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The Digitalization of Project Management in Road Construction of Mongolia

Bachelor Thesis

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I hereby affirm in lieu of an oath that I provided the submitted bachelor thesis.

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I did not use any sources other than those stated. In case that the work is additionally submitted on a data medium, I declare that the written and the electronic form are entirely identical. The work was not submitted in the same or similar form to any examination authority.

Ulaanbaatar, Mongolia, May, 1,2023

Place, Date



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Abstract

Digital transformation has become a critical concept in the construction industry, offering new possibilities for optimizing project management, improving efficiency, and reducing costs. However, Mongolia's road construction sector has a range of challenges, including limited resources, a fragmented supply chain, and a need for more modern infrastructure. This thesis explores the importance of digital transformation and the LEAN construction method in the Mongolian road construction industry. Furthermore, it examines the opportunities and challenges of implementing digital technology and a LEAN management approach.

Using a survey and data analysis research design, we surveyed specialized road construction engineers and member companies of the Mongolian Road Association to gather data on the current state of digital methods and project management approaches in the industry. We also conducted a mock study of LEAN Construction software and management approaches to assess its potential for improving project management in the road construction sector.

Our findings suggest that digital transformation and LEAN construction approaches can significantly improve project delivery and performance in Mongolian road construction. However, significant challenges must be addressed, including limited technological infrastructure, resistance to change, and a need for more skilled workers.

This thesis provides valuable insights for the Mongolian road construction industry stakeholders, including government agencies and contractors, on the benefits and challenges of digital and management transformation. The results can inform policy and decision-making around adopting digital technologies and LEAN methods and contribute to developing a more sustainable and efficient road construction sector in Mongolia.

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1 Introduction

1.1 Problem Statement

In recent years, Mongolia's construction industry has been a tremendous business element and has experienced rapid growth, with road construction playing a crucial role in the country's development. However, traditional project management methods have proven ineffective in meeting the needs of current road construction projects. This thesis explores the potential benefits and obstacles of digital transformation of road construction project management in Mongolia.

Digital transformation plays a significant role in the fourth industrial revolution, changing how organizations and people operate and work. Before digitally transforming construction project management, we implement LEAN methods to adopt digital transformation in project management success can stimulate streamlining, communication, and quality improvement, which are fundamental components of successful project management.

This thesis aims to determine the current state of road construction project management in Mongolia and identify the potential benefits and obstacles to implementing LEAN and digital technology. It will also explore the cultural and technical advantages and barriers to digitalization and provide considerations for implementing LEAN and digital transformation of road construction project management. The study will be conducted through a literature review, case studies, interviews, and surveys with stakeholders and superintendents.

This thesis aims to contribute to future development regarding the LEAN construction approach and digital transformation in road construction project management. In addition, it provides an understanding of how the road construction industry in Mongolia can benefit from LEAN and technology.

1.2 Research Questions / The Aim of Study

This thesis study aims to explore and review the current development of road construction project management in Mongolia, including its potential benefits and drawbacks, technical and cultural obstacles, and the foundation for digital transformation. The construction industry in Mongolia has been increasing in recent years, and road construction projects play a significant role in the country's development. However, some big projects take longer than the planned date, sometimes 2 to 4 years, even though companies start every summer and end before winter.

However, traditional project management methods have proven to need to be more efficient in meeting the demands of current road construction projects. Therefore, exploring the potential benefits of digitalization in road construction project management in Mongolia is essential.

Digitalization is becoming increasingly important in the construction industry worldwide, and Mongolia is no exception. Using digital technologies such as our partner, the LEAN Construction of Koppla, agile and LEAN project management software, and other tools, Mongolian road construction project management can streamline processes, reduce errors, and improve overall project efficiency. With the help of digital transformation, To comprehensively implement digital transformation in the road construction industry or companies, it is crucial to evaluate its current state and situation thoroughly.

To achieve this, ask key research questions, such as "What are the current project management practices in road construction in Mongolia, and what are the main challenges facing this industry?" This question will help us understand the industry's current state and identify the key issues that must be addressed.

Another critical question to consider is, "How does the work culture in Mongolia differ from that of Germany, and how might this impact the use of software?" this will allow us to understand the potential cultural barriers that might hinder the adoption of new technologies and suggest ways to overcome them.

Overall, by conducting a comprehensive analysis of the road construction industry in Mongolia, we can gain valuable insights into the challenges and opportunities for digital transformation and provide recommendations to facilitate its implementation.

1.3 Scope and Limitation of the Thesis

This research paper only covers the preparation of the transformation of the traditional to digital project management process. However, certain limitations need to be acknowledged.

First, it is essential to note that project management research's current and future development is defined solely by Mongolian Road Association member companies. Therefore, the findings and analysis presented in this document need to expand in scope.

Next, we use construction project management software "LEAN Construction "from our partner and advisor, Koppla. They have provided us with the necessary software license and related documents, which allows us to streamline our research with a single software.

Lastly, Mongolian road construction projects are set to begin at the end of April. Therefore, there will be no opportunity to work on actual projects; only a mock project will use. As a result, the results' scope and discussions will limit the example project.

2 State-of-the-art

2.1 Introduction to Construction Project Management

2.1.1 Project Management Overview

Any undertaken activity involves time and resources and has an intended outcome. For example, such an activity could be the construction of a physical infrastructure such as a highway, a bridge, a building, or other forms of infrastructure; and major and minor maintenance works related to such physical infrastructure. To achieve the desired outcome, it is essential that the entire activity is undertaken professionally and that it is completed within the allocated time and budget. It is also necessary that the whole process and the outcome have a minimal social and environmental impact and that the stakeholders are consulted (1).

This entire activity can be broadly categorized as a project. The management of a project right from its inception to completion can be called Project Management (1).

Every project has a specific goal or objective to achieve. To achieve the objective, there have to be several input parameters and processes to realize the result. All these activities will require coordination and optimization to learn the desired outcome within time and budget with the least (and agreed) social and environmental impact. Hence there is a need to manage all project activities (1).

The PMBOK GUIDE defines project management as phases designed to manage the project using the necessary knowledge and tools to meet the project's targets and success criteria. Forty-seven project management procedures are categorized under ten knowledge areas and five project management phases. The five project management phases and knowledge areas are(3):

1. Initiating; this entails the identification and definition of the project (3).
2. Planning; under this process phase occurs the planning of all the knowledge areas, which takes place before starting the execution stage (3).
3. Executing; is the execution process, transforming the customer's imagination into real (3).
4. Monitoring and controlling; this phase controls the knowledge areas and tracks any changes (3).
5. Closing; this is the finalizing process of the project (3).

While knowledge areas are (3):

1. Project Integration Management; includes the track to determine how to define, execute, manage, control, and close the project (3).
2. Project Scope Management; is used to include all the data to finish the project exactly as the customer wants and expects (3).
3. Project Time Management; is used to develop and control the project schedule (3).
4. Project Cost Management; is used to develop and control the project budget (3).
5. Project Quality Management; refers to the quality policies and objectives for the project (3).
6. Project Human Resource Management; includes identifying, organizing, and managing the project's team members, workers, and human resources (3).
7. Project Communication Management; is used to include information about the communication process between the stakeholders in the project (3).
8. Project Risk Management; refers to identifying, ranking, and controlling the risks in the project (3).
9. Project Procurement Management; includes the procedures needed to track the relationships with the organizations outside the project, including sub-contractors, suppliers, or any other organization that delivers products to the construction project (3).
10. Project Stakeholder Management; includes the identification of any stakeholder who can affect the project directly or indirectly. It also consists of the controlling process with the stakeholders (3).

2.1.2 LEAN management

In the beginning, industry practitioners observed Toyota facilities and saw many tools and methods distinct from what they practiced. Believing this was the basis of Toyota's competitive advantage, many companies set out to emulate them. According to Koskela (1992), 11 critical principles are essential to the lean philosophy, including(5):

1. Reduce the share of non-value-adding activities (also called waste)(5)
2. Increase output value through systematic consideration of customer requirements (5)
3. Reduce variability
4. Reduce cycle time
5. Simplify by minimizing the number of steps, parts, and linkages(5)
6. Increase output flexibility

7. Increase process transparency
8. Focus control on the complete process
9. Building continuous improvement into the process
10. Balance flow improvement with conversion improvement
11. Benchmark

Identifying and *eliminating waste is fundamental to a lean organization* such as Toyota. Liker (2004) highlighted that the heart of the Toyota Production System is eliminating waste. Waste is anything that absorbs resources but creates no value. Ohno identified the following seven wastes or “*muda*”: overproduction, waiting, transportation, overprocessing, inventory, movement, and defects, and highlighted that the preliminary step towards applying the Toyota Production System is to identify wastes completely. Liker added one more waste: waste of unused employee creativity, which resulted in losing time, ideas, skills, improvements, and learning opportunities by not engaging or listening to employees) (5). The wastes appearance in road construction:

- **Over-production:** Producing faster or in greater quantity than the customer demands does not add value. Instead, it is caused by a failure to balance supply to demand, such as large batch sizes; unreliable processes; unstable schedules; unbalanced workstations; working on forecasts, and inaccurate information rather than actual order. Example: Blasting and crushing more aggregate than needed. Solution: Use a pull (kanban) system instead of a push, which requires communication between the producer and consumer (7).
- **Transportation:** Unnecessary movement of people or material between processes. It is caused by poor layouts, large distances between operations; large batch sizes; multiple storage locations. Example: Aggregates being fetched from a far-away quarry; using central rather than local stock-piling areas; removing earth material that could be used for construction. Solution: Higher precision in the information about the workplace can allow better planning (7).
- **Excessive Inventory:** Storing raw materials, work in process, or finished goods wastes space and effort. A lack of balance in workflows, large batch sizes, and long changeover times causes it. Sometimes, it leads to the scrapping of stagnant material that stays in inventory for a long time. Example: Crushing is done before road construction starts; aggregate in stock-piling gets segregated into different particle sizes. Solution: Use communication to balance supply and demand (7).

- **Unnecessary movement:** The unnecessary motion of people, materials, or machines within a process. Poor workstation layout, transfer of material, large batch sizes, and reorientation of material cause it. Example: A wheel loader feeding a crusher may need to move excessively due to poor layout. Solution: By collecting movement information, layout improvements can be identified (7).
- **Waiting times:** Unused machines, workers, or goods not being worked on do not add value. It is caused by a failure to synchronize activities, such as operators waiting while machines cycle; long changeovers; unreliable processes or quality; batch completion rather than single-piece transfer between operations; time to perform rework. Example: Haulers waiting to unload to a crusher; trucks waiting to fill the asphalt paver. Solution: Communication of the required arrival time allows the vehicles to optimize their traveling speed and potentially remove vehicles. Automate specific machines, such as asphalt compactors, to remove operators (7).
- **Over-processing:** Processing beyond the customer's requirements can occur as a precaution due to insufficient information, such as a lack of standardization of best techniques, unclear specifications, or quality standards. Example: Using unnecessarily much aggregate; doing more compacting than needed. Solution: Improved measurements of work status; more transparent information about required standards (7).
- **Defects:** Rework may be needed if sufficient quality is not achieved. For example, unclear operating procedures cause; vague specifications; inadequate training; incapable processes; suppliers; operator errors (7).
- **Unused employee:** unused employee fails to use the team's skills or knowledge. A decentralized command structure allows for the artisans responsible for producing the work to be more engaged in the process and use their knowledge to improve production (20)

„LEAN management is an approach to continuous improvement that involves optimizing subcontractors, materials, and processing times. It also aims to design the entire value chain efficiently. Through various methods, procedures, and principles, LEAN management aims to harmonize processes and create a holistic production system that eliminates waste across all company divisions. (4)“

2.1.3 LEAN management in construction

Construction projects are considered a temporary stage in the production system. However, the construction industry has a higher waste percentage when compared to

the manufacturing industry. The LEAN concept is defined as eliminating and reducing time waste, delivering the material at the needed time, and giving the customer the best product value (3).

