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An Improved Time Scheduling Process for the Case Company

Metropolia University of Applied Sciences

Master of Engineering

Industrial Management

Master's Thesis

03 May 2023

PREFACE

This thesis work embarks on a challenging journey of tackling a highly fascinating subject. I want to express my gratitude to the case company for giving me the chance to work on such an interesting subject. While traveling along this road, I have gained knowledge on a lot of new subjects, and I have also developed fresh viewpoints on the approach to handling organizational issues.

My special thanks to thesis supervisors, Dr. Thomas Rohweder and M.A. Sonja Holappa for the consistent support and guidance provided throughout the thesis. The assistance allowed me to maintain my motivation and complete the difficult task of finishing the thesis by the deadline.

I want to express my gratitude to the Managers and other team members who helped me with this work and were involved at all stages; without their assistance, I would not have been able to perform this work.

Last but not least, I want to offer my heartfelt gratitude to my family and friends for sticking with me with unwavering support and drive throughout the process.

As the light at the end of the tunnel for this work approaches, I am eager to apply the knowledge to new endeavors and explore more interesting avenues in the future.

Espoo, 03.05.2023

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Abstract

Author:	Abitha Venkatramani
Title:	An Improved Time Scheduling Process for the Case Company
Number of Pages:	79 pages + 2 appendices
Date:	3 May 2023
Degree:	Master of Engineering
Degree Programme:	Industrial Management
Professional Major:	Data Driven Business
Supervisors:	Dr. Thomas Rohweder, Principal lecturer M.A. Sonja Holappa, Senior Lecturer

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The thesis is for a Case company that handles projects of varying scopes, and they are facing issues in handling the uncertainties that cause delays in the project schedule. The objective of this study is to identify the areas of weakness and provide recommendations in the form of an action plan to improve the existing time scheduling process for the case company.

The thesis work adopted the applied research approach with four stages to handle the issue concerning the case company and develop practical and useable solutions. The first stage was to understand the existing process and identify its strengths and weaknesses. One weakness was chosen as the critical weakness and an extensive literature study was performed to collect ideas to resolve the weakness. The ideas from the literature were transferred to recommendations through the co-creation process and finally validated to develop the final recommendations.

The current state analysis revealed that the strengths and weaknesses were distributed all along the process. The main weaknesses areas identified were the input to the process, the review session, the developed time schedule, and the scope change handling procedure. An extensive literature study of the critical weakness scope change handling procedure resulted in identifying the five areas to address to improve the process. The various recommendations for all five areas can be summarized as the inclusion of new steps in sub-processes, performing validation studies, and developing new process flow charts and process descriptions.

The outcome of this study was the final recommendations in the form of an action plan and the implementation plan helps to improve the existing time scheduling process of the case company. The thesis work has helped to improve the project efficiency and project planning. Further studies for the other weaknesses identified can help to improve the process continuously.

Keywords: Time schedule improvement, Scope change management, Change impact analysis, Change control tracking, Roles and Responsibilities, Communication

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PIM	Probability and Impact assessment Matrix
CSA	Current State Analysis
CF	Conceptual framework
SRA	Schedule Risk Assessment

1 Introduction

Companies and organizations regardless of their size require to handle projects of varying scopes and timelines continuously. The project management team is responsible to steer a project over the life cycle by planning, monitoring the progress, and successfully delivering the project by the agreed time and budget. The key challenge for the project management team is to ensure that the projects are delivered on time and have processes that help to achieve time efficiency. One of the essential activities of project management that determine the efficiency of the projects is the time scheduling process adopted by the organizations.

Time scheduling is defined as a technique used to prepare the flow of activities and the schedule to perform the planned work. It is usually presented as charts depicting the timeline (APM, 2020). Organizations usually have an existing process to prepare and execute the time schedule for a project to ensure a similar and uniform approach is adopted in all the projects. As in any process, there is a critical need for continuous process improvement also for such time scheduling processes to spot the inefficiencies and eliminate them.

This study intends to identify the issues that affect the existing time scheduling process for engineering design activities and to develop an improved time scheduling process for the case company.

1.1 Business Context of the Case Company

The case company is an Engineering service provider for a wide range of chemical industries that provides advanced technological and engineering expertise in designing production plants. The case company is based in Finland and has over a few hundred employees working on various engineering and management teams. The company handles multiple projects of different scopes

ranging from small improvements in existing production plants to designing and constructing a completely new production plant.

The case company management function handles the planning, monitoring, and execution of various projects along the life cycle. Delivering all projects within the planned budget and resources is critical for the case company to be competitive and productive.

1.2 Business Challenge, Objective, and Outcome

The case company has handled numerous projects in the past years and has a definite process to plan and execute the projects. The existing time scheduling process handles the timeline and prioritization of the project execution among the various engineering teams involved. Many uncertainties occur during the project execution, and the initial time schedule developed should be able to accommodate these unexpected problems and deliver the goals. The project management team is attempting to identify the uncertainties and is trying to plan the project with improved time efficiency. Therefore, it is necessary to identify the problems in the current planning and time scheduling process of the case company that causes delays in the schedule and improve it.

The project management team for every project consists of a project manager, a project controller, and team leaders from various engineering functions who are technical experts involved in the project. Team leaders manage independent engineering functions comprising team members of varying expertise.

The objective is to develop recommendations to improve the existing time scheduling process for the case company and the outcome of the study is an action plan with recommendations. The outcome provides the case company with an improved process that helps to handle the uncertainties in a project and maximize the efficiency of projects.

1.3 Scope and Outline of the Study

This study is divided into four sections to address the business problem stated in section 1.1. The first two sections provide detailed information regarding the existing process at the case company and possible solutions available in the literature for the identified issues. The latter two sections involve developing an improved time scheduling process and validating the newly developed time scheduling process.

The study contains seven sections. Section 1 introduces the business problem and the objective of the study. Section 2 outlines the project plan, data collection and explains the reasons for choosing the research approach. Section 3 presents the current time scheduling process adopted by the case company and summarizes the strengths and weaknesses as findings. Section 4 provides detailed literature regarding the possible solutions for the most critical problems identified and outlines the conceptual framework. Section 5 presents the initial proposal for the improved time scheduling process. Section 6 adopts the feedback received for the initial proposal and confers the final improved time scheduling process.

This study does not include the implementation and further development of the time scheduling process. It focuses mainly on the current state, identifying the most critical issues, and developing an improved time scheduling process. The following section outlines the project plan and provides information on the selected research approach and design, and the data collection.

2 Project Plan

The challenge, objective, and outcome were presented in Section 1. This section starts with a description of the selected research approach and design, followed by the data collection and analysis methods.

2.1 Research Approach

The research approach for conducting research on any topic is a crucial parameter as it determines the accuracy, reliability, and validity of the findings from the research. Therefore, it is important to choose the correct research approach to ensure that the research conducted helps in contributing to resolving the problem identified.

Hedrick et al. (1993) describe the similarities and differences between basic research methods and applied research. Any research method requires adequate planning. Basic research is adopted to develop new knowledge and innovations and employs an experimental approach to reach the goal. Basic research is mostly used in universities to build theory and in most cases is executed over a long period. The practical usability of the solution developed is not considered a priority in basic research.

Hedrick et al. (1993) mention that applied research is a direct approach and is effective in handling real-world problems with practical solutions. It is a non-systematic approach usually executed in time-constrained situations and focuses on developing immediate solutions. There are numerous approaches available to perform the applied research and they include evaluation research, research and development, and action research. The main differences between the two methods are that basic research focuses on addressing universal problems whereas applied research focuses on addressing specific issues in an organization or institute.

According to Kananen (2013), applied research combines development and research and aims to produce practical and useable solutions in organizations. Kananen (2013) highlights that applied research is employed in an organization to continuously improve processes by directly interacting and working with the people involved in the process. As mentioned in section 1.2, the objective of this study is to develop recommendations to improve the existing time scheduling process of the case company which is a continuous improvement process. Applied research is selected to perform this study as the issue is concerning a specific organization and the purpose is to develop a practical solution that can be employed immediately.

The scope of the study involves developing recommendations to improve the time scheduling process and implementation of all the ideas is excluded from the scope of this study. As the study requires to understand the underlying reasons for the problem, which is subjective phenomena, the qualitative approach is chosen over the quantitative approach.

2.2 Research Design

The business challenge defined in Section 1 is studied in four stages to achieve the desired outcome. Figure 1 shows the Research design adopted in this study.

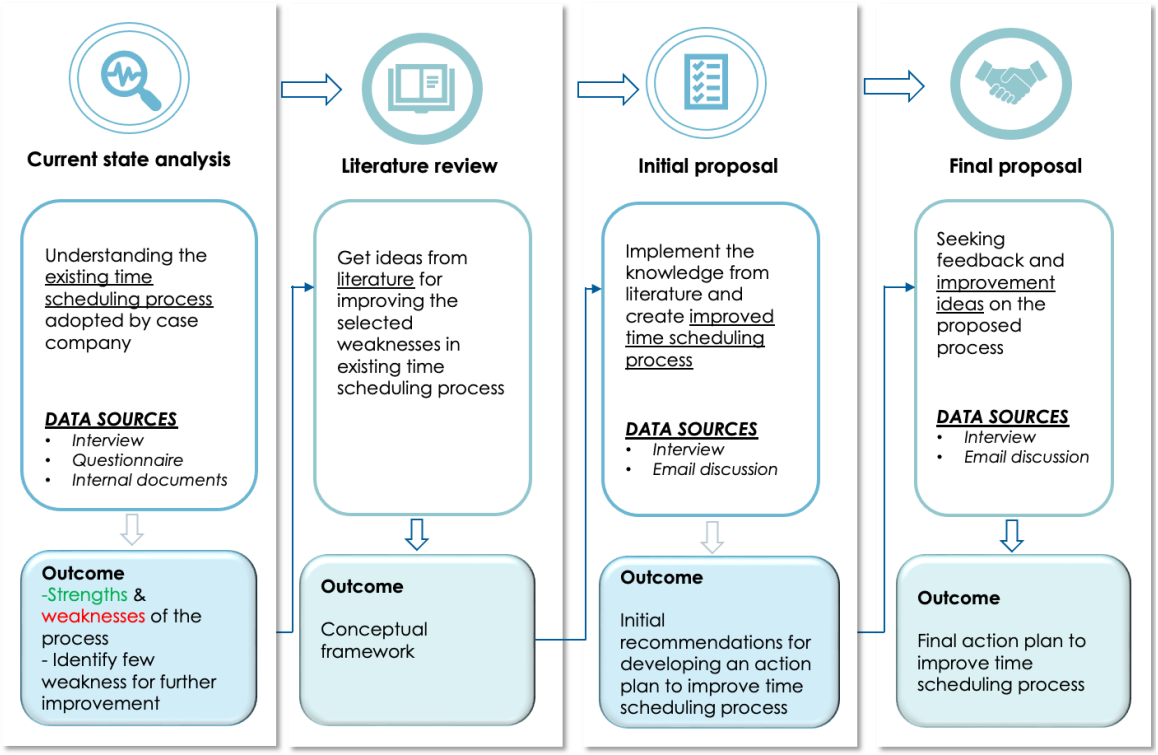

Figure 1. Research Design of this study

As shown in Figure 1, the current state analysis is the first stage of the study. Before attempting to solve any problem, it is important to understand the current situation completely. Hence, the current state analysis is performed to review the existing internal documents relating to the time scheduling process descriptions, work procedures, and work instructions. The core group for this study is selected in such a way that it helps to understand the issue from different functions and perspectives. The individual one-to-one interview is conducted with the members of the identified core group for the study. A questionnaire is prepared, and the core group is asked to answer it. At the end of the current state analysis, the strengths and weaknesses of the process are summarized. From the list of weaknesses, one critical weakness is selected for further improvement.

The literature review is the second stage depicted in Figure 1. After understanding the current time scheduling process adopted by the Case Company, the literature knowledge is studied to obtain ideas relating to the most critical weakness identified in the earlier stage. The discoveries from the literature are compiled to create a conceptual framework for this study. The next stage is

to create an initial improvement recommendation based on the techniques identified and the conceptual framework developed in the earlier stage. The co-creation involved people from the core group identified for this stage using one-to-one interviews. The outcome from this stage is an initial recommendation for process improvement.

As shown in Figure 1 the fourth stage is the validation of the recommendation created in the earlier stage. The validation is performed by presenting the developed initial recommendation to the core group members. Feedback from the group is incorporated to create the final recommendations for process improvement.

2.3 Data Collection

This study involves collecting data from various sources such as internal documents, questionnaires, and structured interviews. An overview of all the data collection methods is presented in the following table. Table 1 shows the Data 1 collection for the current state analysis including the internal documents that are examined.

Table 1. Data 1 collection and internal document

No.	Informant/ Source	Approach	Time	Documented
1	Instruction – Planning and control schedule in Internal DMS	Document	Accessed - 10.1.2023	Summary of internal documents.docx
2	Instruction – Progress tracking in Internal DMS	Document	Accessed 10.1.2023	Summary of internal documents.docx
3	Instruction – Schedule preparation and update in Internal DMS	Document	Accessed 10.1.2023	Summary of internal documents.docx
5	Project Managers (2)	Interview-Video call	Week 3 – Jan 2023	Field notes
6	Project Planners (2)	Interview-Video call	Week 3 – Jan 2023	Field notes
7	Discipline managers (3)	Interview-Video call	Week 3 – Jan 2023	Field notes
8	Discipline leads (3)	Interview-Video call	Week 3 – Jan 2023	Field notes

As shown in Table 1, the Data 1 collection has various methods such as interviews and documentation with the selected core group to gain the required knowledge regarding the existing time scheduling process. Table 2 presents the second round of data collection that is performed during the initial process improvement recommendations.

Table 2. Data collection during the initial recommendation stage

No.	Informant/ Source	Approach	Time	Documented
1	Project Manager (1)	Interview - video call, Email inquiry	Week 6 – Jan 2023	Field notes
2	Project Planners (2)	Interview - video call	Week 6 – Jan 2023	Field notes
3	Project Controller (1)	Interview - video call	Week 6 – Jan 2023	Field notes
4	Discipline managers (2)	Interview - video call	Week 6 – Jan 2023	Field notes
5	Discipline leads (2)	Interview - video call	Week 6 – Jan 2023	Field notes

In the second data collection round, Data 2 collection is done through interviews facilitated to co-create the initial recommendations for process improvement. Email inquiry was used to reach people during issues with schedule availability.

Data 3 collection includes getting feedback from validation of the initial recommendation for the improved time scheduling process and is presented in Table 3.

Table 3. Data collection for validation of initial recommendation

No.	**Informant/ Source**	**Approach**	**Time**	**Documented**
1	Project Manager (1)	Interview – video call	Week 10 – March 2023	Field notes
2	Project Planner (1)	Interview – video call, Email discussion	Week 10 – March 2023	Field notes
3	Team Manager (1)	Interview – video call, Email discussion	Week 10 – March 2023	Field notes

The last data collection will be Data 3. As shown in Table 3 the validation of the initial recommendations provided to improve the time schedule process will be done with the different members. The validation interview was conducted as a one-to-one interview and email discussion through an online application.

The following section presents the findings from the current time scheduling process as strengths and weaknesses.

3 Current State Analysis of the Time scheduling process

This section describes the current state of the time scheduling process and presents the results categorized as strengths and weaknesses. The previous section presented the data collection method adopted during the current state analysis of the process.

An overview of the current state analysis (CSA) is presented through the process map of the main time scheduling process and the related sub-processes in this section. The input to the process, the time-schedule preparation process, and the scope change handling process are the sub-processes included in the main process.

Having a clear and detailed understanding of the current process is critical to establish benchmarking and creating best practices within an organization. Despite having established procedures for executing a certain process within an organization, there are always opportunities for improvement. And it is by conducting a current state analysis of the process using critical tools such as process mapping, areas that are lacking in the process can be identified. Without such an analysis, it may be assumed that the process is close to its ideal state, which is not necessarily the case. Mapping the existing process is a critical tool for any organization to identify any inefficiencies in the existing process and facilitate continuous improvement.

3.1 Overview of the Current state analysis

Knowledge and understanding of the existing time scheduling process adopted by the case company were gained by collecting information through internal documents, conducting one-to-one interviews with different stakeholders, and facilitating a few questionnaires to various teams. The first step was reading the existing internal documents relating to the time scheduling process. Instructions relating to planning, updating, developing the schedule, and tracking the progress were examined. The process description of the time scheduling process was

studied. The core group for this study was selected in such a way that it helps to understand the issue from different functions and perspectives. The members of the core group mainly involved a few Project Managers, Project Planners, Discipline Managers, and Discipline Leads to provide an insider view of the existing process.

