Trax Ghana's greenhouse production of bell peppers in Northern Ghana

A case study of Trax Ghana's greenhouse project and how project management methods can support their planning phase

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Abstract

This thesis seeks to uncover how the non-governmental organization, Trax Ghana, planned its first greenhouse project in the Upper East Region of Ghana. This was conducted by narrowing the analysis to how Trax Ghana planned its bell pepper production, which can provide implications for the overall planning phase. Interpretation of the findings related to their conducted planning phase lays the foundation for guiding how the planning phase can be supported. Establishing appropriate project management methods for the bell pepper production is particularly important as Trax Ghana supports its beneficiaries financially through the sales income from bell peppers. Supporting Trax Ghana's achievement of its project objectives is the study's main purpose.

The thesis was conducted as a qualitative case study, with semi-structured interviews as the dominating applied technique for gathering data. Examination of project documents and unstructured observations supported the findings through interviews. Fieldwork in Ghana was also conducted to collect the necessary data to achieve the thesis's objective.

Trax Ghana's planning phase had several deviations from the examined project management knowledge areas of project schedule management, project cost management, and project risk management. I find evidence that graphical techniques can support the project schedule management. As a solution, a Gantt chart was applied to share its project schedule. The most significant deviation is a lack of financial analysis for the bell pepper production, related to the project cost management. Financial analysis tools were developed in collaboration with Trax Ghana to address this. Lastly, Trax Ghana's risk management can be supported by implementing a risk analysis. A template for risk assessment was therefore designed to support its risk management. In general, the findings uncover that Trax Ghana could benefit from expanding its current project management for its planning phase with additional project management methods.

Preface

This master thesis has been written as a part of my Master of Science in Industrial Economics and Technology Management at the University of Agder (UiA). The primary motivation behind the thesis was to use my theoretical knowledge to contribute to a real-world project in a developing country, which I was allowed to do through the Engineers Without Boarders Master with Meaning program. Although the work has been extensive and challenging, I have been rewarded with significant knowledge and insight into project management subject.

I want to express my gratitude to Engineers Without Boarders and Trax Ghana for providing me with this opportunity. I offer a special thanks to Trax Ghana for hosting me during my fieldwork and providing me with essential data to conduct this research. Furthermore, I would like to thank Robert Martinez for his supporting role as a student mentor during my fieldwork. I really appreciated my stay in Ghana and the opportunity to gain an authentic experience of the culture and the wonderful people of Ghana.

I also want to thank my supervisor, Hossein Baharmand, for providing me with invaluable and constructive feedback during the writing process. Your guidance has been essential for my research.

Finally, I am grateful to my family and friends who have supported me through the semester and have been cheering for me in times of struggle.

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1. Introduction

Africa has an extreme poverty rate (Saleh, 2022), whereas research (African Union Commission, 2015; Aikins & Toit Mclachlan, 2022; Obour, Arthur, & Owusu, 2022) has uncovered an unrealized potential to increase Africa's national prosperity through agricultural development. This thesis studies the non-governmental organization Trax Ghana, and its greenhouse project in a rural community in Northern Ghana. The project seeks to lift its beneficiaries out of extreme poverty by facilitating education to improve their socioeconomic livelihood (Ingeniører uten grenser, n.d.; Trax Ghana, n.d.). Hence, Trax Ghana's project performance directly influences the improvement of the beneficiaries' livelihoods, which can create ripple effects for their families. Assisting Trax Ghana in achieving its objectives can contribute positively to the development process for a rural community in Ghana. This thesis therefore aims to contribute to Trax Ghana's first greenhouse project by analyzing and supporting its planning phase. The following subsections contribute to establishing the context of the research questions.

1.1 Background

International development (ID) projects aim to promote living conditions, education, or health in developing countries and are a dominant method of delivering international aid (Golini, Kalchschmidt, & Landoni, 2015; Golini & Landoni, 2013; Hermano, López-Paredes, Martín-Cruz, & Pajares, 2013) Hence, ID projects attract a diversified form of funding and collaboration with recipient governments or non-governmental organizations (NGOs) (Golini & Landoni, 2014; Hermano et al., 2013). Khang and Moe (2008) explain that the funding mainly takes the form as concessionaire loans, grants, or technical assistance. Providing job opportunities, improvement in maternal health, or other skills training are examples of project objectives within ID projects (PM4DEV, 2015). Trax Ghana's greenhouse project can be characterized as an ID project as its project objectives are to ensure the beneficiary's completion of primary and secondary levels of education. These education levels are costly, which makes it difficult for the poorest households to afford with their annual income. Financially supporting the beneficiaries can facilitate their access to higher education and expand their career options. Hence, the greenhouse project is designed to lift the beneficiaries from poverty, which contributes to avoiding the social challenges of teenage pregnancy and school dropouts (Trax Ghana, 2022; Trax Norway & Trax Ghana, n.d.).

Saleh (2022) reports that poverty is an extensive challenge in Africa, with approximately one-third of Africa's population in extreme poverty in 2022. Moreover, Aikins and Toit Mclachlan

(2022) stress the lack of agricultural and rural development as one factor for Africa's failure to reduce its extreme poverty rate. In 2015, the African Union Commission developed and implemented Agenda 2063 (African Union Commission, 2015). Agenda 2063 is Africa's master plan for transforming Africa, and its first aspiration is to eradicate poverty (African Union, n.d.; African Union Commission, 2015). Furthermore, Agenda 2063 propose strategies related to the modernization of African agriculture and agro-businesses to achieve their first aspiration of a prosperous Africa (African Union Commission, 2015). Trax Ghana supporting their beneficiaries through an agro-business is in line with Agenda 2063's aim to reduce the poverty rate in Africa through agricultural development.

In May 2022, a 300 square meters greenhouse facility was established on the Trax Ghana farm located in the Bongo District in the Upper East Region. The NGO Engineers Without Borders (EWB) Norway funded the greenhouse project. EWB aims to support aid organizations' projects with technical assistance and has earlier collaborated with Trax Ghana to establish a goat farm and install solar panels on the Trax Ghana farm (Ingeniører uten grenser, n.d.). Figure 1 presents a visual overview of the Trax Ghana farm. These projects align with EWB's vision to facilitate development through humanitarian engineering (Shareitfair, n.d.).

Figure 1 A photo of the Trax Ghana farm including their goat farm and the greenhouse tunnel. A solar photovoltaic system is installed on the goat farm's roof, providing the farm with electricity. The greenhouse tunnel is covered with a shade net and a water borehole and pump located on a tank metal stand (not in the picture) to provide water distribution. The photo was taken during the fieldwork by Helene Bergo Nygårdsvik on Sep 22nd 2022.

Ten girls from poor households were selected from the local Junior High School as beneficiaries of the project. The beneficiaries are encouraged to engage and learn about the agricultural occupation in the greenhouse in their leisure time while being supported financially through Trax Ghana, covering their basic needs with the proceed from the sales of vegetables (Trax Ghana, 2022).

The current vegetable production, illustrated in Figure 2, consists of seven rows of bell pepper plants which constitute a total of approximately 600 bell pepper plants.

Figure 2 A photo of the greenhouse production of bell peppers inside the greenhouse facility. A drip irrigation system follows the seven rows of bell pepper and distributes them with water from the water borehole and pump. The bell pepper plants are cultivated in growing buckets filled with growing medium. Trellis twine supports the plants while growing tall, and a rubber mat covers the ground inside the greenhouse facility. The photos were taken during the fieldwork by Helene Bergo Nygårdsvik on Sep 22nd 2022.

1.2 Motivation

Promoting the agricultural sector undermines Ghana's commitment to the UN Sustainability Goals (SDGs). Particularly SDG 1, *"No poverty"* and SDG2, *"End hunger, achieve food security and improved nutrition and promote sustainable agriculture"* (Blind, 2019; Obour et al., 2022; United Nations, n.d.). This is in line with the African Union Commission's (2015) Agenda 2063, which aims to increase farmers' and national prosperity and food security by scaling and modernizing African agriculture and agro-businesses. Several researchers[1] emphasize the need for radically modernizing the agriculture sector by stating that open field smallholder farming is characterized by low productivity, profitability, and sustainability. In 2020, President Nana Addo Dankwa Akufo-Addo unveiled 75 greenhouses in the Greater Accra Region. The Business Development Ministry stated that these greenhouses are a part of Ghana's process to modernize agriculture and the agricultural sector appealing to youth. The Ministry plans 1000 additional greenhouses across Ghana. These greenhouses provide job opportunities and facilitate economic benefits for Ghana by scaling its vegetable production to become a net exporter of vegetables (Ministry of business development, 2020).

[1] See e.g., The World Bank (2008), Dang et al. (2020), Business & Financial Times (B&FT) (2022), Forkuor, Amponsah, Oteng-Darko, and Osei (2022).

The motivation for conducting this thesis is to facilitate achieving the UN SDGs mentioned above by contributing to greenhouse projects both theoretically and with evidence-based insights from ongoing projects. Investigating Trax Ghana's planning phase could provide evidence for how greenhouse projects in Northern Ghana can achieve optimal planning for the projects' contribution to prosperity and food security.

1.3 Context of the study

Agriculture has been a principal sector of Ghana's economic growth. The contribution to the gross domestic product was about 19,7% in 2021, making agriculture one of Ghana's most significant economic sectors (Ministry of Food and Agriculture, 2021; O'Neill, 2022b; World Bank national accounts data & OECD National Accounts data files, n.d.). Approximately 30 % of Ghana's labor force is engaged in agriculture (International Labour Organization, 2021; O'Neill, 2022a), and smallholder farmers constitute the largest segment of the Ghanaian agricultural sector (Chamberlin, Xinshen, Kolavalli, & Breisinger, 2007; Ministry of Food and Agriculture, 2021). Hence, modernizing Africa's agriculture will significantly contribute to increasing its prosperity. Furthermore, according to the Ghana Poverty Assessment (2020) report, farmers in Northern Ghana are especially poor and vulnerable household groups. This is in line with Cooke, Hauge, and McKay's (2016) report that the Northern, Upper East, and Upper West regions, which aggregate Northern Ghana, have the highest poverty rates. Hence, farmers in Northern Ghana are economically constrained to contribute to modernizing agriculture by applying agricultural inputs such as fertilizers and mechanization services (Business & Financial Times (B&FT), 2022).

Trax Ghana's greenhouse project is located in the Kabusgo community in the Bongo District of the Upper East Region (Akapule, 2019; Ingeniører uten grenser, n.d.). The greenhouse's location is illustrated in Figure 3, which is a location in Northern Ghana.

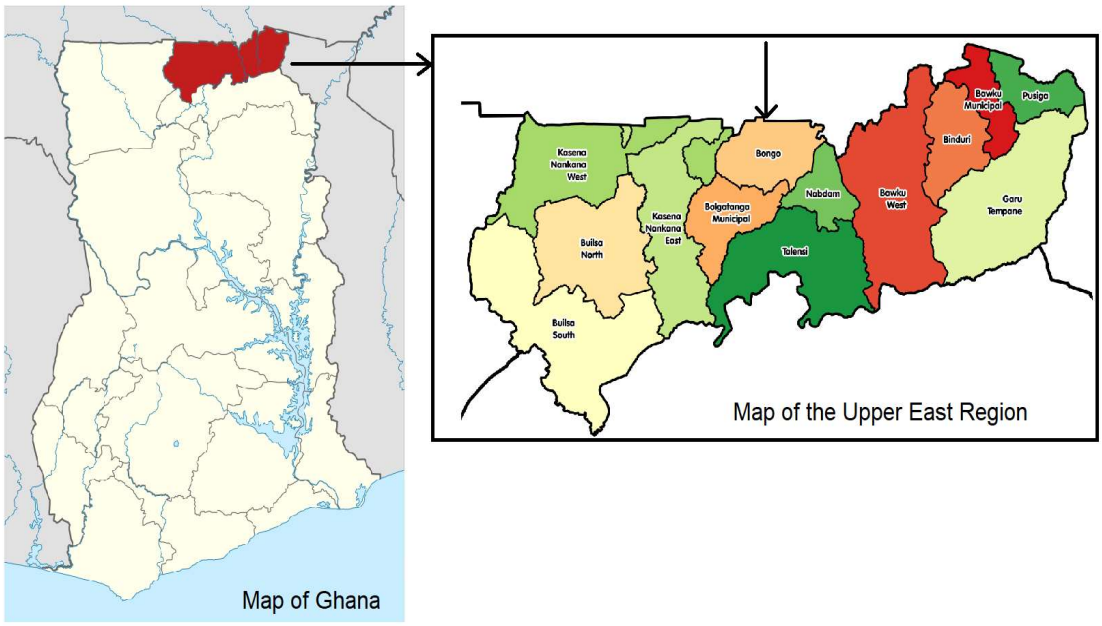

Figure 3 A Map of Ghana where the Upper East Region and Bongo district are pointed out. The figure is constructed based on figures retrieved from Wikimedia Commons (2012) and (2018).

Ghana is divided into six agroecological zones, where the Bongo District is located in the Sudan Savannah zone. This zone is characterized by an annual rainfall of 750 to 1050 mm between May and October, followed by a dry season from November to April (Antwi-Agyei, Dougill, & Abaidoo, 2021). Antwi-Agyei et al. (2021) and Armah et al. (2011) note that this agroecological zone is one of Ghana's driest, exposing the poor smallholder farmers dependent on rain-fed agriculture for livelihood to significant risk and uncertainty. However, Trax Ghana's greenhouse project provides a controlled environment for agricultural production, reducing the open-field farmer's climate challenges (Forkuor et al., 2022). Hence, Forkuor et al. (2022) state that greenhouse farming can increase agricultural productivity and sustainability.

1.4 Research objective and research questions

This thesis follows the well-known project management life cycle (initiation, planning, execution, and completion) (Kerzner, 2009; Köster, 2010; Project Management Institute, 2017; Tonnquist, 2016) and aims to explore the planning phase of Trax Ghana's greenhouse project. The planning phase has been referred to as one of the most critical phases in the project life cycle due to its massive impact on meeting the project's scope, time, and budget (Abbasi & Al-Mharmah, 2000; Kerzner, 2009; PM4DEV, 2015)

In the context of ID projects, literature states the imperativeness for NGOs to adopt project management tools and techniques to meet its projects' objectives (Golini et al., 2015; Khang

& Moe, 2008; PM4DEV, 2015; PM4NGOs, 2020). Therefore, this thesis objective is to support Trax Ghana and other potential NGOs active in the development to effectively use project management tools and practices for the planning phase of greenhouse projects. The starting point for developing the study's research question was to analyze Trax Ghana's greenhouse project considering its project management practices. Although initial research questions were vague, they became more focused during the literature study and data collection, in line with Nygaard (2017).

The thesis seeks to answer the following research questions:

"How did Trax Ghana plan the greenhouse production of bell pepper in Northern Ghana?"

"How can we support the planning of greenhouse projects for Engineers Without Borders in Northern Ghana?"

1.5 Structure of the thesis

Given the provided introduction in this section, the rest of this thesis is organized as follows. In section 2, the thesis provides a comprehensive literature review on project management of planning for schedule, cost, and risk management. Project management is thereafter explained in the contexts of ID projects and greenhouse production to provide a theoretical framework for the thesis. Section 3 presents the methodological approach in this thesis. The section includes justifications for the selected data collection methods and explains their practical implementation. The section also elaborates on data analysis, validity, and reliability. Section 4 describes the qualitative and quantitative results that constitute the thesis findings. These findings are discussed in section 5, based on the theoretical framework and related to the research questions. Lastly, the conclusion summarizes the findings in light of the research questions, and provides a solution based on the findings.

