

GENERAL CONTRACTOR SUPERVISOR'S BEHAVIOUR TREE

The general contractor supervisor's (GCS) behaviour map starts with planning the detailed schedule for the current work phase and the relevant WCR (Figure 1). Here the GCS reviews and updates the detailed plan of the work content and sets the definition of done for the work contained in the matter. This detailed planning of the work will be done according to what has been agreed upon with the subcontractor. In other words, the subcontractor supervisor (SCS) will be informed of any adjustments needed for the plan, and once the GCS and SCS have agreed on the work content, they will update the plan. This work plan and contract content revision between GCS and SCS is often done in a work activity initiation meeting. In this in-person meeting, the supervisors will discuss and agree on details of the work content and adjust the plan. These adjustments may be repeated multiple times before the installation starts

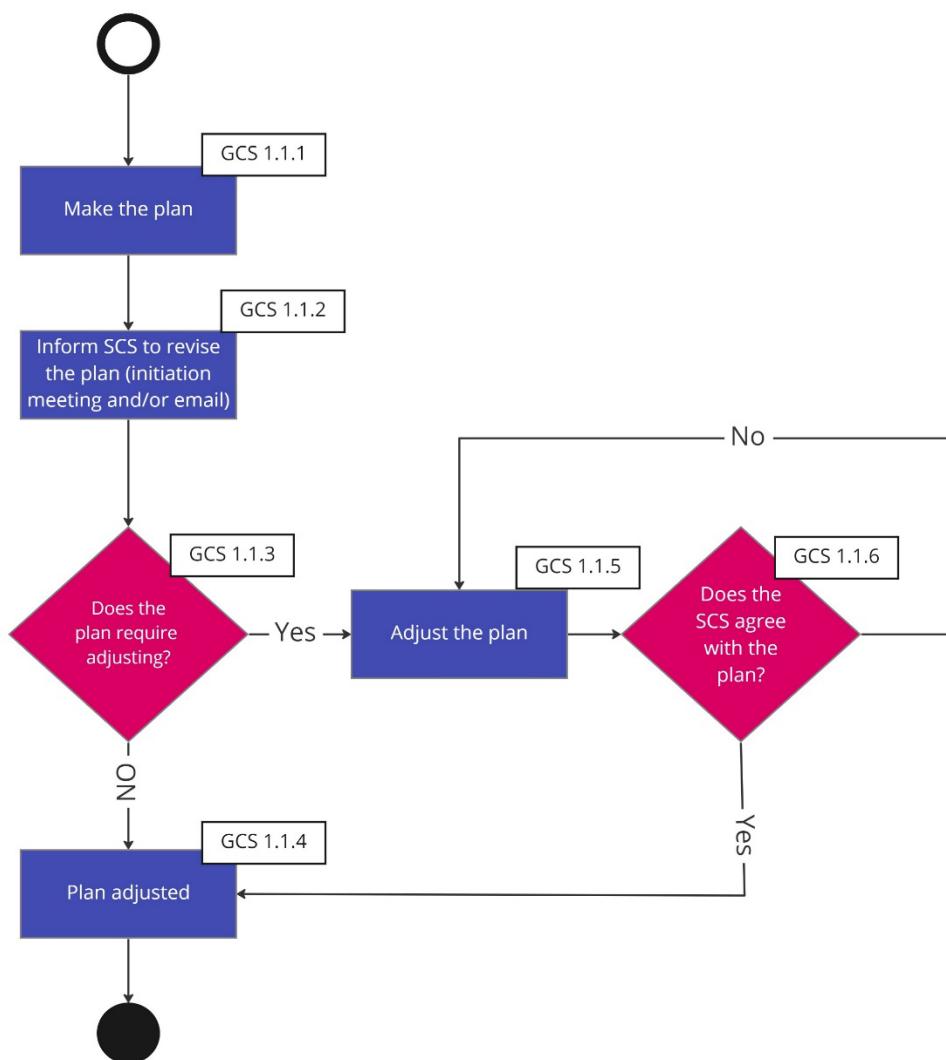


Figure 1. GCS 1.1 Task planning

Once the schedule is complete and confirmed, the material delivery content and the logistics need to be planned (Figure 2). Here the GCS's responsibility is to verify that they have the suitable material defined, matching the assembly tasks in the work plan and that material

quantities are correct. After that, they identify the material supply chain type and consider its effect on delivery procedures (See section 6.4 for more information). The next step is to place the material orders properly in advance, considering the suppliers' delivery times. Here in the GCS 1.2.3 it is important to note that if the planned deliveries are not possible from the preferred supplier, the GCS may contact another supplier. Once the materials arrive at the site, the GCS will check if they are the correct materials and if the delivery is complete. If there is any defect in the order quality, they will inform the supplier to fix these issues. Once everything is completed, the GCS will ask the SCS to send the working crew (WCR) to perform their tasks.

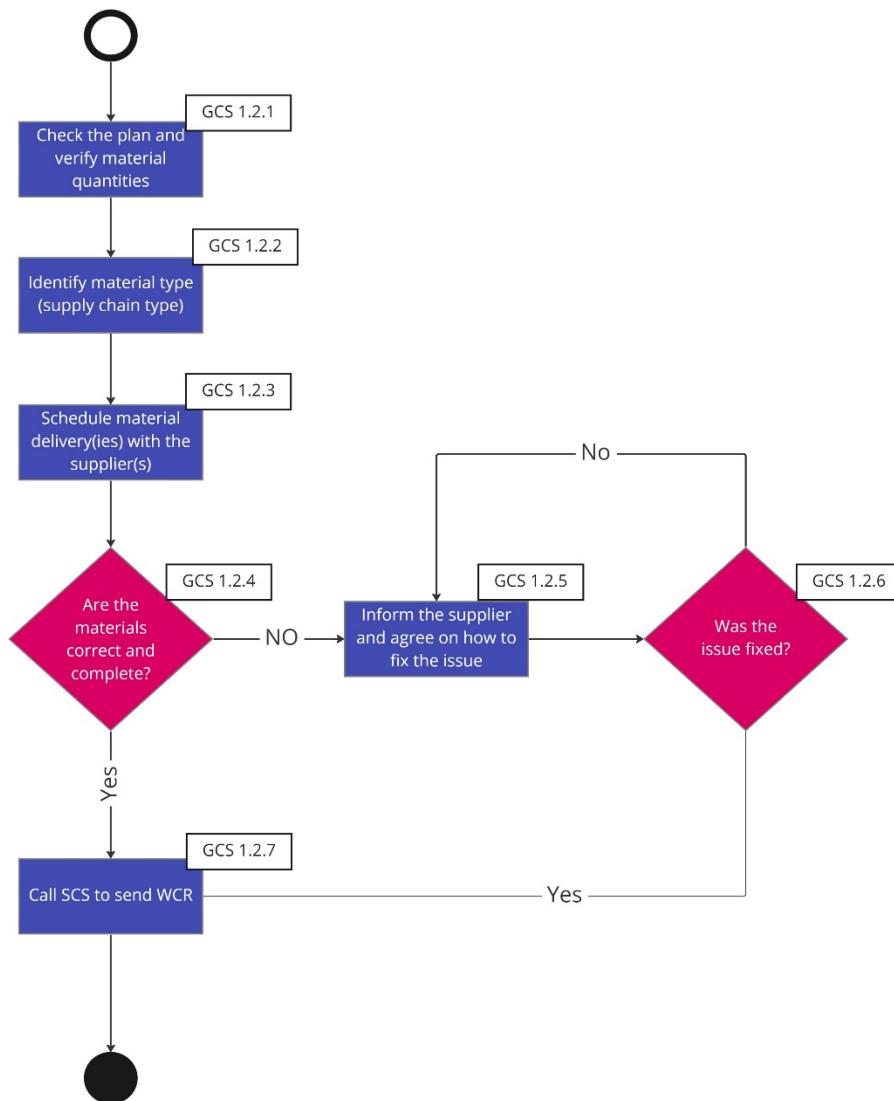


Figure 2. GCS 1.2 Material order

Before the arrival of the WCR, the GCS will check the plan and verify the latest situation at the site by going to the location in which the WCR should be soon working (Figure 3). Concerning the plan, they will find the next available tasks and check if their prerequisites are met. The GCS will add the problem-solving task to their action item list if some prerequisite is missing. For example, GCS could notice that an earlier working crew has not cleaned the location or that there is not enough material at the site to perform instructed tasks, e.g., ask the responsible person to clean the location or to make another call-off delivery to the supplier. Suppose the original locations specified in the joint plan are not available, but some

preparatory tasks are included in the work content. In that case, the GCS may instruct the WCR to start with those while waiting for the problems to be solved. If solving the original issue cannot be done within a few hours, the GCS may not even call WCR to the site, or if they are already at the site, the supervisor could tell the crew to leave the site.

Similarly, if there are not enough preparatory tasks, the crew is sent away from the site as the supervisor continues solving the original issue. Once the problem is fixed, the supervisor instructs the crew to continue or contact the subcontractor supervisor and asks them to send the crew back to the site. By these steps, the GCS verifies which tasks they can allocate to the WCR. Once the working crew arrives at the site, the supervisor will orient the worker crew and give instructions regarding the work tasks. If the work crew has already received orientation to the site earlier, and the subcontractor supervisor has given the instructions, the general contractor's supervisor moves to the next step.