To ensure that individual opinions are not shadowed in group discussions and obtain opinions from different perspectives in the beginning stage, the one-to-one interview was chosen as the mode of data collection over a workshop. The individual one-to-one video interview was conducted with the members of the identified core group. Interviews were conducted with pre-planned questions. As hybrid working is adopted these days, video interviews were preferred over in-person interviews. Observations from interviews were logged as field notes during the event. A questionnaire was prepared, and the core group was asked to answer it. Email inquiries regarding specific issues were also facilitated by a few who were not available for a one-to-one interview. The questions for the questionnaire and email inquiries can be found in Appendix 1 and Appendix 2.

Of the various problems recognized in the current state analysis, the most critical weakness that hinders the performance of the time scheduling process was identified to study further and improve the effectiveness of the process.

3.2 Description and Analysis of the existing time scheduling process

The existing time scheduling process was mapped as a flow chart using general flow chart symbols and notations. The time scheduling process is presented in the main process flow chart in Figure 2.

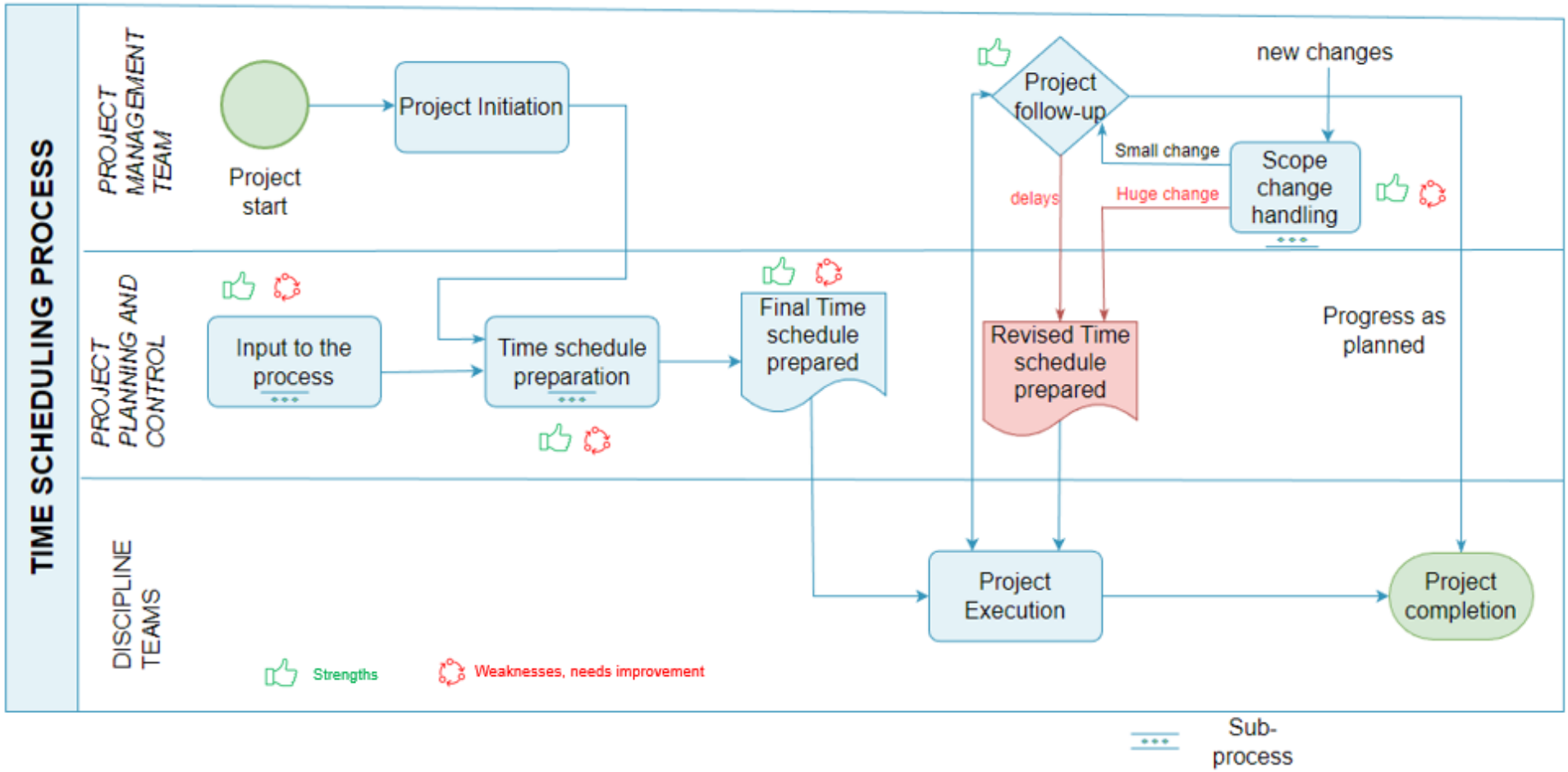

Figure 2. Flow chart of Time scheduling process

As seen in Figure 2, the main time scheduling process is divided into three sub-processes namely the Input to the process, the Time schedule preparation, and the Scope change handling process. The following subsections provide detailed information regarding the activities performed in the sub-processes. The main process starts with the project initiation by the project management team. After the initiation, the project planning team uses the input to prepare a preliminary schedule which will be reviewed in the review session along with the project members to create the final schedule. The final time schedule prepared is taken to use in the project execution by the individual teams which is regularly followed by the project management team. The team ensures the completion of the project as per the time schedule without causing any changes to the timeline agreed upon. However, certain unforeseen situations can cause the project to delay and require that there are changes to the already prepared time schedule. At these times, the time schedule is revised to reflect the new situation.

As seen from the internal documents and interviews, the availability of clear instructions for creating, planning, and follow-up of schedules indicates that the case company is aware of the importance of this step-in project and there is a standardized approach in all projects. From the interview of the core group identified and questionnaires, it was clear that a definite process and clear instructions are available for creating and planning the time schedule for different projects. Proper and sophisticated tools are available for preparing detailed time scheduling for projects. Moreover, the project management and planning team are aware of the importance of continuous improvements and planning in improving the efficiency of the projects. In addition, the process includes a review session to discuss with other project members which is critical in creating realistic schedules. One of the interviewees stated that,

> *Project Management considers and recognizes the importance of planning and are open to feedback. (CSA interviewee 1)*

As the project comes to an end, the company has a process that collects feedback from various disciplines regarding the things that could have been improved in the project execution. The issue is that the lessons learnt from

previous projects that would help in avoiding the repetition of the same issue were not rigorously followed up. This is causing at times similar problems to the surface also in future projects.

3.2.1 Sub-process: Input process

The first step in preparing the time schedule is to receive proper inputs to the time scheduling process. The flow of activities in receiving the input for preparation is shown in Figure 3 below. The areas of identified strengths and weaknesses are indicated with symbols in green and red respectively.

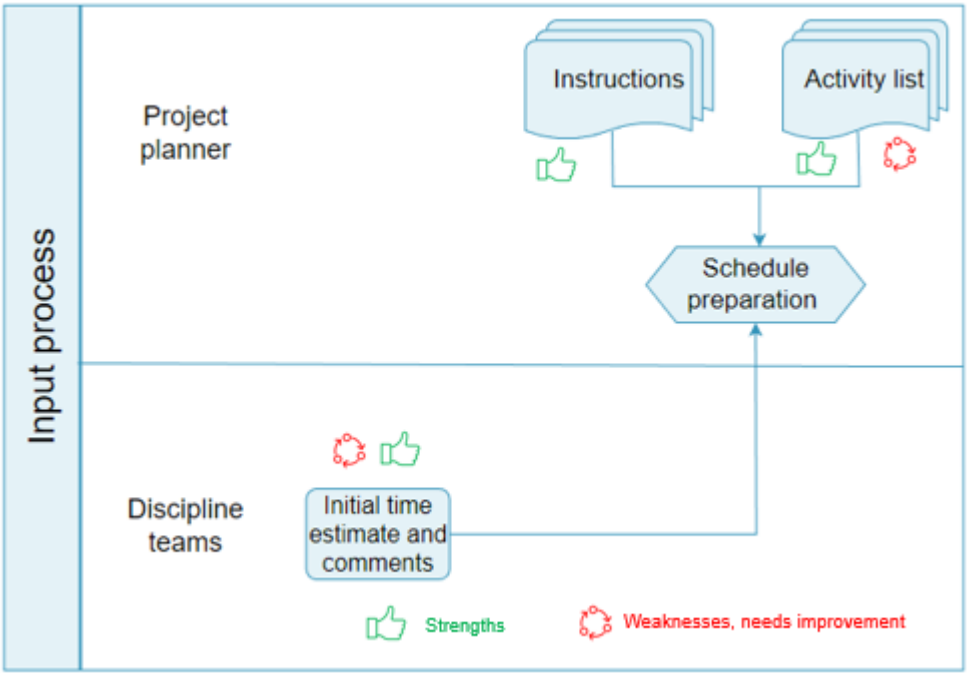

Figure 3. Flow chart of Sub-process- Input process

The case company has clear instructions for planners to create, plan, develop, and monitor the time scheduling process. Different types of pre-filled templates in the tool are available for different types of projects. The interview with members revealed that pre-filled templates are helpful for planners to understand the requirements of the project and save considerable time in preparing the initial links of activities. But the drawback with these templates is that for many projects, the templates require many changes, and that disturbs the established links

between the tasks in the tool. This led to requiring more time to update the schedule in the tool. In the interviewee's own words:

> *The templates are generally not suitable for all projects and requires too many changes (CSA interviewee 2)*

An activity list in Excel format that defines the required tasks by each discipline for a specific type of project is available for the planners. These activities are added to the schedule and are tailored at a later stage along with the project team. Each individual discipline also provides time estimation based on the scope of the project. With all the inputs received the preparation of the schedule is performed by the planners.

The weaknesses noticed are that the individual discipline time estimates do not have a standard procedure and it largely depends on the experience of the discipline lead. Sometimes this results in creating too optimistic schedules. The activity list has most of the tasks that need to be executed but does not define the order of execution required and this causes issues in delivering the activities as planned in the time schedule. This also requires attention from individual disciplines during the beginning stages of every project. The prioritization of activities in the schedule is not often as required in project execution and disciplines are having difficulty in following the time schedule. In the interviewee's words, the problem is as follows:

> *The relationship between tasks is not in line, there is always something changing in your own discipline's tasks after you have commented on the schedule. (CSA interviewee 3)*

3.2.2 Sub-process – Time schedule preparation process

The process visualization of time schedule preparation is presented in Figure 4 below.

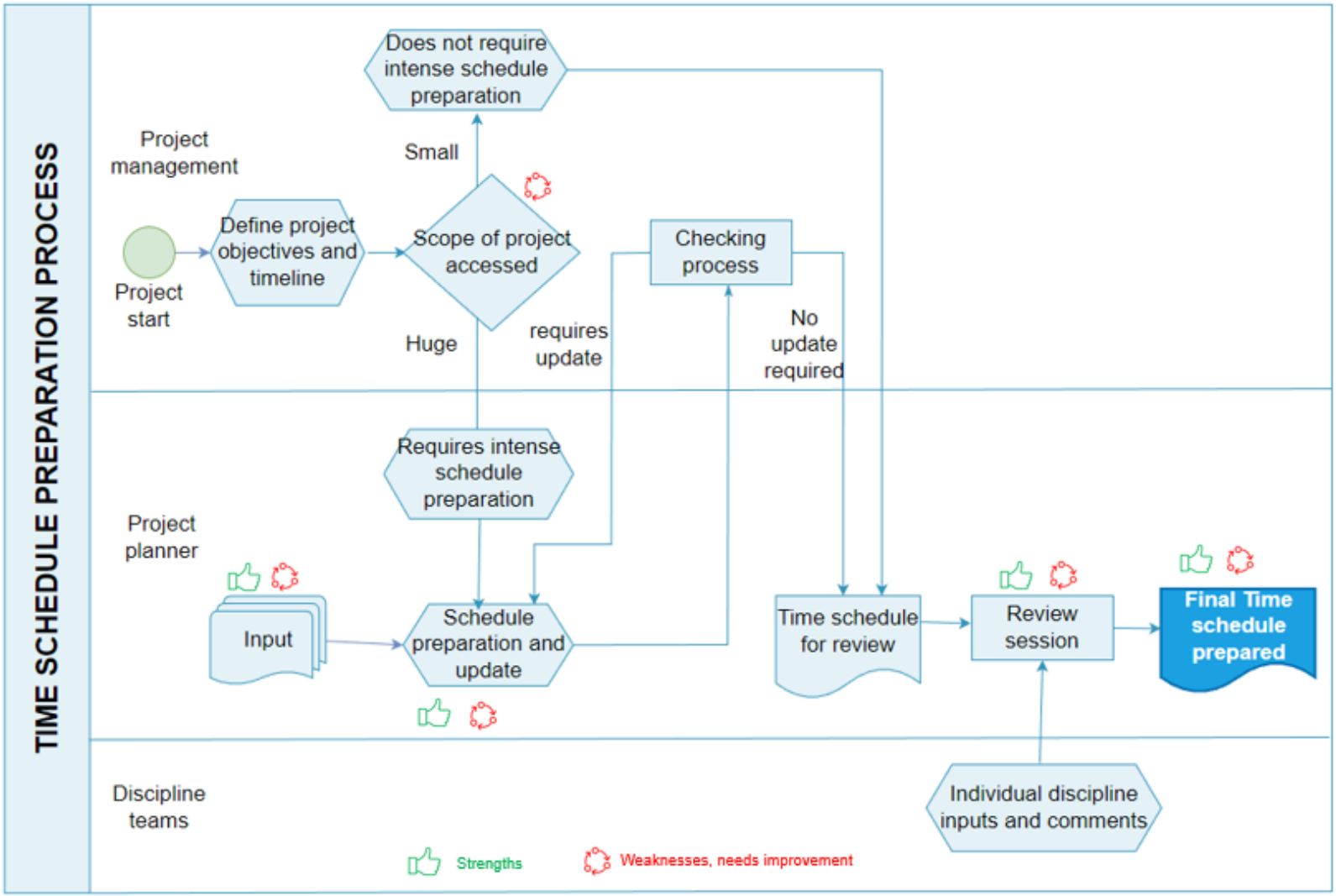

Figure 4. Flow chart of Sub-process- Time scheduling preparation process

As shown in Figure 4, when the project starts, the scope is defined by the project management along with the process owners. If the project scope is small, a simplified time schedule listing all the activities and time frame is prepared, and project execution is continued. For projects with a huge scope, the project planner collects all the inputs required to prepare the detailed schedule as stated in Section 3.2.1. After the preliminary schedule is prepared and checked by the project management team, the first version is reviewed along with the other project members in the review session. The final version is created by incorporating the comments from the individual disciplines.

Based on the interviews and the internal documents, the company can create detailed time schedules to reflect the project needs. The detailed time schedule developed has both positive and negative impacts. It is seen that detailed schedules are very useful for the planning team to follow up and track the project but at the same time, it does not provide clarity to disciplines on interdisciplinary impacts. The developed time schedule chart is lacking the ability to reflect the iterative nature of the project.

One of the commonly mentioned weaknesses is that the implementation of the review session is not efficient and largely depends on the project management team. At times the review session is held as discussions through email as the project team includes many team members and common discussions are time-consuming. Inter-disciplinary and project management communications are lacking during the review sessions and the impact of inter-disciplinary comments is mostly not clear for individual disciplines. In a few cases, there is a lack of designated people from the disciplines to address any issues. One interviewee expressed this as follows:

> *It is hard to hear other discipline comments when the comments are gathered individually and not in a common meeting. (CSA interviewee 6)*

Another important weakness identified during the CSA is that the communication between the disciplines and project management does not happen at the beginning and this always affects the execution of the project.

3.2.3 Sub-process – Scope change handling process

The process visualization of scope change handling process is presented in Figure 5 below.