2. Literature review

This section introduces fundamental literature that contributes to understand how projects with corresponding characteristics to Trax Ghana's greenhouse project could be planned. First, the project life cycle and project management are introduced. Then, the literature introduces an extract of project management methodology related to the planning phase, which is essential to this thesis. Lastly, literature concerning project management for development projects and management of perishability is briefly reviewed as these are distinct aspects of the project.

2.1 Project life cycle and project management

Projects aim to achieve its objectives within a defined time period with its constrained accessible resources. It is impossible to recreate a previous project exactly, and therefore every project is unique as proposed by several researchers[2]. Maylor (2010) summarizes a project's characteristics by presenting that they are focused, temporary, and unique. Moreover, projects are planned and executed in an environment that constantly changes. Hence, projects are related to uncertainty which intensifies the complexity of developing accurate plans (Portny et al., 2009).

A project consists of a sequence of phases connecting its beginning with its end. The sequence is often referred to as the project life cycle, and there is no ideal life cycle due to the complex nature and diversity of projects. Hence, the project management team should choose its project's most fitting life cycle (Kerzner, 2009; Köster, 2010; Project Management Institute, 2017; Tonnquist, 2016). However, the project life cycle typically contains a variant of the project phases initiating, planning, execution, and completion (Kerzner, 2009; Köster, 2010; Project Management Institute, 2017; Tonnquist, 2016).

Project management is defined as *"the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements"* (Project Management Institute, 2017, p. 10). Tonnquist (2016) and the Project Management Institute (2017) argue that adopting and applying appropriate project management methods is crucial for project success. This is in line with Kerzner (2009), who states that successful project management is tightly associated with achieving the project objectives. The reason is that project management is associated with considerable project benefits. Kerzner (2009) highlights that project management contributes to the early identification of risks, identification and division of responsibilities among the

[2] See e.g., Kerzner (2009), Portny et al. (2009), Köster (2010), Tonnquist (2016), Project Management Institute (2017).

activities, and performance measurements. Adding to this, the Project Management Institute (2017) emphasizes meeting stakeholder expectations and managing constraints as arguments for adopting project management methods. Project management is related to the project life cycle phases, as each phase has a series of appropriate project management tools and techniques (Project Management Institute, 2017; Tonnquist, 2016).

The initiating phase is the first project life cycle phase, where the project's feasibility is analyzed and determined as a part of a preliminary analysis (Kerzner, 2009; Köster, 2010). At the end of this phase, the project management decides whether to decline the project or proceed forward in the life cycle (Kerzner, 2009). Second is the planning phase. Köster (2010) argues that project planning provides a holistic overview of the required activities to achieve the project objectives within the organizational constraints. This includes establishing project schedules and resource plans, calculating costs, and handling risks. The planning phase lays the foundation for the initial development of a project plan (Kerzner, 2009; Köster, 2010; Tonnquist, 2016). Next is the executing phase, where the project plan is implemented. Then the project plan is monitored and controlled to respond to changes in the project environment (Köster, 2010; Tonnquist, 2016). The final phase is the completion phase, where the project results are evaluated. This last review can serve as input for a new project's initiation phase to learn from similar projects' mistakes and successes (Kerzner, 2009; Köster, 2010; Tonnquist, 2016).

According to Abbasi and Al-Mharmah (2000), the planning phase is one of the most critical phases of project management as it determines and defines the activities to be done during the execution phase. In addition, Kerzner (2009, p. 412) emphasizes the importance of planning with the proverb, *"failing to plan is planning to fail."* Project planning is a repetitive process due to the fast-changing environment during the project life cycle. Nevertheless, a realistic starting point is essential (Kerzner, 2009; Köster, 2010; Maylor, 2010). The Project Management Institute (2017) states that developing a project plan is a starting point but emphasizes that the plan must be flexible enough to adopt changes in priority and acquired knowledge during the execution phase. Hence, the project plan must be structured enough to be reviewed and controlled (Kerzner, 2009).

2.2 The initiating phase

The initiating phase is closely related to the planning phase, as the preliminary analysis is further elaborated and detailed in the planning phase (Tonnquist, 2016). Köster (2010) states that the initiating phase lays the foundation for achieving project success. Hence, some practices from this phase are briefly presented as a supplement to extend the understanding of the planning phase. This includes the project management knowledge area project scope management, and its techniques the SMART rule and the SWOT analysis.

Project scope management is vital to the initiating phase, as it defines what is included and excluded in the project (Köster, 2010; Project Management Institute, 2017). The Project Management Institute (2017) presents that scope management defines the project scope as the required activities to deliver the predetermined results within the project constraints. Hence, Köster (2010) emphasize that the project scope must be systematically formulated to avoid misunderstandings about the project work among the project management and their stakeholders. She calls attention to the SMART rule as a tool to define the project scope, where SMART is an abbreviation for specific, measurable, achievable, realistic, and time-bound (Kerzner, 2009; Köster, 2010; PM4NGOs, 2020; Portny et al., 2009; Tonnquist, 2016). Furthermore, Tonnquist (2016) and Kerzner (2009) relate the SMART rule to the project objectives that inform which results the project aims to deliver. PM4NGOs (2020) further assert that the SMART rule is necessary to secure an initial reference point so the project objectives can measure change. Adding to this, Kerzner (2009) states that several research and development projects have been reestablished later in the project life cycle as they detected that the initial project objectives were not achievable. This indicates that the project objectives should be specific rather than general.

The SWOT analysis is a part of the initial project risk management as it provides an overview of the current project situation (Tonnquist, 2016). SWOT is an abbreviation for strengths, weaknesses, opportunities, and threats, and the analysis examines the project from each

perspective (Maylor, 2010; Project Management Institute, 2017; Tonnquist, 2016; Ying, 2010). A template for performing a SWOT analysis is illustrated in Table 1.

	+ Factors that can facilitate the project	- Factors that can obstruct the project
Within the execution organization	Strengths	Weaknesses
Outside of the execution organization	Opportunities	Threats

Table 1 A template for the SWOT analysis retrieved from Tonnquist (2016, p. 88). The SWOT analysis maps factors that can facilitate and obstruct the project within and outside the execution organization. Strengths and weaknesses are classified as factors within the organization, and opportunities and threats are classified as factors outside the organization.

Ying (2010) and the Project Management Institute (2017) argue that the SWOT analysis is a strategic tool that comprehensively balances the internal and external project aspects, and examines whether the positive aspects counterbalance the negative ones. Hence, the SWOT analysis is a strategic tool for choosing the best-suited strategy for achieving the project objectives (Tonnquist, 2016; Ying, 2010). According to Tonnquist (2016), the SWOT analysis is conducted before the formulation of the SMART project objectives, as the selection of objectives depends on the current situation. Adding to this, the Project Management Institute (2017) and Tonnquist (2016) highlight that the SWOT analysis contributes to identifying risks in project risk management by presenting the project's opportunities and threats.

2.3 The planning phase

The Project Management Institute (2017) introduces ten project management knowledge areas for the project life cycle, as depicted in Figure 4. A knowledge area is defined by its knowledge preconditions and describes its processes, practices, tools, and techniques (Project Management Institute, 2017).

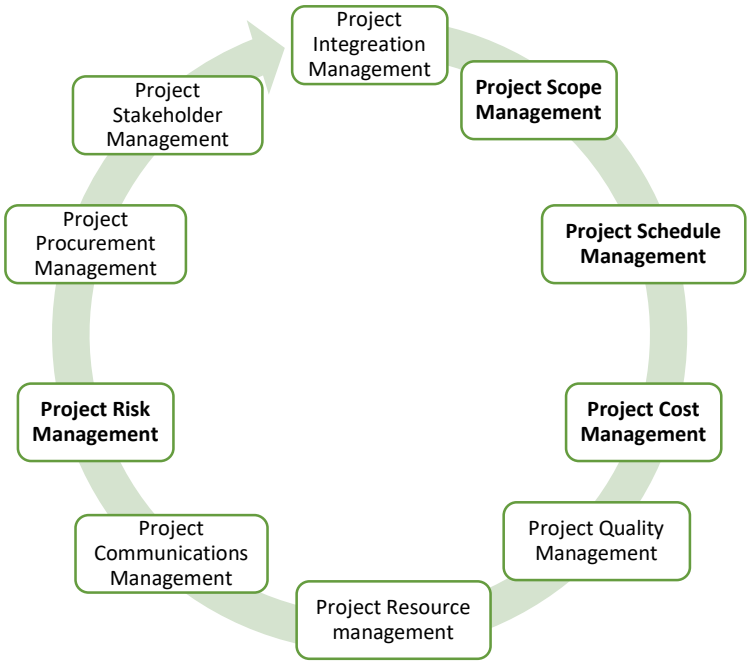

Figure 4 An overview of the nine most used project management knowledge areas presented by the Project Management Institute (2017). Project scope management, project schedule management, project cost management, and project risk management are highlighted as they are included in this thesis.

Due to the scope and objective, this thesis targets only an excerpt of the project management knowledge areas for the planning phase. This includes project schedule, cost, and risk management, which will be explained in the following sub-sections. These areas are identified by PM4NGOs (2020) as knowledge areas significant for managing development projects. Furthermore, the thesis presents an excerpt of tools and techniques for these areas, as illustrated in Figure 5.

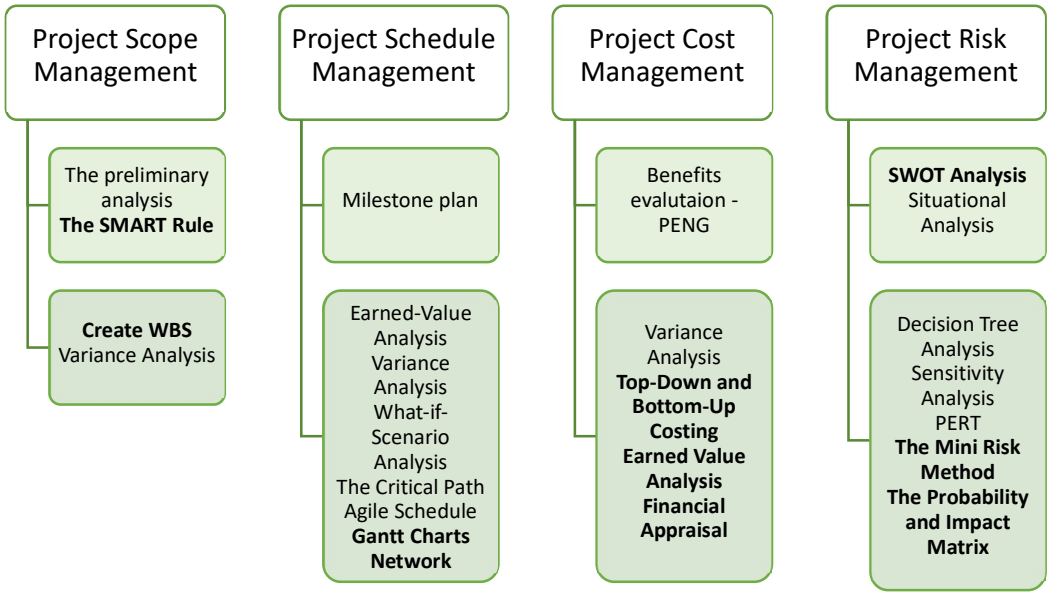

Figure 5 Project management tools and techniques for the presented project management knowledge areas: project scope management, project schedule management, project cost management, and project risk management. The first link presents tools and techniques related to the initiating phase, while the following is the planning phase.

2.3.1 Project schedule management

Time is a principal delimitation of a project, and project schedule management is therefore essential to complete the project on time (Köster, 2010; PM4DEV, 2015; PM4NGOs, 2020; Project Management Institute, 2017; Tonnquist, 2016). Tonnquist (2016) specifies that the project schedule provides guidelines for evaluating the project status and forecasting if the project will achieve its goal on time. Hence, the project schedule can act as a tool for communication, managing stakeholder expectations, and a standard for reporting project performance (Project Management Institute, 2017). Kerzner (2009) and Tonnquist (2016) summarize the scheduling outcome as an up-to-date picture of operations for internal and external use and further provides the foundation for pursuing optimal project execution.

Schedule management involves creating a schedule that provides information about the project activities. This includes defining the activities, along with the sequence and activity duration (Maylor, 2010; PM4NGOs, 2020; Project Management Institute, 2017). Maylor (2010) recommends creating a graphical project schedule as it facilitates the review and revision of the plan by simplifying the involvement of the project's stakeholders. In this regard, Kerzner (2009) presents Gantt charts and network scheduling as some of the most common graphical scheduling techniques. However, the first step is to map the activities to include in the project schedule.

Several researchers[3] give prominence to the project management tool Work Breakdown Structure (WBS) as a technique to develop a detailed overview of the project activities. A WBS contains and structures all the project work and further decomposes the work into tasks until the lowest activity level is reached (Köster, 2010; PM4NGOs, 2020; Tonnquist, 2016). According to Tonnquist (2016) and Kerzner (2009), the WBS process decreases the probability of missing essential parts of the project, which causes changes and increased workload during the project. The WBS can be illustrated in several ways. The Project Management Institute (2017) proposes that it can be presented as an outline or an organizational chart, while Tonnquist (2016) explains how the WBS can be viewed as a hierarchical mind map.

After the activities are mapped through WBS, the project manager can develop a Gantt chart. Gantt charts illustrate the relationship between activities and time (Maylor, 2010; PM4NGOs, 2020; Tonnquist, 2016), as illustrated in Figure 6. A number of researchers[4] highlight that Gantt charts are widely used because they present a simple, readable overview of the project activities. However, Maylor (2010) presents some principal limitations related to the Gantt chart. He warns that Gantt chars can quickly become outdated because of difficulties in updating manually. Hence, Gantt charts can cause a misleading sense of certainty about the project status (Maylor, 2010). Adding to this, Lewis (2007) emphasize that the Gantt chart does not provide certain information about how activity delays affect the remaining activities and project. Consequently, Maylor (2010) argues that Gantt charts are best suited for relatively simple projects within a considerably static environment.

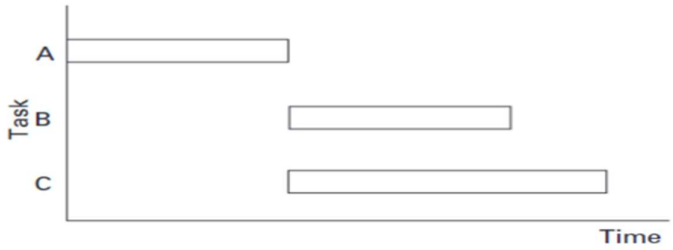

Figure 6 A template of a Gantt chart retrieved from Lewis (2007, p. 71). In Gantt charts, the activities are placed on the vertical axis, and the time is placed on the horizontal axis (Project Management Institute, 2017). Between the axes, the activities are illustrated as bars, milestones as dots, and dependencies as arrows (Maylor, 2010; Tonnquist, 2016). However, this figure is simplified as it only illustrates the activities as bars.