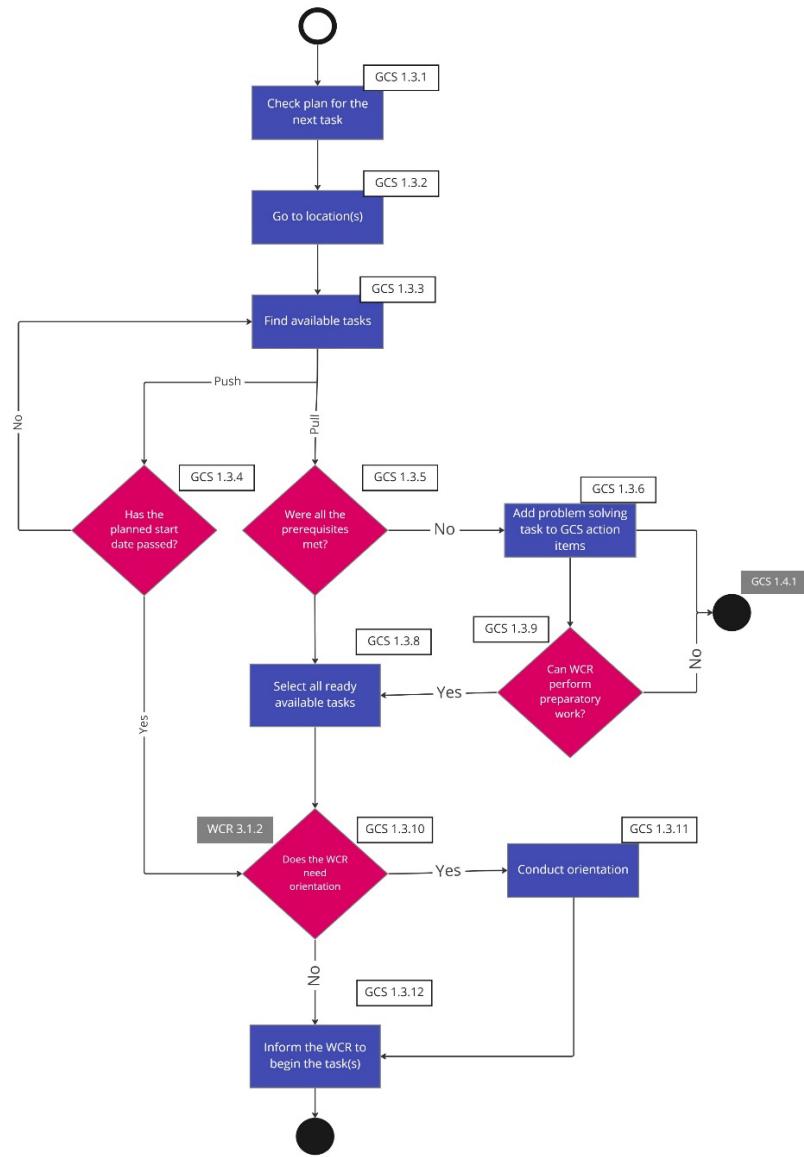


Figure 3.GCS 1.3 Task assignment

The issue fix loop will occur for all of the task prerequisites. Most notably, this would happen for the labour, material, locations, equipment, and adjacent tasks. However, the process, design and conditions might also need verification on special occasions. The general contractor supervisor's problem-solving behaviour, illustrated in Figure 4, begins with checking

all the unsolved issues from the GCS action item list and selecting action items based on their priority. Next is to identify who is responsible for the issue occurrence and who will be solving it. This responsibility identification is used for both financial and work content management. Once the issue is assigned, the following behaviour varies in relation of the acting WCR and the estimated time to fix the issue. If the issue is resolved by the WCR whose work it is blocking, they are assigned to fix it. If not, it is essential to understand the estimated time to fix the issue. If fixing the problem takes more time than it is logical to keep the original WCR waiting, they may be instructed to leave the site. Then again, if the waiting time is not an obstacle and/or WCR has some preparatory tasks they can do (GCS 1.3.9), they may remain at the site. Once the issue is fixed, the GCS informs the WCR to start or continue their work and update their action item list.

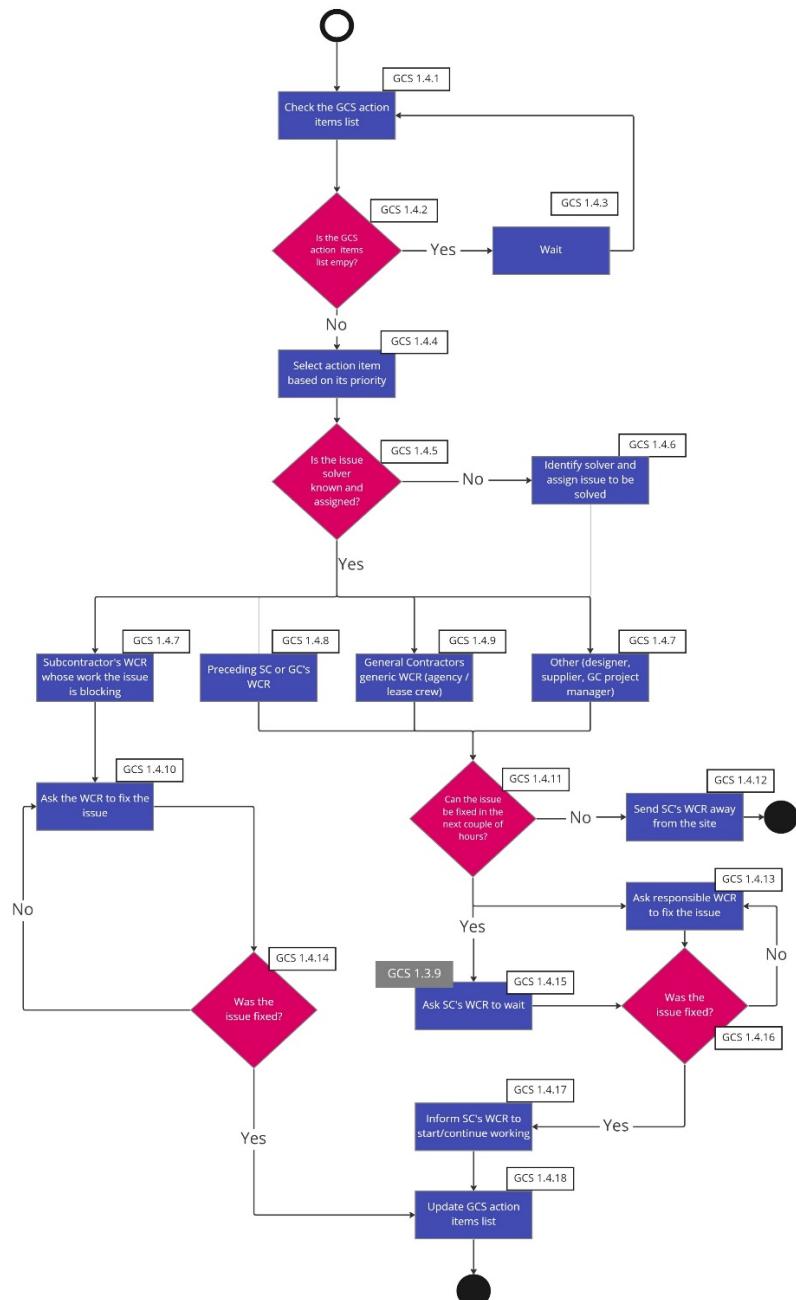


Figure 4 GCS 1.4 Problem solving

Once the installation(s) have been performed and there are no known problems, the GCS will move on to the quality inspection (Figure 5). Here the first step is to collect the information required to perform the quality inspection of the specific work content. This may be uploaded into the agreed quality management system or merely to an agreed quality inspection action item list. Nevertheless, information will come from the source documents, such as the contract documents, detailed design specifications and applied quality standards. In the event of not finding any documentation related to the quality inspection content, the GCS will check the prerequisites of the upcoming tasks and verify if those are complete as the end result of the task(s) that are inspected. Once this specific inspection item list is known, the GCS will go to the location and begin the quality inspection. The quality inspections can be done either by the GCS, with the SCS and/or the WCR or with the consultative inspector appointed by the client. If any defects are found, these issues will be managed according to the problem-solving workflow (Figure 4). If no defects are found, the GCS will instruct the WCR to cover the installation if necessary and finally update the plan with the accepted quality inspection result.