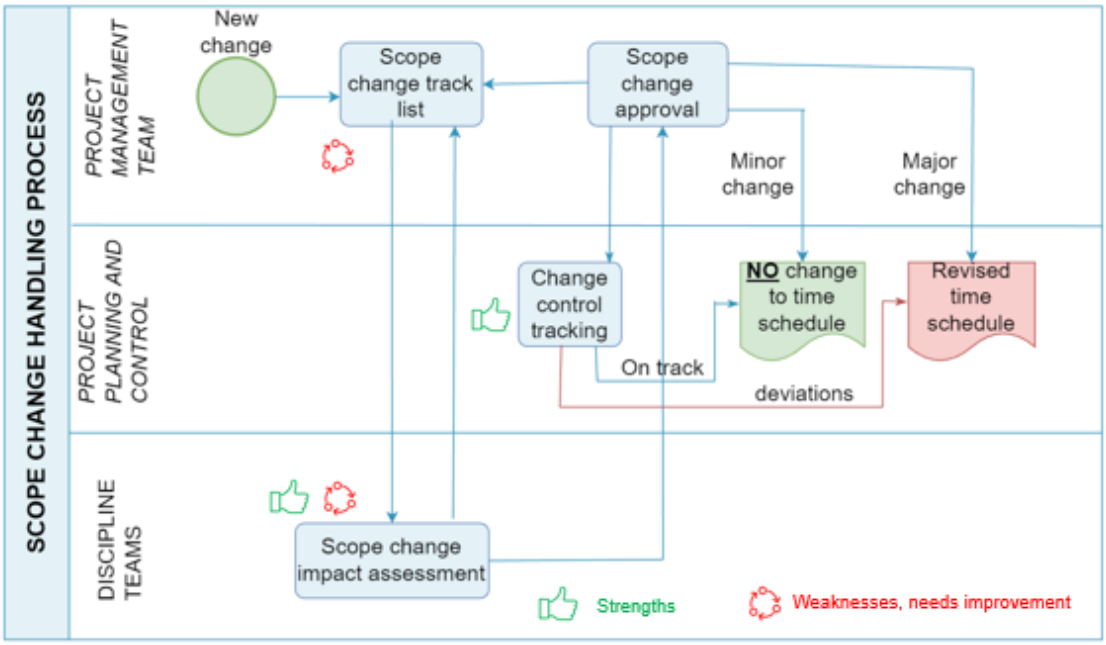

Figure 5: Sub-process: Scope change handling process

Despite the best efforts to avoid any scope change along the project execution, in some cases, there can be new scope changes that arise in the projects. During such scenarios, the discipline team along with the project management follows an existing scope change handling procedure. The process starts with recording the change received into the track list and the responsible discipline teams perform the change impact analysis. Once the impact of the new scope change is assessed by the individual teams, it is communicated to the project management team for approval. The project management team along with the project control team evaluates the results provided by the discipline teams to

make informed decision regarding accepting or rejecting it. When decided to proceed with the change initiated, if the intensity of the changes has a significant impact, the time schedule will be updated by the planner. No change to the time schedule happens if the impact is minor. After updating the time schedule, the project execution continues and the project follow-up by the project management team continues to ensure the project is completed as per the new schedule deadlines.

Defining the scope at the beginning of the project is a crucial first step that has an adverse effect on the time schedule. It was stated that in many cases, scopes are not frozen in the beginning stage and hence the available time schedule does not reflect reality or causes more revisions to time schedule creation. One of the interviewees stated the following,

> *Having simpler scheduling in the beginning to discuss between the discipline and project management helps to provide comments. (CSA interviewee 4)*
>
> *Not freezing the scope in the beginning is the most common issue and makes it difficult to know the reality of situation. New changes are always expected in projects (CSA interviewee 5)*

Apart from freezing the scope at the beginning of the project, the other important area of concern is the scope change handling procedure. The company has an existing scope change handling procedure and the necessary tools to record all the changes, prepare an impact assessment, and track the changes. Though there are existing procedures and tools available to handle the scope change, the issue mentioned during the interviews was in implementing them effectively. Another important issue mentioned during the interviews was regarding the existing change impact assessment method. The current method focuses more on the impact on the budget and resources and lacks a bit of clarity to handle the impact to time schedule. It was mentioned that there is currently an ambiguous situation regarding the identification of when a schedule re-forecasting may be required.

3.3 Summary of the findings

A current state analysis was carried out to identify the strengths and weaknesses and the findings are presented in Table 4. The strengths are highlighted in green, and the weaknesses are highlighted in red.

Table 4. Summary of strengths and weaknesses of the process

#	Findings	Category
1	Existence of a time scheduling process	Strengths
2	Clear instructions for time schedule preparation and scope change handling are available	
3	Prepared using sophisticated tools	
4	Very detailed time schedules are prepared and are helpful in monitoring the progress	
5	Pre-filled time scheduling templates available for different types of projects	
6	Feedback is gathered and focused on improving the process	
7	Flow of tasks and prioritization of activities are not well defined in the existing time scheduling templates	Input to the process
8	Updated activity list is not user-friendly, requires many of input from disciplines	
9	Review session is not implemented effectively.	Review session
10	Inter disciplines comments and impacts are unclear	
11	Developed time schedule cannot illustrate the iterative nature of engineering activities	Developed time schedule
12	Too optimistic time schedules are prepared	
13	The method of freezing the scope at the beginning of the project is not effectively implemented.	Scope change handling procedure
14	Lacking in the change impact analysis	
15	Lacks in the practical implementation of the existing scope change handling procedure	
16	Implementation of lessons learnt is not effective and lacking in most cases – no follow-up done	Implementation of lessons learnt

As shown in Table 4, a total of 16 Findings were identified and are categorized into 5 categories namely the input to the process, review session, developed time schedule, scope change handling procedure, and implementation of lessons learnt. The findings resulted in 6 strengths and 10 weaknesses. When analyzing

the findings stated in Table 4, it was seen that the weaknesses were spread across various categories and not one step was found to be the weakest link. While focusing on weaknesses is important to improve the process, it should be highlighted that existing strengths must be retained and utilized to benefit the overall performance of the process.

3.4 Key findings to study further

The findings from the current state analysis were categorized and summarized in Table 4. From the list of findings, the critical weakness that has a large impact on the time scheduling process is chosen for further study and is presented in Table 5 below.

Table 5. Critical weaknesses for further study

Category	#	Findings
Scope change management	13	The method of freezing the scope in the beginning of the projects is not effectively implemented
	14	Lacking in the change impact analysis
	15	Lacking in the practical implementation of the existing scope change handling procedure

All the categories mentioned in Table 4 are important to improve the overall efficiency of the time scheduling process. As the weaknesses identified in the study are distributed across different domains, the thesis emphasizes on enhancing a specific category that is deemed to be the most crucial element. The definition of scope is a vital component for the success of any project, as it serves as the basis for all subsequent activities. Similarly, any new change to the already defined scope of the project may not be desirable but they are often unavoidable during the project execution. In both these scenarios, there is a risk of scope creep, where there would be a need for additional tasks, deliverables as well as resources. The occurrence of a scope creep situation can have a significant impact on the time schedule, and it is important to prevent it from happening to ensure that the time schedule reflects reality and is achievable. Therefore, the

most crucial aspect of maintaining the project progress and achieving desired outcomes is the effective management and implementation of these scope changes. Consequently, the effective management of scope changes in projects is currently identified as the most critical area requiring improvement in the time schedule process. It can be established that any change in scope directly resonates as an impact on time schedule.

Overall, the focus in the next Section 4 is on redefining and improving the existing procedures and tools. To address the weakness of scope management, this study draws on existing knowledge and practical method discussed in the relevant literature. This knowledge is used to develop the initial recommendations for the improvement of the process.

The following section presents the knowledge from the literature to address the critical weaknesses identified in the current time scheduling process.

4 Improvement ideas from Relevant literature

The outcome of the current state analysis in the previous section helped to recognize the most critical weaknesses to be addressed to improve the existing time schedule process. In this section, literature research is performed to explore potential approaches to address the identified weaknesses. Accordingly, this section presents the comprehensive knowledge and ideas to improve the scope handling in projects gained from various relevant literature. The summary of the identified ideas from the literature is gathered into five sub-categories and presented in visual format as a conceptual framework.

4.1 Project scope and scope creep

The project scope is a comprehensive documentation of specific objectives, requirements, deliverables, and anticipated results which is commonly agreed upon between the organization and the client (Kraus et.al, 1992). Project Scope can be considered a core component in the project planning process and has a significant impact on the success of any project. The scope determines the required cost, time, deliverables, and timeline to execute the project successfully. Failing to freeze the scope of the projects, in the beginning can lead to scope creep situations (Ahmed and Jawad ,2022).

Komal et.al (2020) defines scope creep as a situation that increases demand and expectation to deliver more than the initial agreement between the organization and the client. Scope creep results in severe negative consequences such as project delays, a decrease in quality, an increase in the planned cost, or customer dissatisfaction. Ajmal et al. (2021) presented a statistical overview that the total project failure rate is about 19% and of which 50% is caused solely due to scope creep. The above result is a clear indication that scope creep is one of the main reasons for project failure and can have a huge impact on the time schedule of a project.

Although it is undesirable, change is unavoidable in some justifiable situations. This situation can be overcome by utilizing a proper scope change handling procedure. An effective scope change handling procedure is crucial in minimizing or eliminating the negative impacts of scope creep and ensuring the project is completed according to the time schedule.

Project managers can utilize the standards provided by the Project Management Institute (PMI) as a guideline to efficiently plan and manage the changes that occur in projects (McCann, D.E, 2013). The scope management process typically consists of the following essential steps: planning the scope, gathering the requirements, defining the scope, developing a work breakdown structure, verifying the scope, and controlling the scope (Al-Rubaiei et al., 2018). The above-mentioned key steps can be categorized into different areas identifying, initiating the process, assessing the impact, validating, and tracking the change.

4.2 Ideas on improving change impact analysis

The most critical step in the scope change handling procedure is to assess the potential impact of change in terms of cost, time, tasks, and resources. Lock and Kotonya (2020) emphasize that impact analysis is an essential step to have a thorough comprehension of the magnitude of the change, and the complexity involved and accurately determine the time and the cost involved in implementing the change.

Change impact analysis is the method adopted by companies to identify the potential impacts due to the change initiated and develop a feasible plan to achieve the success of the project by avoiding adverse scenarios. Typically, when there is a new change, it usually does not solely pertain to a particular area of impact but tends to affect various other tasks and deliverables. Improper impact analysis can cause the project management team to face difficulties in the decision-making process of accepting or rejecting a change (Lock and Kotonya, 1999). Failing to properly assess the impacts causes even a small change to have a huge impact on the overall success of the project.

4.2.1 Impact analysis process definition

Lock and Kotonya (1999) suggest the main activities to be followed in an impact analysis process as different steps. These steps are presented in Figure 6 below.

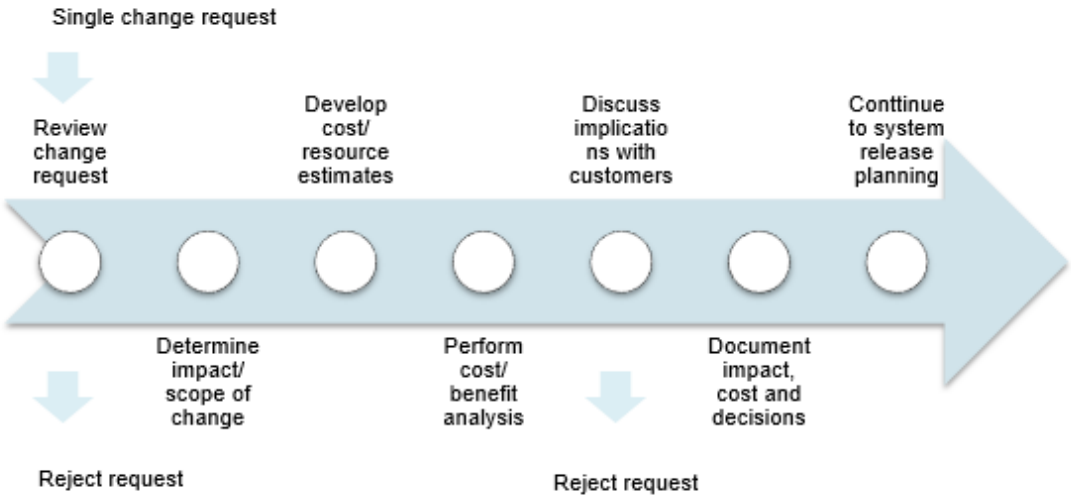

Figure 6: Impact analysis process (Lock & Kotonya, 1999)

The author suggests a framework that can be used to create an effective impact analysis process. Figure 6 presents various steps to ensure that the process can assess the impacts of the change in terms of cost, resource, time, and risk. This process will enable the team members to have a better understanding of the requirement that can be well documented and further implemented in project execution if the decision was accepted. The defined process is required to be presented as a process description in the instruction manual to standardize the approach and ensure that the tasks in all projects are carried out consistently. Process description makes it possible to break the complex process into smaller parts to help the members to understand the process and clearly define the roles and responsibilities.

The above-mentioned impact process method has a direct influence on the betterment of time schedule. Even though the case company in this thesis has an existing scope change handling procedure with impact assessment as the first step, there is a need for clarity to perform this step. Therefore, detailed instructions or guidelines to perform the impact analysis is essential. The

literature knowledge helps to clearly define the process to be followed in the assessment step.

4.2.2 Impact analysis determination method

The impact determination is usually done by traceability extraction methods such as:

I. Pre-recorded traceability analysis – This technique is used to analyse and ensure traceability in a project by creating a pre-populated traceability matrix. It uses information from projects and end-users to create relationships between different entities and this information is used as a basis for projects (Lock & Kotonya, 1999).

II. Dependency analysis – This technique is used to create traceability by predicting the possible propagation paths. The method focuses on creating a model that would help to identify relationships between different models (Lock & Kotonya, 1999).

III. Plain experience analysis - This technique uses existing experience as the basis to create the path propagation and relationship between the change and the areas of impact. This method can be regarded as a simple and effective method to perform impact analysis (Lock & Kotonya, 1999).

IV. Extrapolation analysis – This technique uses existing experience to perform predictions and understand the possible direct and indirect impacts that will be caused by a new change (Lock & Kotonya, 1999).

V. Certainty analysis – This technique uses two measures namely degree and certainty of definition in combination to identify the most possible and least possible impact predictions. The result is a value within the range of 0 – 1, where 1 would mean that the certainty of the impact is highest (Lock & Kotonya, 1999).

VI. The existing determination method currently available in the case company needs to be reassessed using the methods described above to possibly improve the process.

4.2.3 Analysis method for classifying change

Stekolschik (2016) suggests the possibility of incorporating the ABC analysis method as a tool to manage the problem of change risk and avoid adverse consequences.

ABC analysis method categorizes the change based on effort and the areas/teams affected by any change. The change categories defined in this method are presented in Figure 7 below.

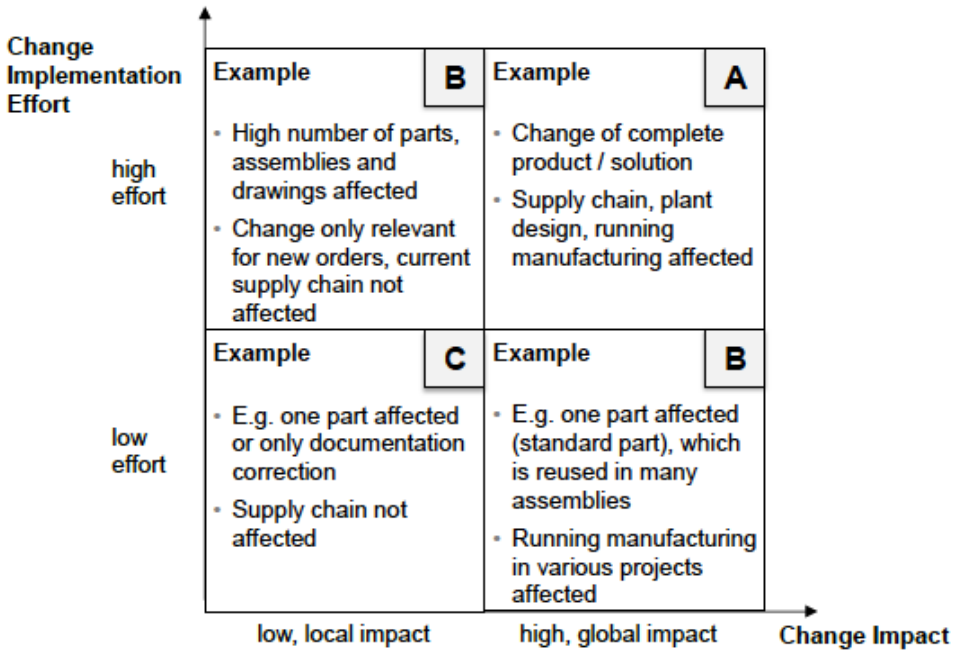

Figure 7: Change classification (Stekolschik, 2016)

The change classification method suggested in Figure 7 is an example of an Engineering project that would have a change impact on both internal and external parts of the organization. When employing this method to handle the

issue of the case company, the area of impact would be different teams within the same organization. The change categories in Figure 7 indicate:

- 'A' changes: High impact - change causes huge cost and a huge area of impact
- 'B' changes: Medium impact - change causes either huge cost or huge area of impact
- 'C' changes: Low impact - change causes low cost and low area of impact

4.2.4 Impact assessment matrix

One of the key steps mentioned in impact analysis in Figure 6 is the impact assessment step. To improve the assessment process, Ifeanyi (2019) have adopted a matrix approach named Probability and impact assessment matrix (PIM). It is also commonly known as a risk assessment matrix and is used in projects to identify the risks and develop proper mitigation methods to reduce the risk (Ifeanyi, 2019). It is one of the quantitative risk analysis methods that map the probability of occurrence to the consequence of the project. Each risk is quantified in two factors namely the probability and the intensity of consequence and helps to classify all the risks as low, medium, or high risk. Ifeanyi (2019) presents the basis for deciding the risk level based on the probability and consequence factors as in Table 6 below.