Network scheduling provides the opportunity to show the interdependencies between activities that Gantt charts cannot offer (Kerzner, 2009; Lewis, 2007). Hence, network scheduling is

[3] See e.g., Kerzner (2009), Köster (2010), Maylor (2010), Project Management Institute (2017), Tonnquist (2016), PM4NGOs (2020).
[4] See e.g., Lewis (2007), Maylor (2010), Project Management Institute (2017), Tonnquist (2016).

preferred by projects with higher complexity as a graphical scheduling technique (Maylor, 2010). According to Kerzner (2009) and Köster (2010), the interdependencies between activities are illustrated through network construction in network scheduling. Tonnquist (2016) presents that network scheduling is commonly visualized in the diagram formats: activity-on-node (A-o-N) and activity-on-arrow (A-o-A). A-o-N is the most commonly used technique of the two (Maylor, 2010; Project Management Institute, 2017; Tonnquist, 2016). A-o-N illustrates the activities from the WBS and their duration as a box. Furthermore, arrows link the activities together to represent the logical sequence of activities (Lewis, 2007; Maylor, 2010). The diagram is illustrated in Figure 7, which Lewis (2007) and Maylor (2010) refer to as a simple-to-understand diagram showing the project course.

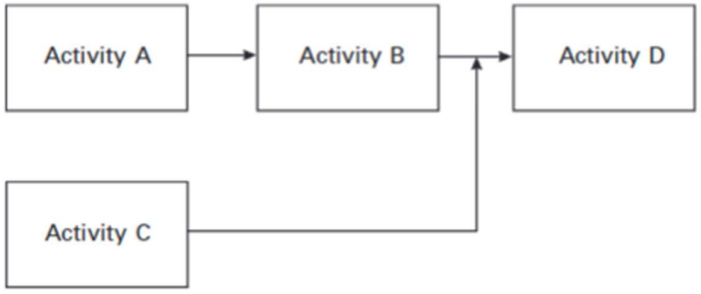

Figure 7 Activity-on-node (A-o-N) diagram retrieved from Lewis (2007, p. 72). Activity D arrows entering from Activity B and C. To be able to start, Activity D must have all arrows entering that activity emanates. Hence, Activity B and C must first be completed for Activity D to start (Portny et al., 2009).

A vital factor affecting schedule management is that the project environment is constantly changing (Project Management Institute, 2017; Tonnquist, 2016). The Project Management Institute (2017) states that the project schedule should be modified throughout the project to respond to changes. Changes can occur when new project information is available, and the project management team's experience increases along with an understanding of threats and opportunities. This is in line with the findings of Tonnquist (2016), who present that the changing environment forces the project manager to adapt and change the project schedule continually. Accordingly, the Project Management Institute (2017) posits that project schedule management is an iterative process.

2.3.2 Project cost management

Jin, Shen, and Wang (2018) state that project cost management is essential for success. This statement is supported by Köster (2010), who further points out that projects are constrained by its accessible amount of money. The Project Management Institute (2017) enhances that cost estimates of resources related to the project activities is the primary concern of cost

management. Kerzner (2009) claims that cost control also includes anticipations about the project's future to execute corrective actions before it is too late. This is in accordance with Amann and Eichenberger (1998), who state that budgets, as a control device, can measure resource consumption and track the progress of a project. Further, the Project Management Institute (2017) notes that the cost estimates should be adjusted to include increased information as it becomes accessible and the presumptions are tested.

Studying cost planning, Köster (2010) and Portny et al. (2009) argues that the project schedule is financially expressed in a project budget. Hence, they state that the project budget can be developed based on the activities found through the WBS. This is consistent with Tonnquist's (2016) findings, which suggest that estimating costs can begin as soon as the activities are mapped through the WBS. As the project does not receive revenue until the executing phase, the project economy mainly consists of estimating and managing costs (Tonnquist, 2016). This illustrates the importance of cost control. Adding to this, the Project Management Institute (2017) implies that the budget determines a cost baseline that can be used to monitor and control project performance.

A budget can be developed through top-down or bottom-up costing (Maylor, 2010; Portny et al., 2009). Portny et al. (2009) explain top-down costing as a process where the top and middle managers with the highest authority levels estimate the cost of the major project activities. After that, the estimates are provided to an inferior management level to determine the cost of their activities within the limitations of the provided estimate. The process carries on until all the activities are budgeted. Bottom-up costing is explained by Maylor (2010) and Amann and Eichenberger (1998) as costing based on the hierarchical division of activities from the WBS. Each activity is assigned a cost by working from the lowest hierarchical division to the highest. The result is a total budget based on the sum of all costs. Moreover, PM4NGOs (2020) underlines that the project budget is only as good as the cost estimates that it is based on. Consequently, the project budget always consists of a certain level of uncertainty (Portny et al., 2009). Tonnquist (2016) supports this statement by adding that there is always a level of uncertainty in any estimates and that the risk of exceeding the budget depends on this. The level of uncertainty is highest at the first project life cycle phase and decreases as the project approaches the execution phase. Hence, Tonnquist (2016) highlights the importance of the initiating phase so that stakeholders know that the project cannot be guaranteed to stay within the project's constraints.

After the costs are estimated, a financial appraisal compares the potential project rewards with the estimated costs (Maylor, 2010). Tonnquist (2016) and Maylor (2010) stress that project estimates should not exceed the available economic resources and introduce several methods to determine the project's feasibility or net benefit. This includes the payback analysis. The payback analysis estimates the project's required payback time related to the invested capital (Maylor, 2010; Tonnquist, 2016). Maylor (2010) refers to this method as the most elementary method of financial project evaluation as it explains when the project breakeven and becomes profitable.

The presented cost management activities all participate in the project's planning phase. However, the costs are reported and followed up in the execution phase to monitor the project status and keep the project costs under control (Tonnquist, 2016). Tonnquist (2016) suggests that the project manager must decide when the costs should be reported, for instance, at defined stages of activity completion. Moreover, Kerzner (2009) accentuates the need to manage costs rather than follow up and report costs and introduces the Earn value measurement system (EVMS) to respond to this need. Several researchers[5] draw attention to this system. Tonnquist (2016) states that by implementing EVMS, the project manager can determine actual results and resources used throughout the project. Adding to this, Portny et al. (2009) explain that EVMS can interpret the project status in terms of the project schedule and budget while tracking resources. The main reason for introducing this system was to illustrate how cost estimates and the project budget are related to the execution phase.

2.3.3 Project risk management

The importance of project risk management is highlighted by several researchers[6]. The Project Management Institute (2017) argues that risk management aims to capture opportunities (positive risks) and avoid or mitigate threats (negative risks). Hence, the aim is to balance risk and reward. This is consistent with the findings of Maylor (2010), who states that opportunities should be considered wherever risk is assessed. Furthermore, according to Teller, Kock, and Gemünden (2014), a positive relationship is uncovered between risk management and project success. This statement is supported by Kerzner (2009), who states that risk management increases the probability of project success by being a proactive process. Although studying

[5] See e.g., Lewis (2007), Kerzner (2009), Portny et al. (2009), Tonnquist (2016), Project Management Institute (2017), PM4NGOs (2020).

[6] See e.g., Kerzner (2009), Portny et al. (2009), Köster (2010), Maylor (2010), Tonnquist (2016), Project Management Institute (2017), PM4NGOs (2020)

risk management, researchers tend to list the included risk management processes slightly differently. However, the Project Management Institute's (2017) overview includes the processes: plan risk management, identify risks, perform a qualitative and quantitative risk analysis, plan risk responses, implement risk responses, and monitor risks.

Plan risk management involves defining how risk management practices will be structured and performed. The plan may include a risk strategy, methodology, roles and responsibilities, and a schedule for when and how often the risk management processes will be performed throughout the project (Kerzner, 2009; Project Management Institute, 2017). Adding to this, Köster (2010) notes that contingency plans with budget and estimated time are the main output of performing risk planning.

Tonnquist (2016) explains that risk identification identifies possible risk events. He elaborates that identifying risks begins at the initiation phase and advises using as many sources as possible for input. The assignment description, the WBS, the SWOT analysis, and the requirement specifications are examples of relevant sources. Moreover, the Project Management Institute (2017) adds that the outputs from this process are a risk register and risk report that collect information so the project management team can respond strategically to identified risks. The Project Management Institute (2017) and Köster (2010) agree that identifying risks is an iterative process since new risks may emerge at any stage of the project life cycle.

A comprehensive risk analysis includes a qualitative and quantitative analysis of risks (Kerzner, 2009; Köster, 2010). Kerzner (2009) and Tonnquist (2016) posit that a risk analysis consists of providing each identified risk with a probability of happening and predicting the impact this will have on the project. Moreover, the Project Management Institute (2017) states that this process classifies the risks, such as efforts that can be directed toward high-priority risks. Adding to this, Maylor (2010) states that there are several techniques to assess the level of risk. The mini-risk method and probability and impact matrix techniques are briefly explained.

Tonnquist (2016) introduces the mini-risk method as a simple tool to classify and illustrate project risks. In this method, likelihood and consequence are rated on a scale from one to five, and the risk value is calculated by multiplying the respective values. Subsequently, the project manager determines which level of risk value requires a risk response measure (Tonnquist, 2016). Table 2 illustrates the mini-risk method.

Risk	Likelihood 1 to 5	Consequence 1 to 5	Risk value L x C	Risk response
The system is too slow	2	2	4	
The current scanning system is not sufficient	4	5	20	Request new equipment

Table 2 The mini-risk method retrieved from Tonnquist (2016, p. 210). In this risk analysis, the first risk has a manageable risk value that indicates that this risk is not critical and, therefore no risk response is listed. The second risk has a high enough risk value for the project to implement a risk response. Hence, this risk can be classified as a high-priority risk.

The probability and impact matrix (see Table 3) is presented by the Project Management Institute (2017) as a grid for mapping the probability and impact of each risk. Furthermore, they state that the matrix specifies probability and impact combinations that allow the project manager to divide the risks into priority groups. This method categorizes opportunities and threats using descriptive terms and numeric values (Project Management Institute, 2017).

		Threats					Opportunities				
Probability	Very high 0,9	0,05	0,09	0,18	0,36	0,72	0,72	0,36	0,18	0,09	0,05
	High 0,7	0,04	0,07	0,14	0,28	0,56	0,56	0,28	0,14	0,07	0,04
	Moderate 0,50	0,03	0,05	0,1	0,2	0,4	0,4	0,2	0,1	0,05	0,03
	Low 0,30	0,02	0,03	0,06	0,12	0,24	0,24	0,12	0,06	0,03	0,02
	Very low 0,10	0,01	0,01	0,02	0,04	0,08	0,08	0,04	0,02	0,01	0,01
		Very low 0,05	Low 0,10	Moderate 0,20	High 0,4	Very high 0,8	Very high 0,8	High 0,4	Moderate 0,20	Low 0,10	Very low 0,05
		Negative impact					Positive impact				

Table 3 Probability and impact matrix retrieved from Project Management Institute (2017, p. 408). Probability is the probability that the risk will happen, and impact is the predicted impact the risk will have on the project. The red numeric values represent a high-priority group as the impact and probability are high or very high. Yellow represents a moderate priority, while green values have a low priority.

As claimed by the Project Management Institute (2017), the planning of risk responses is performed throughout the project. They specify that this process includes developing options, selecting strategies, and deciding actions to minimize threats and maximize opportunities. Adding to this, Kerzner (2009) and Köster (2010) specify that each risk response should have a risk owner responsible for the implementation. The risk management processes elaborated previously in this subsection are related to the planning phase, and the forthcoming processes are included in the execution phase (Tonnquist, 2016). Implementing risk responses is tightly linked to the risk response plan, as it ensures that the risk responses are implemented as planned

(Project Management Institute, 2017). Moreover, Köster (2010) summarizes the main activities of monitoring risk: tracking risks, maintaining the applicability of the risk response plans, and detecting emerging risks. These are consistent with the findings of the Project Management Institute (2017), which adds that this process is performed throughout the project.

2.4 Project management for development projects

The main objective of ID projects is to improve people's lives through skills training and other livelihood programs (Ahsan & Gunawan, 2010; PM4DEV, 2015). These objectives can be classified as soft objectives that aim to serve sustainable social and economic development (Ahsan & Gunawan, 2010; Crawford & Bryce, 2003; Golini et al., 2015; Khang & Moe, 2008). Hence, Youker (2003) argues that the profit motives usually found in industrial and commercial projects' hard objectives are often missing in ID projects. Furthermore, Golini et al. (2015), Youker (2003), Ahsan and Gunawan (2010), and PM4DEV (2015) list several additional distinctive characteristics of ID projects. This includes contrasting stakeholders, high stakeholder involvement, and a complex project environment.

According to Youker (2003), high stakeholder involvement is necessary as the project's soft objectives are more challenging to define and less visible and measurable than the hard objectives. Adding to this, Khang and Moe (2008) note that the key stakeholders prioritize the soft objectives during the project evaluation. They stress that the soft objectives must be defined, monitored, and measured through project management methods. Measuring the soft objectives is essential in ID projects as overlooking them could lead to measuring resource mobilizations and efforts (hard objectives) rather than results (Khang & Moe, 2008).

Youker (2003) and PM4DEV (2015) list reoccurring issues in managing ID projects. Youker (2003) points out a realistic and current project schedule and budget, poor control mechanisms for early detection of problems, and poor or no risk analysis as some of these issues. These findings are partly consistent with PM4DEV's (2015) findings of poor estimates of time and costs, incomplete and unrealistic project schedules, and lack of project risk management as common obstacles. Furthermore, PM4DEV (2015) argues that project management tools and techniques can target these obstacles. Khang and Moe (2008) draw attention to their life-cycle-based framework as a project management method to measure project performance explicitly developed for ID projects. Moreover, Golini et al. (2015) state that some project management guidelines have been created for NGOs managing ID projects, mentioning the guidelines by PM4DEV (2015) and PM4NGOs (2020). On the other side, Golini et al. (2015) add that the

guidelines are similar to traditional project management tools and practices. Hence, he argues that ID projects can take advantage of traditional project management methods. Regardless of the chosen project management methods, they should measure both the project's soft and hard objectives (Khang & Moe, 2008).

2.5 Planning the greenhouse production of fresh agricultural products

As climate factors that affect vegetable production can be controlled to some extent in greenhouses, Elings, Saavedra, and Nkansah (2015) argue that the vegetable crops to produce should be selected based on the market demand. Hence, they emphasize that the production should be limited to exclusively growing vegetables with an assured market exists. This is consistent with the findings of O. Ahumada and R. J. Villalobos (2011) and O. V. Ahumada, Villalobos, Leyva López, and Solano Noriega (2020). They find that decisions connected to the selection of crops, the total area to plant each variety, and when to grow are mainly based on forecasts of expected demand and prices in the season ahead. O. V. Ahumada et al. (2020) state that the presented decisions relate to the initial planning of planning the production of fresh agricultural products. The selection of vegetable crops affects the activities, their duration in the production schedule, and the labor requirements (O. Ahumada & R. J. Villalobos, 2011). Hence, the vegetable crop applies guidelines and directions for planning production.

O. V. Ahumada et al. (2020) summarize the planning process for producing fresh agricultural products through the four production phases: initial planning, growing phase, harvest phase, and postharvest phase. These are illustrated in Figure 8.