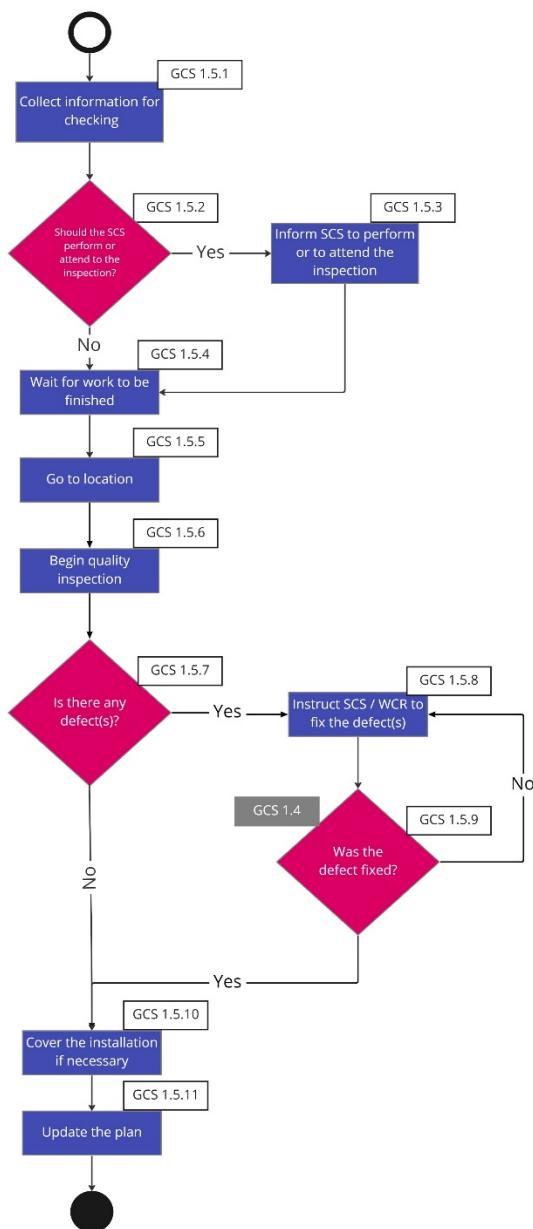


Figure 5. GCS 1.5 Quality inspection

SUB-CONTRACTOR'S SUPERVISOR BEHAVIOUR TREE

The subcontractor's supervisor (SCS) behaviour illustration has been divided into four separate behaviour trees. These are task planning, crew assignment, problem-solving and quality inspection. In task planning (Figure 6), the first point of action is that the SCS receives the work plan. The subcontractor's production manager can give this plan or then in the event of small and medium companies, the SCS could have received the plan during the contract negotiation as they would be the person making the contract. After receiving the plan, the SCS will revise its content and inform GC if it needs to be updated. When the plan is correct, the next thing is to adjust the responsibilities of the plan in terms of providing the materials. If the plan includes material procured by the subcontractor, they will initialize the material order. Once the availability of the required materials has been verified, the SCS would move on next major task, which is the crew assignment.

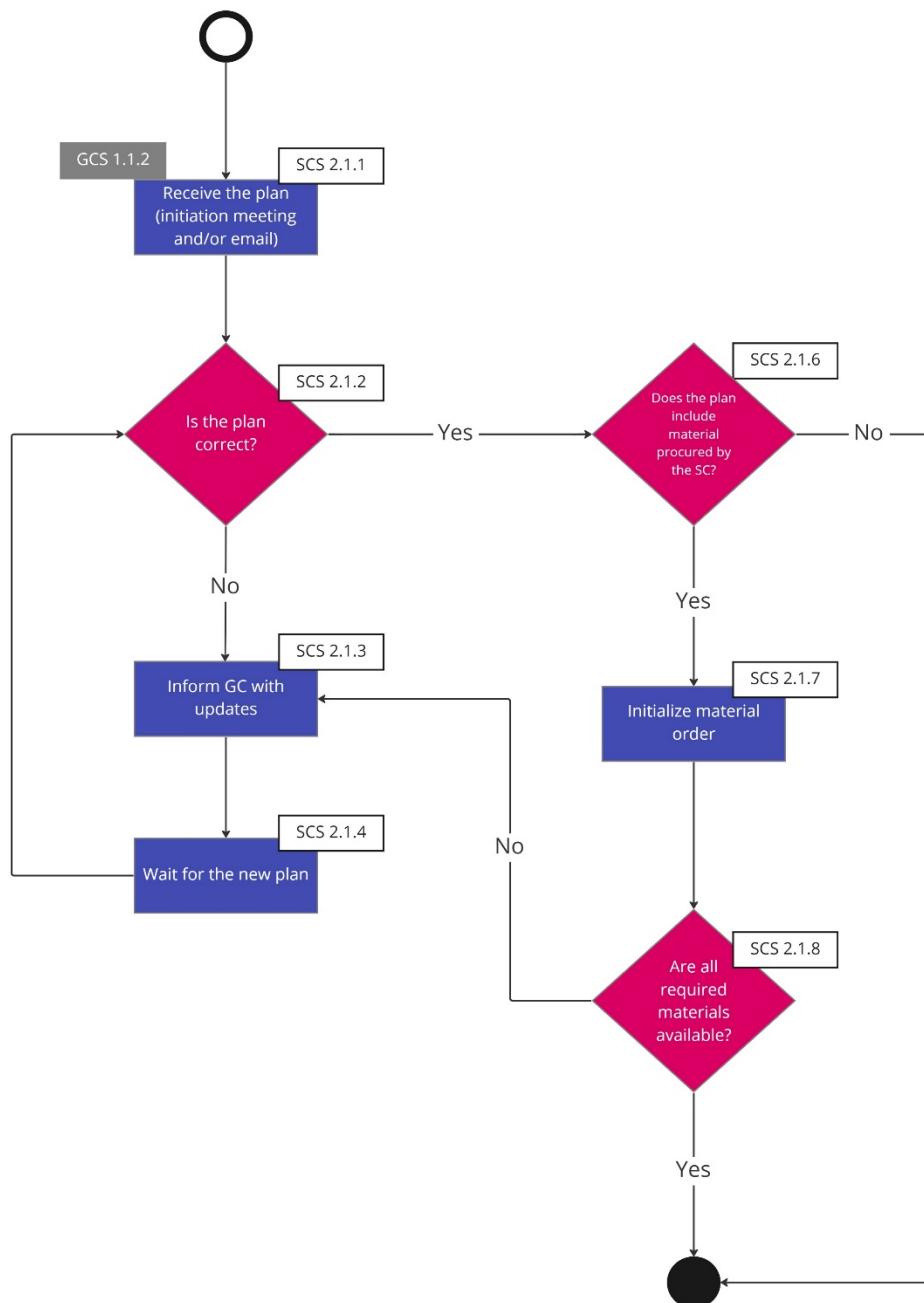


Figure 6. SCS 2.1 Task planning

The crew assignment begins by waiting for the detailed instructions from the GCS. These instructions include the exact time, location and productivity rate required from the subcontractor as they start their work. After receiving these instructions, the SCS will order materials to the site or the logistics terminal if necessary and check their working crews' availability. The sub-contractor's supervisor's main task is to coordinate the different crews of the company between different sites. Once the general contractor asks for the workers, they will check if they have any available human resources. If not, they will attempt to stall the installation with the GCS until resources are freed from another site, or they will lease or hire a new workforce. They will update the WCR assignment list if they have the resources available. In other words, instruct workers to go to the site and start the work according to the plan and detailed instructions (Figure 7).