Table 6: Decision on risk level based on PIM (Ifeanyi,2019)

Consequence / Probability	**Negligible (0 - 5 %)**	**Minor (6 - 20%)**	**Moderate (21 - 40 %)**	**Serious (41 - 50%)**	**Disastrous (>50%)**
0 -10 %	Negligible	Negligible	Negligible	Tolerable	Tolerable
11 - 40%	Negligible	Negligible	Tolerable	Tolerable	Intolerable
41 – 60%	Negligible	Tolerable	Tolerable	Intolerable	Intolerable
61 – 90%	Tolerable	Tolerable	Intolerable	Intolerable	Intolerable
91 – 100%	Tolerable	Intolerable	Intolerable	Intolerable	Intolerable

The existing impact assessment matrix can be improved by reassessing the already defined impact matrix using the knowledge from the literature.

4.3 Ideas on improving the change control tracking process

Project monitoring and tracking are critical to identify the project progress in a timely manner and intervene with actions when necessary. The basis for any project control and tracking is the schedule developed (PMKC, n.a). During process scope change, it is important to perform change control tracking as it helps to ensure the scope impact assessed is executed and implemented as desired. This step is inevitable throughout the whole project progress and especially when the project scope changes as it avoids scope creep, facilitates informed decision-making, mitigates risk associated with scope change, and ensures accountability for the activities performed.

4.3.1 Performance indicators

Numerous project efficiency indicators exist for analyzing the performance of the current or completed projects. These indicators are important for project managers to monitor the project performance in terms of various factors and are employed as a tracking tool in change control.

1. **Schedule variance (SV) –** Compares the difference between the actual project time schedule and its anticipated time schedule (Usmani, 2022). Positive SV indicates a positive situation in terms of project execution whereas negative SV indicates delays. SV should not be the only metric used (Short, J.W, 1993).

2. **Cost variance (CV) –** Compares the deviation between the planned and the actual budget in projects (Usmani, 2022).

3. **Schedule Performance Indicators (SPI):** A variation of the usual SPI metric that considers the budget at completion (BAC), earned value and the actual value can be used to identify areas that require improvement to perform better in future projects. A value of 1 or greater than 1 indicates that the project has been completed according to the planned schedule (Aldrige, 2021).

4. **Schedule Efficiency Index (SEI):** A metric used to analyze the efficiency of the time consumed in a project. A value of 1 or greater than 1 indicates that the project has been completed according to the planned schedule (Aldrige, 2021).

5. **To complete schedule performance indicator (TSPI):** A metric similar to PI that helps to analyze the utilization efficiency of the remaining time in projects. A value of 1 or greater than 1 indicates that the project has used the remaining time efficiently *(Aldrige, 2021)*.

6. **Design phase cost performance index (DPCI):** DPCI is the ratio of the budgeted cost of the project to the actual cost of the project to measure the project efficiency specifically in the design phase *(Kuprenas, 2003).*

7. **Schedule sensitivity index (SSI):** SSI is an activity sensitivity measure and helps to identify the low, medium, and high sensitive activities.

These metrics are required to provide more insights regarding the completed project performance to the Project Managers and help to identify areas of improvement in a project.

4.3.2 Schedule risk analysis

Schedule risk analysis (SRA) is one of the effective techniques employed in projects to determine the potential impact of activity on project schedules and costs (PMKC, n.a). It is helpful to overcome issues caused due to unexpected events or in situations where the optimistic schedule is developed. It can be used by Project Managers to identify the risks associated with the project schedule and take the required mitigation measures to execute the project within the original budget and schedule. PMKC (n.a) presents the four steps involved with performing a schedule risk analysis below:

- Develop a baseline schedule
- Define uncertainty in terms of cost and time probability distributions
- Run Monte-Carlo simulations
- Interpret the sensitivity measures

The result of SRA is a set of sensitivity measures that help to provide insights regarding the criticality and sensitivity of the activities involved in the project (PMKC, n.a).

4.3.3 Control limit indicators chart

The utilization of the Statistical process control (SPC) technique in Earned Value Management (EVM) for monitoring and controlling projects is not a novel idea. Colin and Vanhoucke (2014) present a new SPC approach coupled with the tolerance intervals to produce two project control charts namely the X chart and the R chart. The authors present the possibility of using an illustrative control chart with upper and lower control limits that can be used as indicators to know the schedule performance.

The control chart presented in Figure 8 uses the already known metric schedule performance index (SPI) or the schedule performance index using an earned schedule, SPI(t), and offers the possibility to identify deviations in either direction. An observation below the lower control limit indicates that the project schedule is at risk and requires corrective actions. Similarly, a situation of having an observation above the upper control limit (UCL) is an indication of an opportunity and the need for re-forecasting the schedule. If the project performance remains within UCL and LCL, it can be assured that the project is being executed as expected.

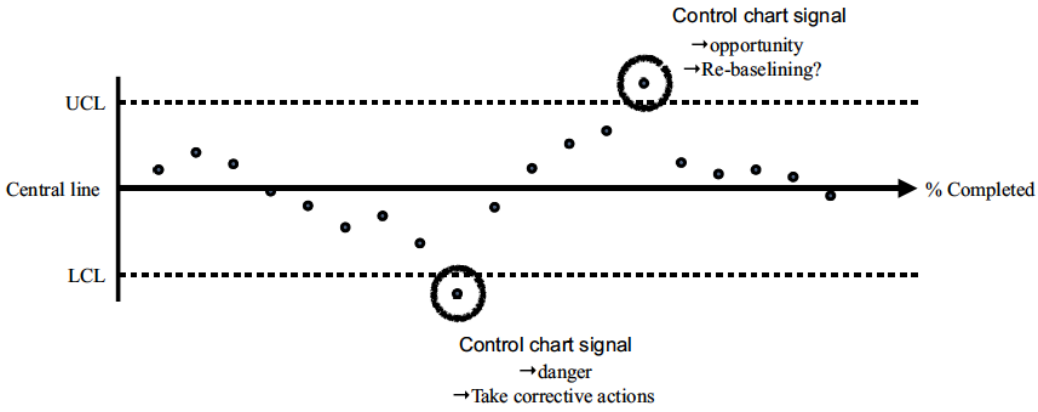

Figure 8: Illustrative control limit chart (Colin and Vanhoucke, 2014)

Vanhoucke (2011) presents two variations to the above-mentioned project tracking method named Top-down project tracking which employs the EVM method and Bottom-up project tracking that employs schedule risk analysis.

- Top-down project tracking - This method uses the most common metrics such as schedule performance index (SPI) and SPI(t) to identify certain critical parameters.

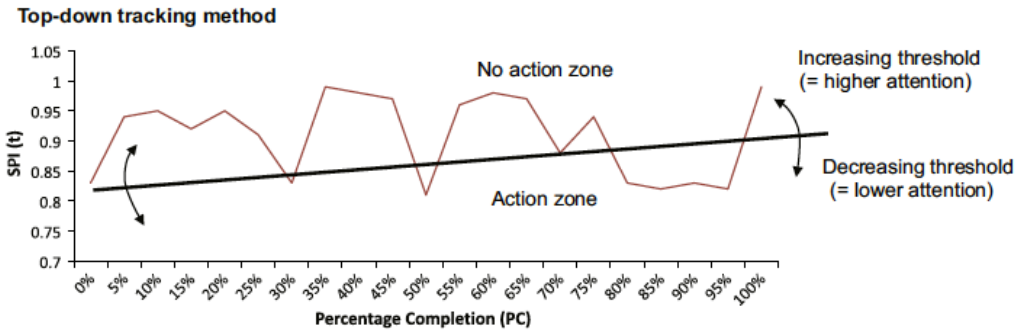

Figure 9: Top-down tracking method (Vanhoucke, 2011)

As seen in Figure 9, a factor below a certain SPI can be an indication for the Project Manager that the project is lagging and requires attention (Vanhoucke, 2011). Decreasing SPI(t) threshold for a project is an indication that the project considers higher attention at the beginning of the project compared to the later stages of the project.

- Bottom-up project tracking – This method uses sensitivity measures such as SSI to evaluate critical activities that are lagging.

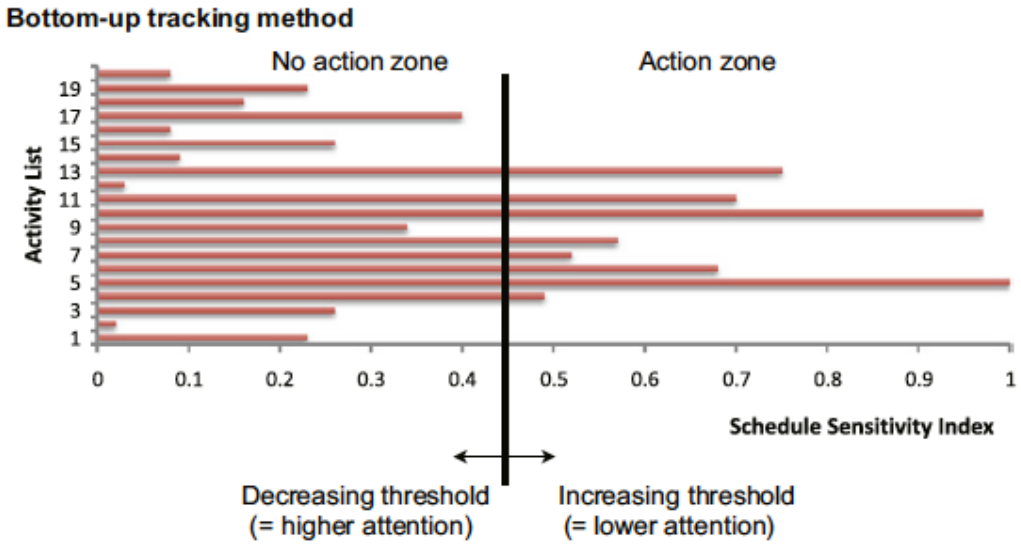

Figure 10: Bottom-up tracking method (Vanhoucke, 2011)

As seen in Figure 10, activities with a sensitivity value greater than a certain threshold indicate that attention and action is required (Vanhoucke, 2011). Decreasing the SRA action threshold indicates that more activities are considered sensitive. Having many highly sensitive activities is an indication that the project requires intense control.

4.4 Ideas on improving the tools used to handle changes

Any organization handling a huge project requires executing of various plans, projects, and tasks. With the help of proper tools, Project Managers can handle several information quickly and improve the accuracy of the work executed. Tools are indispensable in project management as they help to handle the complex coordination between teams, manage the resource and budget allocation, and effectively track and monitor the project (Technolabs, 2019).

Numerous tools are required to efficiently handle the scope change process including the change register, change assessment, change order, risk

management tools, change management tools, and collaboration tools (Desmond, 2017). Organizations can use either inhouse tools or more efficient management tools from the market to perform the required tasks.

4.4.1 Enhancing existing change register and assessment tool

A change register or change tracking list is an essential tool in the change management process and is the heart of the change management process as it helps to record and document all the changes in the entire project phase (Wale, n.d). This tool is critical for Project Managers to track the changes and communicate the information to all the team members to properly plan and take required action. The change register is used as the foundation for deciding whether to accept or reject a modification (Group, 2018).

The change register should ensure to provide many details regarding the change, and it typically contains information such as the date of origin and closure, description, status, type and nature of change, priority, deviations caused by the change in terms of cost, time, and resource, follow-up action required and responsible person (Group, 2018).

Group (2018) has presented the possibility to have information related to risk assessment as part of a change register template. The necessity of risk assessment and prioritizing is emphasized in Sections 4.3.3 and 4.3.4, and adding the results to the change log is crucial in bringing additional clarity. The risk assessment sheet provides information such as probability, risk rating, triggers, phase, response, contingency plan, and response plan (Group, 2018).

4.4.2 Utilization of PM tools in market

It is common for organizations to develop and use in-house tools that cater to specific needs and requirements. However, these tools can lack some of the features that exist in more standard tools in markets and can affect the project efficiency. The previous sub-section 4.4.1 discussed the possible ways to

improve existing in-house tools for change management used in organizations. Other alternatives to the in-house tools are the market-available project management tools, which can provide better collaboration, tracking, prioritization and create visually interactive dashboards to monitor the project.

Business Intelligence tools available in the market can provide better tracking possibilities, thereby helping project managers to have a better understanding of the risks and issues (Windsor, 2020). Standard tools such as Monday.com, Primavera, and SAP have change management plan templates as a package that can be used by organizations.

Benedecti and Brito (2021) have evaluated a few project management tools such as MS Project, Jira, Asana, Trello, and Basecamp available on the market based on different requirements and highlighted that these tools can help organizations to become more effective and agile.

Abdel-Khalek et al. (2019) discusses the possibility of using Oracle Primavera Contract Management (PCM) to handle claims and perform delay analysis for a construction project. The authors have compared the tools on various requirements and proved that these tools are effective in controlling cost, monitoring documents, and avoid delays in the time schedule.

Risk assessment can be performed using tools available in the market and some of them include SAP risk management, Primavera, and Service now. Risk assessment tools can be selected based on their ability to provide better functionality, useability, integration, and cost (Nwokolo, 2022).

4.5 Ideas on improving the communication

Communication is considered as the lifeline of a project and especially during situations when new changes occur. It is critical that everyone is informed regarding the changing situation and clearly redefine the requirements. Ineffective communication can result in misunderstanding, inadequate definition

of tasks, and unclear goals which can lead to schedule delays and increased project costs. Planning the project communication and communicating the planning effectively is the key to improve the project performance and having a positive impact on the quality and better decision-making (Zulch, 2014).

4.5.1 Developing change communication plan

A communication plan is a practice that helps Project Managers to devise the strategy to be followed over the entire life cycle of a project but more important in change processes. Zulch (2014) defines communication as a cornerstone for all aspects of a project such as cost, resource, scope, and time. Developing a communication plan helps in avoiding unnecessary meetings, mistakes, misunderstandings, and delays. AIPM (2021) presents the factors to be considered before a communication plan is created:

1. Who are the stakeholders involved?
2. What is being communicated?
3. Why is the information being communicated?
4. When is the information planned to be communicated?
5. How is the communication performed?

The above questions help to include the necessary components for a communication plan which includes the purpose, mode of communication, frequency of communication, and the required audience.

The basic guidelines that can be followed to create an effective communication plan is presented below (Team, 2022):

1. Define the line of communication
2. Set SMART goals for communication (Carmicheal, 2023)
3. Identify the project communication goals
4. Identify internal and external stakeholders
5. Define the level of communication for different types of communication goals and stakeholders

6. Define the purpose of the communication
7. Define the communication methods
8. Define the communication schedule

Line of communication refers to either formal or informal mode of communication. Depending on if the communication is performed with internal or external stakeholders the method of communication varies. Internal communication methods can be oral communication, written communication, non-verbal communication, and electronic communication. The external communication method is critical for the organization as it is important for the image of the organization involved (Zulch, 2014). Thus, it is critical to plan communication for both internal and external stakeholders.

Oral communications can be performed in the form of meetings, smaller discussion groups, and announcements. These can happen either face-to-face or through calls over Skype, Google Hangouts, or Teams. Written communication includes emails, reports, presentations, and memoranda (Zulch, 2014). According to Villanovau (2021), it must be emphasized to the team members that communication has to be made a priority and highlights that it is important to not assume that things are clear for everyone. It also highlights that it is critical to initiate communication, especially during negative situations.

4.5.2 Developing benefits communication matrix

The importance of classifying change based on the impact and effort was presented in Section 4.3.3.

The impact and effort matrix presented in Figure 7 can be used to prioritize and highlight the communication tactic that can be utilized in projects. The different change classifications may require different communication modes and prioritization (benefitfocus, 2018) as shown below:

1. **High impact/ Low effort – Quick-wins**
    - helps to achieve larger impact with minimal effort
    - should be prioritized and maximized
2. **Low impact/ Low effort – Fill-ins**
    - easy to execute
    - do not require high prioritization as they do not have a big impact
3. **High impact / High effort – Require planning and budget**
    - requires immediate attention and high effort
    - require the highest prioritization
4. **Low impact/ High effort – Not worth it**
    - requires high effort for insignificant impact
    - should be minimized and least prioritized

Based on the prioritization, the Project Manager defines the mode of communication, and this is developed and presented in the communication plan.