LEAN construction differs from LEAN manufacturing primarily in that construction projects are usually limited to a fixed period and location, requiring optimization in a short timeframe. However, eliminating waste is also essential in LEAN construction (4). Therefore, LEAN construction aims to optimize the site by improving the construction process, minimizing the use of resources, and avoiding waste to increase customer value (4). The most important terms of Lean Construction are:

- **Last Planner System (LPS):** The Last Planner System(14) is a project management approach used in the construction industry that emphasizes collaboration and improves the predictability of project outcomes. The LPS involves a series of interrelated planning and control processes that aim to increase the reliability of construction activities, reduce waste, and enhance the flow of work on a construction site. It also promotes collaboration and communication among project stakeholders, increases transparency, and improves the overall efficiency of construction projects. The process is iterative and involves ongoing monitoring and adjustment to ensure that the project remains on track and that any issues are addressed on time. The last planner system primarily comprises the following components (4).
 - **Milestone and Phase Planning (4):** The milestone and phase plan are developed based on the overall process analysis. In the phase plan, (weekly) work packages in the form of work packages are created in the form of so-called phases. The phases are based on solid start and end milestones within end milestones within the time window under consideration. Milestones can be, for example, the application submission, the excavation's start and end, and another start, completion and start, completion and handover dates (4).
 - **Overall Process Analysis (4):** The process analysis aims to create a holistic overview of the project and its value streams. Developing this overview creates a common understanding of the project, and the existing dependencies between the trades are made clear to all involved. Thus, potential risks and opportunities can be uncovered directly (4).
 - **6-Week look ahead (4):** The milestone and phase plan is the basis for the next phase, the 6-week preview. Each planner or trade can use the

milestone and phase plan as a basic plan to plan upcoming activities and daily individual goals for the next six weeks and clarify dependencies with other stakeholders. The Post-it-based system makes creating and modifying the plan straightforward (4).

- **Weekly Preview/Last Planner Meetings (4):** The weekly preview is part of the 6-week preview and is updated weekly. Weekly meetings and adjustments effectively and efficiently manage the planning and construction processes. In addition, collaborative discussions promote agile adaptation to new conditions, and potential deviations can be uncovered immediately. Because of the Last Planner system's collaborative approach, variations are identified directly without causing significant problems. The goal of Last Planner® meetings is to increase a sense of commitment among performers to complete tasks on time (4).
- **Takt Planning and Control (4):** The word Takt is of German origin and translates to rhythm, cadence, or cycle. As such, it was first used to keep time in music. A related word is Taktzeit, which translates to cycle time or interval (16). Takt planning and takt control are two critical components of LEAN construction that focus on improving efficiency and reducing waste by synchronizing workflow with customer demand. Takt planning and control are often used to ensure that work is completed steadily, with each task or activity conducted in a predictable amount of time.
- **Takt planning (4):** Takt planning is the process of synchronizing the rate of production or completion of work with the speed of customer demand. It implicates breaking the project into smaller, manageable pieces and scheduling appointments to ensure that each piece is completed in a predictable and uniform amount of time. The purpose of takt planning is to create a "heartbeat" for the project that retains a steady flow of work and ensures that each task or activity is completed on time and within the specified cycle time. In the figure, the columns represent a time duration, the rows represent a Takt area, and the colored boxes represent a scope of work, trade, or package of measures and businesses (17).

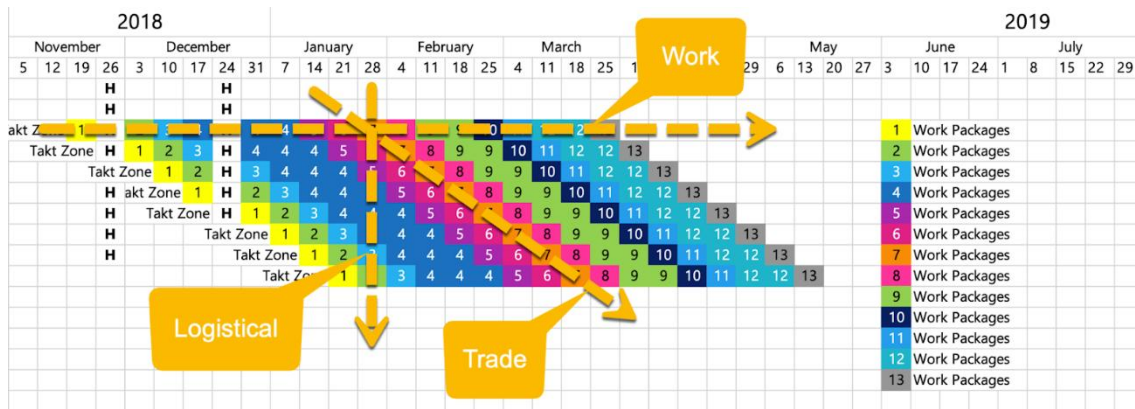


Figure. Takt plan - A Visual Schedule(17)

- **Takt Control (4):** On the other hand, Takt control is the process of monitoring and adjusting the workflow to ensure it remains in sync with customer demand. It involves tracking the progress of the work against the planned schedule and adjusting the plan as needed to maintain the required production rate. Takt control ensures that the project remains on track and that any issues or delays are identified and addressed promptly.
- **Takt Area (4):** In LEAN construction, the takt area is used for planning and optimizing space on a project site. By calculating the takt size for each task or activity, the project team can determine the space needed to complete the work efficiently and effectively. For example, assume a construction project that requires installing 100 windows within a 4-week timeframe, with 20 workdays available; the production rate should average five windows per day (100/20). Since each window takes approximately 3 hours to install, the takt time would be 3 hours per window. To determine the takt area, multiply the takt time by the required production rate, resulting in 15 square feet per window per day.
- **Takt time (4):** Takt time is a concept that originates from Lean Manufacturing and is now used in construction. It means the time required to complete a task or activity within the construction schedule. Takt time sets the maximum time to complete a task while meeting the project deadline.
- **Target / Actual Comparison:** Target/actual comparison is a crucial tool used in Lean Construction to monitor progress toward achieving the project goals and targets. It involves comparing the substantial improvement of the project to the target progress set during the planning phase and then making adjustments to the plan as necessary to keep the project on track. The comparison aims to identify and address any issues or problems early in the project before they significantly impact the project schedule or budget. Then, by continuously

monitoring progress and making adjustments as necessary, the project team can improve efficiency, reduce waste, and deliver a high-quality project that meets or exceeds the contractor's expectations.

The Last Planner System (LPS) and Takt Planning and Control are two critical components of Lean Construction. LPS is a project management approach that emphasizes collaboration and improves the predictability of project outcomes. Takt Planning and Control focus on improving efficiency and reducing waste by synchronizing workflow with customer demand. Takt Planning and Control ensure that work is completed steadily, with each task or activity taking a predictable amount of time. Implementing LEAN construction practices allows construction projects to be completed more efficiently and with less waste.

2.1.4 Agile management

Agile is the philosophy that shapes the predominant Agile approach to managing projects. It was initially outlined in the *Agile Manifesto*, consisting of 4 core values and 12 principles, which today are the building blocks of the Agile project management method. Agile emphasizes customer focus, adaptability, and continuous improvement to deliver more excellent value faster. It encourages open cross-functional communication, regular feedback exchange, and constant knowledge sharing to achieve these results (22). 12 Principles Behind the Agile Manifesto (24):

- I. **Satisfy Customers Through Early & Continuous Delivery:** the importance of delivering value to the customer quickly and continuously. By frequently providing small increments of functionality, the team can gather feedback and adjust to meet the customer's needs.
- II. **Welcome Changing Requirements Even Late in the Project:** requirements can change throughout the Project, and Agile processes should embrace that change rather than resist it. As a result, the team remains responsive to the customer's needs.
- III. **Deliver Value Frequently:** Deliver small increments of functionality to the customer. By doing so, the team can demonstrate progress and gather feedback early and often.
- IV. **Break the Silos of Project:** the importance of collaboration and breaking down barriers between team members. Team members can communicate more effectively and deliver better results by working closely.

- V. **Build Projects Around Motivated Individuals:** motivated individuals are the key to a successful project. The team can achieve great things by creating an environment that fosters motivation and trust.
- VI. **The Most Effective Way of Communication is Face-to-face:** the importance of direct communication between team members. Face-to-face communication is the most effective way to convey information and ensure everyone is on the same page.
- VII. **Working Software is the Primary Measure of Progress:** the importance of delivering working software frequently. The most concrete measure of progress ensures that the team has value for the customer.
- VIII. **Maintain a Sustainable Working Pace:** a sustainable pace is vital to ensure the team can maintain productivity over the long term. Burnout and overwork can lead to decreased effectiveness and quality.
- IX. **Continuous Excellence Enhances Agility:** the importance of continuous improvement and excellence in technical practices. As a result, the team can remain agile and adapt to changing circumstances by continually improving.
- X. **Simplicity is Essential:** the importance of keeping things simple. Complexity can lead to confusion and mistakes, so striving for simplicity wherever possible is essential.
- XI. **Self-organizing Teams Generate the Most Value:** self-organizing teams are more effective than micromanaged ones. By empowering the team to make decisions and take ownership of their work, they can generate the most value for the Project.
- XII. **Regularly Reflect and Adjust Your Way of Work to Boost Effectiveness:** Continuous improvement through reflection and adjustment is essential. Regularly reflecting on the team's performance and adjusting their approach can make them more effective and efficient.

The Agile Manifesto is built upon four core values, which are (26):

- Individuals and interactions should be valued over processes and tools (26).
- Creating working software should be valued over producing comprehensive documents (26).
- Customer collaborations should be valued over negotiating contracts (26).
- Being able to respond to changes should be valued over following a set plan (26).

Also, there are five general phases involved in Agile project management (26):

- **Envision.** The project and overall product are first conceptualized in this phase, and the needs of the end customers are identified. This phase also determines who will work on the project and its stakeholders (26).
- **Speculate.** This phase involves creating the initial requirements for the product. Next, teams will work together to brainstorm a features list of the final product, then identify milestones involving the project timeline (26).
- **Explore.** The project is focused on staying within project constraints, but teams will also explore alternatives to fulfill project requirements. Crews work on single milestones and iterate before moving on to the next (26).
- **Adapt.** Delivered results are reviewed, and teams adapt as needed. This phase focuses on changes or corrections based on customer and staff perspectives. Feedback should be constantly given so that each part of the project meets end-user requirements. The project should improve with each iteration (26).
- **Close.** Delivered results are reviewed, and teams adapt as needed. The final project is measured against updated requirements. Mistakes or issues encountered within the process should be examined to avoid similar problems in the future (26).

2.1.5 Agile in the construction industry

Agile project management is becoming more and more popular in the construction industry. The construction industry is known for its complex projects involving many stakeholders, tight schedules, and constantly changing requirements. Agile project management can help construction companies to be more responsive to changes and to deliver projects more efficiently. Construction companies can prioritize collaboration, communication, and flexibility by adopting Agile project management. They can work closely with clients, architects, engineers, and other stakeholders to ensure the project meets their needs and expectations. They can also use Agile project management tools and techniques, such as daily stand-up meetings, sprint planning, and retrospectives, to improve communication and coordination among team members.