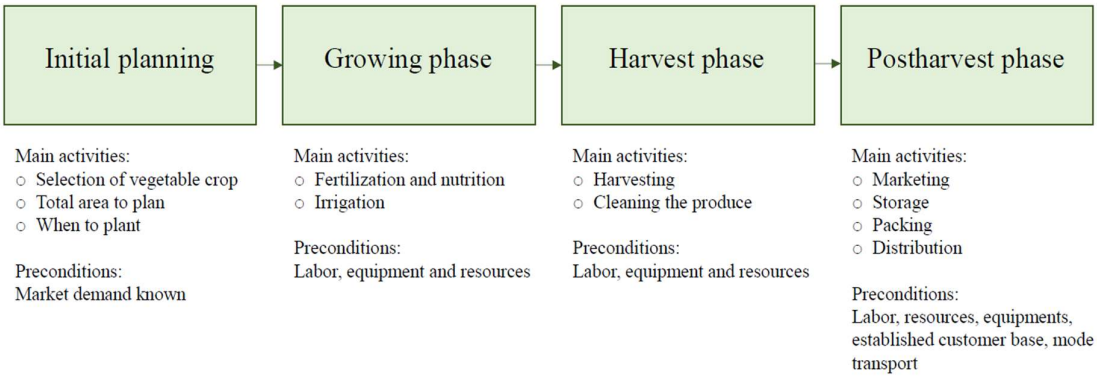

Figure 8 A summary of the production phases of fresh agricultural products based on O. V. Ahumada et al. (2020) "planning process for a shipper/grower". This includes the production phases: initial planning, growing phase, harvest phase, and postharvest phase. The main activities and their preconditions are presented for each production phase.

After the crop is selected and planted, the production enters the growing phase. In this phase are activities like fertilization and irrigation scheduled as the planted seed grows to its full-

grown plant. Additionally, this phase involves the preconditions of labor, equipment, and other resources to perform the activities. When the vegetables are ready to be harvested, the production enters the harvest phase. After harvesting, the postharvest phase prepares the vegetables for the customers. This includes decisions regarding marketing, storage, packing, and distribution (O. V. Ahumada et al., 2020). These production phases and activities are a part of the agricultural supply chain. As reported by Borodin, Bourtembourg, Hnaien, and Labadie (2016), the agricultural supply chain consists of the primary operations: production, storage, processing, and distribution. Additionally, OECD/FAO (2016) claims that an agricultural supply chain cover upstream and downstream value chains. Hence, the agricultural value chain covers the entity range from agricultural inputs such as seeds, medicines, and equipment to retailing fresh products (OECD/FAO, 2016).

An essential characteristic of producing fresh agricultural products is the management of perishability. As O. Ahumada and R. J. Villalobos (2011) claim, managing the supply chain of fresh products is a complicated planning problem considering the decay of fresh products. This is in line with Han et al. (2021), who present perishable characteristics as one of several factors affecting fresh produce production and distribution planning. They explain that perishability exposes farmers to short-term distribution decisions as freshness is one of the critical factors affecting the customer experience. Adding to this, O. Ahumada and J. R. Villalobos (2011) assert that profit and losses observed by growers of fresh perishable crops are highly dependent on short-term post-harvesting decisions. This includes profitable supplying decisions, as limited shelf life prevents prolonged storage and forces the producers to supply the market continuously. Further, O. V. Ahumada et al. (2020) highlight that insurance, subsidies, and contracts can reduce the grower's risk exposure and ensure a dependable income. According to Borodin et al. (2016), one of the most addressed and discussed topics in the agricultural sector is planning problems. Hence, several studies[7] have developed tools and systems to plan the production of fresh products. These models aim for growers to establish accurate plans to reduce exposure to risk and uncertainties, optimize their profitability and reduce food loss.

[7] See e.g., O. Ahumada and Villalobos (2009), O. Ahumada and J. R. Villalobos (2011), O. Ahumada, Villalobos, and Nicholas Mason (2012), Flores et al. (2019), O. V. Ahumada et al. (2020).

2.6 Planning the greenhouse production of fresh agricultural products in Ghana

Studying vegetable production in Ghana, Forkuor et al. (2022) and Trend Economy (2021) states a rising trend of vegetable importation. Hence, Forkuor et al. (2022) posit that this is evidence of increased demand for high-quality fruit and vegetables, highlighting the demand in big urban centers such as Accra, Takoradi, and Kumasi.

There are several highly valued vegetable crops in Ghana, including tomato, bell pepper, cucumber, and carrots (Elings et al., 2015). According to Forkuor et al. (2022), Ghana has a good market potential for greenhouse production as farmers can sell their products immediately or within a few days after harvesting. However, Forkuor et al. (2022) and Donkoh, Adzawla, Kudadze, and Ansah (2016) state that the pricing regime is challenging, especially during the rainy season. In the rainy season, market competition increases as the open-field farmers harvest and sell their products. On the other side, during the dry season the competition decreases as the open-field farmers struggle to produce vegetables. Consequently, the market demand increases. These changes in demand cause difficulties in obtaining constant vegetable prices in all seasons for greenhouse farmers as the production costs remain unchanged (Forkuor et al., 2022).

3. Methodology

The methodological approach of this thesis demonstrates how the research explicitly adheres to formal and specific procedures, which is in line with Yin (2018). The following section explains and justifies the thesis research design and its included elements and phases, which is the chosen design frame and techniques for gathering and analyzing data. Lastly, the thesis validity and reliability are discussed according to the conducted methodological approach.

3.1 Research design

Research design is connected to the decisions made from the beginning to the end of the research (Thomas, 2017). As Yin (2018, p. 26) notes, *"(..) the design is the logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions*". Thomas (2017, p. 130) illustrates the process of research design through five stages and clarifies how they are interrelated in his figure "Process of research design." The purpose of the research and research question(s) define the beginning of a research and guide the subsequent stages. Reviewing the research question in light of the literature can clarify the initial research question and guide the requirement for selecting a qualitative or quantitative analysis. A convenient design frame and technique for collecting data is then selected to ensure that the collected data can address the research question (Thomas, 2017). Based on this, Figure 9 is developed to provide a visual overview of the phases and elements in this thesis research. The research design is further explained in detail and justified in the following subsections.

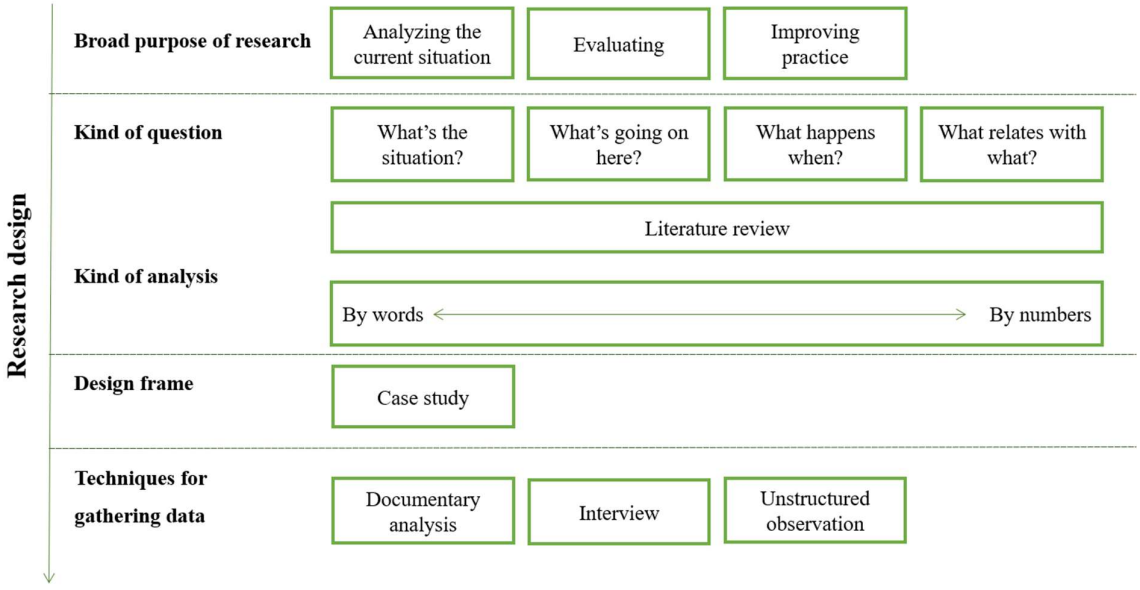

Figure 9 A summary of the research stages and elements included in this thesis's research design. The figure is inspired and adapted from the illustrated process of research design by Thomas (2017).

This thesis' research phases were not conducted sequentially, as Figure 9 illustrates. The research process was characterized by going "back and forth" between the different research design stages, which Dubois and Gadde (2002) refer to as systematic combining. They state that this process can provide the opportunity to expand the understanding of both the literature review and collected data. This process was critical in the research establishment phase to align and direct the research question, literature review, and collected data. Before the fieldwork, I gathered data in cooperation with Trax Ghana to ensure sufficient data availability for the chosen research question. Hence, the research question was adapted to ensure that study was feasible and could provide an applicable foundation for further research.

3.2 Case study

Yin (2018) and Schoch (2020) describe case study as a design frame to gain an in-depth understanding of a case within its context, which can be a phenomenon in a real-world context. This is in line with the research of Thomas (2017), who explains a case study as a comprehensive analysis of one or a small set of cases to achieve a deep understanding of their examined aspects. Furthermore, Yin (2018) and Schoch (2020) suggest that "how" and "why" research questions are a reasonable basis for choosing a case study as a design frame. They explain this by stating that "how" and "why" questions aim to provide a comprehensive description of a phenomenon. Hence, case study was considered a suitable design frame for the chosen research questions.

According to Thomas (2017) and Schoch (2020), data for case studies are commonly gathered by combining several methods and techniques. The reason is that combining methods contributes to understanding different aspects of the case and context, hence gaining an in-depth understanding (Thomas, 2017). Yin (2018) and Schoch (2020) highlight documentation, archival records, interviews, and observations as relevant sources for gathering data, as case studies tend to focus on qualitative data.

This thesis aims to understand how Trax Ghana conducted its greenhouse project's planning phase. The purpose of the research and research question contributed to selecting a case study as the thesis design frame. This thesis has the planning phase as the research's case, and Trax Ghana constitutes the context. The case study is limited to in-depth research into one specific case, containing no elements of comparison. Thomas (2017) refers to case studies with these characteristics as a single case study. The greenhouse project is Trax Ghana's first greenhouse project; hence, the planning phase cannot be compared to earlier conducted planning phases.

However, Schoch (2020) states that the results from a case study can provide knowledge that can be applied to similar cases and situations. This transferability also applies to Trax Ghana.

3.3 Data collection

To answer the research questions, a qualitative case study was considered suitable. However, data collection involves some analysis of cost management, a quantitative approach to complement the qualitative research in line with Thomas (2017). For the purpose of this study, data was collected through interviews, observations, and documentary analysis. Table 4 provides an overview of the sources for data collection. The applied techniques for gathering data will be presented and explained in the following subsections.

Source	Number	Timeline
Interview notes	15	14.09.21-01.10.22
Project documents (Internal reports, project information, written notes)	10	12.09.21-22.09.22
Observation notes (during fieldwork)	5	22.09.22-01.10.22
Other (emails)	12	23.08.22-17.11.22

Table 4 Overview of the applied sources for data collection . The sources for data collection were interview notes, project documents, observation notes, and email communication. The number of collected data through the different sources is listed together with the time period the corresponding data was collected.

3.3.1 Interviews

Yin (2018) emphasize interviews as one of the most crucial sources for gathering data in case studies. He explains this by referring to the need to collect explanations to answer the "how" and "why" research questions. This thesis focuses on how Trax Ghana's planning phase can be supported. Hence, interviewing the project management team (informant A-D in Table 5) and stakeholders was essential to understand how the project management team performed their planning, including factors affecting the planning phase. This information lays the foundation for analyzing how the planning phase could be improved. The interviews were semi-structured as an interview guide (see A.1 Interview guide) provided a list of themes to cover, but supplementary questions were asked when necessary (Thomas, 2017). The informants were encouraged to express themselves openly and were asked to elaborate on topics outside the interview guide if they were presumed to be related to the research questions. This provided

flexibility to the interviews. To ensure the quality of the gathered data, the informants were asked follow-up questions during the interview to clarify that the information was understood correctly. Follow-up questions were also asked after the interviews if some information appeared unclear.

Patton (1990) refers to the in-depth focus on information-rich cases where a relatively small sample of informants is selected for data collection as purposeful sampling. The informants were selected based on predetermined criterion characteristics, a sampling strategy Patton (1990) refers to as criterion sampling. The selection was purposeful as the predetermined criterion was that the informants could provide relevant information to answer the research questions. Table 5 provides an overview of the chosen participants in the interviews.

Informant	**Position Title**	**Organization**
Informant A (Key informant)	Project director	Trax Ghana
Informant B (Key informant)	Greenhouse manager	Trax Ghana
Informant C	Greenhouse assistant	Trax Ghana
Informant D	Greenhouse helper	Trax Ghana
Informant E	Founder and current project coordinator	Trax Norway
Informant F	Project manager	Engineers Without Borders
Informant G	Assemblyman	Bongo district assembly
Informant H-M	Beneficiaries (6 of 10)	Trax Ghana
Informant L	Managing director	Urban Jungle Agro

Table 5 A description of the informants interviewed in this thesis. This includes the informant's position title and organization.

Ahead of the fieldwork, informants A-F (see Table 5) were interviewed digitally through video conferences. These interviews were approximately one hour and recorded to develop written meeting minutes. Subsequently, the meeting minutes were sent to the meeting participants shortly after the interviews. This is intended to encourage the informants to provide written feedback on necessary edits and missing relevant information. Hence, the email

communication after the meeting strengthened the accuracy and reliability of the collected data from these interviews.

The project director of Trax Ghana facilitated face-to-face interviews during the fieldwork in Ghana. His participation in the project ensured that the informants were familiar with the intention of the research and that they were available to participate as informants. These interviews were documented through interview notes. A student mentor representing EWB served in a supporting role during the fieldwork. The student mentor participated in most of the interviews, and the interview notes were discussed with him afterward. This strengthened the quality of the interview notes.

Informants A-D is a part of the project management team, whereas A-B has leadership roles and is therefore classified as key informants. The key informants were interviewed several times during the fieldwork to get an accurate and deeper understanding of their information. On several occasions, they were informed about the specific areas of information the subsequent interviews intended to target. This allowed them to prepare their information before the interview. Their preparation was essential for obtaining their information fully comprehensive.

The stakeholders affected by the greenhouse project and with incentives to influence the project's planning phase for the greenhouse production are informants E-M. Hence, they were interviewed during the fieldwork to understand their participation and influence on Trax Ghana's planning phase. According to Tonnquist (2016), these are prime stakeholders. Trax Ghana has other prime and secondary stakeholders who are not interviewed as they are not considered stakeholders to affect greenhouse production, and therefore are outside of this thesis scope. However, the excluded stakeholders will likely affect their planning related to Trax Ghana's work for the beneficiaries.

Informant L was interviewed since the greenhouse project is Trax Ghana's first greenhouse project, it does not have comparable equivalents. Urban Jungle Agro is an established greenhouse vegetable producer in the Greater Accra Region (Urban Jungle Agro, n.d.). The managing director was interviewed to get another perspective on the planning phase of greenhouse projects in Ghana. This interview was conducted as a face-to-face meeting by my student mentor. A meeting minute was written from the interview, and the managing director approved the information's accuracy and accepted its use. Me and Trax Ghana could not participate in the interview with Urban Jungle Agro. However, Trax Ghana's participation was

desirable as it may have broadened our understanding of Trax Ghana's planning phase by comparing them to Urban Jungle Agro. With their participation, new perspectives could have been enlightened through discussion between Urban Jungle Agro and Trax Ghana. Hence, further strengths and weaknesses related to Trax Ghana's planning phase, within its contextual influences of being a greenhouse project in Ghana, could have been uncovered.