4.6 Ideas on providing clarity on roles and responsibilities

Missing ownership of tasks and requirements has been one of the key reasons for problems in the efficient execution of projects, especially in a change situation. When the roles and responsibilities are clearly defined it helps to increase productivity and decrease the time and cost involved. Asana (2021) provides a guideline to follow to increase clarity in roles and responsibilities for a process.

4.6.1 RACI matrix for defining roles

Many models that exist to define task ownership and the RACI matrix is one of most used. It is also known as a responsibility assignment matrix (RAM) or linear responsibility chart (LRC) and is used as a project management tool to provide clarity concerning the roles and responsibilities of the people involved in the project. Costello (2012) presents the roles and level of influence of different people according to the RACI matrix definition and is as below:

- ‘R’ – Responsible – Individual/s who perform the task – Can be one or more people involved
- ‘A’ – Accountable – Individual who approves the task – Only one approver
- ‘C’ – Consulted – Individual/s who provide suggestions mostly subject-matter experts
- ‘I’ - Informed – Individual/s who are conveyed regarding the decision/situation and can include managers and external stakeholders

To create an efficient RACI matrix, Maria (2018) provides the following guidelines:

1. Create a list of activities and deliverables
2. Define the project members/ persons involved
3. Determine the roles and responsible job titles and deliverables expected
4. Conduct review sessions with members
5. Implement RACI matrix in projects

4.6.2 Developing training plan

Though creating clear and detailed instructions for any process is important, it cannot replace the need for training people to provide more clarity regarding the process and roles and responsibilities. The absence of training can indicate that it is assumed that everyone on the team understands their roles and responsibilities. Along with defining the roles and responsibilities using the RACI matrix, there is a need to strengthen the understanding of roles and responsibilities through training. Korsten (2002) highlights the three steps to be followed while developing a training plan:

1. Analyzing the requirements for training
2. Converting the requirements into an action plan
3. Evaluation of the training

The most important step of the training plan is the requirement analysis which is conducted through a need assessment survey and gap analysis. This step

focuses on identifying the audience and the areas to focus on training. It is critical to make the communication plan an important part of the training plan. University of Minnesota (2016) presents various factors to be considered in developing a training development model and it is presented in Figure 11 below.

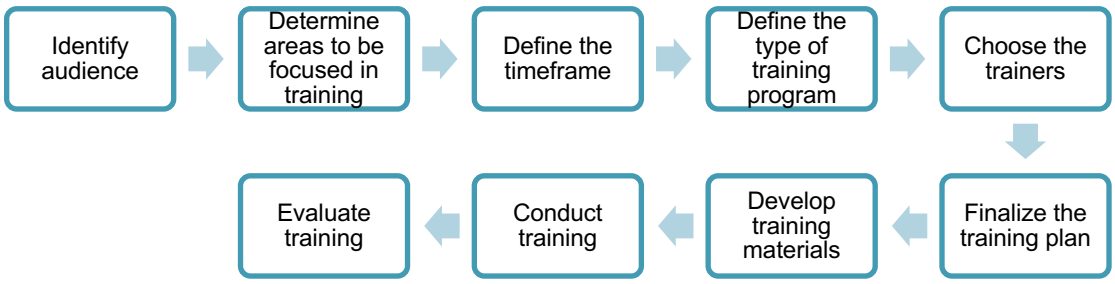

Figure 11: Training development model

After the training is conducted it is critical to evaluate the success of the training. Most of the training is concluded by receiving feedback. But it cannot be the only means to evaluate the success of the trainings. There are multiple ways to evaluate trainings conducted and one of the effective methods is the Kirkpatrick Model. The main advantage of this model over the others is its simplicity and are accuracy in evaluating the training conducted. Valamis (2022) explains the four levels in the Kirkpatrick model:

- **Level 1: Reaction** – Determines whether the learners found the training useful. Measures the satisfaction, engagement, and relevance of the training. Done by receiving feedback after the training.
- **Level 2: Learning** – Determines whether the learners have acquired the knowledge from training. Measures the skill and knowledge gained from the training. Done through assessment and questionnaires.
- **Level 3: Behavior** – Determines the true impact of the training by measuring the behavioral change and indicates whether the knowledge is implemented in actual work. Done through observations and interviews.
- **Level 4: Results** – Determines whether the targeted outcome has been achieved through training. Done by tracking the performance metrics.

4.7 Conceptual framework of the study

The improvement ideas and concepts collected from the literature are summarized as a conceptual framework in a visual format in Figure 12. Sections 4.2 to 4.6 presented the existing knowledge relating to the selected weaknesses and the relation to this study.

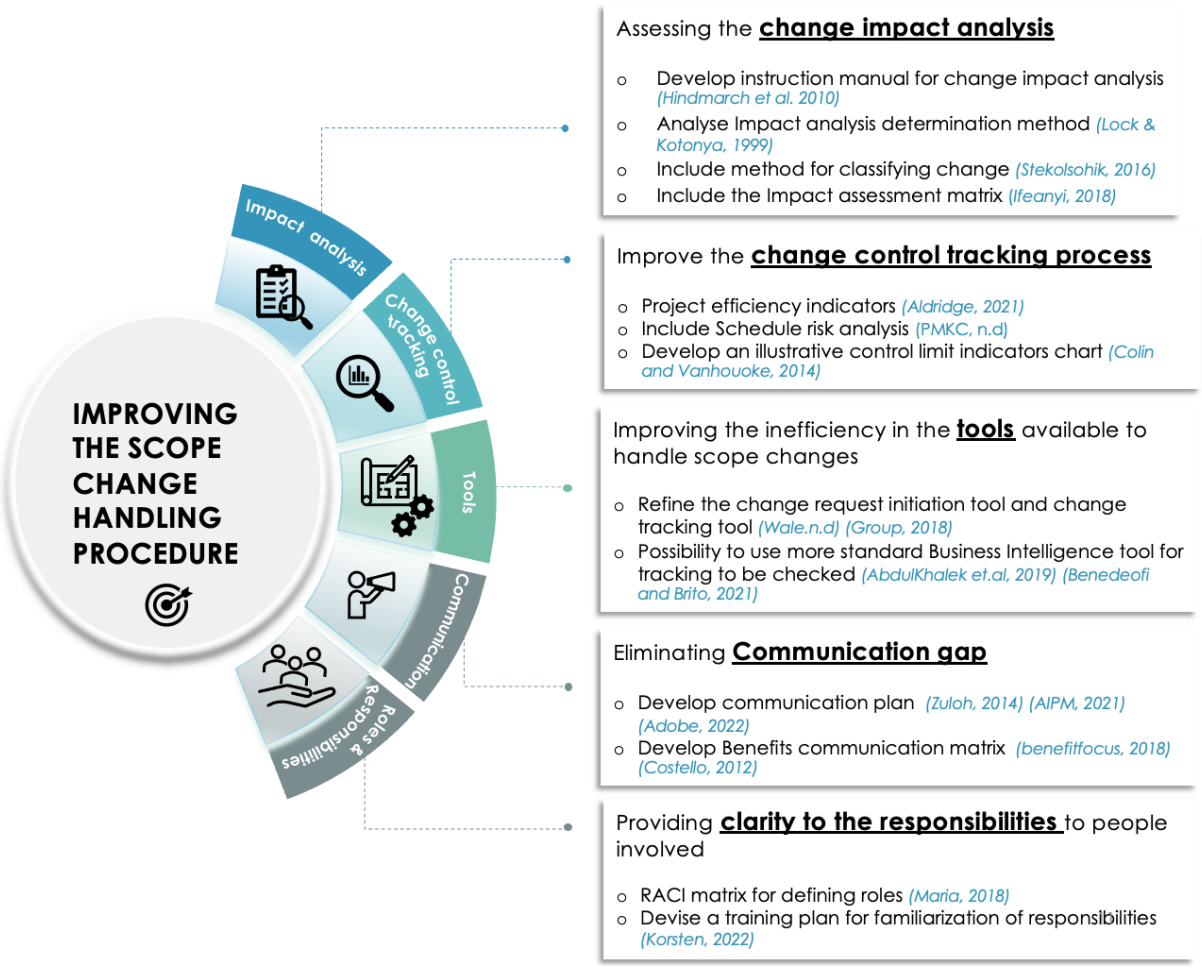

Figure 12: Conceptual framework of the study

As shown in Figure 12, the conceptual framework containing the ideas is divided into five categories depending on where the improvement occurs in the scope change handling process.

The change impact assessment category includes commonly used methods to prepare the impact assessment matrix, impact analysis determination method, and method for classifying change. It also presents the guidelines and practices

to be followed while preparing an instruction manual for a process. The change control tracking category presents a few ideas that can be incorporated into the existing tracking process to improve the efficiency of the process. This includes including project efficiency indicators and creating an interactive visual chart for tracking. The tools category presents the general ways to create change initiation and tracking tools to improve the existing tools. The communication category discusses the guidelines to create a communication plan and provides communication modes for prioritized change. The final category provides improvement ideas for defining the roles and responsibilities in a process.

The next Section 5 will be the initial recommendations developed based on the ideas collected from the literature study. The conceptual framework will be followed to handle and address the critical weaknesses identified. The initial recommendations will also incorporate the existing strengths of the process to co-create solutions for improving the existing time schedule process.

5 Improving time scheduling process – Initial Recommendations

The previous section presented the ideas from the literature to address the weaknesses of the current time scheduling process. Section 5 presents an overview of the initial recommendations developed using the ideas from the literature along with the study group identified. This section summarizes the initial recommendations for the various areas of weaknesses and provides a detailed description of the recommendation co-creation process.

5.1 Overview of recommendations created

The conceptual framework from the literature research was used as a basis to create the initial recommendations along with the core group identified for this stage. The core group comprised mostly the same people from CSA, but few changes were made. As many of the areas to address were from Project Management and Project Control, one person from the Project Control team and one more Team manager were added to this group. The earlier stage involved more than one person from the Discipline lead whereas in this stage only one lead was included in the group.

The process of creating the recommendations mainly involved discussing, brainstorming, and assessing the ideas identified from the literature. The discussions started with the briefing of the findings from the CSA and ideas structured as a conceptual framework. The main focal point of the discussions was to ensure whether the various ideas satisfy a few criteria. The first criterion was the practical nature of the idea, which ensured that the idea has the potential to be practically implemented in real projects rather than just a theoretical approach. The second criterion was to ensure that the idea aligns with the existing approach adopted in the case company. The third and most important criterion was the ability of the idea to bring value addition to the overall process.

The co-creation process was conducted as one-to-one interviews and many small group discussions. There are a couple of reasons to adopt these two methods over one common workshop. The area of weaknesses identified required expertise from varied domains and thereby demanding many people from different functions to be part of the core group. Therefore, smaller group discussions or one-to-one interview provides the advantage of involving only the relevant people, which would help to focus on selected weaknesses to the required depth rather than getting suggestions from all on a peripheral level. This also helped to manage the availability of all the required people and initiate more than one round of discussions on the same topic. Another reason to choose these two methods was to ensure that individual opinions are not shadowed in larger group discussions.

As hybrid working is adopted these days, video interviews and discussions were preferred over in-person interviews. Observations from interviews were logged as field notes during the event. All the recommendations from the discussions were structured as an action plan for each of the categories mentioned in the conceptual framework. The developed action plan was shared with all the participants through email to receive their comments on the recommendations for all categories. The following sections present the initial recommendations created for each of the categories stated in the conceptual framework.

5.2 Recommendations on improving change impact analysis

The first category identified in the literature research to handle the scope change process was the change impact analysis. The importance of the change impact analysis to address the critical weakness of the scope change handling procedure was presented in Section 4.3. Figure 13 presents the initial recommendations for the change impact analysis category and the process of transition from current state analysis to initial recommendations.

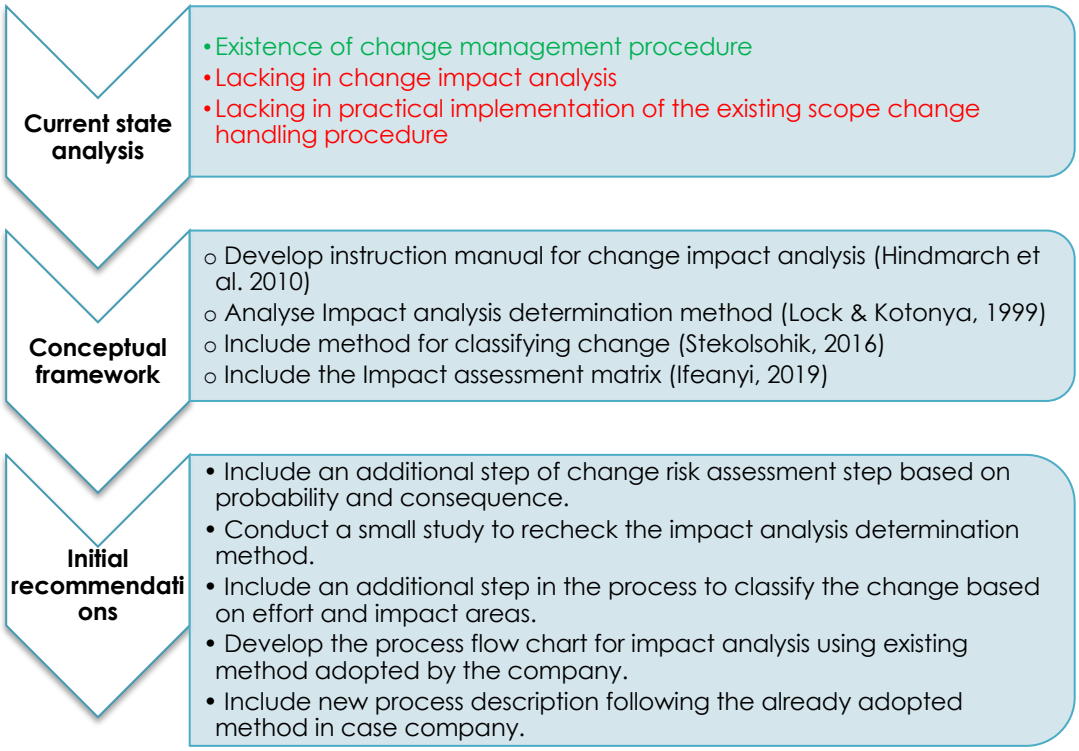

Figure 13: Initial recommendations for change impact analysis category

As seen in Figure 13, the current state analysis resulted in a weakness relating to change impact analysis that led to identifying ideas to resolve this weakness through the literature research. As stated in Section 5.1, these ideas were evaluated to ensure that they are practical, suitable to the case company, and finally can add value.

The discussions for this category started with the first idea identified from the literature which was the inclusion of a new step of risk assessment in the change-handling process. The risk assessment is performed using the probability and consequence matrix and helps to determine the risk level associated with the new change. This enables the Project Managers to be prepared to mitigate the risks associated with the change. During the small group discussion with the members of the core group, it was clear that the process of risk assessment is not completely new to the case company. The case company has the risk assessment as a mandatory step during the initial scope assessment of a project. Hence, the benefits of performing this step were recognized during the discussion

and led to the suggestion of including this step also as a part of the change impact analysis.

The second topic of discussion in the brainstorming session was regarding the impact analysis determination method. The existing scope change handling procedure does include an impact analysis method. The literature research provided alternative methods to perform the impact analysis which is described in detail in Section 4.3.2. The methods identified in the literature have a slightly different approach compared to the existing methods adopted in the case company. To identify the possible differences and analyze the better method of impact determination method, performing a small validation study comparing the existing process in the case company to the methods in the literature was suggested. It is strongly believed that this study would enable the case company to identify the possible areas within the existing change impact determination method that could be improved using the ideas from the literature. One of the attendees stated that,

> *It is useful to compare the existing methods to other possibilities so we know if there is something that can be improved in the existing process. (Co-creation process attendee)*

The next recommendation in this category is to include a new step of classifying the change based on the level of impact and effort. The co-creators agreed that the step to include the classification of the change is critical. The words of the attendee regarding the classifying change,

> *It is important to have more understanding of the consequences of the change to the whole project schedule not only to one discipline. So, the idea of change classification feels important. (Co-creation process attendee)*

A few of the changes can appear to be very small but can possibly have a significant effect in terms of effort but not much on the cost or maybe vice versa. The approach required to handle the change largely depends on the impact area. This critical reason was recognized by the core group and the recommendation

to classify the change as a low, medium, or high-impact change was agreed upon as a vital step in improving the existing process.