Below are some important aspects of agile project management in construction:

- **Collaboration and Communication:** Agile project management in construction emphasizes the importance of cooperation and communication among team members. Including regular team meetings, face-to-face communication, and open communication channels to ensure everyone is on the same page.
- **Iterative Planning and Execution:** Agile project management in construction emphasizes iterative planning and execution, where work is broken down into

smaller, more manageable tasks; this allows for greater flexibility and adaptation to changing requirements and situations.

- **Continuous Improvement:** Agile project management in construction focuses on constant improvement and learning from past experiences. Including regular retrospectives, the team reflects on what went well and what needs improvement and then changes its processes and procedures accordingly.
- **Embracing Change:** Agile project management in construction recognizes that change is inevitable in any construction project. Therefore, the team must be prepared to adapt to changing requirements and be flexible in their approach to project management.
- **Delivering Value:** Agile project management in construction emphasizes providing value to the customer by focusing on the essential features and functions. Allowing the team to have a working product for the customer as soon as possible can help reduce waste and improve overall project quality.

Below are some common challenges the construction industry faces and how an Agile approach to project management can help solve them (27):

- **Low transparency in the construction process (27):** A challenge that construction companies often face is the inability to properly track their operations from concept to execution, resulting in chaos. To deal with this problem, Agile preaches visualization at every workflow step. This can be achieved by integrating *Kanban boards* (Figures 1 & 2), where Agile construction teams can visualize their work process's stages (and substages). Eventually, these boards will turn into value stream maps, allowing teams to quickly discover constraints, eliminate waste, and promptly react to an emerging issue. Furthermore, making the work process more transparent helps bridge gaps between planning and execution (27). Construction companies can break down their high-level plans into work packages and connect them with the teams responsible for further elaboration and delivery.
- **Poor communication:** Ineffective communication is one of the main reasons for many failed projects, regardless of the industry. No wonder Agile teams put forward "Individuals and Interactions" before "Processes and Tools." However, due to the high complexity of the construction industry's work process, there is often inadequate communication and a lack of accountability (27). Integrating regular feedback loops (Figure 2) to sync progress and discuss issues is how Agile solves that. For example, Agile construction teams engage in daily meetings where they present what work has been completed and what they

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plan to get done and discuss anything standing in their way of accomplishing that keeps everyone on the same page and ensures that any blockers are revealed quickly. Team members are also encouraged to get into follow-up conversations after the meeting and help each other if somebody is stuck (27).

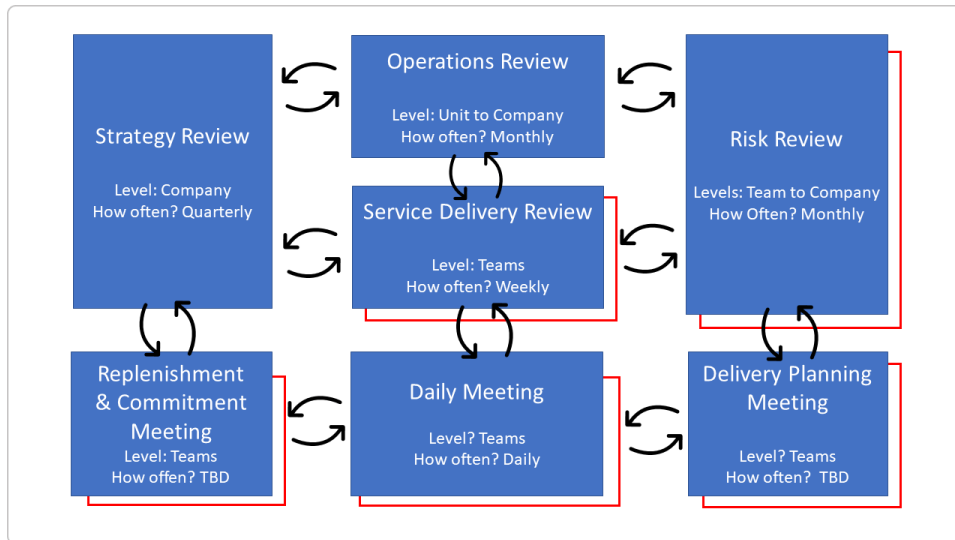


Figure 2: Feedback loops in Kanban

- Project delays:** Delays can range from inaccurate budgets to contractor problems. However, another cause lies within unstable and cumbersome processes that lead to less predictability, and this is where Agile has a solution to offer. While various factors can cause project delays, one significant contributor is unstable and cumbersome processes, leading to low predictability. Agile methodologies, such as Lean/Agile, offer solutions to this problem. One way to improve predictability is using Lean/Agile metrics like lead time, cycle time, and throughput data. These metrics allow construction teams to track how long work activities flow through the process and identify areas for improvement (27).

2.1.6 Agile and LEAN management

Agile and Lean management are two popular methodologies organizations have used to streamline their processes, improve efficiency, and increase productivity. Both methods have unique approaches and benefits, but combined, they can provide organizations with a robust framework for managing projects and processes.

When combined, Agile and Lean management can benefit the construction industry. Here are some of the critical benefits, sorted by category:

1. Improved efficiency

- a. Reduction of waste: Lean principles focus on eliminating waste, which can help reduce costs and improve efficiency.
- b. Faster completion times: Agile methodologies emphasize rapid iteration and frequent feedback, which can help construction teams work more efficiently and complete projects faster.
- c. Improved collaboration: Agile methodologies prioritize cooperation and teamwork, which can help construction teams work more efficiently and effectively.

2. Improved quality

- a. Reduction of rework: Eliminate rework by building quality. Agile methodologies also emphasize regular testing and feedback, which can help reduce errors and improve quality.
- b. Continuous improvement: Lean and Agile methodologies prioritize continuous improvement, which can help construction teams identify and address quality issues quickly.

3. Increased flexibility

- a. Adaptability to change: Agile methodologies emphasize flexibility and responsiveness to changing requirements, which can help construction teams adapt quickly to unexpected changes.
- b. Improved communication: Agile methodologies prioritize communication and feedback, which can help construction teams stay informed and respond quickly to changes.

4. Increased customer satisfaction

- a. Meeting customer needs: Lean principles prioritize delivering value to the customer, while Agile methodologies prioritize collaboration and responsiveness to customer needs. Combining these methodologies can help construction teams meet customer needs more effectively.
- b. Faster delivery times: Agile methodologies emphasize rapid iteration and feedback, which can help construction teams deliver projects faster and more efficiently.

5. Improved Collaboration

As a result, organizations can create a culture of collaboration, innovation, and continuous improvement by combining Agile and Lean management.

Table 1: Comparison between the combination of agile and lean and traditional project management:

Aspect	Agile and LEAN Construction	Traditional Project Management
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Project Planning and Control	Emphasizes iterative and continuous planning, with frequent adaptations to changing conditions. Project objectives are prioritized and broken down into manageable workloads.	Focuses on upfront planning, with less flexibility for changes during construction. Planning is typically based on the critical path method and other established project management tools.
Project Team Organization	Team members are cross-functional and self-organizing, focusing on collaboration, empowerment, and continuous learning.	Team members have defined roles and responsibilities, with a hierarchical structure and less emphasis on collaboration and shared decision-making.
Communication and Stakeholders management	Stakeholders are actively involved in the project, with frequent communication and feedback loops. There is a focus on transparency and a shared understanding of project goals.	Communication with stakeholders may be less frequent, with less emphasis on feedback loops and stakeholder engagement. There may be a greater focus on managing stakeholder expectations rather than actively involving them in the project.
Project delivery speed	Emphasizes rapid value delivery through iterative planning, construction, and testing cycles. Projects are broken down into smaller components and delivered in incremental stages.	Emphasizes adherence to a defined schedule and timeline, with less flexibility for change or deviation. Projects are typically delivered in one large, final stage.
Quality control and	Emphasizes continuous	Emphasizes quality

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waste reduction	improvement and waste reduction through regular inspection, adaptation, and value stream mapping.	control through established standards and protocols, with less emphasis on waste reduction and continuous improvement.
Risk management	Emphasizes a proactive approach to risk management through frequent inspection and adaptation. Risk is identified early on and addressed through continuous improvement.	Emphasizes a reactive approach to risk management through contingency planning and risk mitigation strategies. Risk is typically addressed once it has occurred rather than being proactively identified and managed.

2.1.7 LEAN and Agile in the construction industry

In the construction industry, The traditional approach to project management involves a rigid, step-by-step process that can be slow and inflexible. However, lean and agile project management methodologies offer a more dynamic and efficient approach to construction project management.

Lean project management focuses on reducing waste and increasing efficiency in the construction process. This approach involves continuous improvement and focuses on delivering value to the customer. By eliminating unnecessary steps and streamlining processes, lean project management can help construction companies save time and money.

Agile project management, on the other hand, emphasizes flexibility and adaptability. This approach involves breaking up the project into smaller, more manageable tasks and prioritizing them based on customer needs. As a result, agile project management allows construction companies to respond quickly to changes in the project scope or customer requirements.

By combining lean and agile project management methodologies, construction companies can achieve even greater efficiencies and deliver more value to their

customers. This approach involves applying lean principles to the overall project management process while using agile methods to manage individual tasks and adapt to changing requirements.

The construction industry can benefit significantly from adopting lean and agile project management methodologies. These approaches can help construction companies reduce waste, increase efficiency, and deliver more value to their customers. Furthermore, by combining the best of both worlds, lean and agile project management can help construction companies stay competitive in a rapidly changing industry.

Table 2: Comparison between the combination of agile and lean construction and traditional construction project management

Aspect	Agile and LEAN Construction	Traditional Construction Project Management
Delivery Method	Iterative and incremental delivery, with a focus on delivering value early and often	Sequential delivery, with a focus on completing each phase before moving on to the next
Project Planning	Dynamic and adaptable planning based on continuous feedback and changes in requirements	Detailed planning at the outset of the project, with limited flexibility for changes
Communication	Frequent communication and collaboration between project teams and stakeholders, with a focus on shared understanding and decision-making	Limited communication and stakeholder collaboration are often consulted only at specific project stages.
Risk Management	Proactive identification and mitigation of risks through regular reviews and continuous improvement	Reactive management of risks as they arise, with limited preparation for potential risks
Quality Control	Emphasis on continuous improvement, waste	Quality control focused primarily on final

	reduction, and ensuring quality at every stage of the project	inspections and compliance with specifications.
Team Structure	Self-organizing teams with overlapping roles and responsibilities, empowered to make decisions and solve problems.	Hierarchical team structure with clearly defined roles and responsibilities
Project Scope	Flexible and adaptable scope, with the ability to adjust based on changing requirements and priorities	Fixed scope, with limited ability to adjust without significant changes to project plans
Project Cost	Emphasis on controlling costs through waste reduction and efficient use of resources	Focus on completing the project within budget through adherence to pre-determined cost estimates.
Project Schedule	Emphasis on completing the project quickly through efficient use of resources and continuous improvement	Focus on completing the project within a pre-determined timeline.
Customer Satisfaction	Focus on delivering value to stakeholders and responding to their needs and priorities.	Limited focus on stakeholder satisfaction beyond compliance with specifications

2.2 Project Management Software

Project management software is essential for successful project management in today's complex and fast-paced business environment. It gives project managers the tools to plan, organize, and execute projects effectively. Some key features of project

management software include task management, team collaboration, resource allocation, budget tracking, and reporting.

Using project management software, project managers can quickly identify project milestones, monitor progress, and ensure that all project activities are completed on time and within budget.

Additionally, project management software enables team members to communicate and collaborate effectively, which is crucial for ensuring everyone is on the same page and working together towards the same goals.