After conducting 15 interviews, in combination with email communication and observation, the data collection ended as I reached data saturation for my research questions (Fusch & Ness, 2015). At this point, the ability to obtain new information from Trax Ghana has been attained, which aligns with how Fusch and Ness (2015) define data saturation. However, interpreting the collected data and discussing the findings uncovered additional questions to expand the understanding of the collected data, which was not acted upon due to the limitation in time for this research.

According to Nygaard (2017), informed consent is a part of the ethical guidelines related to conducting ethical research. Hence, the informants were given an information sheet (see Appendix A.2) about the research and the purpose of their participation in advance. To use the informants' information, they had to give informed consent and sign a consent form included in the information sheet. The document specified whether the interview was recorded and agreed that their information could be used in the research project. However, their preconditioned consent did not influence the informants' selection or contribution to this research.

3.3.2 Documents

Internal project documents provided by EWB, Trax Ghana, and Trax Norway were examined to collect data about Trax Ghana's planning phase. The existing documents were mainly strategy documents for the greenhouse project and the overall Trax Ghana farm, which were kept as internal documents. However, extracts from these documents were published online. The fieldwork provided access to analyzing Trax Ghana's project-specific documents for their planning phase. These documents provided information about the greenhouse project's costs and schedule, which helped me understand their project cost and schedule management.

3.3.3 Unstructured observations

Using this research design, structured and unstructured observations can be applied when gathering data (Fetters & Rubinstein, 2019; Thomas, 2017). Fetters and Rubinstein (2019) explain that structured observations use a template to record observations that can be

statistically measured and analyzed. On the other side, unstructured observations are used to collect data to develop a broad description of a phenomenon. However, the unstructured observations are structured in how they are conducted toward the research questions (Fetters & Rubinstein, 2019). In this research, unstructured observations were a part of the data collection during the fieldwork. The observations strengthened the understanding of the bell pepper production in the greenhouse, which was necessary to understand how Trax Ghana planned the greenhouse production. Recognizing the current execution phase strengthened the understanding of the planning phase. The observations in this study also contributed to developing interview questions more specifically directed toward the research questions. This helped extract more relevant information from the respondents during the interviews.

3.4 Data analysis

When studying how to analyze qualitative data, Nygaard (2017) and Johannessen et al. (2016) claim that the biggest challenge is to process the amount of data into manageable portions. Nygaard (2017) highlights that several researchers structure the data by coding and organizing the coded data within categories called themes (thematic analysis). Kiger and Varpio (2020) explain that thematic analysis aims to identify, analyze, and report repeated patterns in data. Hence, they emphasize that it is an appropriate method for mapping shared experiences, thoughts, or behaviors. Furthermore, the themes should provide a framework for collecting the necessary information to resolve the research questions (Kiger & Varpio, 2020). Braun and Clarke (2006) indicate that the themes could be identified through a "bottom-up" or "top-down" approach. A "bottom-up" approach includes a coding process where the data is not placed in a preexisting coding frame, and the data guide the thematic analysis. On the other hand, the "top-down" approach is where a determined coding frame guides data collection. The combination results in a more detailed analysis of a limited selection of thematic areas (Braun & Clarke, 2006).

The coding process of qualitative data is described by Thomas (2017) as comparing the collected data multiple times to find meaningful patterns. Delvetool (n.d.) define qualitative coding as a method for interpreting, organizing, and structuring the collected data into valid theories. They assert that the coding process systematically categorizes excerpts from the collected data (Delvetool, n.d.), which can be conducted with computer-assisted tools or manually (Yin, 2018). A computer-assisted tool will contribute to locating words and phrases in the prepared documents from the data collection that matches a defined set of codes (Yin, 2018). Manual coding involves reading through the collected data and applying codes to

excerpts. This process is commonly performed several times to include relevant aspects in the data collection excerpts (Delvetool, n.d.). Delvetool (n.d.) states that the first coding round is fast and loose. The next rounds reanalyze the initial codes to develop more specific and accurate codes reflecting the discovered patterns. However, despite the coding technique, Yin (2018) and Delvetool (n.d.) posit that there is still a considerable data analysis process after the coding to construct thorough descriptions and explanations from the discovered patterns.

Thematic analysis established the data analysis method in this thesis. Analyzing the collected data through the interviews before the fieldwork revealed that selecting the project management knowledge areas as the overall themes was convenient. Hence, project schedule management, project cost management, and project risk management were selected as the coding themes through a "top-down" approach. Schedule management and cost management were chosen as themes as they are directly related to a project's limitations in terms of time and constrained resources (Kerzner, 2009; Portny et al., 2009; Project Management Institute, 2017; Tonnquist, 2016). Additionally, these interviews revealed that project risk management was highly relevant to include as it was the project management team's first greenhouse project. The interviews also revealed that the project management team could benefit from analyzing these themes. Besides, satisfying data availability for these themes supported the selection.

The selected themes helped structure the data collection process through better organization of the interview guide. Hence, the raw data was already in some way related to the overall themes. This simplified the first round of coding, as it was possible to search for patterns related to one theme at a time. I organized the collected data from interviews, documents, and unstructured observations to relate to one theme. Then I highlighted findings that I could relate to the literature review and used this knowledge to apply the first round of codes. As it discovered that the themes are closely related, the following coding processes searched for patterns within all three themes. The outcome from the data analysis was a set of findings that are discussed in consideration of the literature review and research questions. The coding process established evidence for developing theories about how the planning phase could be supported. Figure 10 shows an example from the executed coding process for the theme project risk management.

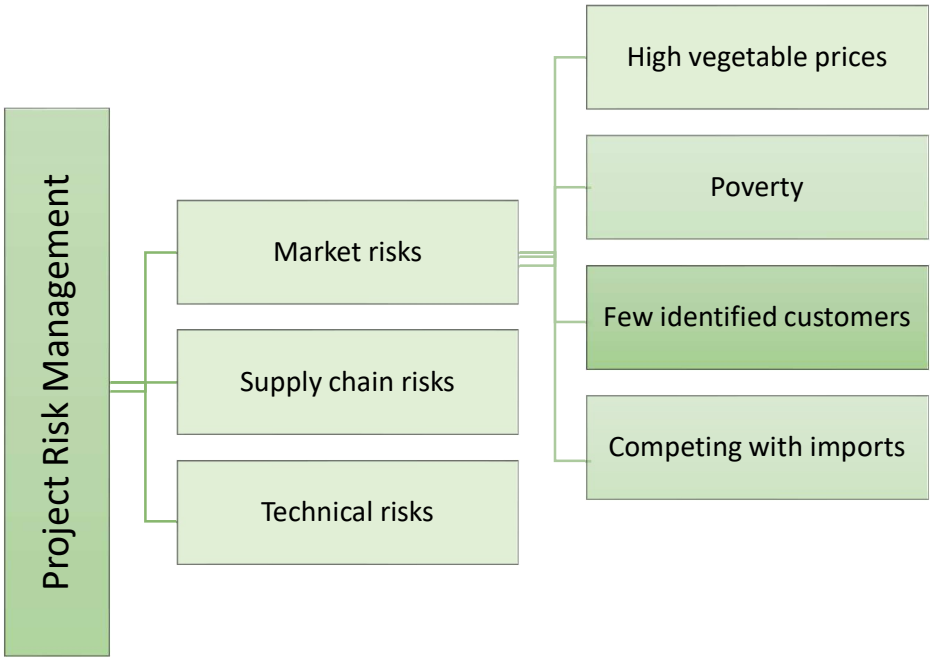

Figure 10 Example of the coding process under the theme project risk management. In this case, the coding process discovered market, supply chain, and technical risks as the first categories for identified risks. Subsequently, several subcodes were identified as arguments for the identified risk's existence. This included high vegetable prices, poverty, few identified customers, and competing with imports for market risks.

3.5 Validity

Case studies are frequently criticized for having low validity and reliability due to the researcher's emotional involvement, which can control how the nonnumerical information is interpreted. Hence, the researcher can potentially cause undesirable biases in the results from the data analysis (Leung, 2015; Quintão & Andrade, 2020; Riege, 2003). To avoid these pitfalls, the data in this study was gathered using multiple sources and techniques to strengthen the research validity. This process is called triangulation, which increases the research's overall quality (Nygaard, 2017; Yin, 2018). This research combines in-depth interviews with unstructured observations and documentary analysis to verify the data's validity. Nygaard (2017) refers to validity as a concept that can enhance critical thinking that targets research biases. She presents validity as a concept for evaluating if the research measures the concept as intended. Validity can further be classified into internal and external validity (Thomas, 2017; Yin, 2018). Yin (2018) explains internal validity as establishing a causal relationship between the studied variables. Furthermore, Yin (2018) and Thomas (2017) posit that external validity is related to which degree the results can be generalized beyond the immediate study.

This study aims to understand how the current planning phase has been conducted to make assumptions on how it can be supported and developed. Data collection was conducted until I

reached data saturation for my research questions to strengthen internal validity. There were made inferences about how different variables affected Trax Ghana's planning phase, and these were later evaluated and discussed with the key informants and my student mentor. This helped me keep an objective approach to the findings, and I received feedback on the accuracy of the discovered patterns.

The findings in this research can illuminate challenges and approaches to overcome similar challenges in a greenhouse project in Northern Ghana. Hence, other projects in the area can use the findings as discussion points when conducting their project-specific planning phase. This indicates that there is a degree of external validity in this study. However, no generalizations were made based on the case findings.

3.6 Reliability

Reliability is related to the consistency and dependability of the collected data (Thomas, 2017). Hence, the research reliability determines if repeating the research could provide the same results (Nygaard, 2017; Yin, 2018). Suppose another researcher should perform this case study with qualitative methods, the results would not necessarily correspond with this research. The chosen research design allows the researcher to focus on different aspects during the data collection. Additionally, the researcher interprets the collected data, contributing to the possible variation. However, to increase the reliability, the key informants were interviewed on several occasions and with different approaches. This included semi-structured interviews, conversations about their project documents, and discussion during the unstructured observations. The key informants also received the thesis after the collected data was interpreted, serving as an opportunity of providing feedback on how the data represents their explanations and understanding. The empirical data was also discussed with the student mentor to understand to which extent we agreed on the accuracy of the interpreted data.

4. Findings from the case

This section presents the findings related to how Trax Ghana planned its greenhouse production of bell pepper, which is the thesis's first research question. First, it is presented how Trax Ghana selected the vegetable crop to produce, as the selection provides guidelines for how they plan its greenhouse production. Then, the findings are presented in line with the introduced project management knowledge areas for the planning phase. These findings provide a basis for discussing its planning related to the literature review and how this planning phase can be supported. The findings are further discussed in section 5.

4.1 Selecting the vegetable crop to produce

The first step in planning the greenhouse production was to select a vegetable crop to produce in the greenhouse. The greenhouse manager conducted this task based on the manager's knowledge and expertise in greenhouse technology from a university degree in Agriculture Technology. A market analysis was conducted to analyze the current vegetable market in the Bolgatanga district, which can be viewed as a representative market for the Upper East Region and Northern Ghana as a whole. This market analysis was not documented in writing. Consequently, the analysis results had to be obtained through interviews with the greenhouse manager and the remaining project management team.

The greenhouse manager emphasized the necessity to select a vegetable crop with sufficient market demand and highlighted that the requirement is that the forecasted selling price corresponds with the greenhouse production costs. Consequently, the market analysis aimed to identify a niche market with high demand and few competitors within vegetable crops. The greenhouse manager also considered that targeting a niche market could avoid the challenging pricing regime during the rainy season. The market analysis revealed a high demand for red and yellow bell peppers, as these vegetables are currently imported from neighboring countries, and the open field production only manages to produce green bell peppers. Furthermore, the analysis detected that the purchasing power of the customers located at open field markets, where vegetables are traditionally sold, was inadequate. However, as it was uncovered that red and yellow bell peppers were classified as a luxury crop in the Bolgatanga district, the market analysis uncovered that targeting customers in hotels, restaurants, or individual clients could provide an acceptable selling price. Hence, red jet bell pepper and boogie orange bell pepper were selected as the vegetable crops to produce in the greenhouse. Interviews with the remaining project management team discovered they had the same perception of the reason for selecting bell pepper as the vegetable crop to produce in the greenhouse.

Additionally, the interview with the managing director at Urban Jungle Agro backed the statement about red and yellow bell peppers as luxury vegetables in Ghana. There was further added that a large market for luxury fruit and vegetables has been developed in Accra. However, the managing director claims this market is limited in Northern Ghana. These statements are inconsistent with Trax Ghana's market analysis which claims that the market for luxury vegetables is sufficient in the Upper East Region and Northern Ghana. Hence, Trax Ghana has not planned its agricultural downstream supply chain to supply bell peppers to the Greater Accra Region.

To collect and present the different aspects of choosing bell pepper as the vegetable crop to produce in the greenhouse, a SWOT analysis was developed in collaboration with the greenhouse manager and the project director. The SWOT analysis is illustrated in Table 6.

	+ Factors that can facilitate the project	- Factors that can obstruct the project
Within the project and execution organization **Internal factors**	**Strengths** The greenhouse enables all-year production. External threats to crops under cultivation are minimized. E.g., pests, diseases, etc. The climate creates a suitable environment for greenhouse farming. Available management staff with technical knowledge and skills in greenhouse technology. Committed and hardworking project staff. Bell pepper is a "niche crop" in high demand, especially in northern Ghana.	**Weaknesses** High investment and operating expenses for greenhouse farming. Time-consuming to produce bell pepper. Requires regular periodic inspection. The production requires many resources (inputs). Lack of storage facilities to store unsold harvested produce. Lack of technical support services. E.g., soil (growing medium) testing equipment. Limited, high-interest credit to support production base. Nonexistence / weak value chain for green bell pepper The greenhouse has no ventilation system if there is a need to reduce the temperature during the peak of the heat/dry season.
Outside the project and executing organization **External factors**	**Opportunities** Bell pepper is a niche market product, especially in northern Ghana, hence has a competitive advantage. Bell pepper is today imported to northern Ghana from the south and neighboring country, Burkina Faso. There is already an established market demand – Targeted individuals and households, hotels, and restaurants. Bell pepper is included in most dishes prepared at home, hotels, restaurants, etc. Bell pepper has value-added components.	**Threats** Limited customers who buy bell pepper in bulk – most customers buy in smaller quantities involving movements and increasing production costs. Weak government support policies on the cultivation and marketing of bell pepper. Few readily identified customers are willing to pay the price for bell pepper. The pricing of vegetables varies with the seasons. Higher prices during the dry season than the rainy seasons. Fragmented marketing structure of bell pepper and lack of standardization of marketing of produce. They are competing with the imports of green bell pepper from foreign/neighboring countries. Imports of inputs for green pepper cultivation and high level of inflation.