During the co-creation process, it was recognized that visualizing the steps involved in the impact analysis as a process flow chart would improve the clarity of the required actions by the responsible team. The case company has experience in creating process flow charts using standard methods for other processes. So, the next suggestion was to utilize the experience to develop the process map using the standard methods adopted in the case company. The recommendation was to perform this step after the execution of the above-mentioned recommendations of the addition of new steps and assessment of the impact determination methods.

The current state analysis mentioned the issues in the practical implementation of the existing handling procedure. The small group discussions to improve the implementation of the existing process recognized the suggestion to clearly define the process to be executed as a process description. Though the case company already has an existing process to perform the change impact analysis, it currently does not have a detailed description of the process but a brief mention in the scope change handling procedure. Therefore, the final recommendation in this category is to develop the process description of the change impact analysis.

5.3 Recommendations on improving the change control tracking process

The core group unanimously agreed on the importance of improving the change-tracking process category. Figure 14 presents the transition of the findings from the CSA to initial recommendations for this category. The core group for this study includes the Project Manager, Project controller, and Project planners.

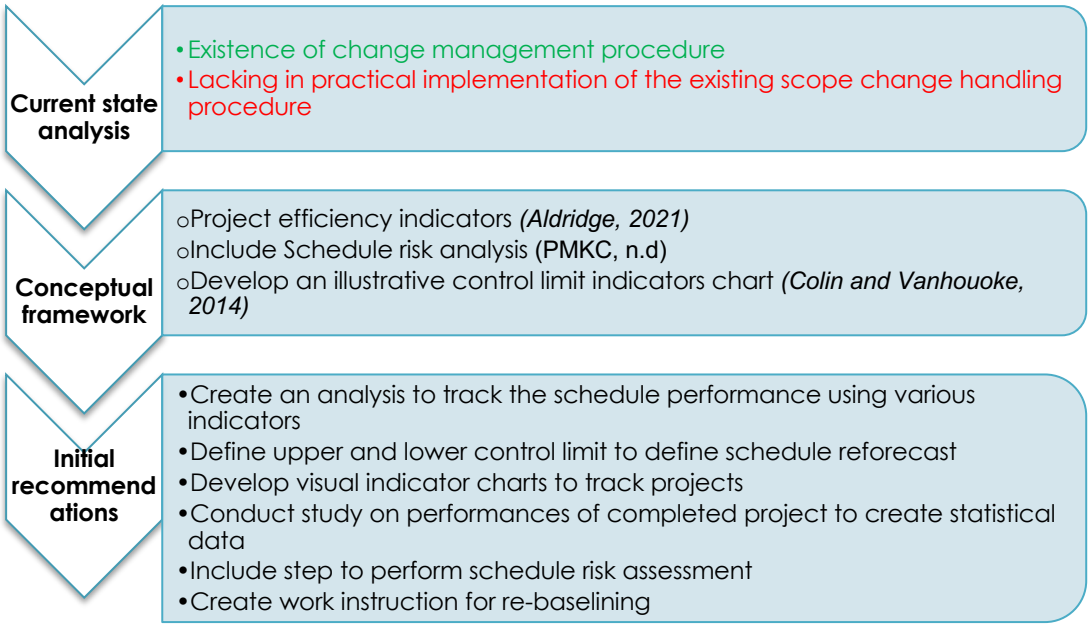

Figure 14: Initial recommendations for change control tracking category

The brainstorming session for improving this category revolved around understanding the importance of utilizing the various schedule performance methods. The member of the core group revealed that the existing schedule preparation tool calculates certain performance metrics such as the schedule variance and cost variance. One of the attendees stated that,

> *Existing tool generates the schedule variance and cost variance, and the schedule variance is employed in tracking process. (Co-creation process attendee)*

The knowledge from the literature regarding the possibility of utilizing other metrics highlighted additional value to the existing methods and hence the idea of incorporating additional metrics to analyze the schedule performance was welcomed by the core group.

The idea regarding the creation of control limits identified from the literature was seen as good value addition to the existing process of tracking. This suggestion was recognized as a possible solution that provides more clarity for the Project Planners and the Project Managers to identify the project scenarios that are

outside the desirable state. The developed control limit helps the team to know when there is a need to reforecast the schedule. The two possible tracking approaches suggested in the literature show potential in identifying the critical activities within the project and emphasize the need for immediate actions for those activities. The idea was welcomed by the core group and the discussions regarding the possible implementation methods lead to an agreement that there is a need to conduct further study to assess the better method to create the control limits. Hence, the recommendation from the discussion was to develop the upper and lower control limit for tracking by conducting a study.

All the members collectively had a similar opinion that any parameter or metrics used in the analysis are effective when available as visualizations. The idea of having the change control tracking process as charts along with the upper and lower control limit was believed to improve the existing change tracking process. The recommendation was to perform the study relating to developing the control limits before this step and incorporate that as a visual chart using the necessary tools.

The brainstorming session of the above-suggested recommendations led to the development of another solution of creating statistical data of completed projects by utilizing the schedule performance metrics. The purpose behind building such a database helps the case company to know the overall picture of all projects in general and help in identifying the recurring causes. This would help in eliminating the causes by employing proper mitigation measures. Therefore, the recommendation was to create a statistical database using the schedule performance metrics. One of the attendees stated that,

> *The idea to have statistical data to see the performance of projects is helpful and can help to understand the situation better (Co-creation process attendee)*

The discussion of the metrics relating to the reforecasting brought up the need for developing work instructions for the re-baselining of the schedule. Similar to the recommendation provided in Category 1 for creating a process description for

change impact analysis, the recommendation to improve change control tracking suggested the work instruction for re-baselining.

The literature emphasized the need for schedule risk assessment (SRA) as a critical step to be aware of the possible impacts that a change can cause on the cost and schedule. It was understood that SRA will improve the existing process by providing realistic assessments of schedule performance over the set objectives. The discussions revealed that the existence of such a technique was familiar to the members of the planning team. One of the members from the core group highlighted the possibility of performing the schedule risk assessment using the existing schedule preparation tool which aligned with the findings from the literature. The attendee stated that,

> *The existing scheduling tool is having the feature to perform a schedule risk assessment. But the complete capabilities are not known, would be good to evaluate it. (Co-creation process attendee)*

Considering the benefits offered by the schedule risk assessment step, the recommendation was to incorporate it into the existing change control tracking process.

5.4 Recommendations on improving the tools used to handle changes

Section 4.4 described in detail the importance of effective tools in improving the scope change handling process. Figure 15 presents the transition of the findings from the CSA to initial recommendations for this category. The core group for this study includes the Project Manager, Project controller, Project Planners, Discipline lead, and Discipline Managers.

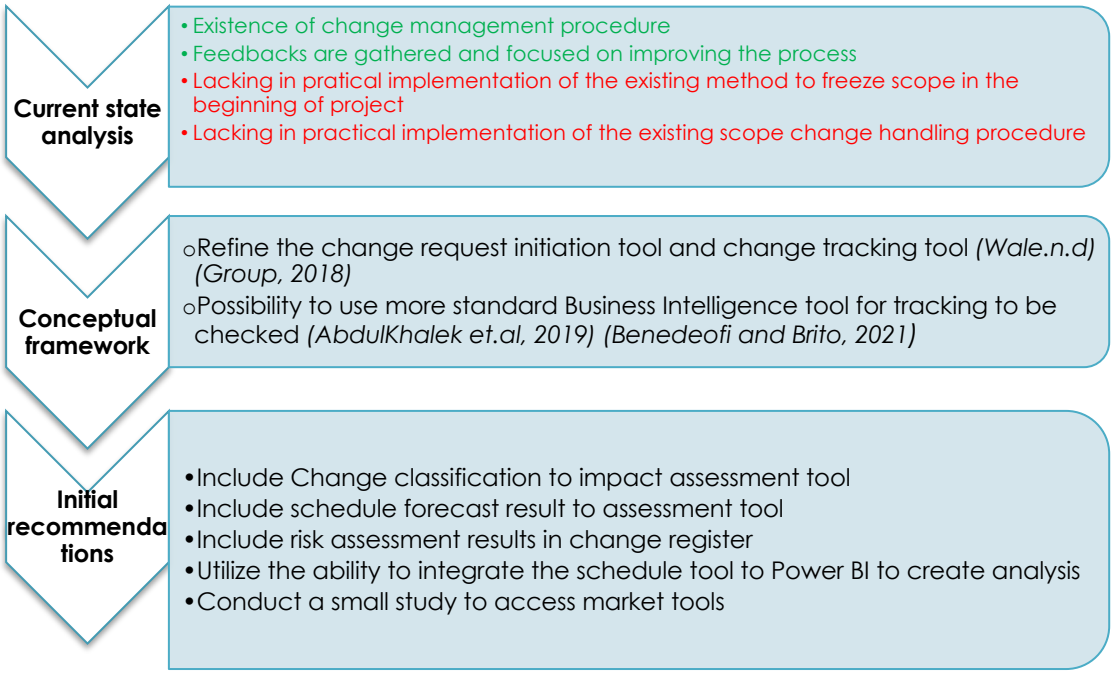

Figure 15: Initial recommendations for tools category

This category has recommendations that are intertwined with the previous two categories and require to be executed after those ones. After the implementation of the recommendations in the earlier categories, they must be reflected in the change register and impact assessment tool for better documentation and tracking process. This was agreed upon in unanimity by all the members of the core group. Further, the discussion included assessing the existing change register and change assessment tool. The conclusion of the discussion was to incorporate the new steps such as change classification and schedule forecast for the new scope change to impact assessment tool. Similarly, the results of the risk assessment were suggested to be incorporated into the change register. The implementation can follow the methods and have all the information suggested by the literature.

Recommendations to improve change control suggested the creation of visual charts and creating a statistical database of various metrics. Execution of these steps would require effective tools to successfully implement them. Literature research showed that there are possibilities to combine the existing schedule preparation tool with Business Intelligence tools such as Power BI. Discussion

with the core group revealed that the case company utilizes the Business Intelligence tools for other purposes and so is aware of the capabilities and benefits of these tools in analysis. Therefore, the core group was eager to explore the possibilities to combine the scheduling tool with the Business Intelligence tools. One of the attendees stated,

> *Business Intelligence tools can be helpful in this purpose, the possibilities of the benefits or the issues associated needs to be assessed. (Co-creation process attendee)*

It was strongly believed that this step would help to build an efficient analysis that would positively influence the tracking process. The discussions also suggested that there could be possibly other tools to perform the same tasks, and this requires evaluation to identify the best solution. One of the attendees stated that,

> *If the existing method is found to lack in efficiency, it is good to be open to try something new. (Co-creation process attendee)*

During the discussions regarding the change control tracking explained in Section 5.3, the possibility to perform schedule risk assessment using existing tools was discussed. Literature also showed that there are various other tools that are existing in the market that can effectively perform this step. The idea to evaluate the performance of various market tools was readily accepted by the members of the core group. The discussions led to the recommendations of performing a small study to assess the market tools and compare the technical capabilities and economic feasibility.

5.5 Recommendations on improving the communication

Communication is an inevitable part of any process and Figure 16 presents the transition of the findings from the CSA to initial recommendations for this category. The entire core group was involved to build the recommendations for this category as communication concerns every member of the group.

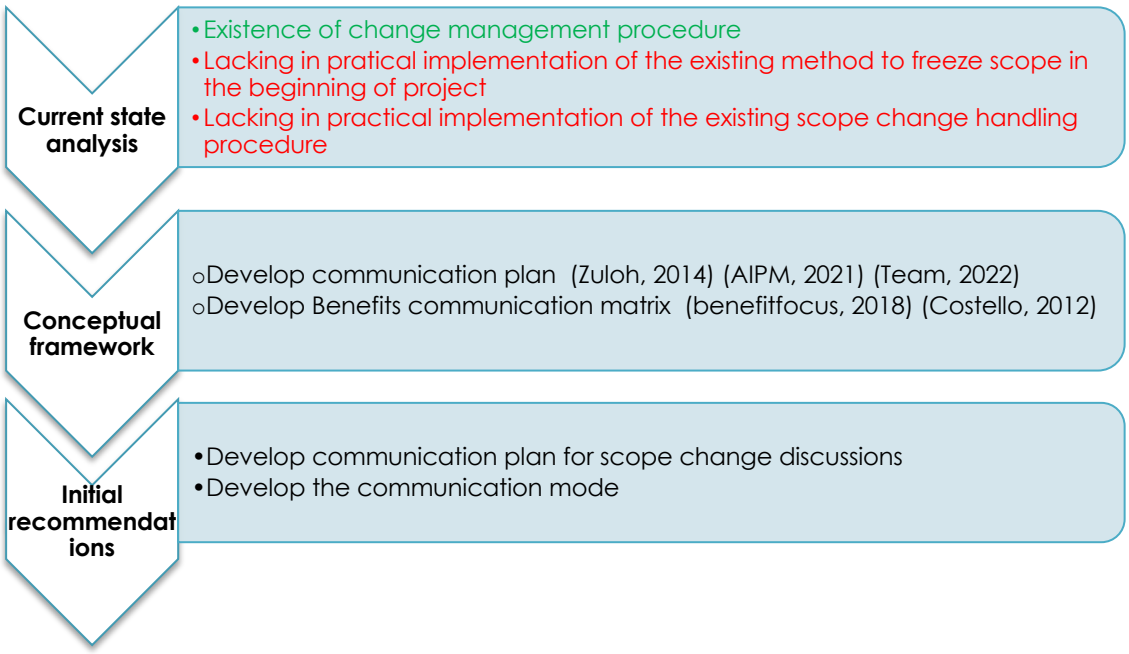

Figure 16: Initial recommendation for communication category

The ideas from the literature for improving the category were developing the communication plan and communication matrix. The brainstorming session for improving communication agreed that the communication plan helps to standardize and provide clarity to the Project Managers regarding the objectives to achieve through communication during scope changes. The idea was supported as it was clear to the members of the core group that the communication plan provides the benefit of improving credibility and offers a method to evaluate the effectiveness of communication during change scenarios. One of the interviewees stated,

> *Communication plan is usually done based on personal experience and mostly for the whole project, but for scope change situation is a nice inclusion. (Co-creation process attendee)*

Along with the communication plan, the idea to define the mode of communication depending on the impact of the change was eagerly welcomed as this helps to resolve the most reoccurring problem of adopting improper communication methods. This can be seen from one of the interviewee's words,

It is always an unclear situation to decide the communication channel and the idea of thinking about communication mode before will help to make it better. (Co-creation process attendee)

The idea to classify the change and also have a suggestion to use certain communication channel for it is a really good idea. It lets people know what to prioritize when facing change situation (Co-creation process attendee)

Therefore, the recommendation to improve the communication was to develop a communication plan and define a communication mode for the scope change handling process at the beginning of the project.

5.6 Recommendations on providing clarity on roles and responsibilities

Scope change scenario requires a clear definition of roles and responsibilities from the people involved. Figure 17 presents the transition of the findings from the CSA to initial recommendations for this category. The entire core group was involved to build the recommendations for this category as roles and responsibilities concern every member of the group.