Ultimately, project management software is vital in improving project efficiency, reducing costs, and delivering projects that meet or exceed stakeholder expectations.

Benefits	Description
Centralized Project Data	Project management software allows all project data to be stored in a single location, making it easy for team members to access and use.
Efficient Communication and Collaboration	Project management software facilitates team communication and collaboration through features like messaging, file sharing, and task comments.
Enhanced Task Management and Tracking	Project management software lets project managers assign tasks, track progress, and set deadlines, ensuring timely completion.
Resource Allocation and Management	Project management software enables project managers to assign resources to tasks, track resource availability, and optimize resource allocation.
Real-Time Project Monitoring and Reporting	Project management software provides real-time project monitoring and reporting, allowing project managers to identify and resolve issues promptly.
Streamlined Budget and Cost	Project management software enables managers to track expenses, manage

Management	budgets, and forecast costs, avoiding overruns.
Improved Project Transparency and Accountability	Project management software promotes project transparency and accountability by giving stakeholders visibility into project progress and status.
Customizable Dashboards and Reports	Project management software allows project managers to create customizable dashboards and reports, providing key stakeholders with relevant project information.
Scalability and Flexibility	Project management software is highly scalable and can be adapted to meet the needs of projects of all sizes and complexities.
Integration with Other Tools and Systems	Project management software can be integrated with other tools and systems, such as accounting software and CRM systems, to improve project efficiency.

2.2.1 Agile – LEAN (LeAgile) Construction Approach/Software

Agile – LEAN (LeAgile) construction management software is connected project technology specifically for the construction industry. It's a tool (or a set of tools) that goes beyond just project management capabilities and enables construction firms to carry out tasks such as managing budgets, ensuring quality and safety programs, setting schedules and timelines, communicating and coordinating with stakeholders across the office and the field, and so much more. In addition, it aims to automate and streamline tasks and connect workflows and data across the project lifecycle to make teams more efficient and productive (29). There are several potential benefits of CPM software:

- **Reduced Risks**

- Increased visibility, efficiency, and collaboration lead to better documentation, fewer defects, and better support for stakeholders — all of which translate to more favorable outcomes (29). With construction

software, you can dramatically reduce the risk of disputes, inconsistent reporting and errors, poor documentation, coordination hurdles, safety hazards, and poor labor quality (29).

- **Increased Efficiency**

- Construction management software has helped the industry reach a turning point. People no longer rely on legacy programs designed for in-office use(29). Research from FMI found that construction professionals spend 35% of their time (over 14 hours per week) on non-productive activities, including looking for project information, conflict resolution, and dealing with mistakes and rework. Even more frustrating is that these non-optimal activities take away from the more critical aspects of a job, like executing the project, communicating with stakeholders, and coordinating with people on site (29). The software streamlines various tasks and minimizes human error and missing data. The solution also enables teams to do things quickly and accurately, so tasks are completed faster, and stakeholders can devote their efforts towards high-value and profit-generating activities (29).

- **Maximized Profits**

- The software improves the quality and accuracy of work. Estimates show that around 4 to 6% of the total cost of a project is related to rework(29). Heightened expense is another reason why construction software is so essential. It helps minimize the risk of rework, keeping your project on schedule, and protecting your bottom line (29).

- **Improved Decision Making**

- A robust construction management solution gives you the data and insights to make more informed decisions. Whether you need to call on a specific project or are looking to make high-level and strategic decisions across all your projects, your construction management software should be able to give you the necessary info (29).
- Hierarchical structure causes slow decision-making. Removing hierarchical management can help reduce decision-making time and promote a more collaborative work culture.

- **Improved Collaboration**

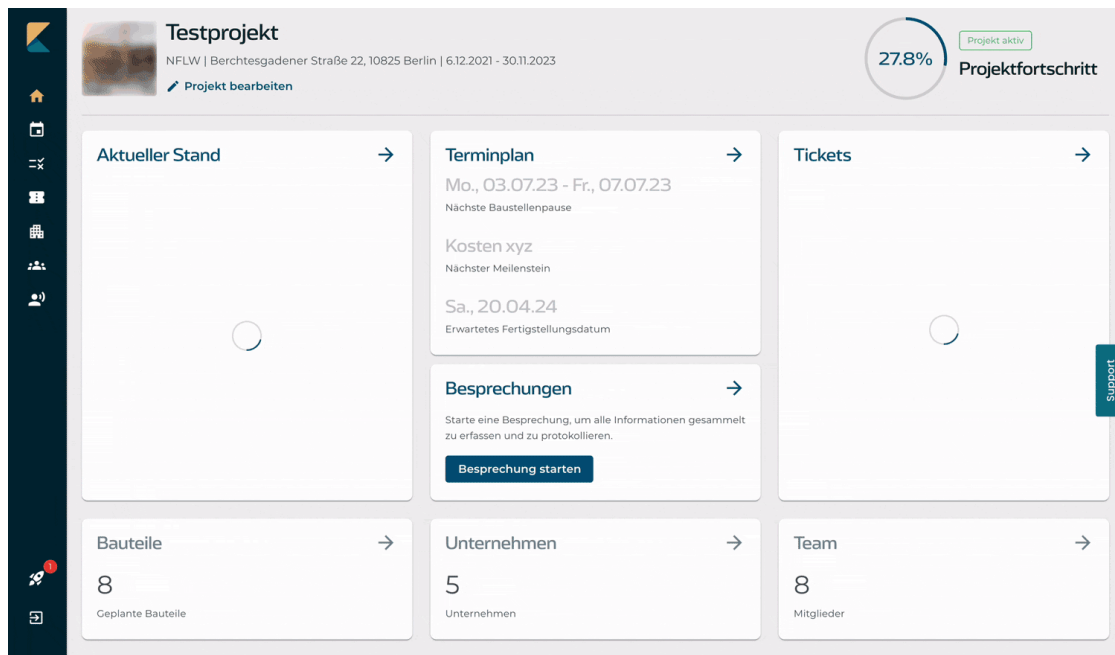
- The Agile-Lean approach encourages teamwork and accountability by promoting collaboration across different functions and breaking down barriers between them. This approach encourages open communication

and transparency, increasing trust and respect among team members and subcontractors.

2.2.2 Construction Software – KOPPLA

2.2.2.1 The KOPPLA

Koppla is an intuitive and collaborative agile scheduling tool that supports linear and LEAN methodology for all types of construction sites.



2.2.2.2 Koppla Software

Koppla construction software is project management software designed specifically for construction companies of all sizes. It provides a centralized location for storing project data, allowing team members to access and use the necessary information (30) quickly.

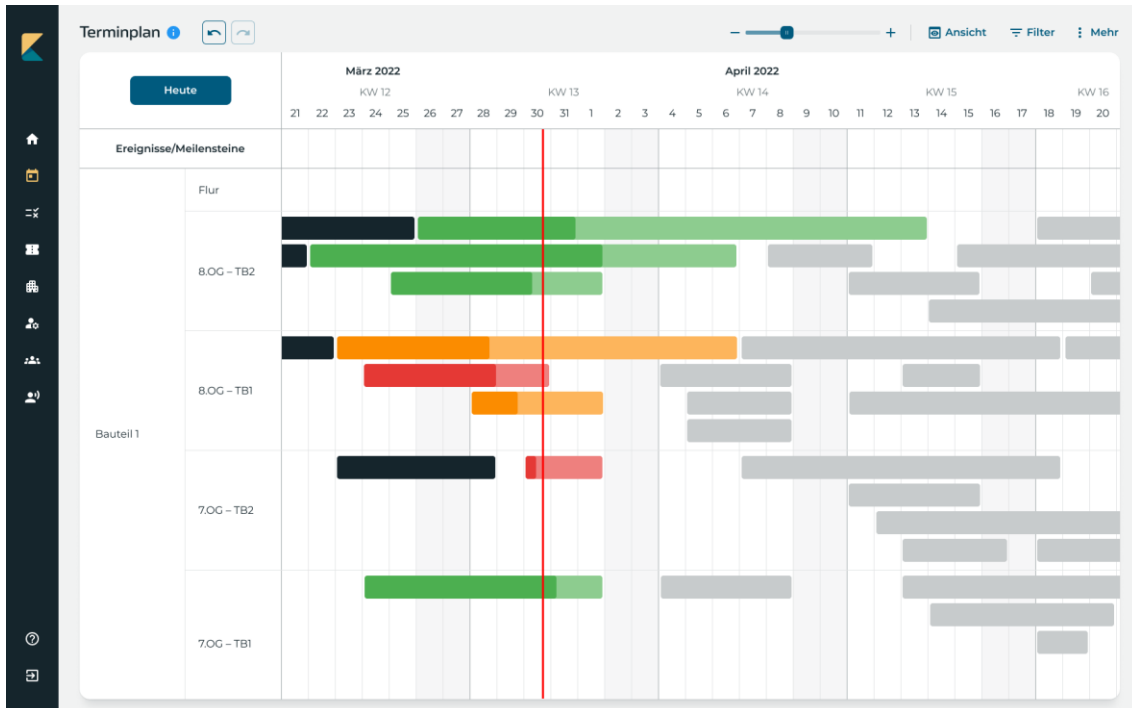
Here are some crucial advantages of construction software:

- Real-time updates ensure that all involved parties are always up-to-date.
- Grant permissions to control who can change data and who only has read access.
- The software is specifically designed for on-site use.
- Available in different languages.
- Recording all relevant data is much faster than manually searching for information from different sources.
- Illegible handwriting no longer plays a role in digital recording. The entered data is well-captured digitally, leaving no room for interpretation.

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- All project information can be accessed through the construction software and evaluated or analyzed.- Task assignment per trade or company, including "finished" feedback, always shows the current status.

Features of the software include:



- Real-Time Update
- Specifically Made for the Construction
- Easy to Use
- Data Analysis
- Automatic suggestions for process automation
- Ticket System
- Permission Management
- Construction Meetings
- Role Management
- Multi-Platform

The software includes various views of the trades, an autopilot that suggests ways to shorten construction time, time planning/time control, and defect/release notifications. Koppla construction software is easy to use, and support is available for setup and ongoing use (30).

The software suits all builders and construction companies who plan or manage a construction site and need to monitor on-site processes. This includes project

developers, construction managers, general contractors, subcontractors, and construction management consultants. The company size does not matter. Construction software is just as helpful for smaller companies as for larger ones (30). In addition, there are highly beneficial tools and functions integrated into Koppla:

- **For Construction:** As mentioned before, LEAN construction and manufacturing approaches are different, so the koppla is only built for construction projects, which makes it an excellent choice for Mongolian road construction companies.
- **Real-Time Update:** Monitor live updates and changes through software. Also, this can prevent any risks before they cause more considerable risks, such as staff and material shortages and weather.
- **Easy to Use:** The user interface for both the smartphone app and Windows software is easy to understand and intuitive.
- **Visualized Schedule:** Track construction progress with flexible schedule views. Colors help identify trades and issues in real time.
- **Ticketing System:** assign and track responsibilities with clear expectations and deadlines for completion to ensure team members are aware of their duties(Figure).