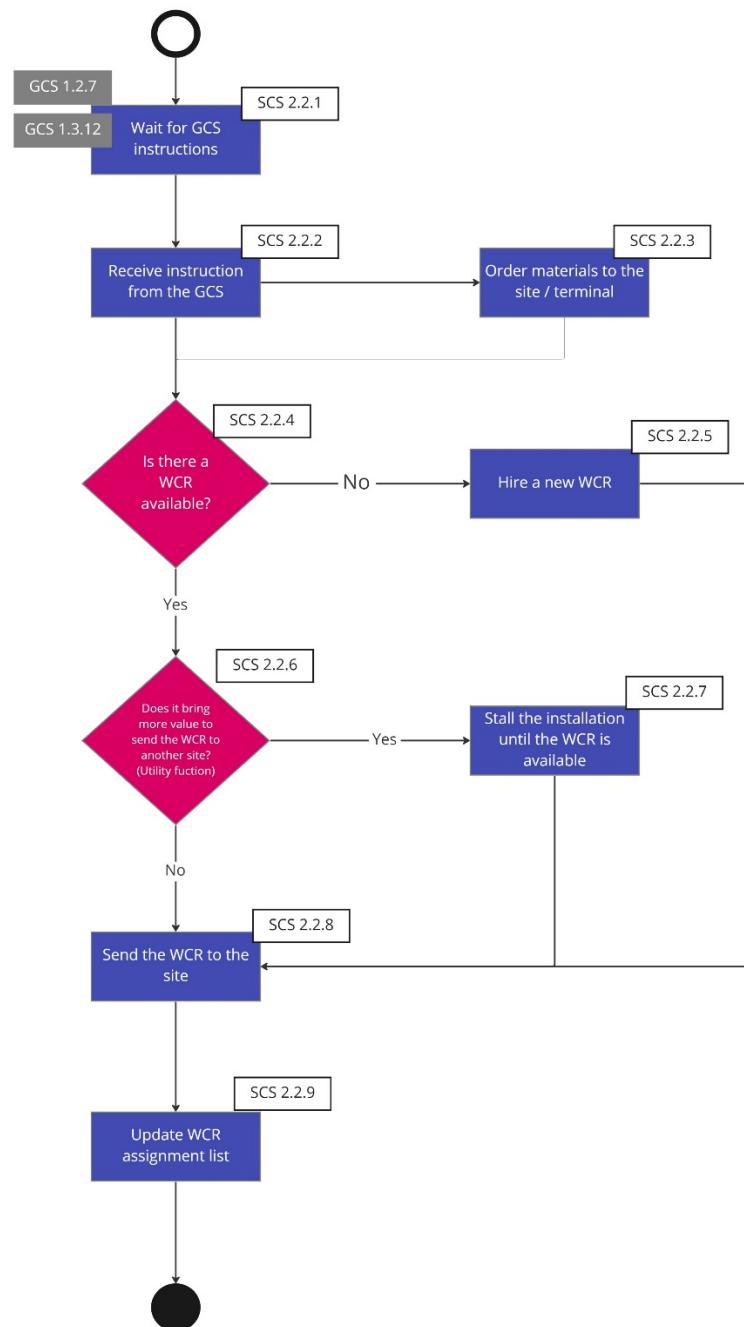


Figure 7. SCS 2.2 Crew assignment

In the problem-solving tree (Figure 8) the SCS waits for updates from the WCR. If they report a problem, the SCS's responsibility is to check the contract to see if that problem has to be solved by the subcontractor. If it is their responsibility, then the SCS would aid the crew in solving the problem. If the problem is someone else's responsibility, then the SCS would just inform the GCS. In that event, the problem would be added to the GCS action item list, and the problem-solving would be done by the GCS (Figure 4/ GCS 1.4.1).

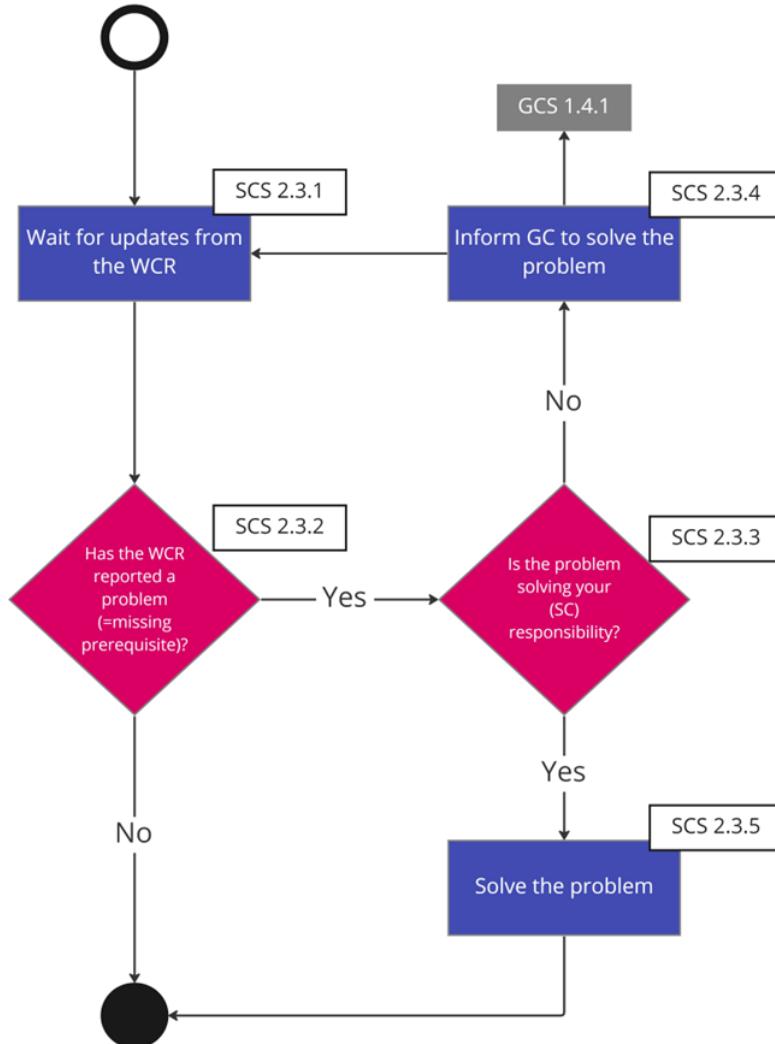


Figure 8. SCS 2.3 Problem solving

As the work has been finished, the SCS will wait for the GCS instructions for performing the quality inspection. Next, the SCS will go to the location and perform a quality inspection according to the instructions. If any defects are identified, they will instruct their WCR to fix those. Once the defects are fixed and the GCS has approved the work completion, the SCS sends an invoice to the general contractor according to the agreed instalment plan of the contract (Figure 9).

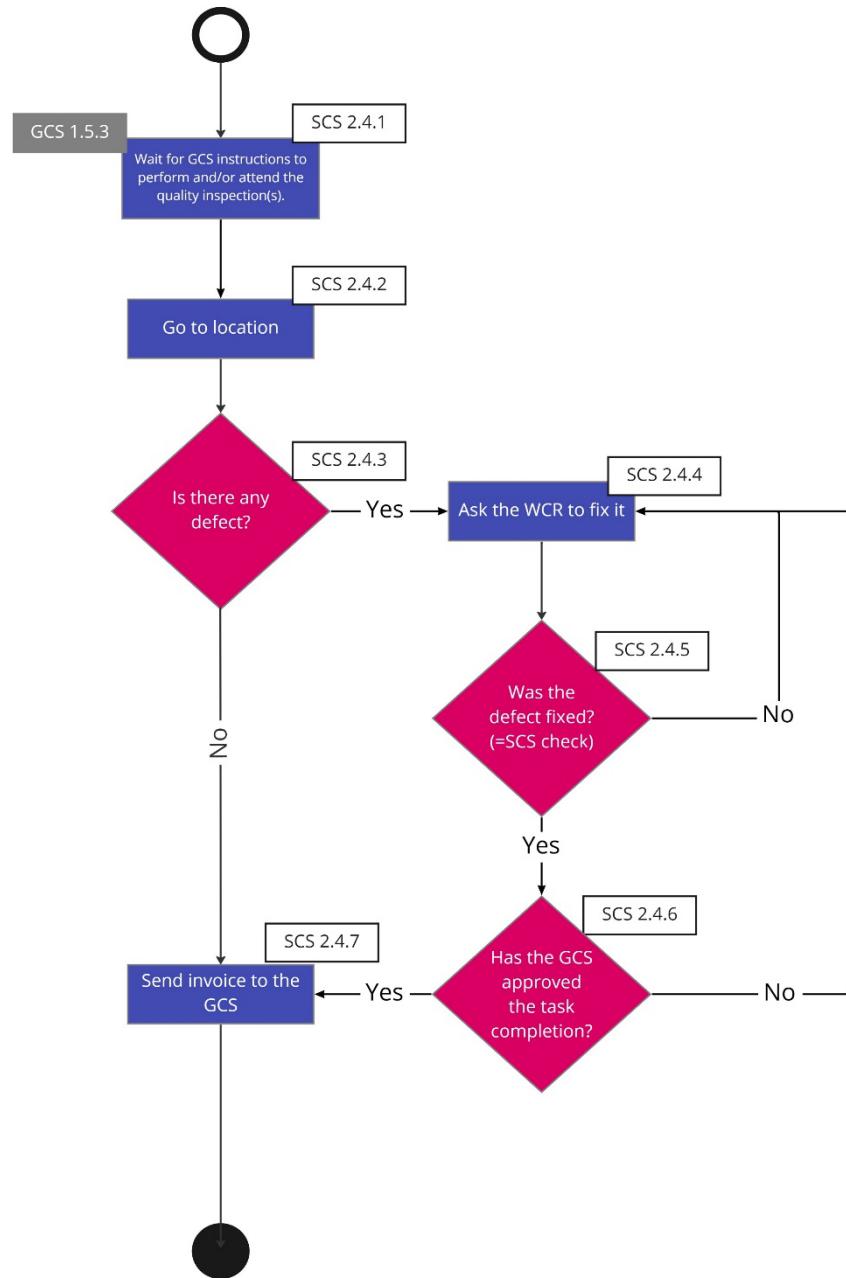


Figure 9. SCS 2.4 Quality inspection

After all the installations have been finished, they will send the WCR to another site and once again coordinate the workers between the different sites.

SUBCONTRACTOR WORKING CREW BEHAVIOUR TREE

The starting point for the working crew (WCR) is to be assigned to a certain construction site by their supervisor. After that, they wait until receiving the orientation of the work site from the GCS. Next, the GCS give a briefing for the work package based on what has been decided between the general contractor and the subcontractor in the contract negotiation and work initiation meeting (Figure 10).