Table 6 A SWOT analysis of the greenhouse production of bell pepper in the Upper East Region and Northern Ghana. The information is collected from Trax Ghana's greenhouse manager and project director based on the conducted market analysis, and their knowledge and experience from their resident region in Ghana. Together we sorted and classified their information as internal or external factors. Furthermore, the internal factors were labeled as project strengths or weaknesses. Additionally, the external factors were defined as opportunities or threats. The accuracy of the information is strengthened through observations and interviews during the fieldwork.

4.2 Scheduling the production of bell pepper

After selecting the vegetable crop, the greenhouse manager planned the bell pepper production. This involved scheduling the production. The greenhouse manager scheduled the production based on established procedures and methods for producing bell peppers in a greenhouse. This process was documented and recorded as internal records by the greenhouse manager. Hence, there was no shared project schedule, and documentation of this process was gathered mainly through interviewing the greenhouse manager during the fieldwork. Despite the lack of a shared schedule, interviews with the project management team confirmed they had the same insight into the bell pepper production. Simultaneously, interviews with the beneficiaries underwrite this conclusion.

To provide precise information about the project schedule, the greenhouse manager developed and shared a written document where the production cycle and activities were further elaborated. Based on this information, a Gantt chart was developed in collaboration with the greenhouse manager to produce a visual overview of the production stages and activities. This is illustrated in Figure 11.

Greenhouse production of bell pepper

Trax Ghana

Project Start Date 02.06.2022

Project Lead Greenhouse manager

WBS	ACTIVITY	START	END
1.	**Seeding stage**		-
1.0	Prepare the soil tray	02.06.2022	04.06.2022
1.1	Nest the seeds	04.06.2022	04.06.2022
1.2	Watering (manual)	04.06.2022	27.06.2022
1.3	Monitoring	04.06.2022	27.06.2022
2.	**Growing stage**		
2.0	Transplanting	27.06.2022	01.07.2022
2.1	Watering (automatic)	27.06.2022	29.08.2022
2.2	Nutrition/fertilizers	27.06.2022	29.08.2022
2.3	Trellis work	11.07.2022	29.08.2022
2.4	Pruning	11.07.2022	29.08.2022
3.	**Harvest stage**		-
3.1	Pick the fruit to baskets	31.08.2022	30.11.2022
3.2	Clean it	31.08.2022	30.11.2022
3.3	Packing to customers	31.08.2022	30.11.2022
3.4	Preparing the buckets for the growing cycle	20.06.2022	27.06.2022

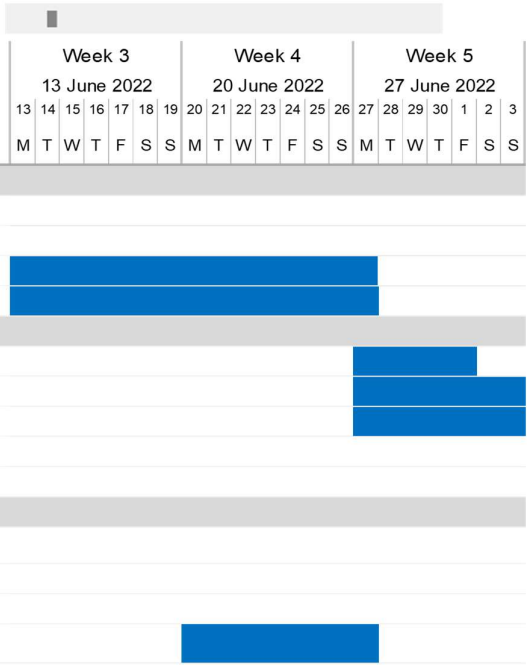

Figure 11 An extract of the Gantt chart developed for the greenhouse production of bell pepper . In the left column, we see the WBS that consists of the production cycle's three stages: seeding, growing, and harvest. Below each production stage is their activities listed in sequential order based on their numeration in the WBS. Based on the activity's start and end date, their duration is illustrated as bars in the production weeks. The project start date was Jun 02nd 2022, when Trax Ghana initiated its first seeding stage, and the production weeks are listed from this date.

The seeding and growing stages presented in Figure 11 are completed in three months, followed by the harvest stage in the subsequent three months. This aggregates the first of two annual production cycles. The greenhouse facility was established in May 2022, and the greenhouse manager planned Trax Ghana's first production cycle to last from June 2022 to November 2022. This was followed by the second production cycle of the first year, from December 2022 to May 2023.

Currently, Trax Ghana can only deliver vegetables during the two annual harvest stages, which creates a three-month gap between each harvest stage where they cannot supply its customers. As a result, Trax Ghana wishes to create an all-year supply of vegetables by expanding the existing greenhouse project with additional greenhouse facilities. An expansion could allow them to onboard additional beneficiaries in the project, which could increase Trax Ghana's impact on improving the livelihood of poor local households.

4.3 Estimating the costs of producing bell pepper and developing a budget

The costs of producing bell pepper mainly consist of the investment costs related to purchasing the greenhouse facility and the project's operating costs. The investment cost for the greenhouse facility was uncovered by Trax Ghana in the planning phase, where a price estimate was provided by the greenhouse supplier Dizengoff and shared with the project director and EWB. EWB financially funded these investments. However, Trax Ghana did not have a shared project overview of the operation costs. Hence, these were aggregated during interviews with the project director and greenhouse manager. Furthermore, interviews and documentary analysis revealed that a financial analysis had not yet been calculated. A project budget was therefore developed, and a financial analysis was conducted in collaboration with the project director and greenhouse manager during the fieldwork.

The key informants explained the lack of cost estimates by stating that the greenhouse project is currently in an establishment and learning phase. They explained that the first year of production would lay the foundation for developing a business plan, establishing connections with potential markets, and getting a deeper understanding of greenhouse and vegetable production.

4.3.1 Investment costs

The primary investment cost was the greenhouse facility supplied by Dizengoff. The package from Dizengoff included some startup materials for greenhouse production in addition to the greenhouse facility. Furthermore, Trax Ghana discovered that some extra local investments were necessary during its planning and execution phases. During the planning phase, a water borehole and pump were installed before the greenhouse facility to provide adequate water distribution. Moreover, the execution phase uncovered the need for extra materials related to the greenhouse facility, such as shade nets and rubber ground mats. The investment costs were mapped to construct a precise and applicable overview of the costs, which Trax Ghana could take direct advantage of. Hence, developing the cost overview in collaboration with Trax Ghana was essential. The investment costs for the greenhouse project are presented in Table 7.

First greenhouse:			**Sum:** 146 750
Investment costs	**Qty**	**Unit price**	**GHS**
Greenhouse structure + training	1	86400	86 400
Drip irrigation system	1	1800	1 800
Water tank (polytank) 2500 l	1	2500	2 500
Tank metal stand	1	1450	1 450
Growing buckets 700	700	10	7 000
Growing medium:			
Coco peat blocks	140	35	4 900
Vermiculite bags	9	300	2 700
Potting mix 25 kg bag	16	150	2 400
Training at site	1	1500	1 500
Delivery	1	6000	6 000
Installation at site	1	11700	11 700
Extra local investments:			
Shade net	1	800	800
Rubber ground mat	1	2400	2 400
Fence around	6	450	2 700
Water borehole + pump (per GH)	1	12000	12 000
Trellis twine	1	500	500

Table 7 Investment costs for Trax Ghana's greenhouse project. The overview is developed in collaboration with the project director. The top rows are the costs related to the package from Dizengoff, and the local investments installed performed during Trax Ghana's planning phase. The headline extra local investments collect the investments Trax Ghana performed during the execution phase.

4.3.2 Annual operating costs

An overview of the annual operating costs for the bell pepper production is constructed as Trax Ghana intends to cover these costs with its income from sales. The overview, presented in Table 8, is developed in collaboration with the project director and greenhouse manager.

First greenhouse:			**Sum:** 100 050
Annual operating costs	**Qty**	**Unit price**	**GHS/year**
Land costs:			
Rent	1	0	-
Property or other taxes	1	0	-
Electricity	1	3000	3 000
Labor costs:			-
Staff	12	2 000	24 000
Staff fuel benefit cost	12	2 000	24 000
Girls (benefits) per month	12	1 000	12 000
Repair and maintenance	12	1 000	12 000
Equipment replacement costs:			
Rubber ground mat	1	2 400	2 400
Trellis twine	1	50	50
Agricultural inputs (upstream value chain)			
Coco peat blocks	20	35	700
Vermiculite bags	2	300	600
Potting mix 25 kg bag	2	150	300
Seeds, insecticide for 1 cycle	2	8 000	16 000
Agricultural outputs (downstream value chain)			
Packaging plastic	1	2 000	2000
Transport to market	1	3 000	3000

Table 8 Annual operating costs for Trax Ghana's greenhouse project. The overview is developed in collaboration with the project director and the greenhouse manager. The project director mainly provided information related to the land and labor costs. The greenhouse manager provided information about the costs directly related to greenhouse production, categorized as equipment replacement costs and agricultural inputs and outputs.

The annual operating costs are classified into five different areas: land costs, labor costs, equipment replacement costs, agricultural inputs, and agricultural outputs. The land was rent-free by local farmers, and its solar photovoltaic system partially covers the electricity costs. Labor costs are the main operating cost and include the project staff, fuel benefits for commuting to the greenhouse from the city, and costs related to the beneficiaries. Equipment replacement costs are related to the annual replacement of the extra local investments in equipment. Moreover, agricultural input costs are related to bell pepper production, while agricultural output costs are related to delivering bell peppers to the final customers.

4.3.3 Comparing the project costs with its expected income

The current source of annual project income is the sale of bell peppers, which depends on crop yield and selling price variables. Interviews discovered that the project director and greenhouse manager estimated the crop yield per year for this project to be 3000 kg bell peppers. This yield

also includes freebies for marketing the first years of establishing a customer base. Their estimate was based on their research from similar greenhouse facilities and estimates from the greenhouse supplier Dizengoff. However, written documentation and references were not provided for this estimate.

The greenhouse manager stated that their target price when selling bell peppers to local traders is 40 GHS/kg and 50 GHS/kg for retailers and targeted individuals. However, Trax Ghana has not established customer bases that accept these prices in the Upper East Region and Northern Ghana. The key informants explained that establishing their customer base is challenging, as few identified customers are willing to pay their target price and buy in bulk. Hence, the customer base is currently uncertain, affecting Trax Ghana's project income.

The managing director at Urban Jungle Agro revealed that their bell pepper price is approximately 35 to 40 GHS/kg for customers near the Greater Accra Region. Their target price is lower than Trax Ghana even though the Upper East Region and Northern Ghana poverty rates are higher than in the Greater Accra Region (Ghana Statistical Service, 2015). The managing director argued that transport from the Bongo District to the Greater Accra Region is currently the only way to achieve sufficient volume and price for luxury food items in Ghana, as the luxury market in Northern Ghana is still limited. Without being specifically asked, the managing director added that the lack of planning and economic analysis is Ghana's most common cause of failed greenhouse projects. However, reliable sources were not provided to support this statement.

A financial analysis was developed to compare the costs with the expected income, based on estimated crop yield and target price, to reveal the annual profit or loss. Their target price of 40 GHS/kg was selected for this analysis, and the income calculation assumes direct sales at this price without commission to intermediaries such as local traders. Furthermore, the expected crop yield included in this analysis is 3000 kg bell peppers. Freebies and potential food losses are excluded from the analysis. The project's breakeven price was calculated since Trax Ghana currently has an uncertain customer base, and the market prices vary with the seasons. This information was valuable for Trax Ghana as the breakeven price can be used as input for Trax Ghana's pricing strategy and had not previously been calculated. The breakeven price is the minimum price per kg of bell peppers to avoid a loss.

The breakeven price can be calculated with and without donor financing of the investment costs. In the financial analysis presented in Table 9, investment costs are excluded, as I assume

that EWB covers these. This assumes that the funding from EWB included a markup that covered investments beyond the greenhouse facility itself. However, information from EWB or Trax Ghana has not been provided to support this assumption. On this basis, the financial analysis is limited to Trax Ghana only covering its operating costs.

		First GH
Investment and amortisation:		
Investment cost	GHS	146 750
Amortisation of investment cost	GHS/yr	-
Total costs:		
Operating cost	GHS/yr	100 050
Total cost	GHS/yr	**100 050**
Income from sales:		
Trax Ghana target price	GHS/kg	40
Expected crop yield	kg/yr	3000
Sales income	GHS/yr	**120 000**
Profitability:		
Profit or loss	GHS/yr	**19 950**
Target price for breakeven	GHS/kg	**33**

Table 9 A financial analysis of Trax Ghana's greenhouse project. The analysis calculates Trax Ghana's profit/loss and target price for breakeven based on their operating costs and expected sales income. The investment cost is excluded from these calculations as it is assumed that EWB covers these. The investment and operating costs are mapped in Table 7 and Table 8. Sales income is calculated by multiplying Trax Ghana's target price with the expected crop yield. The target price for breakeven is calculated by dividing the operating cost with the expected crop yield to determine the minimum price per kg not to make a loss.

Using the inputs from Table 9, the financial analysis reveals a total profit of 19 950 GHS/year. This analysis does not reflect the current situation as Trax Ghana lack an established customer base for this target price and freebies characterize its marketing. However, the analysis highlights its target price for breakeven of 33 GHS/kg based on its total costs and expected crop yield. Trax Ghana can use this analysis to calculate its profitability and target price for breakeven after acquiring more experience with the market and bell pepper production.

4.3.4 A financial analysis for additional greenhouse facilities

As briefly indicated in subsection 4.2, Trax Ghana wishes to expand the current greenhouse project with additional greenhouse facilities, and the property allows four similar greenhouses. A financial analysis for additional greenhouse facilities is therefore conducted in collaboration with the project director. Together we made assumptions to estimate the investment and operating costs for this desirable production situation.

The marginal cost of each additional greenhouse tunnel will be lower than the first investment due to reduced investment and operating costs. This is because the water supply system has sufficient capacity to provide the additional greenhouse facility. Hence, the investment costs

for the additional greenhouse facility are reduced by approximately 10 %. The operating costs are reduced by shared labor as the project management team can presumably share their efforts over several greenhouses. In addition, the sharing between greenhouses can also reduce the electricity cost by sharing this fixed cost with an additional greenhouse facility. For this reason, the annual operating cost is reduced by approximately 16%. The estimates are presented in Table 10.

			Investment funding?	
			Yes	No
		First GH	Additional GH	Additional GH
Investment and amortisation:				
Investment cost	GHS	146 750	133 400	133 400
Amortisation of investment cost	GHS/yr	-	-	**9 231**
Total costs:				
Operating cost	GHS/yr	100 050	83 830	83 830
Total cost	GHS/yr	**100 050**	**83 830**	**93 061**
Income from sales:				
Trax Ghana target price	GHS/kg	40	40	40
Expected crop yield	kg/yr	3000	3000	3000
Sales income	GHS/yr	**120 000**	**120 000**	**120 000**
Profitability:				
Profit or loss	GHS/yr	**19 950**	**36 170**	**26 939**
Target price for breakeven	GHS/kg	**33**	**28**	**31**

Table 10 A financial analysis for implementing additional greenhouse facilities. This analysis presents Trax Ghana's total cost and profitability by implementing an additional greenhouse facility. The estimates are compared to those conducted for their current greenhouse facility (see Table 9), named first GH in this table. The calculations are based on the precondition if the investment is funded externally or not.