Bezeichnung	Verortung	Nachunternehmer	Tickettyp	Status	Fertigstellung bis
Wandanstrich falsch	Vorderhaus, 4.OG, 14.02	Malerfirma Bunt	Mangel	Offen	20.07.2022 Überfällig
Wandanstrich falsch	Vorderhaus, 5.OG, Suite	Malerfirma Bunt	Mangel	Offen	20.07.2022 Überfällig
Risse in Wänden – WZ	Vorderhaus, 3.OG, 13.04	Trockenbauer Steht	Mangel	Freimeldung	25.07.2022
Zu geringe Schichtdicken	Vorderhaus, 3.OG, 13.04	Trockenbauer Steht	Mangel	Freimeldung	25.07.2022
Material wegräumen	Vorderhaus, 3.OG, 13.07	Trockenbauer Steht	Aufgabe	Abgeschlossen	26.07.2022
Wassereintritt	Hinterhaus, EG, 2.0.02	Estrich Erhardt	Schaden	Offen	26.07.2022
Materiallager zu – Schlüssel empfangen	Hinterhaus, 1.OG, 2.1.01	Estrich Erhardt	Notiz	Offen	26.07.2022
Schutt wegräumen	Vorderhaus, 1.OG, Treppenhaus	Fliesenleger Spiegel	Aufgabe	Offen	27.07.2022
Schutt wegräumen	Vorderhaus, 2.OG, Treppenhaus	Fliesenleger Spiegel	Aufgabe	Offen	27.07.2022
Dachfenster gesprungen	Vorderhaus, DG, 6.6.08	Glaserel Durchblick	Schaden	Offen	28.07.2022
Balkontür Glas gesprungen	Vorderhaus, DG, 6.6.08	Glaserel Durchblick	Schaden	Offen	28.07.2022

3 Analysis and Result

3.1 Current Road Construction Project Management Development of Mongolia

Based on a survey and interviews(the profile of surveys and interviews listed in Table 3) with experts and stakeholders in the Mongolian road construction industry, our project management approaches need updating to match those in highly developed countries.

A total of 19 company employees attended the online survey, and nine employees gave interviews. Figure 3 illustrates that 42% of the sample respondents are highway engineers, and 37 % are chief engineers and company directors. Figure 4 shows that 68% of respondents work in a road construction company, and 16% are in a design firm.

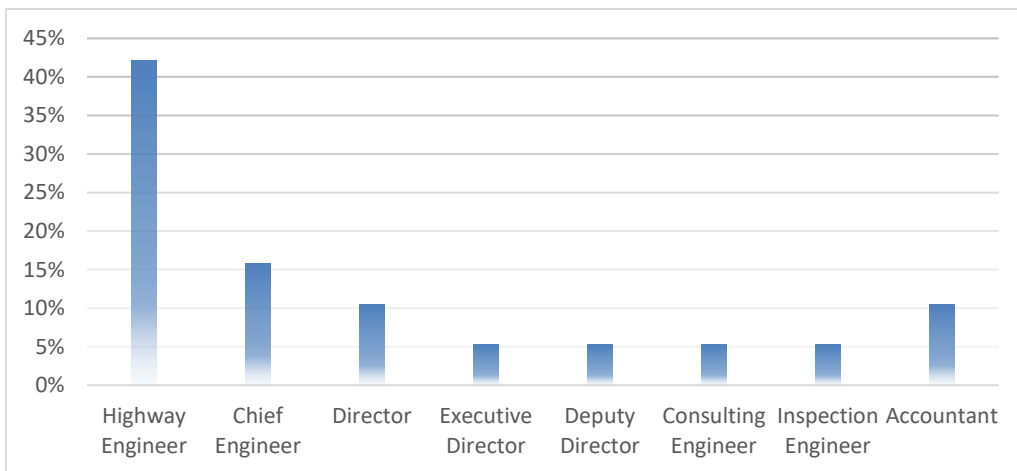


Figure 3: Position of Respondent

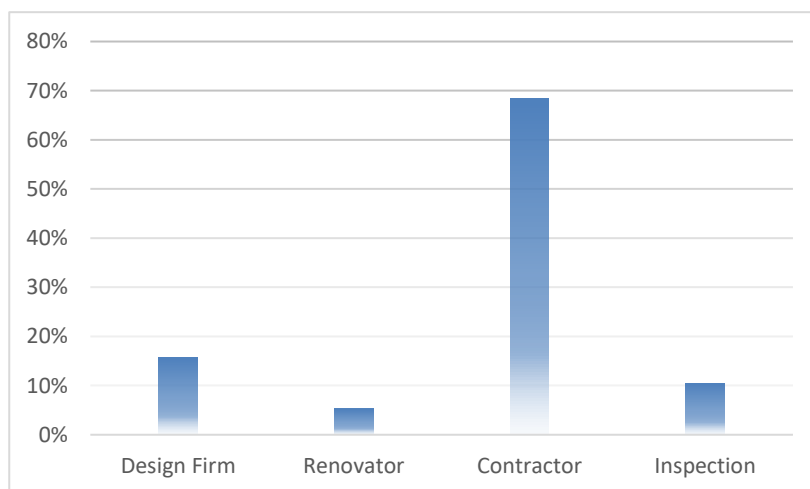


Figure 4: Company Type

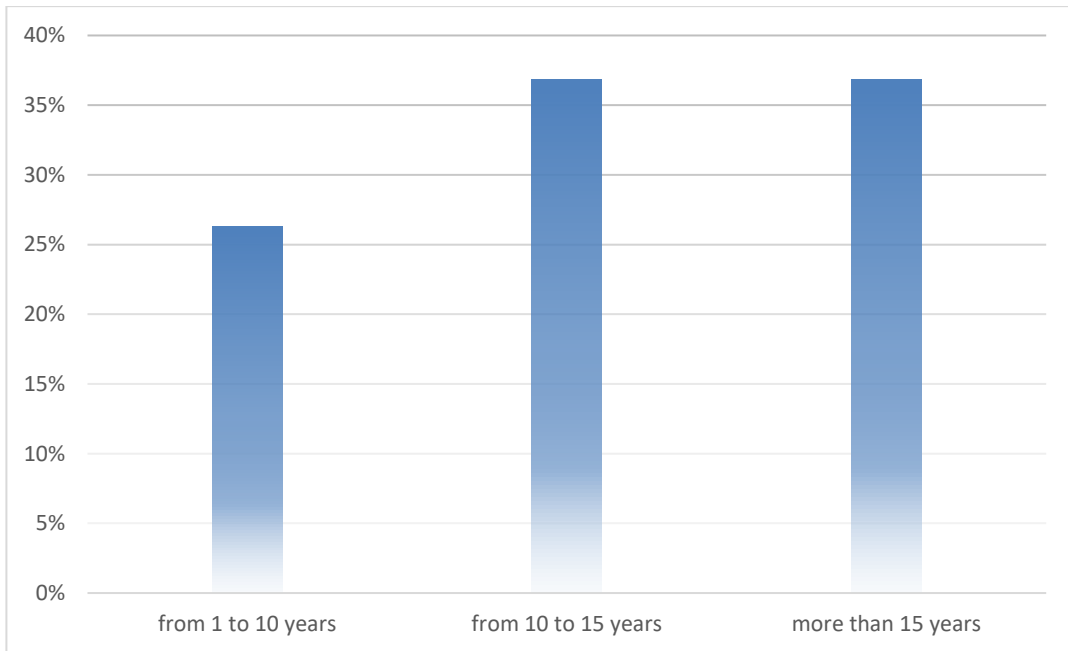


Figure 5: Years of Company Experience in the Road Construction Industry

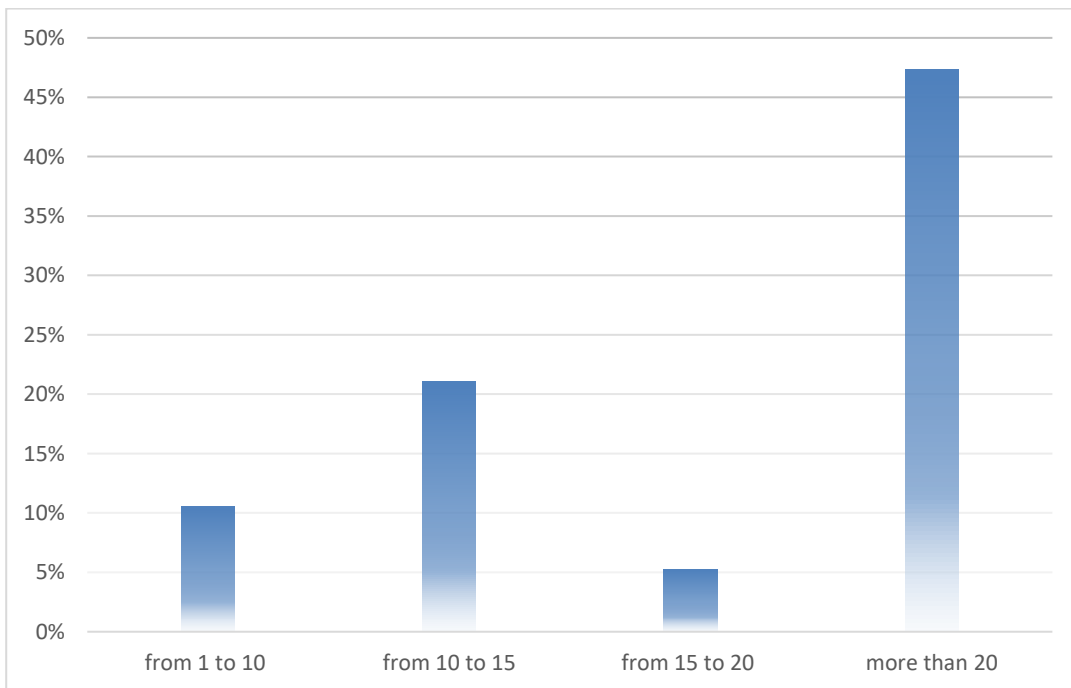


Figure 6: Completed Projects since Company's establishment

From 19 companies, 74% have 10 to 20 years of road construction industry experience, and 47% have done more than 20 projects and construction work since the company's establishment. The other 16% is a relatively new company.

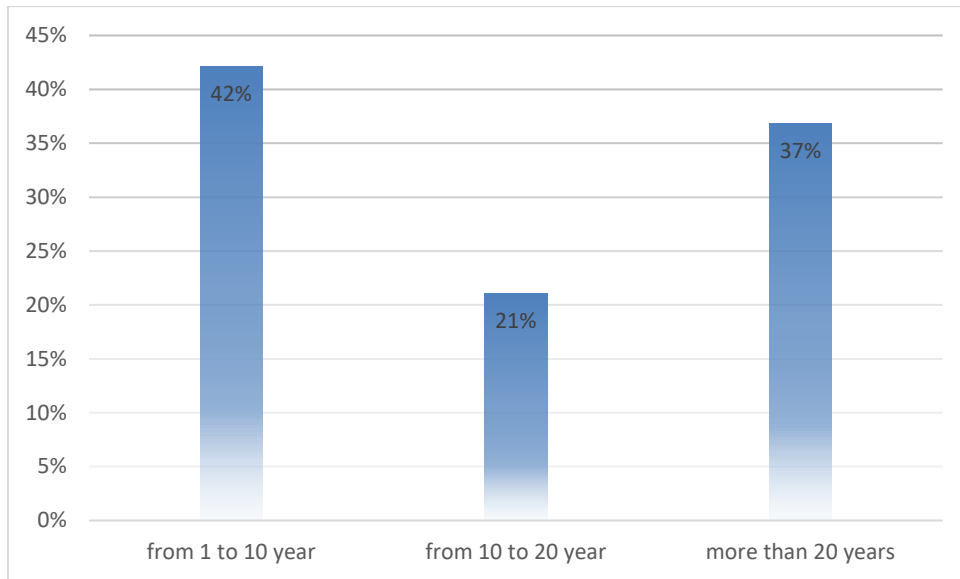


Figure 7: Years of Personal Experience in the Road Construction Industry

Firstly, road construction companies need to have specific work culture or organizational manner, whether a company is large or small, which without particular work culture, will cause lower quality projects, inefficiency, and low morale in the work environment. But the data shows that 72 % have a company work culture(Figure 8). However, the other 28% still need work culture.