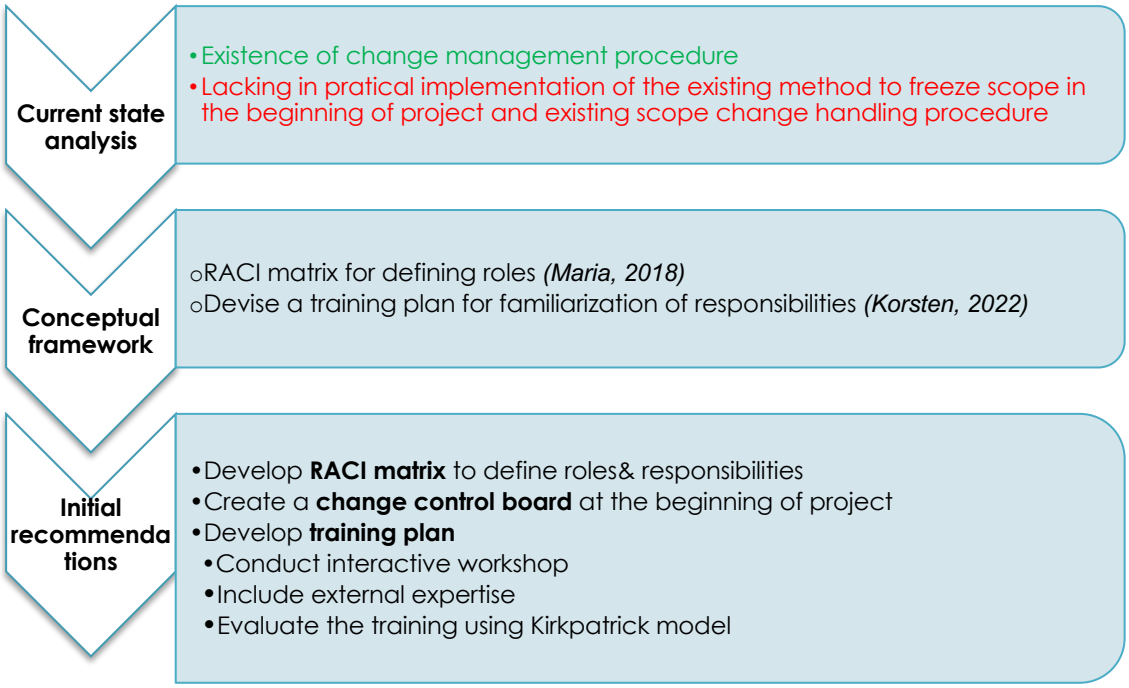

Figure 17: Initial recommendation for roles and responsibilities category

The brainstorming session for this category involved evaluating the idea of well-known concepts of the RACI matrix and training plan. The discussions revealed that the concept of the RACI matrix was already familiar to the members of the core group as this method has been incorporated into other processes. This is clear from the words of one of the attendees,

> *RACI matrix is a familiar concept, and it is a good idea to include this matrix into the existing change management process description. (Co-creation process attendee)*

The inclusion of the RACI matrix to define the roles in the scope change handling process was readily accepted as the members clearly knew the benefits of the RACI matrix. During the session, it was agreed that the RACI matrix is a simple yet effective way to inform people regarding their responsibilities in the change-handling process. This recommendation was seen as a good value addition to improve the implementation issues that are existing in the company, and this can be seen from the words of one of the attendees,

> *RACI matrix definitely helps to avoid the ambiguity of what is expected from certain discipline in this change process. It is a lot easier to understand than a detailed description of roles. (Co-creation process attendee)*

The discussions on the RACI matrix led to the development of another suggestion of creating a change control board specific to the project. This suggestion helps to provide clarity to people involved regarding the responsible person for handling change. The discussions led to the suggestion of creating a control board for change scenarios which can help in providing more clarity on the person to be contacted during such situations.

The unanimous opinion that existed in the group was the need to focus on providing training for all the people involved in the change-handling procedure. Despite conducting training being a familiar concept, the idea of developing a training plan helps to ensure that training is efficient and has all the necessary things considered. The idea from the literature that defines the steps to be

followed in developing a training plan was seen as a good guideline to conduct effective training.

The discussions regarding conducting effective training brought up a suggestion of utilizing external expertise, especially for improving knowledge regarding the capabilities of the schedule preparation and other tools used in the organization. This suggestion was considered to add value to the company as it is necessary to equip knowledge from the experts and in some cases, it can be from experts outside the organization. The suggestion in the words of one of the attendees was,

> *We could have training conducted by external experts mainly for the schedule preparation tool. There are other features of the tools which are still unknown. (Co-creation process attendee)*

The discussions also led to another suggestion of having an interactive workshop for developing schedules. This was seen as an interesting option to make the training more effective and therefore added to the recommendations.

Though conducting training is a familiar concept, the most important part of conducting training is to ensure that the people gain more knowledge. And so, evaluating the training can be considered a critical step. The most common method adopted to evaluate training is to receive feedback, but the literature suggested an alternative approach to evaluating training using the Kirkpatrick model. The discussions regarding the literature-suggested method helped to understand the benefits of these four staged evaluation methods and were thought to be an interesting option to improve the existing evaluation method. Therefore, the decision was to include this new method of evaluation in the recommendations.

5.7 Implementation of selected action points to develop the final solution

The Final recommendations comprise many action points to be implemented across different domains. The thesis mainly focuses on developing an action plan

and the implementation of all the ideas will be performed outside the scope of this thesis. Even though the implementation of all the ideas will continue outside the thesis work, it was seen that the implementation of two specific action points from the list of suggestions adds value to the thesis work performed and will act as a good starting point for further implementation of the recommendations created.

The first action point chosen to implement within this thesis work is developing the process flow chart of the impact analysis from Category 1, mentioned in Section 5.2. Similarly, the second action point chosen to execute within this thesis is developing the RACI matrix for improving the roles and responsibilities from Category 5, mentioned in Section 5.6.

The implementation of the recommendation to develop the solutions was carried out in cooperation with people with expertise in the necessary domain. Validation was performed in a similar way to the action plan developed and the comments received were updated to create the final solution.

5.7.1 Developing the process flow chart of the Change impact analysis process

One of the recommendations to improve the change impact analysis method was to develop the process flow chart. The developed flow chart is presented in Figure 18 below.

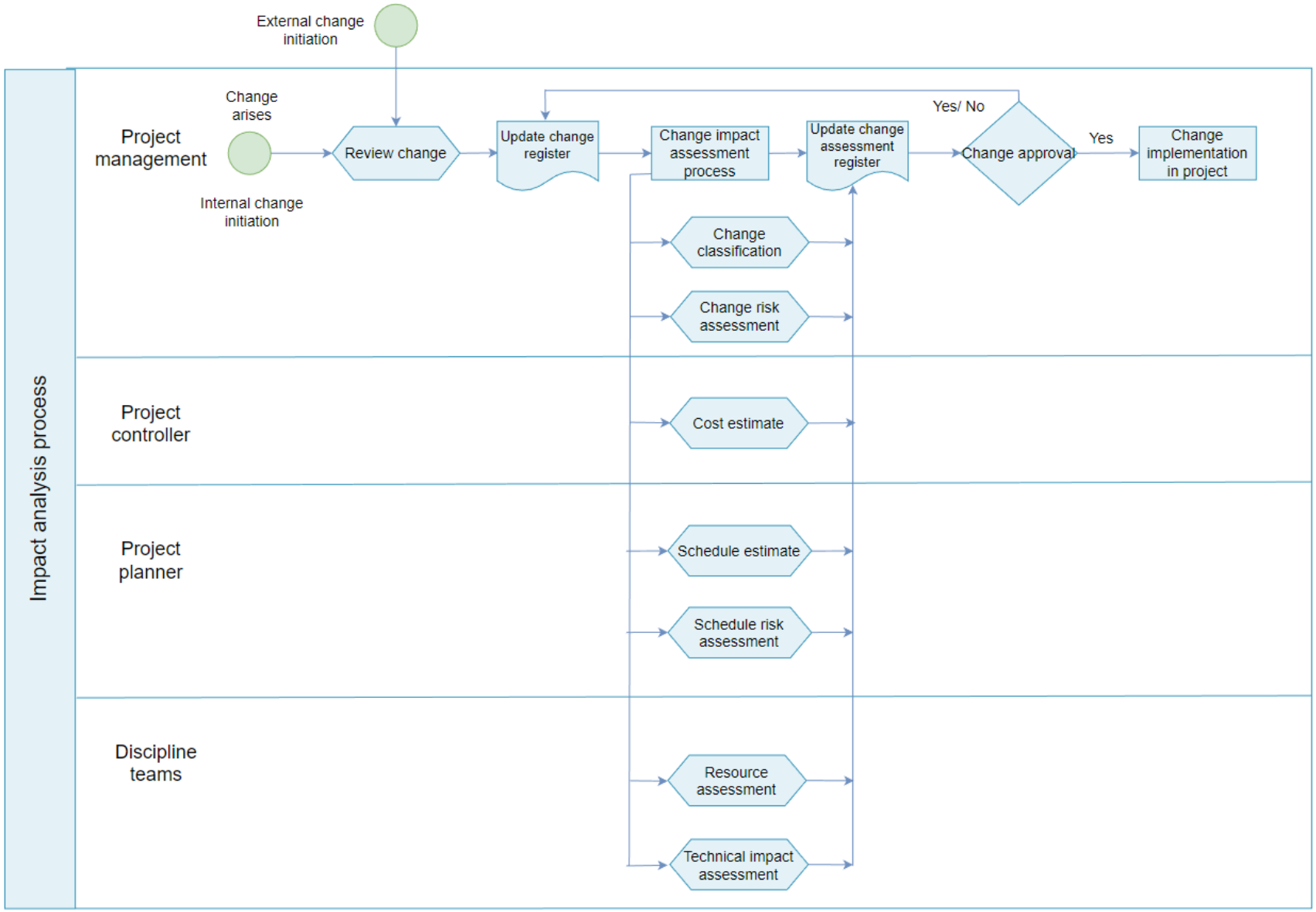

Figure 18: Process flow chart of Change impact analysis process

As already mentioned in Section 5.2, the company is familiar with the methods of creating flow charts using the standard method of flow symbols. This standard method was adopted and all the necessary steps both the existing and the newly suggested steps were incorporated to develop the process flow chart for the change impact analysis. The steps were compared to the literature-suggested steps described in Section 4.2.1 to ensure that a standard approach is adopted. The developed flow chart clearly defines each step to be executed by each team and the order of execution.

5.7.2 Developing the RACI matrix for Change management

One of the recommendations to improve the roles and responsibilities was to develop the RACI matrix. The developed RACI matrix is presented in Figure 19 below.

Activities	Project Manager	Project Planner	Project controller	Discipline lead	Process owner	Customer
Gather change requirement	R A	I	I	C	I	R
Review change	R A	C	C	C	I	I
Change register update	R A	I	I	I	I	
Change classification	R A	C	C	C		
Schedule risk assessment	I	R A	I			
Change impact assessment	R A	R	R	R	I	I
Change execution	I			R A	I	I
Change follow-up	R A	I	C	I	R A C	I
Approve change	R A	I	I	I	R A C	I
Communication	R A	I	I	I	I	R A I

Figure 19: RACI matrix for the Change management process

The process of developing the RACI matrix was executed following the steps suggested in the literature described in Section 4.6.1. The co-creation of this matrix involved a person from Project Management and a member of the Discipline Management team to ensure that opinions from various expertise are considered.

5.8 Summary of the Initial Recommendations

The process of co-creation focused on combining the findings of the CSA and the knowledge from the literature to build the initial recommendations. The core group for this stage was selected to ensure that expertise from different domains was available. The process of co-creation evaluated the ideas from the literature based on a few criteria which were the practical applicability of the idea, the ability to suit the approach of the case company, and the ability to add value to the overall process. The initial recommendations are grouped into the same categories as in the conceptual framework. The summary of all the recommendations created from the various one-to-one interviews and small group discussions is presented as an action plan in Figure 20 below.

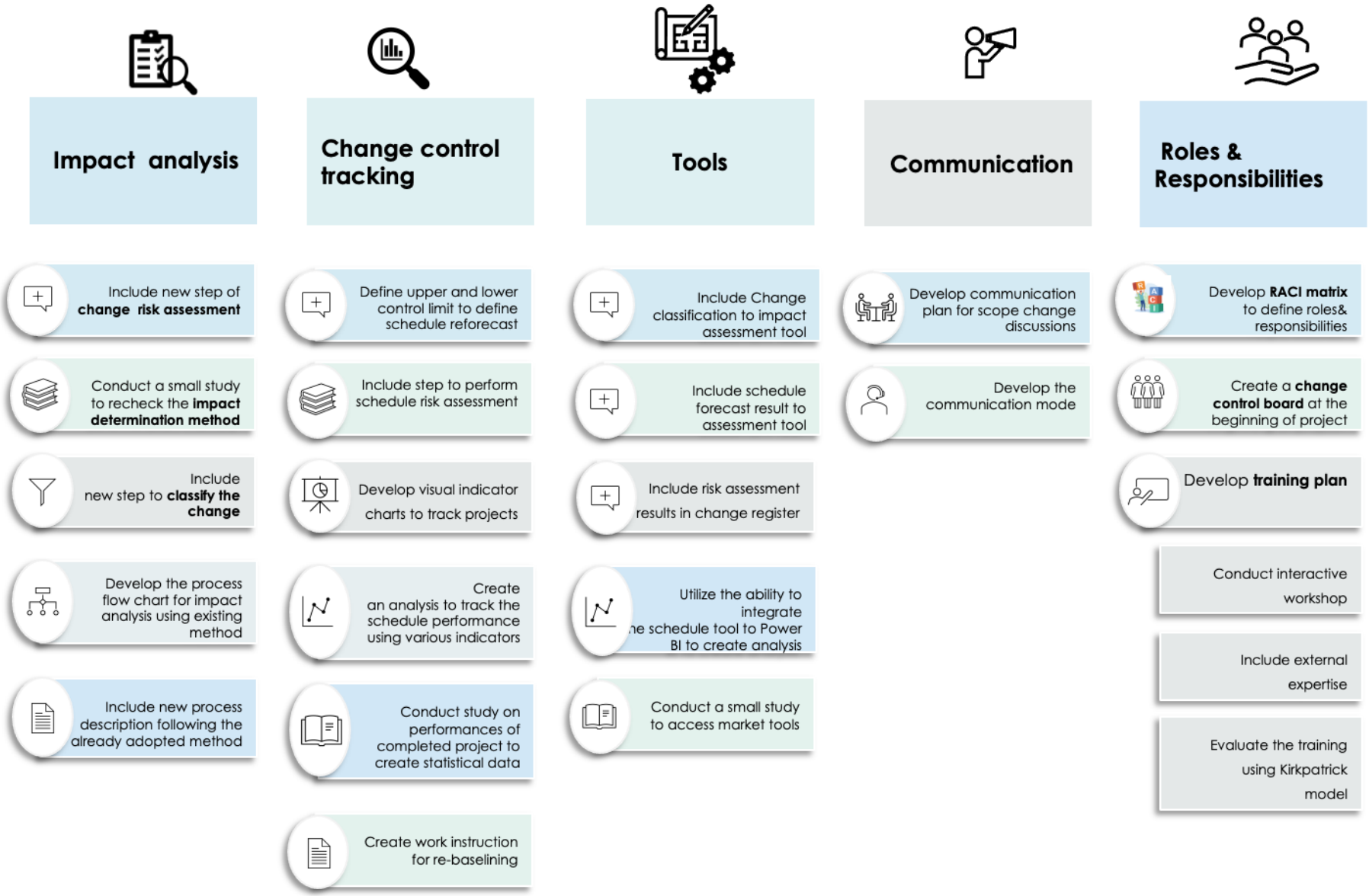

Figure 20: Summary of the initial recommendations created

As presented in Figure 20, the recommendations to improve change impact analysis focused to include new steps such as change risk assessment, a new step of classifying change and performing a validation study of the existing impact determination method. The suggestion also included developing a process flow chart and process description for the change impact analysis process.

The recommendations to improve the change control tracking focused on developing new control limit parameters, new schedule performance metrics, and new steps of schedule risk assessment and having the process tracked using a visual chart. The recommendations also suggested utilizing the new metrics to perform analysis and create a statistical database.

The recommendations to improve the tools used in the scope change process focused on incorporating the new steps included in the above two categories into the existing tools and evaluating the market available tools to execute the scope change handling process. The recommendation suggests exploring the possibilities of combining the schedule preparation tool with the Business Intelligence tools.

The recommendations to improve the communication were to develop the communication plan for the scope change process at the beginning of the project along with a definition of the communication mode for change scenarios. Finally, the recommendations for improving the roles and responsibilities suggested developing a RACI matrix and developing the training plan for the scope change process. From the list of suggestions created, two critical action points of developing the process flow chart for change impact analysis and the RACI matrix to define the roles were executed within the thesis work.

Overall, the recommendations for the different categories were co-created in cooperation with the core group. The following section provides a description of the validation of the initial recommendations created.

6 Validation of the proposed time scheduling process

The previous section presented the initial recommendations that were co-created with the core group. Section 6 presents an overview of the validation of the initial recommendations to develop the final recommendations for the case company. This section also provides a description of the validation process.

6.1 Overview of recommendations validation

The validation of the initial recommendations was performed by presenting the recommendation created to a small core group. The recommendations created belonged to varied domains and require validation from different functions. Thus, the core group for the validation stage involved people from Project Management, Project Planning, and Team management.

The validation was executed in the one-to-one interview and email discussions with the members due to availability reasons. As hybrid working is adopted these days, video interviews and discussions were preferred over in-person interviews. Observations from interviews were logged as field notes during the event. Comments provided to the initial recommendation were updated to develop the final recommendations.