The financial analysis includes clarifying whether the investment cost is funded externally or covered by Trax Ghana taking out a loan. If Trax Ghana covers the investment, the calculations add the amortization cost of a loan with a 4% discount rate and a payback time of 22 years, based on the assumed technical lifetime for a greenhouse facility. These assumptions are not compared to reliable sources regarding loans and greenhouse facilities in Ghana. The target price for breakeven is then calculated with or without funding of the investment cost. This analysis reveals that Trax Ghana's costs and target price for breakeven decrease if they choose to scale its current greenhouse project.

4.4 Risk management for the greenhouse production of bell pepper

The examined project documents uncovered that EWB had performed project risk management related to implementing a greenhouse facility in the Upper East Region. Bottolfsen, Dahl, and Skaug (2020) are three engineers representing EWB that developed a technical specification document that provides information about the greenhouse structure, material selection,

adequate water distribution, and ventilation recommendations. Additionally, they identify risks, performs risk analysis, and recommend risk responses for the technical aspects of Trax Ghana's greenhouse project. Among the risks mentioned, the risks of temperatures, solar radiation, and challenging ventilation in the greenhouse are highlighted. A proposed response to mitigate these risks is installing temperature trackers and a fan system. In summary, the document recommends that EWB and Trax Ghana engage an engineer to construct a cooling system for the greenhouse project.

Observations and interviews substantiate the relevance of the identified risks by EWB. During the fieldwork, three remote temperature and humidity sensors were donated by my student mentor and installed at different levels in the greenhouse. On a sunny day during the fieldwork, the temperature sensors located on the height level of a grown bell pepper plant measured over 42 degrees Celsius. Gardenguide4all (n.d.) and Bottolfsen et al. (2020) state that the maximum temperature for optimal bell pepper production is 30 degree Celsius. If the temperature exceeds this limit in the greenhouse, it will harm the bell pepper plants' fruit production (Gardenguide4all, n.d.). This is consistent with the findings from the interview with the managing director at Urban Jungle Agro, who stated that high temperatures are a well-known problem in Ghanaian greenhouse facilities as the daytime temperatures inside the greenhouse will be higher than the outside air temperature. Hence, managing temperatures are especially significant during the dry season when the outside temperature increases. This is in line with Trax Ghana's identified project weaknesses in the SWOT analysis in Table 6. Trax Ghana has recognized temperature as a project risk and has therefore installed a shade net on the greenhouse facility's roof to reduce radiation and temperature. However, the temperature measured during the fieldwork revealed that temperature management remains a relevant project risk.

Trax Ghana had no written documents related to its project risk management. Hence, information about its risk management was gathered through interviews. Trax Ghana's project director organized a project risk assessment workshop before and after the installation of the greenhouse facility. The project management team and the project's watchman participated in these workshops. The watchman serves a supporting role in the project and contributes to surveillance and the overall odd jobs for the project. Animals in the area, trees at the site, flood waters, and harmful insects were identified as project risks during the workshop. Simultaneously, risk responses were planned to mitigate the identified risks. In addition, the

market analysis performed by the greenhouse manager identified several project threats and opportunities, presented in Table 6, that were discussed during these workshops.

Trax Ghana has identified and performed risk mitigation on several occasions. However, due to the lack of documentation on its project risk management, a template for risk assessment was developed. This is presented in Table 11, whereas its risk matrix is presented in Table 12.

Risk Assesment Trax Ghana greenhouse

Updated by: _____
Date updated: _____
Date next update: _____

				Inherent Risk (without controls)					Residual Risk (with controls)		
Unique ID	Risk Description	Caused by & Consequences	Risk Owner(s) Name and Role	Probability	Impact	Risk rating	Control(s)	Control Owner(s) Name and Role	Probability	Impact	Risk rating
1	Too high temperatures in the greenhouse during the dry season.	Caused by: Climate conditions. Consequences: Can damage the bell pepper plants and reduce the production.	Greenhouse manager, greenhouse assistant, and greenhouse helper.	High	Very High	Critical	Lower temperature with active or passive ventilation. Use evaporative cooling.	Greenhouse manager.	High	Medium	Severe
2	Customers in the Upper East and Northern Ghana can't buy bell peppers for the target price.	Caused by: Market conditions. Consequences: Lost income or food loss.	Project director and greenhouse manager.	Medium	High	Severe	Locate customers that are willing to pay the estimated price for bell pepper. Adjust the downstream value chain to make deliveries in bulks possible. Establish long-term contracts with customers.	Project director and greenhouse manager	Low	Medium	Moderate

Table 11 A proposed template for risk assessment of Trax Ghana's greenhouse project , inspired by McLachlan's (2022) Risk Assessment Matrix. The headline provides information about who and when the risk assessment was last updated and when the next update is planned. The risk assessment presents the identified risks and explains their origin, consequences, and assigned risk owner. The planned risk responses are described as control(s) and assigned a controlling owner for the execution phase. Risk analysis is conducted for inherent and residual risks and assigns a rating to the risk based on the risk probability and impact. The results are presented in the inherent and residual risk columns.

Risk matrix

Impact:		Very Low	Low	Medium	High	Very High
Probability	Very High	Moderate	Severe	Severe	Critical	Critical
	High	Sustainable	Moderate	Severe	Critical	Critical
	Medium	Sustainable	Moderate	Moderate	Severe	Critical
	Low	Sustainable	Sustainable	Moderate	Severe	Critical
	Very Low	Sustainable	Sustainable	Sustainable	Moderate	Severe

Table 12 The risk matrix for the proposed template for risk assessment of Trax Ghana's greenhouse project is presented in Table 11. The risk matrix consists of the variable's probability and impact. The combination of these variables determines the risk rating in table 11.

The template for risk assessment was developed after the fieldwork in Ghana. Hence, the risk analysis in Table 11 is based on my interpretation of Trax Ghana's remaining high-priority risks of temperature management and an uncertain customer base. However, the template is developed as a tool for Trax Ghana to have a conscious relationship to its identified risks and how they develop throughout the project life cycle. In addition, the template aims to measure the impact of its implemented risk responses and provide Trax Ghana with a standardized way to perform its project risk management.

5. Discussion of findings

This section will discuss the findings based on the chosen literature review and related to the first research question. The discussion is structured in line with the presented findings and the chosen literature regarding the project management knowledge areas for the planning phase. Then, the second research question is discussed based on the interpretation of findings related to the first research question. Lastly, received feedback from Trax Ghana related to how the thesis findings can contribute to Trax Ghana's objectives is presented.

5.1 How did Trax Ghana plan the greenhouse production of bell pepper?

Project schedule management

The project schedule was kept as internal records by the greenhouse manager. Hence, there was no shared project schedule to communicate the production performance, as opposed to the Project Management Institute (2017). However, interviews detected that the informants had similar insight into the production status regardless of their lack of insight into the project schedule. This can imply that the project has a relatively small scale and stable environment which, according to the Project Management Institute (2017), decreases the need to modify the project schedule throughout the project. This implication can be supported by O. Ahumada and R. J. Villalobos (2011), who present that vegetables are produced according to defined guidelines, creating a predictable production. Moreover, the greenhouse facility creates a controlled environment for vegetable production, in line with Forkuor et al. (2022). The findings therefore argue that Trax Ghana has a production stability with is current crop, creating a straightforward and understandable production that can be managed and communicated by the greenhouse manager without a shared project schedule.

Trax Ghana aims to implement additional greenhouse facilities which scale their greenhouse production. In this case, they can increase their vegetable production to include additional niche crops. Accordingly, the greenhouse project activities increase, and the vegetable crops' WBS can differ. Thus, getting a holistic overview of the relationship between activity and time can be challenging. Hence, they could benefit from designing a graphical project schedule to get a holistic overview of their expanded production. According to Maylor (2010), a Gantt chart can contribute as a compilation of the project activities in relation to the project time, resulting in an understandable overview of the production. A greenhouse expansion would result in additional beneficiaries and may result in increased project labor. The greenhouse manager

could therefore use the developed Gantt chart (see Figure 11) as a communication tool to strengthen the involvement of the project management team and beneficiaries, as proposed by Maylor (2010). Moreover, the Gantt chart could support their external communication with their customer base, in line with Tonnquist (2016). In this case, the Gantt chart could serve the customer base with information about the predicted timing and quantity for receiving their ordered crop. Hence, it can have a support function related to the greenhouse manager's planning and managing. Gantt charts are easy to develop and understand (Lewis, 2007; Maylor, 2010; Project Management Institute, 2017; Tonnquist, 2016) and can therefore be a suitable tool for Trax Ghana to develop their first graphical project schedule. However, network scheduling is preferable if Trax Ghana uncovers several interdependencies between their activities, which aligns with Kerzner (2009) and Lewis (2007).

Using the greenhouse manager's internal records to create a shared project schedule could benefit Trax Ghana's cost management. In this regard, the greenhouse manager and project director could use the project schedule to develop cost estimates for their operating costs based on the activities from the WBS that are presented in the project schedule. This method for develop cost estimates aligns with the method proposed by Köster (2010) and Portny et al. (2009). Trax Ghana's cost estimates could therefore be developed by the greenhouse manager in collaboration with the project director in the planning phase. The greenhouse manager's involvement in cost estimates could decrease the uncertainty level as the estimates are based on the manager's direct practical and theoretical production experience. This is in line with how their annual operating costs were mapped (see Table 8) during the fieldwork. Moreover, Trax Ghana could apply the project schedule to the EVMS method during the execution phase to interpret the project performance according to the constraints of time, costs, and resources, in line with Portny et al. (2009). Understanding how these factors affect the project could possibly benefit Trax Ghana, as they could gain a deeper understanding of how their project performance is influenced. At the same time, they could gain a more extensive view of risks by using this information as input to current risk management. A shared project schedule could therefore benefit Trax Ghana's cost management in their planning and execution phase.

A project schedule can be a possible source of input to detect risk events, which aligns with Tonnquist (2016), who recommends as many sources as possible for input. As the project schedule is directly connected to vegetable production, production reporting connected to time can contribute to detect production patterns and trends. For instance, the schedule can be combined with the reported crop yield and greenhouse temperature to detect a possible

causality that can constitute a project threat or opportunity. Hence, the project schedule can contribute to Trax Ghana's project risk management if the greenhouse manger creates a shared project schedule which could be included in their risk workshops.

Analyzing the findings related to Trax Ghana's project schedule management reveals that they could benefit from using graphical techniques to present and share their project schedule for bell pepper production.

Project cost management

An essential finding is that Trax Ghana had not developed a cost estimate of their operating costs in the planning phase, which the Project Management Institute (2017) highlight as an essential part of project cost management. The key informants justified their lack of cost estimates by explaining that the greenhouse project is currently in an establishment and learning phase and that their primary focus has been directed toward the beneficiaries. The findings of analyzing the project documents and interviews with the project management team and stakeholders support this statement. The soft project objectives are related to making a socio-economic impact in the beneficiary's lives in Ghana, which Golini et al. (2015) and PM4DEV (2015) note is a traditional objective for development projects. The greenhouse project with these soft objectives can be viewed as a girl-child empowerment program. However, the beneficiaries are supported financially through the proceeds from selling vegetables which provide the greenhouse project with an agricultural enterprise perspective. Hence, the greenhouse project has a profit motive, which Youker (2003) argues is traditionally missing in ID projects. The greenhouse project's dependency on income and constraints by their accessible financial resources stress the importance of project cost control, which is in line with Jin et al. (2018) and Köster (2010).

Köster (2010), Portny et al. (2009), and Tonnquist (2016) emphasize that the mapped activities through WBS could provide information to develop cost estimates in the planning phase. Moreover, the WBS could be a basis for Trax Ghana's bottom-up costing, where each activity related to bell pepper production is assigned a cost, in line with Maylor (2010) and Amann and Eichenberger (1998). This results in a project budget with an uncertainty level reflecting Trax Ghana's uncertainty in its cost estimates. The developed cost estimates of Trax Ghana's operating costs, illustrated in Table 8, were mainly based on the greenhouse managers' internal records for the upstream and downstream bell pepper production, where the activities had been mapped through the WBS. Moreover, the project director had percipient insight into land and

labor costs. Trax Ghana's operating costs were mapped during the execution phase, where the uncertainty level is decreased because of increased accessible cost information, as Tonnquist (2016) and the Project Management Institute (2017) suggest. However, the interviews indicated that the greenhouse manager and project director had sufficient information to develop a cost estimate with a certain level of uncertainty in the planning phase. According to the theory of the Project Management Institute (2017), Trax Ghana could benefit from estimating costs in the project's planning phase as they could adapt the project based on the estimates.

Trax Ghana's lack of cost estimates revealed that it was unknown whether Trax Ghana had sufficient resources to cover the operating costs. Financial resources constrain the greenhouse project, as they aim to become a sustainable project that does not rely on external financial support for its daily operations. The key informants inform that they currently have no agreements with EWB or other donors to receive additional funding during their execution phase. On this basis, Trax Ghana is dependent on income from sales every year to financially support its beneficiaries. As they have an uncertain customer base, financial analysis could reveal an estimated net benefit of their greenhouse production, as stressed by Maylor (2010). The calculations in subsection 4.3 revealed a positive net benefit with the estimated costs and expected income. However, these preconditions are tested during their execution phase. If the estimated net benefit turns out negative, it can reveal a need to apply for financial support for their operating costs.

Although, Khang and Moe (2008) stress that key stakeholders prioritize the soft objectives of an ID project. This indicates that Trax Ghana could benefit from including its stakeholders in its financial analysis to evaluate how the greenhouse project should secure the financial support of its beneficiaries. Especially during their first years of production, the project is in a startup phase, which could provide a steep learning curve for the project management team as it is their first greenhouse project. Youker (2003) states that high stakeholder involvement is necessary to manage an ID project's soft objectives. However, stakeholder involvement may also clarify the stakeholders' expectations regarding how the project's soft and hard objectives are balanced. Scope management in the initiating and planning phase can contribute to clarify their expectations, whereas Köster (2010) highlights the SMART rule as a tool to define and balance the project's soft and hard objectives.

As an agricultural enterprise, Trax Ghana is exposed to risks related to the management of perishability. As their bell peppers decay, Trax Ghana is exposed to short-term distribution

decisions to its customers, in line with Han et al. (2021). This indicates that Trax Ghana is forced to accept the price its customer base is willing to pay to avoid food loss. The greenhouse manager explained that if they do not get their target price from their targeted customers, they could buy their own bell peppers to feed the beneficiaries when they participate in the greenhouse work on Saturdays. However, this is only a short-term solution to avoid food loss and does not provide sustainable project income. O. V. Ahumada et al. (2020) highlight that insurance, subsidies, and contracts are a precaution to reduce risks related to producing fresh agricultural products and ensure dependable income. On this basis, Trax Ghana could use its financial analysis to consider its need to apply for financial support as an agricultural enterprise. The risks uncovered in their market analysis and the SWOT analysis (see Table 6) could further support this decision. Additionally, the financial analysis could be expanded to consider supplying bell peppers to the Greater Accra Region. The managing director expresses that the demand for luxury vegetables is higher in this area, in agreement with Forkuor et al. (2022). In this situation, Trax Ghana could revise the conducted financial analysis in subsection 4.3 with new estimates for their downstream value chain and expected income.

Analyzing the findings related to Trax Ghana's project cost management reveals that they could benefit from developing a project budget and conducting a financial analysis for their bell pepper production.