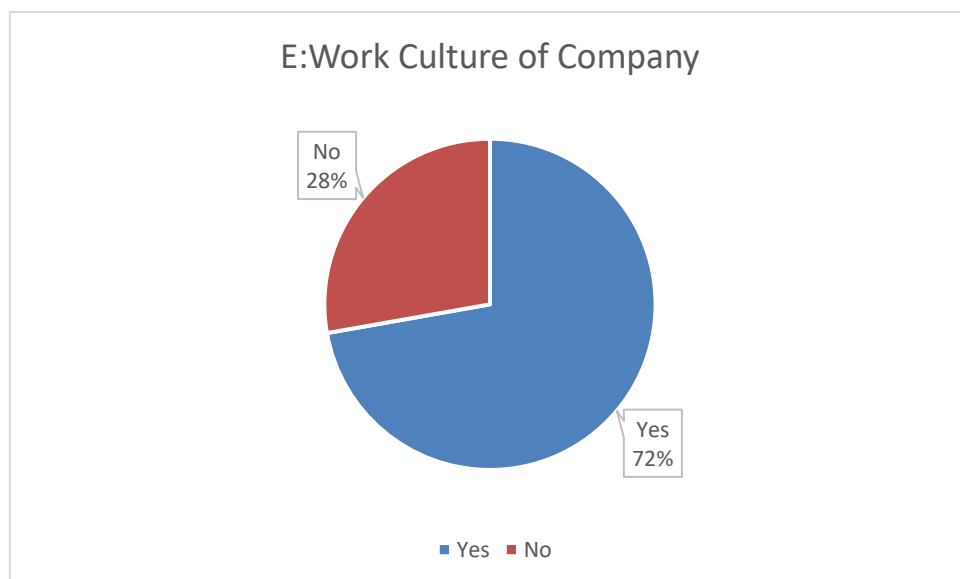


Figure 8: Work Culture of Company

Secondly, From the interview with an inspection engineer who has 20 years of experience in road construction and 5 to 10 years of experience in the Korean Construction Industry, the process of project selection and project audit of the government is time-consuming, complicated, and has robust hierarchy system which does not accommodate the Agile–LEAN management approach.

Hierarchical management, also known as top-down management, has advantages and disadvantages. The benefits are centralized control, quicker implementation, and more clarity(34)(Figure 9). However, the penalties are that it constrains employees' creativity and innovations, which means employees may hesitate to propose new ideas or take risks for fear of repercussions from higher-level management. In addition, it is resistant to change, and sometimes, employees may hesitate to deviate from established processes and procedures. Furthermore, hierarchical management can result in siloed communication, as information is passed down through the hierarchy rather than being shared freely among all team members, leading to misunderstandings and miscommunications. Lastly, Hierarchical management can sometimes result in slow decision-making, as decisions need to be approved by multiple levels of management.

The Agile Lean Organization - The Difference

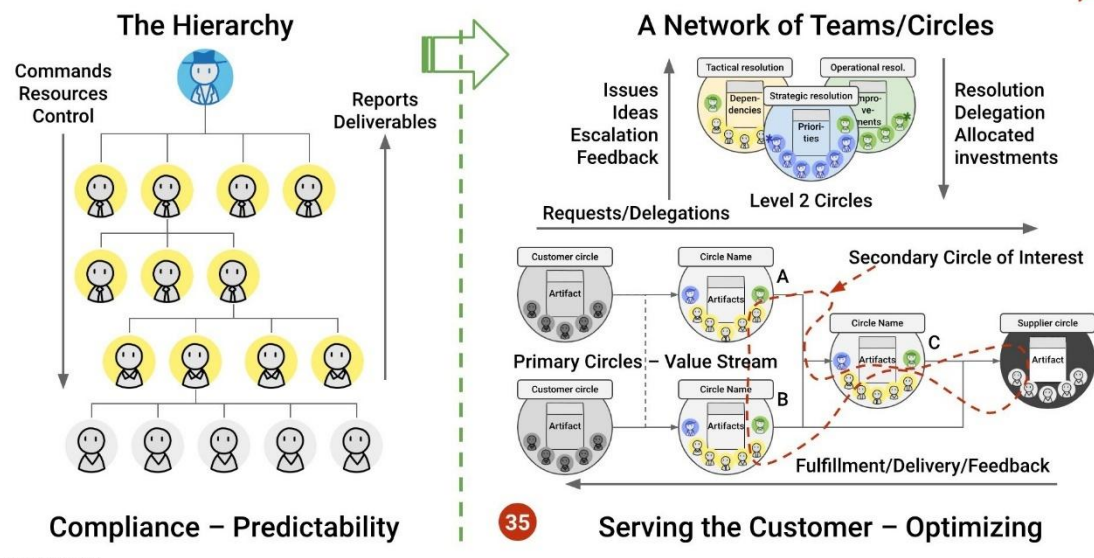


Figure 9: Agile Lean Organization and Hierarchy Difference

Based on this analysis (Table 4), most employees perceive the work culture as positive regardless of the company experience. Therefore, work culture can have a significant impact on project management. A positive work culture can lead to higher levels of productivity, collaboration, and teamwork, which are all critical components of effective project management. In contrast, hostile work culture can lead to lower morale, higher levels of conflict, and decreased motivation, which can negatively impact project outcomes. For example, in the survey, there was a question about what you and your company will do when the project deadline comes soon, and the project still needs to be done, and two companies said they would force the employees to boost their

progress. That is exceptionally amateur and impolite; in this situation, this act will cause accidents and lower road quality, negatively affecting the work environment.

In terms of software and tools for road construction project management, Mongolia may need greater access to modern technologies to improve the efficiency and effectiveness of project management. Advanced software and tools can aid in planning, designing, and constructing roads and monitoring and evaluating project progress. However, with limited access to these resources, Mongolia may require assistance in accurately estimating project timelines, managing budgets, and ensuring quality control, all of which can ultimately impact the success of road construction projects.

Also, regarding project planning and risk management, the companies often follow the written contract between the company and the client or government shown in Table 5. Most companies are proactive and include all the possible risks are natural disasters, accidents, and sudden lack of workforce.

On the other hand, inadequate project planning can lead to cost overruns, environmental damage, and poor-quality roads. Therefore, proper planning is necessary to ensure the project is executed effectively, within budget and timeline, and with minimal adverse environmental impacts.

Furthermore, the need for more skilled laborers in road construction in Mongolia can impact the road's quality and the project's overall success. Skilled labor is essential for road construction, requiring specialized knowledge, expertise, and experience.

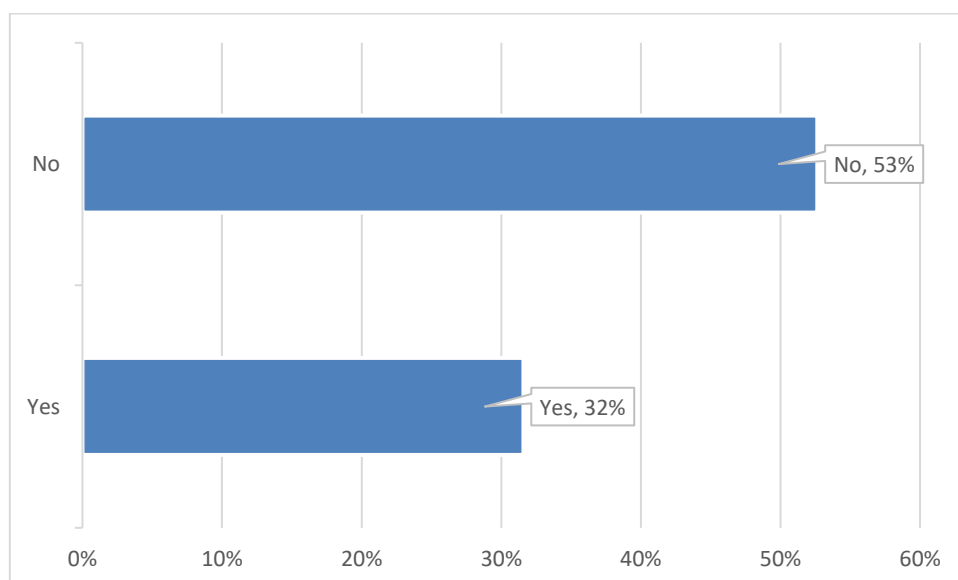


Figure 10: Number of Company provides Training for Employee

Figure 10, Number of Companies that train and provide project management and work organization courses for new, permanent, and contract employees. Eighty-two percent of them need to provide project management training. Without proper PM training, employees may lack the necessary skills and knowledge to effectively manage projects, leading to delays, cost overruns, and poor quality outcomes. But, providing PM training will help employees understand the importance of project management processes and methodologies and how to apply them. This can lead to better coordination and communication between team members and a clearer understanding of project goals and timelines.

In “Mongolia: Road Sector Development to 2016, ADB”, ADB said, *“Mongolia would need to invest more in the sector’s human resources. There is a critical need to scale up and modernize the country’s engineering and vocational training programs. Ideally, sector stakeholders (industry and the DOR) would be involved in education program management, but they also could be involved in education financing. At the same time, the sector associations could work to improve the sector’s appeal to young graduates.”* (28)

A question was taken to define a successful project from different perspectives **“What criteria do you use to define a successful project?”** companies and experts said that if the project is completed within the planned time frame and budget and adheres to standards, it is considered successful. However, the success of a road project cannot be solely defined by its timely completion and adherence to budget. It is equally important to consider other aspects, such as worker safety, stakeholder satisfaction, and assessing environmental impact.

3.2 Current Software and Tools for Mongolian Road Construction Projects

Our road construction companies in Mongolia typically use Microsoft Excel for financing and Microsoft Word for reporting and monitoring purposes shown in Figure 3. While other developed countries have adopted more advanced tools like Oracle Primavera, Microsoft Project, SAP, Autodesk BIM 360, and PlanGrid, which offer valuable security and finance features, we have yet to catch up with them in this regard. As a result, the road construction industry is expected to experience steady growth with modern software and tools, leading to improved quality. Creating high-quality roads and highways will promote the country's future development by facilitating trade, promoting tourism, and connecting remote areas more effectively.

Regarding project monitoring and reporting, Microsoft Word is a logical choice. However, there are several reasons why it may not be the most efficient or practical option. First, Microsoft Word is primarily a word processing program designed to create documents rather than manage projects. While it can be used to create project reports and documents, it may need the necessary features and functions to track and monitor project progress efficiently.

Secondly, using Word for project monitoring and reporting can lead to version control issues. With multiple team members working on the same document, keeping track of changes and ensuring everyone is working on the most up-to-date version can be difficult, and Microsoft Word does not offer real-time collaboration features, which means that team members cannot work on the same document simultaneously, slowing project progress and leading to delays.

Word does not offer advanced data visualization methods like Kanban, Ishikawa, or Value Stream Mapping. However, project monitoring and reporting often involve analyzing and presenting complex data, which may require charts, graphs, and other visual aids. While Word can create basic graphs and charts, it may need more advanced options to present project data effectively.

Microsoft Word can be used for project monitoring and reporting. However, there are more efficient and effective options. For example, Autodesk BIM 360 and Koppla project management software designed specifically for tracking and managing projects can provide more advanced features and functions to streamline progress and ensure successful completion.