6.2 Feedback received from initial recommendations

The initial recommendations created were received very positively and were seen as a promising change to the existing process. The overall work received compliments and most of the recommendations suggested were readily accepted. The effort to address such a critical topic was appreciated and the work results were seen to benefit the company. The same conveyed using the words of the attendees,

> *“The work is an excellent summary of the things happening in the company and so are the ideas to improve them.” (Validation process attendee)*

> *Few of the recommendations are interesting options and implementing them brings benefit to the process. (Validation process attendee)*

Though most of the recommendations were readily accepted, a few minor comments were provided. The first suggestion was to include the process description created as part of the existing change management process instruction rather than having a stand-alone instruction for the change impact analysis process. The reason was to avoid the presence of multiple instructions and help to summarize all the required steps into the existing instructions. The words of the attendee were,

> *It would be efficient to open the process description in the existing instruction. (Validation process attendee)*

The second suggestion was to exclude the development of work instructions for re-baselining. It was believed that the implementation of the other steps would be the priority to improve the scheduling process. It was stated that the existing short description of re-baselining can be considered sufficient and the need for separate instruction will be evaluated at a later stage. One of the attendees stated,

> *The need for separate instructions for re-baselining is not so critical or required at the moment and can be evaluated later. (Validation process attendee)*

The third suggestion was to link the impact assessment tool to the change register tool to enable better documentation and tracking process. The same was conveyed through the words of the attendee,

> *Having the possibility to view the results of impact analysis in the change register tool makes it easier to access and reduce hassle in finding it. (Validation process attendee)*

The above-mentioned comments are summarized in Table 7 below and the changes are highlighted in green.

Table 7: Changes made to the initial recommendations

INITIAL RECOMMENDATIONS	FINAL RECOMMENDATIONS
CHANGE IMPACT ANALYSIS	
Develop new change impact analysis process description instruction	Include process description as a sub-chapter to the existing change management instruction.
CHANGE CONTROL TRACKING	
Create work instruction for re-baselining.	~~Create work instruction for re-baselining.~~
TOOLS	
Include risk assessment results in the change register.	Include risk assessment results in the change register. - Change register to have a link to the impact assessment tool.

As presented in Table 7, the three changes suggested were implemented into the final recommendations.

6.3 Summary of the Final Recommendations

The final recommendations for the process improvements are presented in Table 8 below.

Table 8: Summary of Final recommendations

SUMMARY OF THE FINAL RECOMMENDATIONS		
Category	**#**	**Recommendation**
CHANGE IMPACT ANALYSIS	1	Include new step of change risk assessment.
	2	Conduct a small study to recheck the impact determination method.
	3	Include new step to classify the change.
	4	Develop the process flow chart for impact analysis using existing method.
	5	Include process description as a sub-chapter to the existing new change management instruction.
CHANGE CONTROL TRACKING PROCESS	1	Define upper and lower control limit to define schedule reforecast.
	2	Include step to perform schedule risk assessment.
	3	Develop visual indicator charts to track projects.
	4	Create an analysis to track the schedule performance using various indicators.
	5	Conduct study on performances of completed project to create statistical data.
TOOLS	1	Include change classification to impact assessment tool.
	2	Include schedule reforecast result to the assessment tool.
	3	Include risk assessment results in change register. - Change register to have link to the impact assessment tool
	4	Utilize the ability to integrate the schedule tool to Business Intelligence tools.
	5	Conduct a small study to assess market tools.
COMMUNICATION	1	Develop the communication plan.
	2	Define the communication mode.
ROLES AND RESPONSIBILITIES	1	Develop RACI matrix for change management process.
	2	Create a change control board at the beginning of the project.
	3	Develop training plan - Conduct interactive workshop - Include external expertise - Evaluate the training using Kirkpatrick model

As shown in Table 8, the final recommendations were prepared after implementing the comments provided to the initial recommendations provided and the changes made to the initial recommendations are presented in Figure 20.

Overall, the initial recommendations were validated as planned to build the final recommendations. The next and final section summarizes the work performed in the thesis, describes the next steps to be performed to implement the recommendations, and includes a self-evaluation of the study.

7 Discussions & Conclusions

The final section presents an executive summary, an implementation plan to progress with the next steps, a self-reflection of the thesis work, and concluding the work with a few closing words.

7.1 Executive summary

The case company of the thesis is an Engineering service provider that handles projects of diverse scopes that varies from small maintenance works to building completely new production plants. To execute these projects, the case company has an existing time schedule process but was facing issues in handling the uncertainties that cause delays. The objective of the study was to identify the areas that cause issues and improve the existing time schedule process. The outcome of the study was an action plan with recommendations to improve the existing time-scheduling process.

The research approach selected for the study was applied research as the issue concerned a specific organization and the purpose was to develop a practical solution that can be employed immediately. The approach was to perform the study in four stages. The first stage was to perform a current state analysis to identify the strengths and weaknesses of the existing process. The result of the first stage was selecting the critical weakness to study further. The second stage was to perform an extensive literature study to acquire ideas to address the selected critical weakness. The different ideas found in the literature were structured as a conceptual framework which was used in the third stage of co-creating the initial recommendations. These initial recommendations were validated in the final stage through feedback and the final recommendations were created.

All the stages mentioned above required different people and data to be involved at various stages. The people for the core group were selected from different functions to ensure that the issue was analyzed from all perspectives. The core

group had Process Managers, Project Planners, Project Controller, Discipline Managers, and Discipline leads. Mostly one-to-one interview was adopted to collect data from the core group, but other means used included a questionnaire, small group discussions, and referring to internal documents.

The existing process of scheduling starts with assessing the scope of the project by the Project Manager and for large scope projects detailed schedules are prepared by the Project Planner. Project Planners utilize the instructions and the activity list to develop the schedule which is reviewed in the review session with the discipline members. The comments are implemented to develop the final schedule which is utilized in project execution. A proper follow-up procedure exists to ensure there are no delays. To handle the scope change situations, the case company has an existing scope change handling procedure.

The current state analysis indicated that the issues concerning the existing time scheduling process were mainly in four areas namely the input to the process, the review session, the developed schedule, and the scope change handling procedure. The scope change handling process was selected as the critical weakness to be addressed as the scope is the basis for all the work executed and is critical for developing a realistic time schedule. A literature study of this weakness revealed that there are five areas to be addressed to improve the scope change handling procedure. The ideas relating to each of the categories namely the change impact analysis, the change control tracking, the tools, communication, and roles and responsibilities category were framed as a conceptual framework.

The initial recommendations for each category were co-created predominantly through one-to-one interviews and a few small group discussions with the members of the core group. The process of developing initial recommendations focused to ensure that the ideas from the literature were practical, aligns with the existing approach adopted by the case company, and adds value to the process. The developed initial recommendations for each category had a wide variety of recommendations. They can be summarized as including new steps in specific

sub-processes, performing a few validation studies and evaluation studies, and developing new process flow charts, and process descriptions.

The initial recommendations for the first category of the change impact analysis had five recommendations. The first recommendation was to include a new step of performing risk assessment during scope change situations. The second recommendation was to perform a validation study to compare the existing change impact analysis method to the alternative methods suggested in the literature. The third recommendation was to include a new step of classifying the change based on impact and effort. The other recommendations were to map the entire process as a process flow chart and prepare a detailed process description.

The initial recommendations for the second category of the change control tracking process had six recommendations. The first recommendation was to define upper and lower control limits to define schedule reforecast. The second recommendation was to include a new step of performing a schedule risk assessment. The third recommendation was to develop a visual indicator chart to track projects. The next recommendation was to create an analysis using various schedule performance metrics and indicators to help with the tracking. The other recommendation was to conduct a study on the performances of completed projects to create statistical data. The final recommendation in this category was to create a work instruction for re-baselining.

The initial recommendations for the third category of tools included five recommendations. The recommendations were to include the newly included steps from the other categories to the change impact assessment tool and the change register. The other recommendations were to utilize the ability to integrate the schedule preparation tool into the Business Intelligence tool to create an analysis and conduct a small study to assess the market available tools.

The initial recommendations for the fourth category of communication were to develop a communication plan and the communication mode for scope change situations. The recommendations for the fifth category of roles and

responsibilities had three recommendations. The first recommendation was to develop the RACI matrix to define the roles and responsibilities of scope change situations. The other recommendations were to create a control board at the beginning of the project and develop a training plan to provide more clarity on the roles. The training plan had suggestions to conduct interactive workshops, include external expertise for various tools, and finally evaluate the training using the Kirkpatrick model.

All the initial recommendations created were validated in the final stage through feedback received from the core group selected for this stage. As the recommendations developed required expertise from different areas more than one person was involved in the validation stage. Most of the recommendations from the initial stage were accepted without any change and received only minor comments for a few of the suggestions. The comments are considered minor as the crux of the recommendations was still the same. The minor comments were updated to create the final recommendations in the form of an action plan.

From the list of recommendations, two of the action points were taken to the next stage within the thesis work as it added value to the thesis work as well as to the company. The two action points developed into the solution were the process flow chart for the change impact analysis and the RACI matrix for the scope change management process. The execution of the other action points can be executed parallelly and does not require sequential execution. The various recommendations under all the categories have helped to create an improved time schedule process which helps the case company to overcome the issue of delays caused due to uncertainties.

7.2 Recommendations for the next steps

The outcome of the thesis was the final recommendations presented in Section 6 requires to be taken to the next stage of implementation. To execute these recommendations, an implementation plan has been developed, and is presented in Figure 22. Each recommendation suggested was distinct and the

proposed implementation plan must be applied for every single recommendation. The implementation of the recommendations can be done parallelly and does not require to be executed in sequential order except for the changes relating to the tools which are based on the inclusion of new steps in categories 1 and 2.

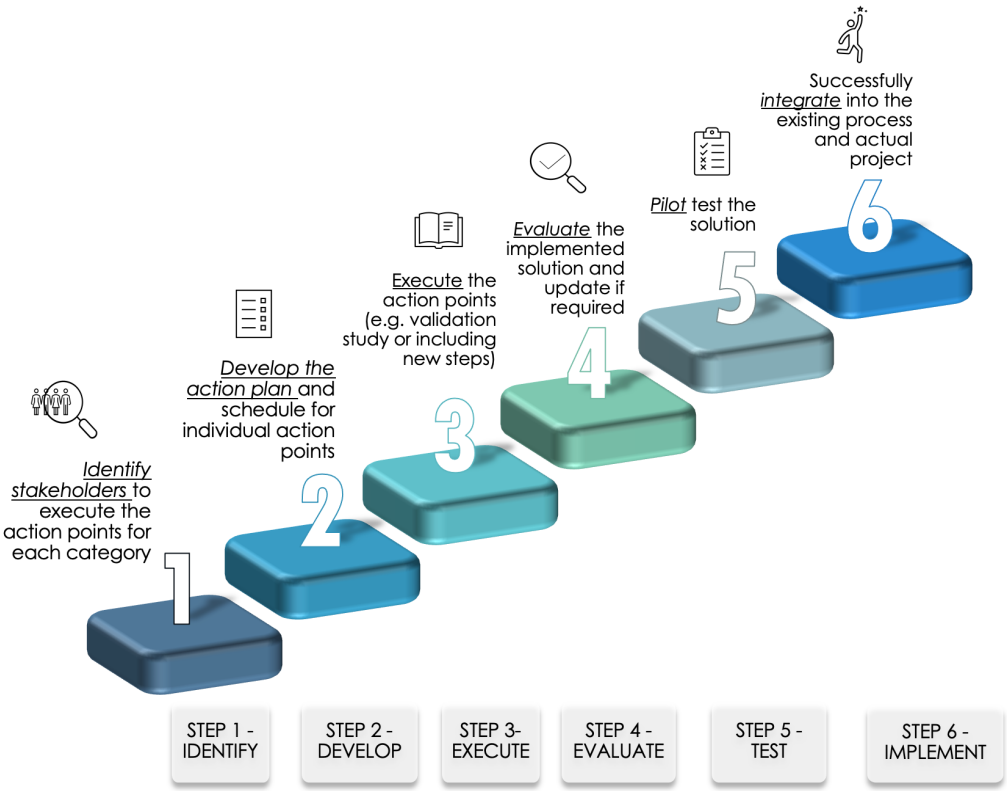

Figure 21: Implementation plan to execute the action plan

The implementation plan suggested comprises six steps. As already mentioned, each recommendation requires different expertise, and hence the first step is to identify the responsible person to handle the recommendation. After identifying the stakeholder to execute the action points, the next step is to develop an action plan with a proper schedule and methods to perform the task. The developed plan is adopted, and the action point is executed. The developed solution is then evaluated to ensure that all the necessary things are included and then employed in small projects to pilot test the solution. After the pilot test is performed, any comments received are updated and the solution is finally integrated into the existing process.

The thesis identified other areas of weakness to improve the existing process but focused on only one critical weakness to study further as part of this thesis. Hence, the next steps include applying the knowledge and similar approach to the other weaknesses to find solution and improve the process further.

7.3 Self-evaluation of the study

The initial objective of the thesis was to develop an action plan with recommendations to improve the existing time schedule process of the case company. The thesis addressed the issue by following a clear structure throughout the execution. The thesis has succeeded in achieving the objective set completely by developing an action plan with recommendations to improve the existing process. Apart from the set objective, two of the action points were taken further to the next step of developing a solution and this adds value to the work performed.

The thesis handles an issue concerning the specific case company by incorporating the applied research method to develop practical solutions. This ensured to have a logical approach and structure to create useable solutions that can be immediately applied to improve the process. The thesis focused on collecting qualitative data using different methods such as one-to-one interviews, small group discussions, a questionnaire, and email inquiries. The method of collecting data through one-to-one interviews and small groups helped to ensure that individual opinions were not shadowed in large group discussions. The work was done by involving relevant people from different functions and varied experiences to help achieve a deep understanding of the issue from all perspectives and avoid any bias that can possibly occur during the data collection. The process of co-creating recommendations along with the different expertise people provided the opportunity to receive better ideas and aided in onboarding and familiarizing the relevant people already to the possible recommendations. The approach of involving different methods, different sources, and different people throughout the work is presented in Section 2 and

is an indication that this study has adopted the triangulation method to add credibility and internal validity.

The time-bound associated with the thesis caused the limitation to address only one weakness to improve the existing process. Hence, the improvements for the other weaknesses identified were required to be addressed outside the scope of this thesis. Although extensive current state analysis of the process was performed by involving people from varied expertise, it would be necessary to acknowledge that there might be other issues apart from the ones identified.

The outcome of this study is tailored specifically to the case company, but few recommendations can be considered transferrable. A few examples of such recommendations would be the ones relating to communication and defining the roles and responsibilities categories, which can be transferred to improve other processes both within and outside the organization.

Apart from achieving the set objectives, the thesis work created the opportunity to assess an already well-established process that in other circumstances would not have been prioritized. Through the thesis, it was possible to address a critical issue for the whole organization which helped to improve the project efficiency and project planning. The thesis work contributed to the organizational goal of continuous improvement of processes. Usually, the issue concerning time schedule would have been performed by people belonging to Project Management or Project Planning. However, the thesis gave the opportunity for the author from the Engineering discipline to analyze the old problem through a new lens and thereby add a fresh viewpoint on the potential issues.

During the execution of the thesis work, a few valuable lessons were learned. The first lesson was the importance of incorporating the possible vacation in the planning to avoid schedule conflicts. The second lesson was the requirement for better planning and adaptability to handle any uncertainties and concerns that arise during the execution. The final lesson was to not try to tackle too many problems at once or underestimate the workload involved. Despite the few

hindrances that affected the thesis execution, it was possible to achieve the objective by the stipulated deadlines through effective communication, constant support from the organization, the excellent involvement of all the stakeholders, and incorporating feedback regarding the work performed.

7.4 Closing words

Process improvement is a continuous process and requires constant efforts from all the people involved. Managing the time schedule is a vital process for any organization and the first steps to improve the process have been initiated with the thesis work. The recommendations can be implemented, and the process can be improved further through constant efforts.

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APPENDIX 1 - QUESTIONS FOR QUESTIONNAIRE (CSA)

1. How is the time scheduling process handled for different projects?

2. Do we have work instruction regarding time scheduling and time estimation?

3. Have you noticed that the time scheduling process is continuously improved? If yes for process continuously improvement, what were the previous improvements/ issues identified previously?

4. Difficulties faced in time scheduling as a manager/discipline lead/ discipline member?

5. How is the input to the time scheduling process?

6. How is the alignment with other disciplines and Project Management?

7. Are the discipline suggestions regarding the time scheduling evaluated and prioritized?

8. How are the deviations from previous project experiences considered in developing time schedule in new projects?

9. What are the strengths of the time scheduling process in your opinion?

10. What are the weaknesses of the time scheduling process in your opinion?

11. Open comments

APPENDIX 2 - QUESTIONS FOR EMAIL INQUIRY (CSA)

1. What are the most common reasons noticed for delays in projects?

2. How are the deviations in the schedule handled and when are the concerns raised and addressed?

3. How are the follow-up and progress tracked?

4. How is the performance evaluated? Who keeps track of these KPIs and are there any improvement projects going on relating to this?

5. What are the current development projects relating to improving the time schedule?

6. How priorities of activities in time scheduling are handled and decided?

7. Any comments on the tool used for the time scheduling process? Any suggestions on improving the tool used?

8. Areas of improvements