb75e40101632258b> Accessed 20.4.2023

Raiyn, J. (2016). "The Role of Visual Learning in Improving Students' High-Order Thinking Skills." *Journal of Education and Practice*, 7(24), pp. 115-121.

Reza Ferial Ashadi, Albert Eddy Husin & Ireng Guntorojati. (2022). "Infrastructure Construction Projects Scheduling Using Manual-Program Evaluation and Review Technique (M-PERT) Method. Case Study: Indonesian Sunda Strait Bridge." *DOAJ Directory of Open Access Journals*, Vol. 29 No. 2 (2022): *Jurnal Teknik Sipil*

Rolfesen Christian Nordahl, Christoph Merschbrock (2016). "Acceptance of construction scheduling visualizations: bar-charts, flowline-charts, or perhaps BIM?" *Procedia Engineering* 164 (2016), pp. 558 – 566

Saib, Suzan & Program, Hubungan & Industri, Fakultas & Kemanusiaan, Seni & Warisan, & Kunci, Kata & Kpi, & Laku, Tingkah. (2020). [https://www.researchgate.net/publication/341792931\\_MAKNA\\_DAN\\_CIRI-CIRI\\_KPI\\_YANG\\_BAIK\\_MENURUT\\_PETROU\\_2017\\_Makes\\_and\\_Features\\_A\\_Good\\_KPI\\_Following\\_Petrou\\_2017](https://www.researchgate.net/publication/341792931_MAKNA_DAN_CIRI-CIRI_KPI_YANG_BAIK_MENURUT_PETROU_2017_Makes_and_Features_A_Good_KPI_Following_Petrou_2017) Accessed 3.5.2020

Serrador, Pedro & Turner, Rodney. (2015). "The Planning Deficit: A Global Quantitative Study on the Planning Phase and Project Success." *Academy of Management Proceedings*.

Setiawan, A. F., Hansen, S., & Fujiono, A. (2021). "Measuring the Influence of Communication Planning Towards Construction Project Performance." *Civil and environmental engineering (Berlin)*, 17(1), pp. 58-65.

Seymour, T and Hussein, S. (2014). "The History of Project Management" *International Journal of Management & Information Systems –ThirdFourth2014* Volume 18, Number 4, pp. 233-240.

Toor Shamas-ur-Rehman, Stephen O. Ogunlana (2010). "Beyond the 'iron triangle': Stakeholder perception of key performance indicators (KPIs) for large-scale public sector development projects." *International Journal of Project Management*, Volume 28, Issue 3, pp. 228-236.

Toor Shamas-ur-Rehman, Stephen O. Ogunlana. (2008). "Critical COMs of success in large-scale construction projects: Evidence from Thailand construction industry." *International Journal of Project Management*. Volume 26, Issue 4, pp. 420-430.

Vandevoorde, Stephan, Vanhoucke, Mario. (2006). "A comparison of different project duration forecasting methods using earned value metrics." *International Journal of Project Management*, Volume 24, Issue 4, pp 289-302.

Wilson, J. (2003). "Gantt charts: a centenary appreciation." *European Journal of Operational Research*, Vol. 149 No. 2, pp. 430-7.

Yin, R. (1994). "Case Study Research." Sage Publications

Yin, R. (2003). "Case Study Research: design and methods." 3 edition, Thousand Oaks, CA: Sage pp. 40-41.

Ziek, P. and Anderson, J.D. (2015). "Communication, dialogue and project management." *International Journal of Managing Projects in Business*, Vol. 8 No. 4, pp. 788-803. <https://doi.org/10.1108/IJMPB-04-2014-0034>

Zulch BG (2014). "Communication: The foundation of project management." *Procedia Technology*, Volume 16, 2014, pp. 1000-1009.

## APPENDIX 1 -Interview questions

### **Gantt Charts, general**

1. How long have you worked with Gantt charts?
2. What are the general advantages of Gantt charts?
3. What are the general disadvantages of Gantt charts?
4. Can you describe the importance of time schedule in project work?

### **The use of Gantt chart in substation case project**

5. Does the development of Gantt chart bring added value to the project?
6. Does the use of a Gantt chart bring added value to the project when monitoring and controlling the project?
7. Are there some drawbacks in planning the project (development of Gantt cart) in detail?
8. Are there some drawbacks in monitoring and controlling the project tasks in detail?
9. How does the use of Gantt chart support timely execution of substation project?
  - 1.9.1. Would it be possible to execute a substation project without a time schedule, please explain?
  - 1.9.2. How does the visual presentation of the project (text and task dependencies) impact your understanding of the project status?
10. How does a detailed project time schedule affect your workload?
  - 1.10.1. During development
  - 1.10.2. During monitoring and controlling

### **The role of the Gantt chart in project communication:**

11. How would you describe communication as a term?
12. What is the role of communication in projects?
13. How would you describe the role and impact of Gantt chart in project communication?

14. How does the use of Gantt chart affect the quality of communication?
15. What kind of communication issues have you encountered when discussing project related matters while using Gantt chart?
16. How would you explain project performance?
17. How does communication affect project performance?
18. How does the use Gantt Chart affect project performance?