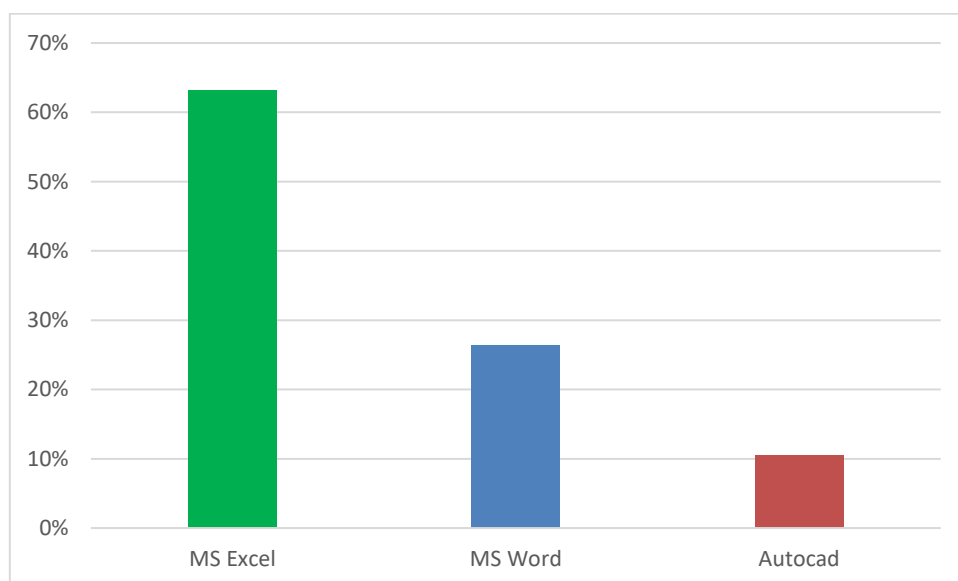


Figure 11: Software for Project Report, Document

Regarding project communication, some companies use Facebook and Viber (Figure 12, Figure 13) to send daily and monthly reports. They seem easy and convenient for team members to stay in touch. However, these platforms also have certain drawbacks that can negatively affect the success of a project.

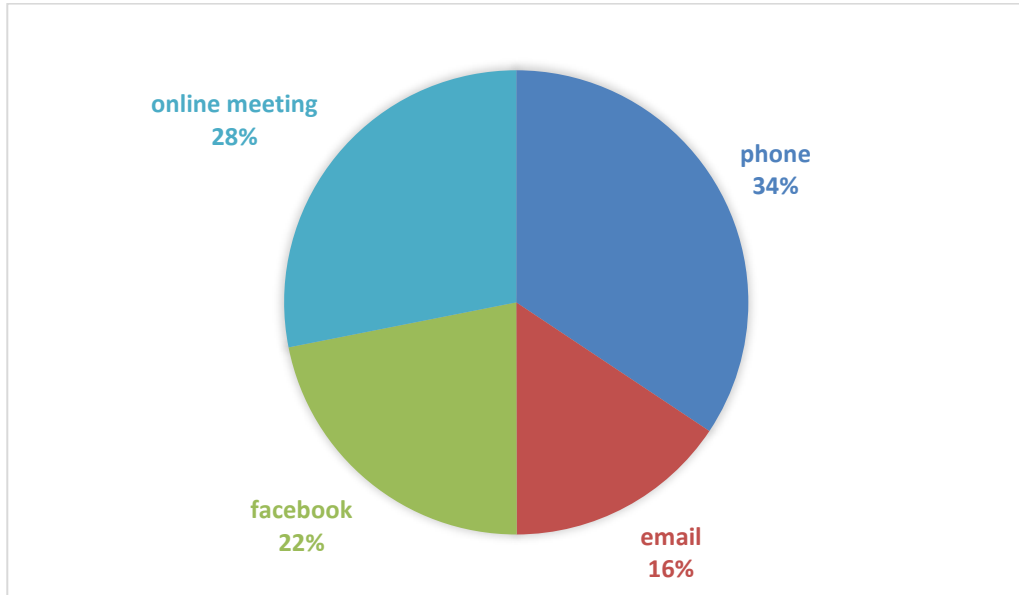


Figure 12: Company's communication channel to employees on site

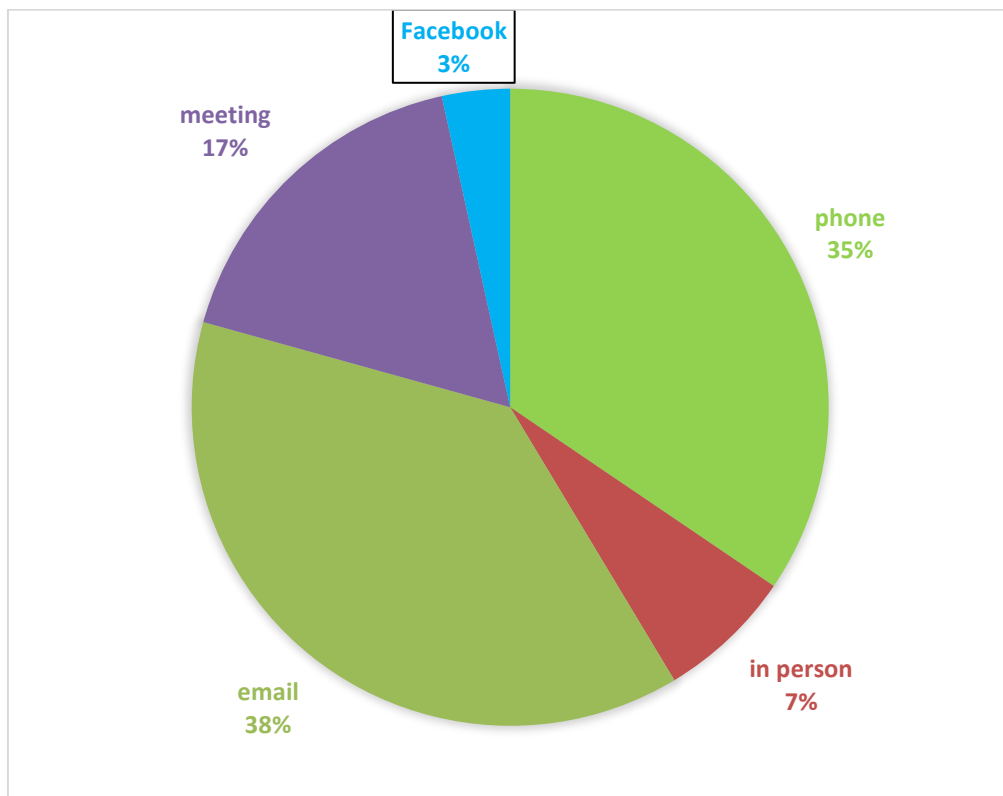


Figure 13: Communication between partner organizations and subcontractors

Firstly, social apps can lead to ineffective communication between team members. Unlike professional communication platforms such as Slack or Microsoft Teams, these platforms do not offer features like threaded conversations, making it difficult to keep track of conversations and ensure everyone is on the same page.

Secondly, these social platforms are not secure for sensitive project communication. Therefore, they are vulnerable to hacking, and there is always a risk of leaking confidential project information, which can cause severe damage to the project and the team's reputation. While Facebook and Viber are great for casual conversations, they have limited functionality regarding project communication. Additionally, these platforms require more project management tools like task lists, calendars, and progress reports, making it challenging for team members to stay on track and monitor their progress.

3.3 Potential Obstacles

Implementing Agile LEAN construction project management and digitalization in the Mongolian road construction industry can face several potential obstacles that may hinder successful transformation. There are some obstacles are determined by survey and research papers:

- **Resistance to change or transformation:** People commonly resist change in many industries. They prefer what they are used to and may be reluctant to adopt new methods or technologies. There are various reasons why resistance occurs:
 - A **lack of understanding** can arise when people need to fully understand the benefits of a new approach, causing them to be hesitant to adopt it. Therefore, it is essential to effectively communicate the advantages of Agile-LEAN construction and digitalization to overcome this barrier.
 - **Comfortable with Current:** When people are familiar with specific processes, they may feel comfortable with the current way of doing things and be hesitant to change. Therefore, it is vital to demonstrate that the new approach will be more efficient and effective and improve quality.
- **Lack of skills and training:** According to the survey(Figure 10), 10 out of 19 companies still need to offer training to new, permanent, or contract employees, which presents a significant potential obstacle to implementing LEAN and

Digitalization. To address this issue, companies should invest in training and development programs.

- **Leadership:** Leadership can motivate the company to adopt LEAN project management methods. However, the change process can be compromised if a leader lacks the skills or knowledge to implement LEAN construction approaches effectively. To facilitate successful change management, leaders need an open mind and willingness to learn and adapt to new approaches and technology. In addition, leadership needs to provide sufficient support. Without this support, employees may not feel encouraged to adopt the methods and may lack the necessary resources
- **Lack of technical knowledge:** A lack of technical expertise can pose a significant obstacle to implementing digitalization and an Agile-LEAN approach in the road construction industry. In addition, many software applications and tools require a basic understanding of technology, and employees need this knowledge to avoid adopting these new processes and tools.
- **Weather Difference:** Mongolia has a harsh continental climate with extreme temperatures and weather events, while Germany has a milder, temperate climate with more consistent rainfall throughout the year. Mongolian climate makes the road construction project more challenging to monitor and control throughout the warm season. Also, the Mongolian road construction works start in spring and end at the end of autumn.

3.3.1 Cultural Obstacles – Work Culture difference between Germany and Mongolia

- **Germany:** Germany is known for its efficient and disciplined work culture. German companies are known for their high productivity and quality output.
 - **Punctuality:** Punctuality is highly valued in German work culture. Being on time for meetings and appointments shows respect for others' time. On the other hand, Lateness is frowned upon and can harm one's reputation.
 - **Clear Communication:** Clear communication is essential in German work culture. Germans are known for their directness and honesty. Consequently, they expect their colleagues to be clear and concise and appreciate open communication.
 - **Teamwork:** German companies place a strong emphasis on collaboration and cooperation. In the workplace, teams are often

structured hierarchically, with a team leader or project manager responsible for coordinating and managing the team's activities.

- **Flexible Work-Life Balance:** In recent years, work-life balance is becoming a trend among Z generation and Millennials workers. Flexible schedules are a significant part of how workers define work-life balance. It can increase workers' productivity and satisfaction with their job.
- **Mongolia:** Their nomadic heritage heavily influences Mongolian work culture. Mongolian workers are known for their adaptability and self-sufficiency.
 - **Authority & Hierarchy:** there is a strong emphasis on respecting authority and hierarchy. This is seen in many different aspects of the workplace, including how seniority and rank are valued and the formalities and protocols observed.
 - **Hard Work & Dedication:** Emphasis on a strong work ethic can be seen as a reflection of Mongolia's nomadic past, where survival depended on hard work, resilience, and adaptability. These traits continue to be valued in Mongolian work culture today, with employees expected to work diligently and put in the effort required to succeed.
 - **Emphasis on teamwork:** Mongolia has a collectivist society, and this is reflected in the country's work culture. Cooperation is highly valued, and employees are expected to work together towards common goals.
 - **Formal communication:** Communication is also essential in Mongolian work culture. However, Mongolians tend to be indirect in their communication style. Communication helps share information, resolve conflicts, clarify objectives, and build vital components of Agile-Lean PM. Effective communication helps share information, resolve disputes, define objectives, and build trust among team members. It also helps identify and mitigate risks, manage changes, and ensure everyone is aligned with the project's goals and objectives. Clear communication and collaboration among team members also help reduce misunderstandings, errors, and delays in the project delivery process.

The work cultures of Germany and Mongolia differ in various ways. German work culture values direct and clear communication, emphasizing stating opinions and sharing ideas openly. In contrast, Mongolian work culture favors indirect contact, focusing on respecting authority and seniority. In addition, Mongolian work culture is more hierarchical than German, with greater emphasis on following instructions from superiors.