Project risk management

Considering the risk management process, the findings revealed that Trax Ghana had performed risk management during their initiating, planning, and execution phase, though it is not documented in writing. Their processes include risk identification, planning, and implementing risk responses, aligning with the Project Management Institute (2017). According to the theory of the Project Management Institute (2017) and Köster (2010), Trax Ghana has an iterative approach to risk management as it is performed at any stage of its project life cycle.

Regardless of Trax Ghana's risk management, the SWOT analysis (see Table 6) and the findings from the fieldwork revealed that their identified risks can still be relevant after their implemented risk responses. This indicates that Trax Ghana could benefit from applying a standardized approach to manage its identified risk and analyze the impact of the implemented risk responses. According to Kerzner (2009) and the Project Management Institute (2017), a risk management plan can define and structure how the project risk management should be

performed. This plan includes a risk analysis that classifies the risk based on a risk rating, highlighting high-priority risks in line with the Project Management Institute (2017). The proposed template in subsection 4.4 aims to support Trax Ghana's risk management by evaluating how Trax Ghana should direct its efforts and disclose the outcome of its applied responses through the calculated risk rating. The template intends to raise awareness of how Trax Ghana performs its risk management.

On the other side, the value of this template for Trax Ghana could be discussed. Trax Ghana identified risks and performed risk responses on several occasions throughout the project. For this reason, there is some uncertainty of the benefit of implementing the proposed template. The analysis is a theoretical approach aiming to support their risk management methodology by expanding Trax Ghana's decision basis to include a risk analysis. The analysis aims to support their workshops as a standardized template to document their risk management. However, the discussion related to Trax Ghana's schedule management proposed that the project has a relatively small scale and stable environment. Thus, Trax Ghana's risk analysis could be self-explanatory for the project management team. Such an analysis could therefore be overabundant for a small project like this. The limited size of the project management team can simplify the flow of information, which facilitates verbal communication over written documentation for planning and managing the project.

Prioritizing preventive measures to identified risks can be particularly useful in Trax Ghana's establishing phase, where financial resources can be especially restricted as they have not received any income. Trax Ghana and EWB have identified temperature as a critical risk, and implemented risk responses, as presented in section 4. However, the fieldwork uncovered that temperature management is still a critical risk. This implies that Trax Ghana may consider installing a cooling system in the greenhouse, which EWB recommended as a response to the temperature risk. However, a cooling system can be a capital-intensive investment, and the decision should therefore be based on a well-considered basis. Trax Ghana could use risk analysis to predict the impact of temperature on bell pepper production, presented by Kerzner (2009) and Tonnquist (2016). Based on this, Trax Ghana can evaluate the need to implement additional risk responses. On the other side, if the risk analysis provides a manageable risk rating Trax Ghana could postpone this investment until their evaluation changes.

Analyzing the findings related to Trax Ghana's project risk management reveals that they could benefit from implementing risk analysis in their current project risk management.

5.2 How can we support the planning of greenhouse projects for engineers without borders in Northern Ghana?

Trax Ghana's planning of the greenhouse production of bell pepper has been analyzed in consideration of the chosen project management areas to search for deviations in their project management. This exploration lays the foundation for discussing how project management methods could support their planning phase. According to the theory of Tonnquist (2016) and the Project Management Institute (2017), Trax Ghana's use of appropriate management methods is crucial for achieving its project objectives. Hence, it is crucial for project success.

Comparing the research findings from Trax Ghana's planning phase to project management literature reveals that Trax Ghana's project management is only partly consistent with the established project management methodology. A substantial deviation from project management literature was uncovered for project cost management. The discussion of the findings reveals that Trax Ghana could benefit from adopting project cost management practices for estimating costs and comparing them with its expected income through financial analysis. These practices could create stability for Trax Ghana by ensuring that they continuously have available financial resources to maintain the bell pepper production and support their beneficiaries. Furthermore, the discussion reveals that their project schedule and risk management are more consistent with project management literature. However, there is also a potential for Trax Ghana to develop these areas further. The importance of taking advantage of standardized methods to document, plan and manage their management of time and risk is particularly emphasized. These findings align with the literature by Youker (2003) and PM4DEV (2015), who disclose that ID projects are characterized by an unrealized potential to strengthen their project management towards managing time, cost, and risks.

This thesis can support the planning of greenhouse projects for EWB in Northern Ghana by providing evidence-based insight from their ongoing greenhouse project. The discussion reveals that Trax Ghana could be supported by developing its project management of time, costs, and risk. The discussion could encourage Trax Ghana to evaluate its current project management and search for methods to cover the gaps presented. On the other side, this thesis can trigger EWB as a funding NGO to participate more actively in Trax Ghana's planning phase. As a key stakeholder, EWB could suggest appropriate project management methods for the ID projects. For instance, in addition to the technical specification document provided by EWB, they can add a project management document or refer to established guidelines as a part of their initiation and planning phase with an ID project. However, this approach may not be

suitable for all ID projects, but as Trax Ghana aims to generate its own income this method can be convenient for their project. As this is the project management team's first greenhouse project, the establishing phase can be challenging and demanding. Supporting their project management in their planning phase can therefore contribute to developing a realistic starting point presented in a project plan, as proposed by the Project Management Institute (2017). Supporting their planning phase can be particularly important as it lays the foundation for the further development and progress of the project. Hence, project management can be considered critical to the planning phase, as accentuated by Abbasi and Al-Mharmah (2000).

According to Khang and Moe (2008), ID projects are principally assisted through financial resources and technical expertise, which aligns with EWB's role in Trax Ghana's greenhouse project. However, the findings in this thesis indicate that Trax Ghana could be further supported through project management training, consistent with the presented literature in section 2.4 regarding development projects.

5.3 Feedback from Trax Ghana

The key informants received a draft of the thesis after the collected data was interpreted, which included a presentation and a discussion of the findings. This served as an opportunity to understand the key informants' views on how this thesis could contribute to Trax Ghana's objectives by supporting its planning phase. In this regard, the project director sent a written statement on how they can benefit from the conducted research and thesis, which is presented as a direct quotation:

"As maintained, this is our first year of such a project (greenhouse) which can be best described as ***a pilot project – learning phase!*** *So, your research will* ***contribute*** *to helping us identify existing gaps in our project management process of initiation, planning, execution, monitoring, controlling, and closure. The feedback will enable us to re-strategize, work on existing gaps/setbacks and build on the success that will effectively produce deliverables that will lead to achieving the objectives of the project."* (Project director Trax Ghana, personal email communication, November 17th 2022.)

The feedback from Trax Ghana established that the thesis could contribute positively to the project by highlighting project management methods Trax Ghana can take advantage of in their ongoing and future projects. Hence, the chosen research questions were recognized as meaningful for the project's development.

6. Conclusion

The purpose of this thesis is to contribute to Trax Ghana's first greenhouse project by analyzing, supporting, and improving its planning phase. Narrowed down to the planning of bell pepper production, the goal of the thesis is to provide impactful recommendations for the overall planning phase. Based on data collected through my fieldwork in Ghana I developed and proposed several project management tools specifically directed toward Trax Ghana's current and future greenhouse projects. The intention is that these tools can enlighten and provide guidance to the project management team, to lay a foundation for improved planning. Accurate and relevant planning establishes how the project unfolds and is a critical success factor for achieving the project objectives within the project constraints. Objective achievement is particularly important for Trax Ghana who support their beneficiaries through their value creation.

How Trax Ghana planned its greenhouse production of bell peppers was examined in relation to project schedule management, project cost management, and project risk management. A series of findings were discovered and discussed, revealing that Trax Ghana's project management is only partly consistent with established project management literature. Substantial deviations are uncovered for project cost management due to deficient cost estimates and a lack of financial analysis for the bell pepper production. Financial analysis tools were presented to Trax Ghana as a control measure to track their financial progress. By establishing its financial situation, Trax Ghana can execute proactive actions if they detect that its financial performance constrains the support they wish to provide for its beneficiaries.

Another finding is that Trax Ghana's project schedule management and project risk management are more consistent with the project management literature. However, Trax Ghana can further develop its project schedule management by implementing graphical techniques to present and share its project schedule. As a solution, a Gantt chart was developed to support Trax Ghana's internal and external communication. The Gantt chart can also be used as input in risk and cost management to improve the accuracy of these areas. Moreover, Trax Ghana's project risk management can be supported by implementing a risk analysis. The designed template for risk assessment can support the project management team's risk management by identifying high-priority risks and how the risks develop after implementing risk responses. Hence, the template can contribute to strategic implement responses to identified risks.

The findings from this thesis highlight the importance of implementing established project management methods to maximize value creation by facilitating more efficient use of project constraints. I believe that Trax Ghana can take advantage of the findings in this thesis to implement suitable project management methods to achieve their project objectives, and thereby create a socioeconomic impact on their beneficiaries and the rural community.

6.1 Limitations of the study

A limitation of the study is that I only analyze the greenhouse production of bell pepper considering an extract of project management knowledge areas. Hence, the thesis excludes several project management areas that are significant to Trax Ghana as an ID project. During the fieldwork, I interviewed the beneficiaries and the assemblyman from the Bongo district assembly, which Trax Ghana classifies as prime stakeholders. Due to the scope of the research questions, project stakeholder management was not included in this thesis. However, Trax Ghana emphasized that supporting the beneficiaries is its primary objective. Hence, the thesis was intentionally limited to view the greenhouse project as an agricultural enterprise rather than a girl-child empowerment program.

Only an excerpt of project management tools and techniques for the chosen project management knowledge areas are presented in this thesis. The most common and acknowledged tools and techniques are presented. This is due to a natural delimitation of the study.

Moreover, this thesis only analyzes the findings related to traditional project management methodology and does not explicitly use the project management methodology developed for ID projects. Consequently, the interpretation of the findings based on the traditional methodology might generate different results of the analysis compared to the methodology developed for ID projects. This was chosen because literature review uncovered several similarities between the project management methodologies. The traditional methodology was more developed for the planning phase, and research by Golini et al. (2015) shows that ID projects can benefit from this methodology.

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8. Appendix

A.1 Interview guide

Greenhouse production of bell pepper

Questions for all informants:

1. What is your profession and role in the greenhouse project?
2. Can you openly tell me about your experience with the greenhouse project from implementation until now?
    a. Can you highlight any examples of aspects the greenhouse project has succeeded with?
    b. Can you highlight any examples of aspects the greenhouse project could have done better?

Questions to the project management team:

3. How and why did you choose the vegetable crop bell pepper to produce in the greenhouse?
    a. Can you tell me the strength and weaknesses of producing bell pepper?
    b. Did you also consider other vegetable crops?
    If yes: Which and why did you not choose this crop?

4. Can you tell me about the production processes included in the greenhouse production of bell pepper?
5. Can you tell me about the costs related to the greenhouse production of bell pepper?
6. Can you tell me about the risks (threats and opportunities) related to the greenhouse production of bell pepper?

Project Management

1. Do Trax Ghana have a project schedule for the greenhouse project?
    a. If yes: Can you tell me how the project plan was developed and used in the project management?
    b. If yes: Can I have access to this project schedule?
    c. If no: Why do you not have a project schedule?

2. Do Trax Ghana have a project budget for the greenhouse project?
    a. If yes: Can you tell me how the project budget was developed and how it is used in project management?
    b. If yes: Can I have access to this project budget?
    c. If no: Why do you not have a project budget?

3. Do Trax Ghana have a plan for risk management?
    a. If yes: Can you tell me how this plan was developed and how it is used in project management?
    b. If yes: Can I access this risk management plan?
    c. If no: Why do you not have a plan for risk management?

A.2 Interview participant information sheet and consent form

Are you interested in taking part in the research project

"Trax Ghana planning its greenhouse production of bell pepper"?

You are invited to participate in a research project whose primary purpose is to examine how Trax Ghana planned their greenhouse production of bell pepper to uncover if and how I can support their planning phase.

Which institution is responsible for the research project?
The University of Agder is responsible for the project (the data controller). The research project collaborates with Engineers Without Borders (EWB) Norway and Trax Ghana.

Why are you being asked to participate?
The selection criteria to be asked to participate is that you have or could have a potential connection to the greenhouse. Participants are selected to map different perspectives connected to the greenhouse and are the project management team or project stakeholders.

To get an in-depth understanding of the different perspectives, it is ideal to interview as many relevant interview objects as possible. The realistic range is to conduct between five and ten interviews.

This information letter will be sent out before the interviews by Trax Ghana. A written information sheet is also available for the informants during the fieldwork. The informants are encouraged to ask questions if needed in person or by contacting me through mail or telephone.

What does participation involve for you?
If you choose to participate in this study, the information you give connected to the greenhouse can be used in the master thesis. The information will be gathered through observations, interviews, and professional conversations.

The interviews will be semi-structured. It will take approximately 1 hour. I will take notes during the interview, and if the participant approves, I will record your answers electronically. The sound recording ensures that the facts noted are correct and all-important aspects are included. The sound recording will be deleted within a week and is only used to transcribe the conversation.

In the master's thesis, you will only be referred to by your work title and background. Names and other personal information will not be included.

Participation is voluntary
Participation in the project is voluntary. If you choose to participate, you can withdraw your consent without giving a reason. All information about you will then be made anonymous. You will have no negative consequences if you choose not to participate or later decide to withdraw.

Your personal privacy – how we will store and use your personal data
We will only use your personal data for the purpose(s) specified here, and we will process your personal data in accordance with data protection legislation (the GDPR).

The master's student and Trax Ghana's project director will have access to your personal data (name, education, and profession). In the master thesis, you will be mentioned only by your work title and relation to the greenhouse project. Your name will not be included. The list of names and contact details will be stored separately on UiA's password-protected server (Office 365-OneDrive).

The fieldwork and interviews are conducted in Northern Ghana, and the master thesis is submitted to the University of Agder in Norway. EWB and Trax Ghana have strict security measures we follow during the fieldwork and use of personal data.

What will happen to your personal data at the end of the research project?
The planned end date of the project is Thu, Dec 1st. The personal data will then be deleted. Digital recordings will be deleted one week after the interviews.

Your rights
So long as you can be identified in the collected data, you have the right to:

- access the personal data that is being processed about you
- request that your personal data is deleted
- request that incorrect personal data about you is corrected/rectified
- receive a copy of your personal data (data portability), and
- send a complaint to the Norwegian Data Protection Authority regarding the processing of your personal data

What gives us the right to process your personal data?
We will process your personal data based on your consent.

Based on an agreement with the University of Agder, Data Protection Services has assessed that the processing of personal data in this project meets requirements in data protection legislation.

Where can I find out more?
If you have questions about the project or want to exercise your rights, contact:
The University of Agder via Helene Bergo Nygårdsvik (student), helenebn@student.uia.no, Hossein Baharmand (supervisor), hossein.baharmand@uia.no or personvernombud@uia.no

If you have questions about how data protection has been assessed in this project, contact:
Data Protection Services, by email: (personverntjenester@sikt.no) or by telephone:
+47 53 21 15 00.

Yours sincerely,

Helene Bergo Nygårdsvik	Hossein Baharmand
Student	Supervisor

Consent form

I have received and understood information about the Trax Ghana greenhouse production of Bell Pepper project and have been given the opportunity to ask questions.

I give consent:

- ☐ To participate in an interview with an electronic recording
- ☐ To participate in an interview without electronic recording
- ☐ That my information could be used as information in the research project
- ☐ That my personal data will be stored until the project's end

I consent for my personal data to be processed until the end of the project.

(Signed by participant, date)