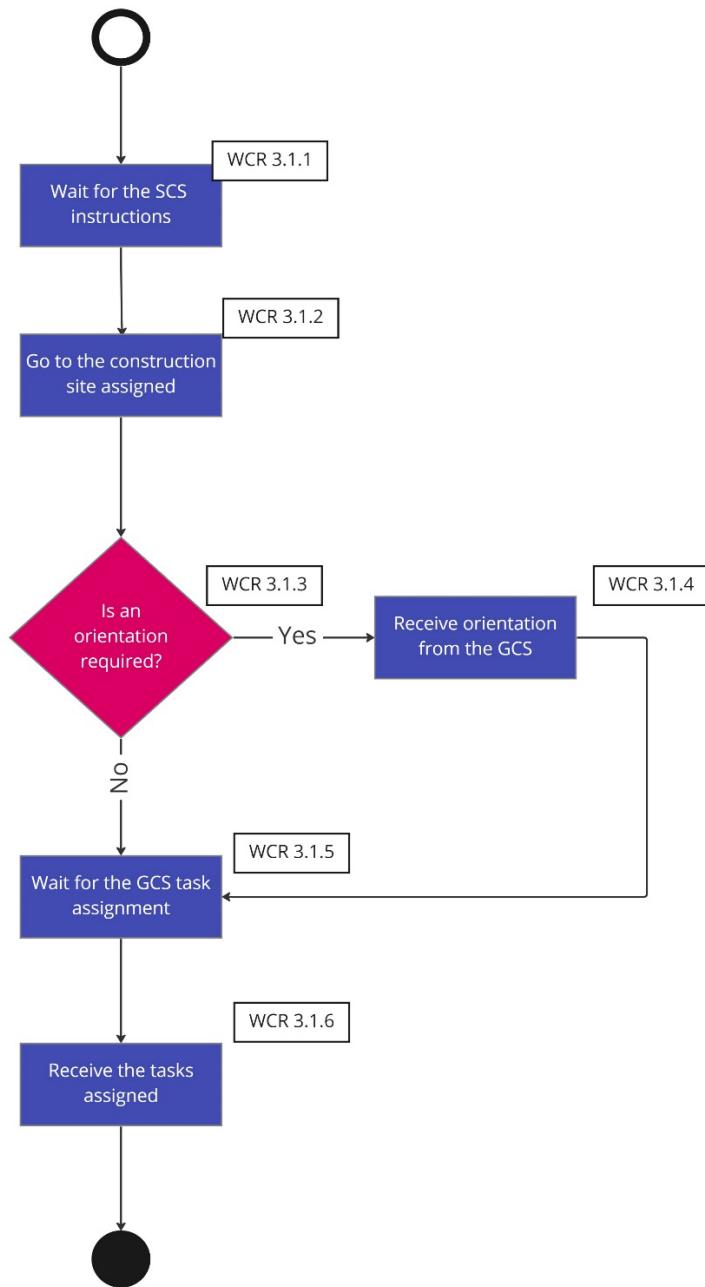


Figure 10. WCR 3.1 Task assignment

After receiving the instructions, the WCR searches for the material and work equipment from the site. They assess whether there is enough material to install for the next few days, and at the same time, they assess whether the material is the specified material and that it is undamaged. If one or more of these conditions is not met, they inform the GCS, who will make the decision based on the information. If all is good with the material, the worker will check that the correct equipment for the work is available and that there is electricity near the work

location. If not, they report to the general contractor. If yes, they transport the equipment to the work location (Figure 11).

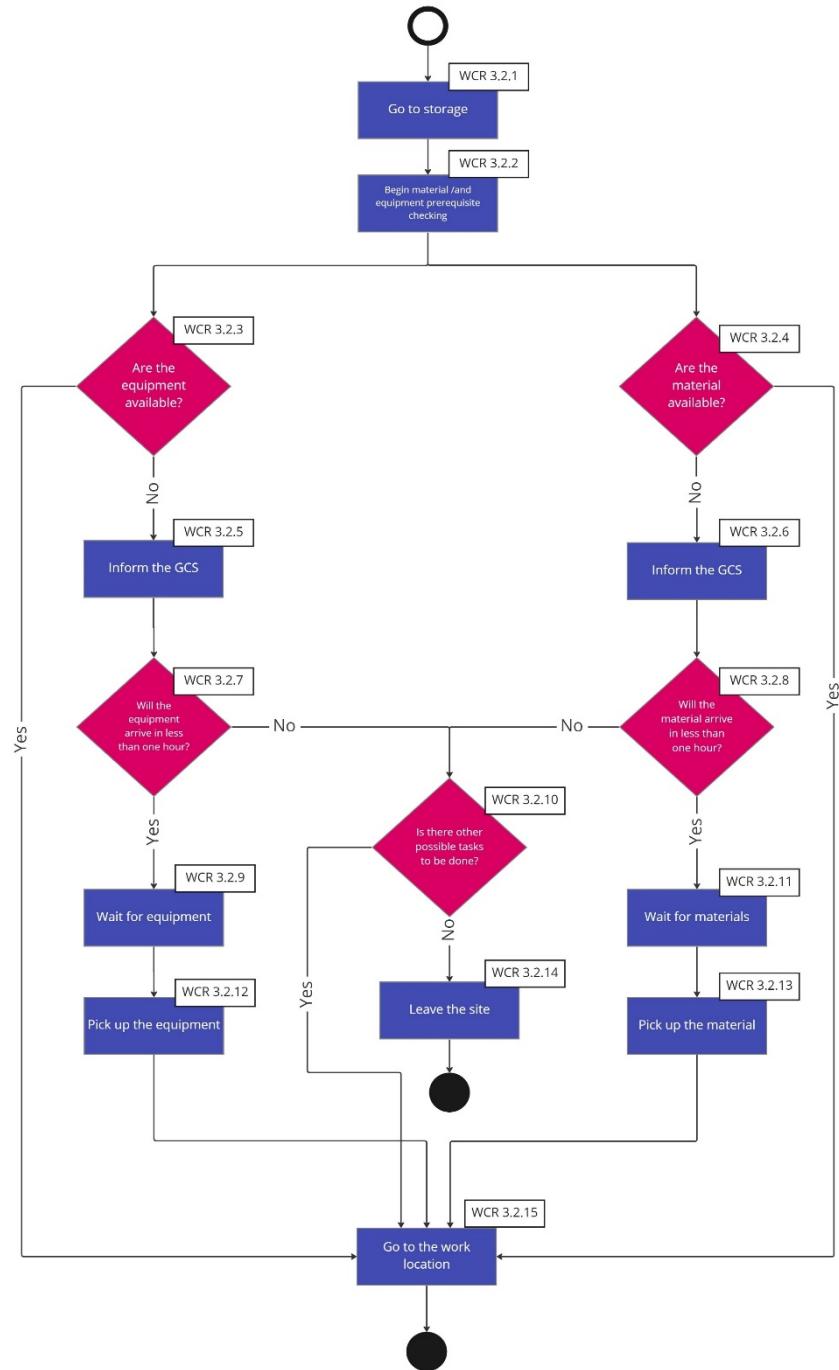


Figure 11. WCR 3.2. Task setup (storage)

Next, they will check if the location given by the GCS is available for work, i.e., empty of materials, equipment or other crews (Figure 12). Typically, the location is a floor that has multiple apartments. It is enough to start the installation if one of the apartments is empty. Additionally, the other prerequisites, such as humidity conditions, must be met to start the installation tasks. For example, the screeding must have dried out below a certain point of moisture before installing laminated flooring. Consequently, in this example, the worker would check during the briefing that those empty apartments are reported to be dry.

Before any work can begin, previous installation tasks must have been finished. In the case example of laminate flooring installation, the preceding task would be the fixed furniture installation. Additionally, the preceding task concerning the laminated floor is the screening, which was already said to be dry enough, but it also must be sanded, and the floor must be clean of dust, among other tasks. In all cases, if a condition is not met, the WCR will inform the GCS. If these conditions are not met, there is a path in the behaviour tree for the work crew to check if there is equipment available for the WCR to perform these unfinished tasks themselves and to check whether there is permission from the GCS to do this work, as it typically is not part of the contract with this particular subcontractor. If all of these are checked, the worker will fix the issue, and after this, they will start the installation of the tasks that were initially assigned to them.