Germany has a more egalitarian approach, with less emphasis on hierarchy and more on teamwork and collaboration. Additionally, achieving a good work-life balance is highly valued in Germany. Employees generally work a maximum of 40 hours per week and are entitled to at least 20 days of paid vacation per year. In contrast, while Mongolians value work-life balance, there is a less formalized structure around it, and working long hours is more accepted.

3.4 Potential Benefits

3.4.1 Benefits of Agile-LEAN Construction Approaches and Digitalization

- **Clear Communication:** Agile-Lean project management promotes collaboration and communication among employees and stakeholders in Mongolian road construction companies, leading to improved work quality and a lower chance of mistakes, late project closing, or rework. By fostering teamwork and organizational culture, Agile-Lean helps teams work together more efficiently and effectively. With frequent feedback loops and open communication channels, problems are identified and addressed before they become significant issues. In addition, the emphasis on continuous improvement and flexibility also allows teams to quickly adjust and adapt to project requirements or environment changes using the last planner tool of Koppla's linear and agile scheduling tools(Figure 9). WAs a result, the team can deliver a high-quality project that meets the client's needs while maximizing efficiency and reducing waste. Also, digital Agile-Lean scheduling tools will improve project monitoring, collaboration, and decision decision-making with real-time tracking and photo documentation, increasing transparency and efficiency.
- **Flexibility:** Agile-Lean project management is renowned for its flexibility, which enables adjustments and changes to be made quickly and easily during project execution. This flexibility is beneficial in industries with frequent changes, such as construction. In the construction industry, unexpected challenges like weather, material availability, or design changes can significantly impact the project's schedule and budget. Agile-Lean project management enables teams to quickly adapt to these changes, reducing the likelihood of delays or disruptions to the project. This flexibility helps teams maintain momentum, stay on schedule, and deliver high-quality work. For example, weather conditions in our country can significantly impact road construction projects during summer. Harsh weather conditions like long and cold winters and hot, rainy summers

with rainstorms can make executing projects and transporting equipment to a site challenging. By implementing Agile-Lean methods, companies can quickly adapt to changing weather conditions and adjust their plans without causing significant delays or cost overruns.

In addition to the above, Koppla's sub-company subcontractor feature has several other benefits. It enables companies to manage multiple entities simultaneously, even if they are located in different geographical locations. This feature allows for greater flexibility in decision-making and implementation, which is especially important for large-scale road construction projects that require significant resources and coordination. Furthermore, it helps to ensure that all parties involved in the project are working towards the same goals and objectives, thereby reducing the risk of miscommunication and misunderstandings. Overall, the sub-company subcontractor feature is a powerful tool that can help companies streamline their operations and achieve greater efficiencies in road construction projects.

- **Efficiency:** Improved capacity, cycle planning, ticketing system, and risk management will increase construction productivity and efficiency. Agile-Lean software/Koppla can help streamline project workflows by providing a centralized platform for all project-related information and tasks. This will eliminate the need for Microsoft Word, Microsoft Project, and some social apps in project communication, reducing miscommunication errors and risk and increasing a project's privacy and security. Also, the software will ease the communication between the company and sub-contractors by providing real-time updates and access to view project progress, deadlines, and any updates and changes. This helps to ensure that projects stay on track and are completed on time and within budget.
- **Reduced Waste:** In the road construction industry there are more critical wastes in our Mongolian road construction industry: waiting for approval, new equipment or materials and transportation costs, and unskilled workers. Waiting is common in our situation, the relation between the government and the company because of intransparency and miscommunication. Now with a centralized platform and LEAN, it can be reduced.
- **Flexibility and Adaptability:** Road construction projects can be complex; unforeseen weather, logistical issues, or material shortages can cause delays and increase costs. Agile-lean project management software offers flexibility due to its iterative and incremental approach, where work is broken down into

smaller, manageable units. This approach allows teams to adjust the scope, timeline, and resources required for each unit, providing greater flexibility in responding to changing project requirements. The software also offers real-time visibility into project progress, enabling teams to identify potential issues early and take corrective actions. Adaptability is another crucial advantage of agile-lean software/Koppla, particularly in the Mongolian road construction industry, where projects often span multiple years and involve various stakeholders. The software allows project teams to adjust their plans and processes as the project evolves, enabling them to respond to changes and ensure project success.

- **Improved transparency and Accountability:** Traditionally, construction project management relies on manual tracking methods and regular status reports, which can be time-consuming and prone to errors. Agile-lean software(Koppla) provides real-time visibility into project progress, timelines, and budgets, enabling stakeholders to access up-to-date information on project status, resource utilization, and cost estimates. By improving transparency and accountability, software and the Agile-Lean approach can help stakeholders make better-informed decisions regarding project performance and resource allocation. For example, if a project is running behind schedule, stakeholders can identify the issue early on and take corrective action to avoid further delays. Similarly, if a project is over budget, stakeholders can identify areas where costs can be reduced and optimize resource allocation to improve the project's financial performance. The software's real-time tracking features also promote accountability by ensuring project team members know their roles and responsibilities and have the necessary resources to complete their tasks. It promotes better collaboration among team members, reduces the likelihood of misunderstandings, and helps ensure that projects are completed on time and within budget.

3.5 Adopting Agile-LEAN Approach, Software

3.5.1 Technical Considerations

- **Integration:** To optimize efficiency, consider integrating the Koppla and Agile-LEAN approaches with the current software and tools before removing them entirely. Then, monitor the process and results to determine the effectiveness of this change. Based on the findings, the company can then decide whether to keep the current tools and software integrated or remove them entirely. However, it is worth noting that while Koppla can improve workflow processes,

it cannot fully replace communication channels. Thus, social communication platforms should still be utilized.

- **User Experience:** The user interface of Koppla software is straightforward and user-friendly. However, it may pose a challenge for employees who need to be proficient in English. Therefore, changing the language from English to Mongolian may be worth considering as long as the software is easy for all employees.
- **Training:** To ensure the successful adoption of the new software among employees and stakeholders, implement training and monitor the learning process.

3.5.2 Organization Considerations

- **Leadership Support**
 - Having the support of senior leaders is crucial to the success of software and agile-lean project management. Implementing the new approach and making required changes to the organization's processes, culture, and resources can be easy with their backing to ensure project success. Leaders must understand the benefits of the agile-lean approach and be prepared to provide the necessary resources, including funding, training, and technology support. They should also be receptive to feedback and willing to make adjustments as necessary to improve project outcomes. Additionally, leaders should ensure regular communication and collaboration between teams and that team members have the autonomy and support they need to implement the agile-lean approach effectively.
- **Training and Development:** Developing the necessary skills and mindset for agile-lean project management requires a focus on continuous learning and improvement. Teams can attend training and workshops to develop collaboration, communication, and problem-solving skills. Applying these skills to real-world projects can provide valuable experience and build confidence. It is also vital to create a culture of learning and development within the organization to support team training. It involves providing ongoing feedback and coaching to team members and creating mentorship and career development opportunities. Organizations should prioritize investing in comprehensive training and development programs to ensure their teams possess the skills and mindset required to implement digitalization and Agile-LEAN management

- **Organizational Culture:** For the agile-lean approach to work, it is essential to have a culture that values collaboration, flexibility, and adaptability. However, implementing agile-lean project management in organizations with a rigid and hierarchical structure may encounter resistance. This resistance could be from team members who are used to working more traditionally and from leaders who may still need to grasp the benefits of the agile-lean approach.
- **Communication and Stakeholder Engagement:** Effective communication and stakeholder engagement is critical to the success of agile-lean management. To achieve this, organizations should:
 - Determine effective communication methods and frequency
 - Provide transparency in project progress and outcomes
 - Be responsive to feedback
- **Continuous Improvement:** Continuous improvement is a crucial tenet of agile-lean project management involving a continuous evaluation and optimization of project management processes, including soliciting feedback from team members and stakeholders and making necessary changes to improve project outcomes.

4 Discussion

Firstly, Koppla is a construction project management software built on Agile-LEAN construction methodology, making it an ideal choice for this research.

Survey graphs and figures show the current management development of the company, which is very important for determining barriers to implementing the Agile-LEAN construction approach and digitalization. The potential obstacles that can hinder successful change or transformation include resistance to change, a lack of skills and training, leadership, and the company's organizational culture. Also, cultural and technological advancement may raise differences between Mongolia and Germany.

When it comes to construction projects, adopting the right approach can make all the difference. Two popular methodologies in project management are Agile and LEAN. The Agile methodology emphasizes flexibility, adaptability, and collaboration in management, whereas the LEAN methodology focuses on maximizing value and minimizing waste in construction processes.

While both Agile and LEAN have proven to be effective individually, combining the two methodologies can offer even more significant benefits. The synergies created by

combining Agile and LEAN can improve project efficiency, collaboration, and overall quality.

For example, when using the Agile methodology, team members are encouraged to work together and to change course as necessary to ensure that the project stays aligned with customer needs. Meanwhile, the LEAN methodology emphasizes continuous improvement and the elimination of waste in all forms, including time, resources, and materials. By combining the two methodologies, the team can ensure they deliver high-quality results while using resources efficiently.

In summary, the Agile and LEAN methodologies complement each other well, and when used together, they can lead to a more effective and efficient project management process.

In addition, as mentioned earlier, the Agile-LEAN software/Koppla can also provide other benefits to construction projects. For example, it can enable team members to collaborate more effectively, helping to ensure that everyone is on the same page and that work is being completed efficiently. Furthermore, the software can help to identify potential issues before they become significant problems, thereby reducing the likelihood of delays or cost overruns. The software can also provide detailed analytics and reporting, allowing project managers to gain valuable insights into their projects and make data-driven decisions. Overall, the Agile-LEAN software/Koppla offers a comprehensive suite of tools and features that can help construction teams to work more effectively and efficiently, resulting in more successful and streamlined projects.

To successfully transform and digitally modernize the management of a road construction company, the chief engineers and directors must support the initiative can be achieved through providing necessary training to employees, being open to feedback, and engaging with employees. Leadership support is crucial as it sets the tone for the entire transformation process. When leaders show their support, it helps create a positive work environment conducive to change. Leaders should also trust in the outcome of the transformation process to foster a sense of ownership and accountability among employees. In summary, to digitally transform the management of a road construction company, leadership should provide support and training, be open to feedback, and engage with employees. As a result, the company can create a positive work environment conducive to change and achieve successful transformation.

5 Conclusion

In summary, this thesis analyzes the potential benefits and challenges of implementing Agile-LEAN construction project management and digitalization in the Mongolian road construction industry. In addition, the thesis identifies potential obstacles that could hinder successful transformation, such as resistance to change, lack of skills and training, leadership challenges, and cultural differences between Mongolia and Germany.

The thesis highlights the potential advantages of adopting Agile-LEAN construction methods and digitalization, such as improved communication, flexibility, adaptability, increased efficiency, reduced waste, and improved transparency and accountability. Furthermore, the thesis suggests that these approaches can help address some of the Mongolian road construction industry's critical challenges.

The thesis recommends integrating software programs like Koppla scheduling and management software to streamline progress and ensure successful completion. Furthermore, the thesis proposes integrating the new software with existing tools before entirely replacing them and closely monitoring the process and results.

The thesis emphasizes the importance of leadership support, training, and development, organizational culture, communication, stakeholder engagement, and continuous improvement to successfully adopt Agile-LEAN construction and digitalization. The thesis concludes that careful planning, implementation, and continuous improvement are necessary to ensure successful transformation in the Mongolian road construction industry.

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