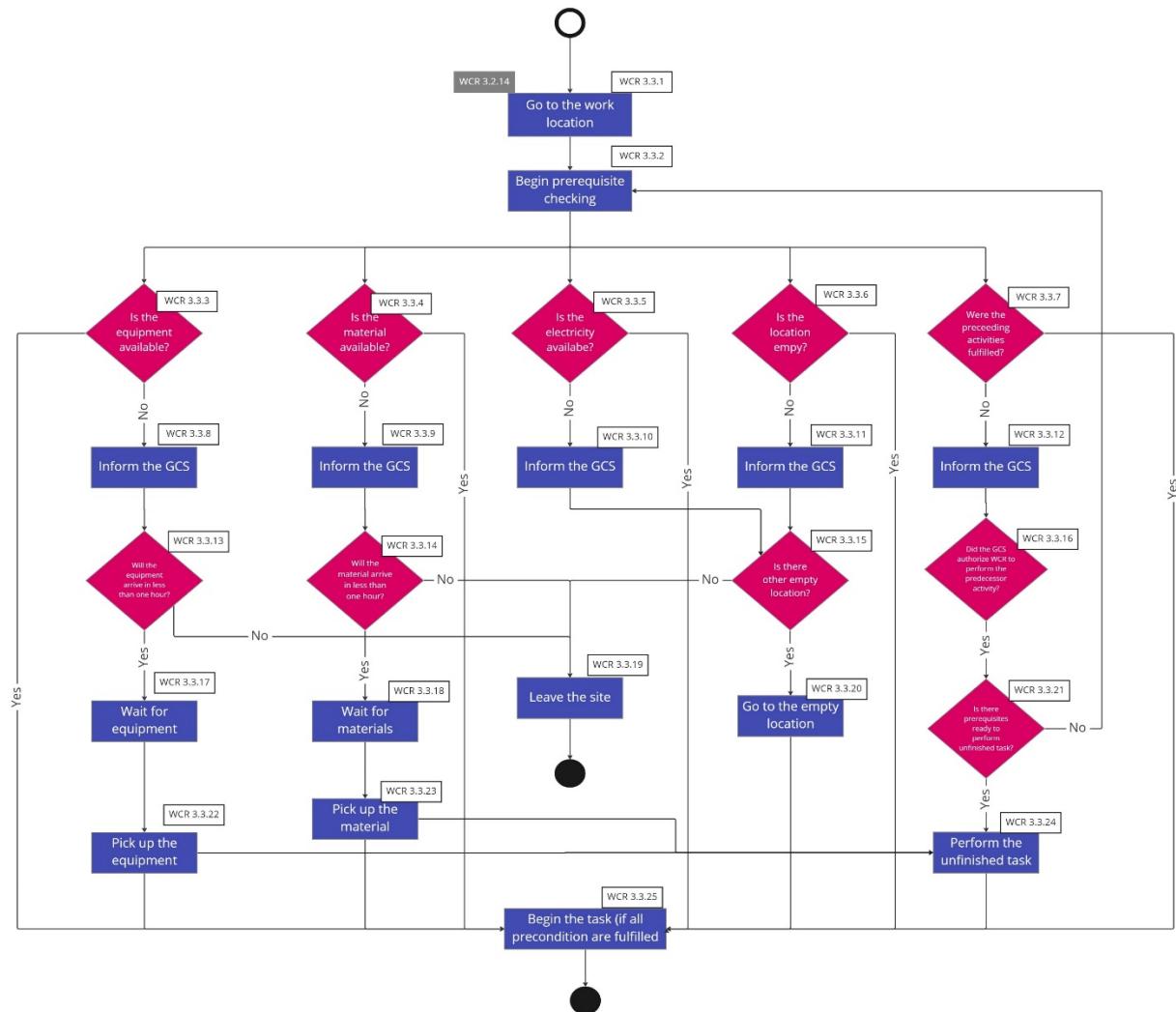


Figure 12. WCR 3.3 Task setup (work area)

Once all the prerequisites are complete, the crew will start their installation tasks (Figure 13). The work crew can check and report the problem to their supervisors if the installation runs into trouble.

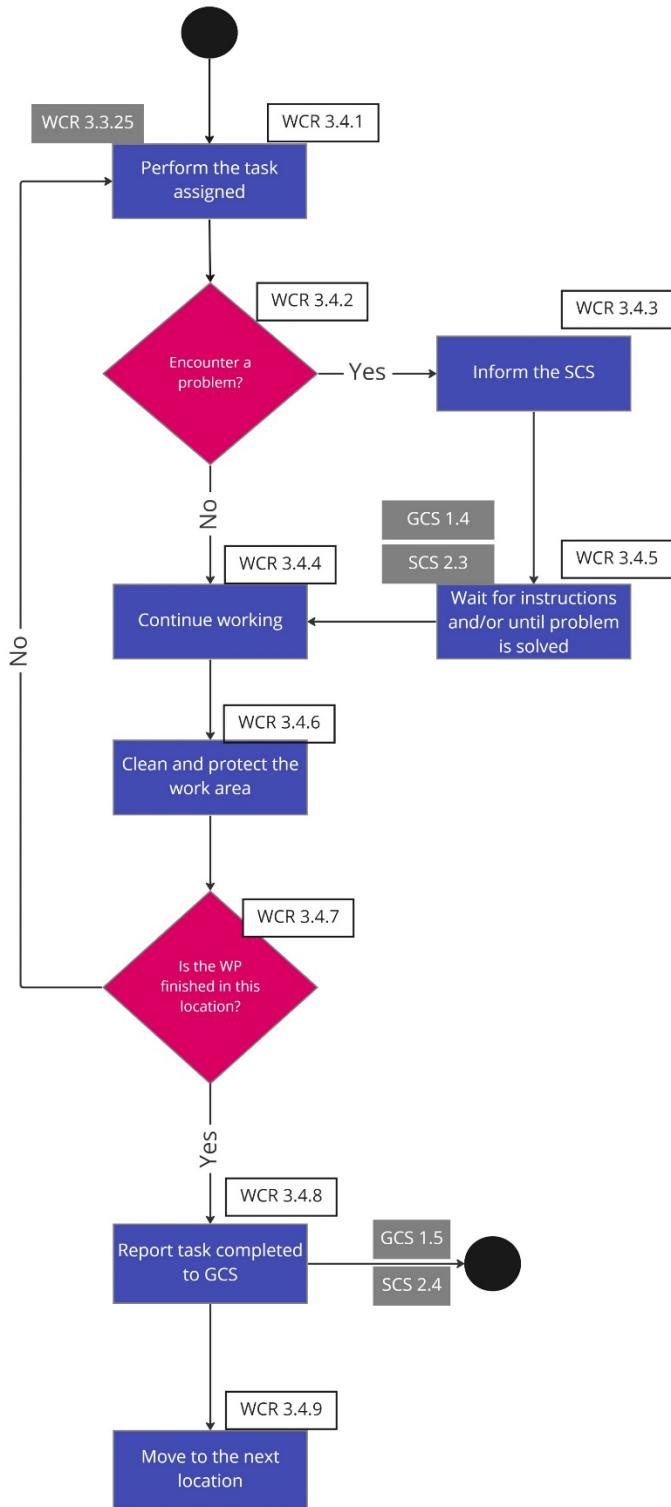


Figure 13. WCR 3.4 Task performance (work area)

Once the installation is complete, the worker will clean the area and, if instructed, install a covering for the material installed (e.g. cardboard on laminate). If this was not the last location on the floor, they would go to the next location and loop back to check all the prerequisites of their task. If it was the last location on the floor, the path would continue to inform the general contractor to inspect the quality, and if there were any defects detected, the worker would fix those. If there are no defects, or after they are fixed, the worker loops back to searching for materials, and finally, after looping through the building, they will report to the general

contractor that there are no more empty apartments. The general contractor will instruct the worker to leave the site (Figure 13: WCR 3.4).

These problems can be such as, but not limited to, lacking in preceding tasks, equipment or missing material (see Figure 14). If the problem can be solved by the subcontractor, the responsibility falls to the SCS (see Figure 8). Consequently, if the issue requires general contractor's attention, it will be moved to the respective supervisor (see Figure 4). Here, the WCR would wait for instructions from the SCS. It is important to note that these issues can occur even if the installation prerequisites were in order when the installation started. In other words, any of the prerequisites may become missing during the installation, interrupting the assembly work. Therefore, all the prerequisites must also be maintained fully during the installation until the tasks are completed.

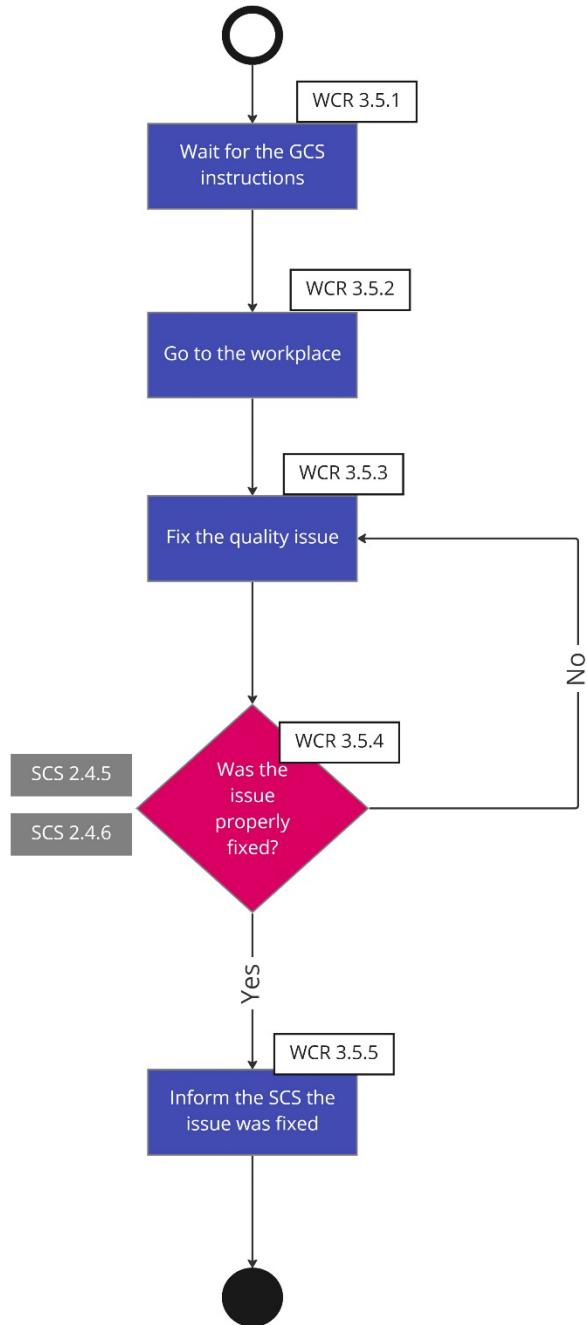
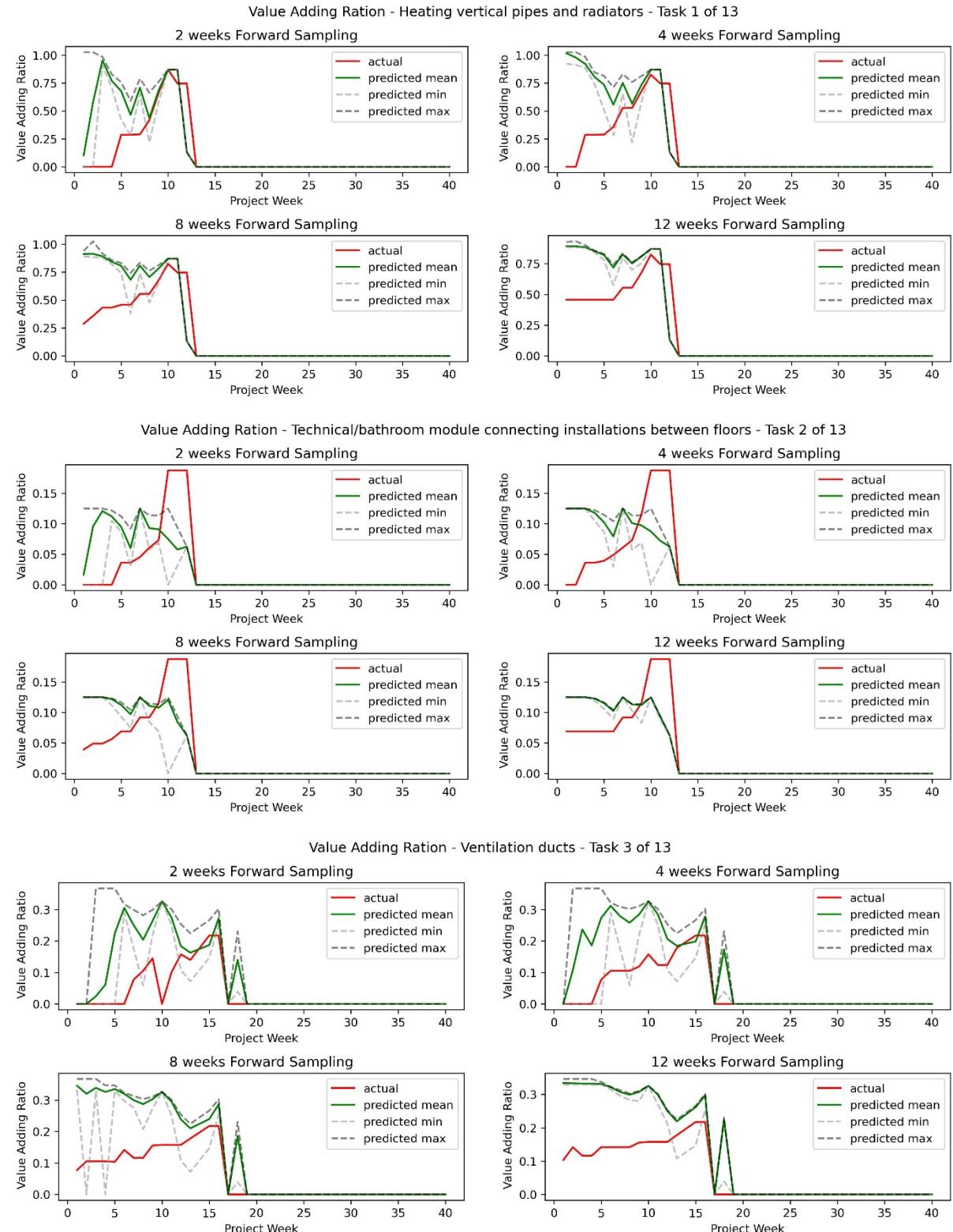
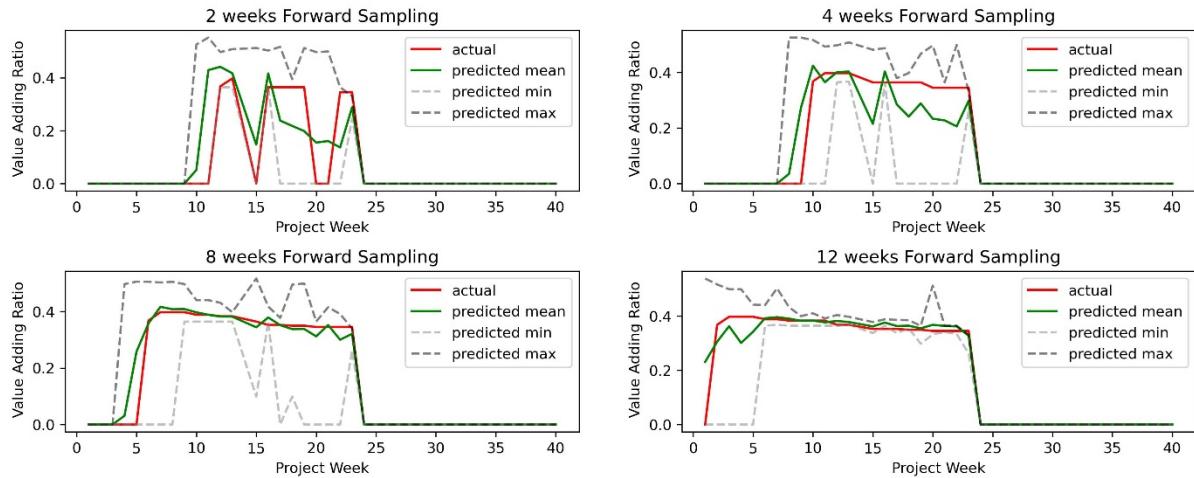


Figure 14. WCR 3.5 Quality defect solving

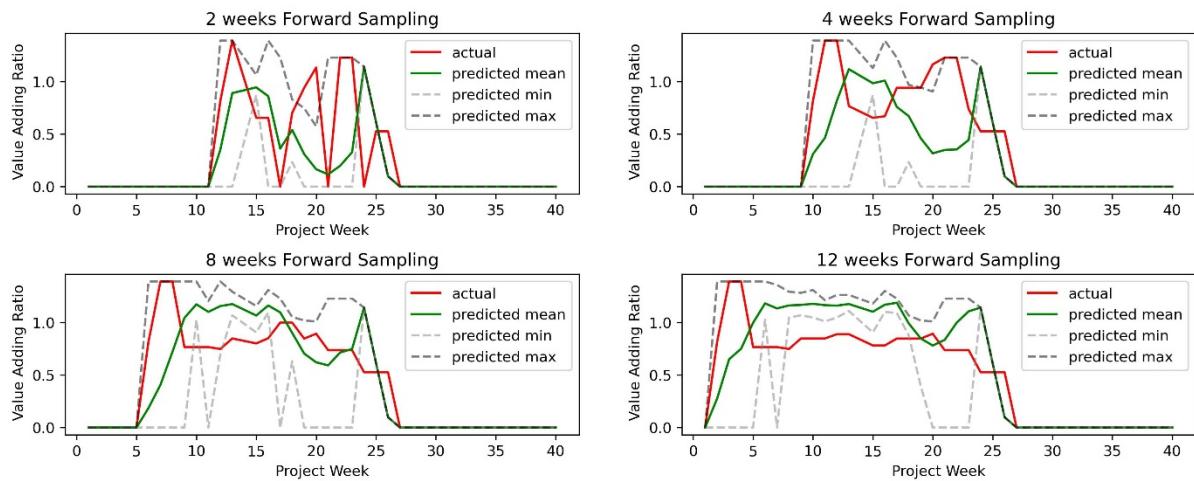
VALUE-ADDING RATIO DATA



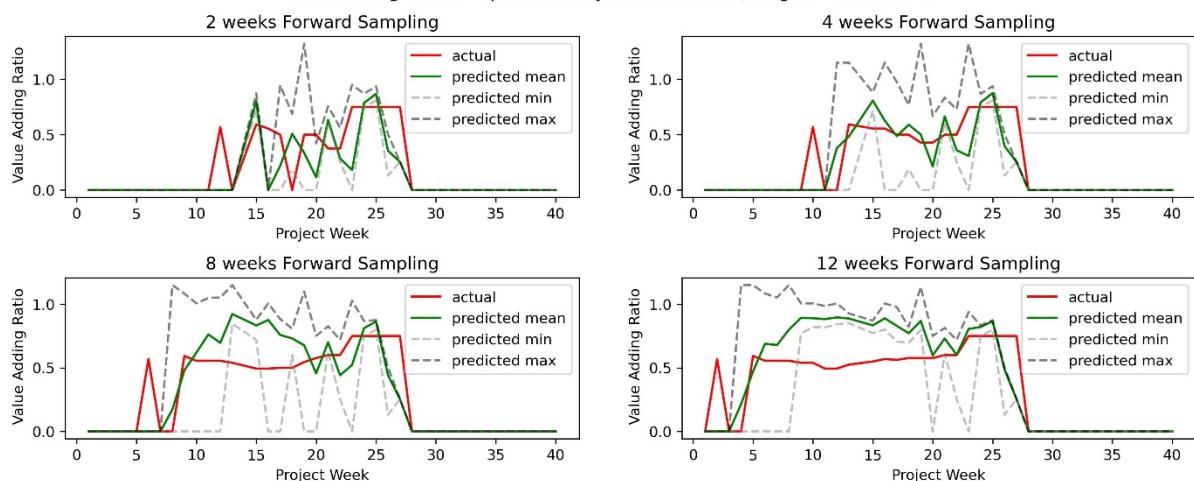
Value Adding Ration - Apartment drywall installation, stage 1 - Task 4 of 13

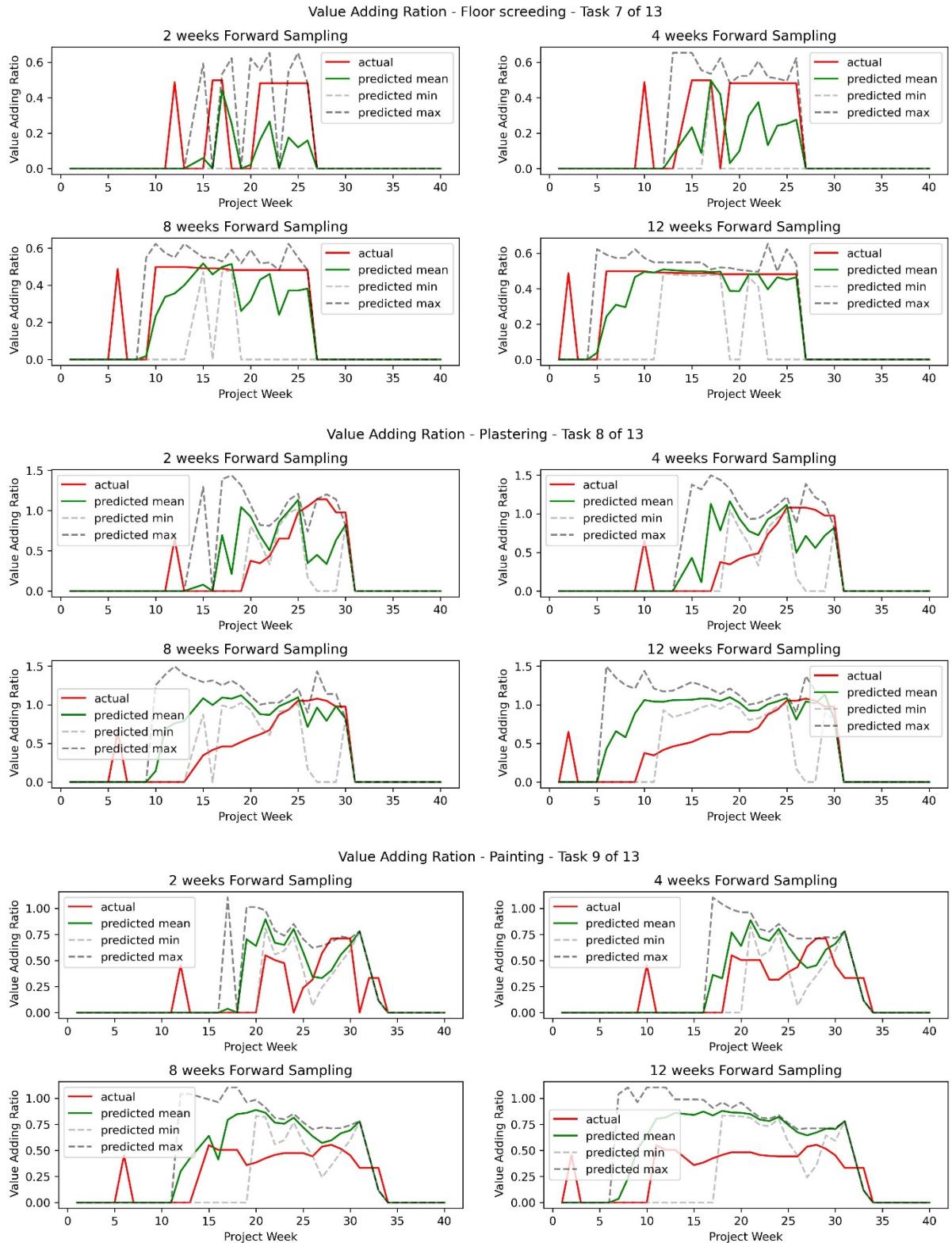


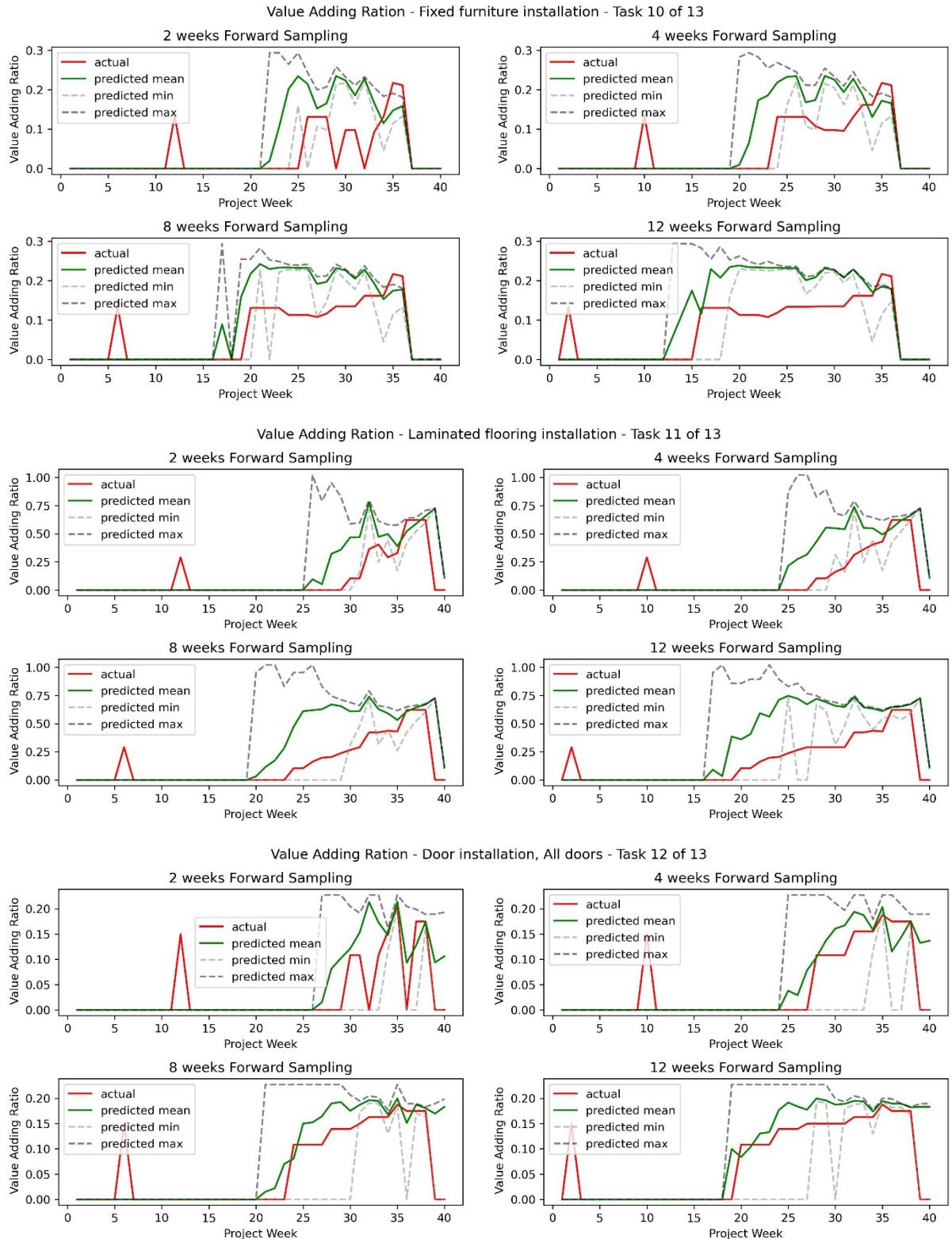
Value Adding Ration - Service installations to partition walls and suspended ceilings - Task 5 of 13



Value Adding Ration - Apartment drywall installation, stage 2 - Task 6 of 13







Value Adding Ration - Skirting - Task 13 of 13

