Reworks in Infrastructure Projects in Aurora: Its Causes and Prevention

Edward F. Olivera[1], Joefil C. Jocson[1]

[1]*Graduate School, Master of Engineering Management, Nueva Ecija University of Science and Technology, Cabanatuan City, Philippines.*

Corresponding Author: edward_olivera@yahoo.com

Abstract: - An independent consultant or a contractor should analyze the project documents and conduct a constructability evaluation, according to the case. This type of assessment is looking over paperwork to see if there is enough information to allow the contractor to build the project without any questions or changes before bidding. If the requirement for project change can be eliminated prior to bidding, a significant amount of rework can be avoided. Again, the team doing the review should not have been engaged in the project's planning or design. Involvement of all project stakeholders is crucial. If the capital improvement project may affect an operational facility, it is advised that key operations people be allocated full-time to the planning and design phase. By ensuring that operational demands are sufficiently addressed throughout the planning and design phases and not introduced via revisions during construction, such an assignment could assist avoid some rework. Furthermore, essential operational employees should be allocated to the owner's project management team to deal with changes and anticipated changes, ensuring that changes do not negatively influence operational needs and avoiding some rework to address operations difficulties caused by changes during construction. If the same problems that led to revisions on prior projects are discovered in a new project design, they can be addressed before construction begins. This will help to minimize the need for rework as a result of construction adjustments.

Key Words: — ***Reworks, Prevention, Infrastructure.***

I. INTRODUCTION

Transportation, power, and water facilities are all public goods that benefit everyone in the economy, and the government's provision of these services is important to the economy's success. That is not a debatable conclusion. Infrastructure projects, on the other hand, are frequently promoted as excellent sources of fiscal stimulus, regardless of the benefits of the end products they provide. Because the success of infrastructure projects as economic stimulation isn't as evident as the advantages of the infrastructure they provide, this argument requires greater consideration.

Infrastructure projects are extremely enticing to politicians as a kind of fiscal stimulus, so this scrutiny is doubly crucial. Infrastructure spending creates enormous construction sites that serve as a visible reminder to voters that the government is striving to remedy a crisis.

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As a result, concerned citizens should be informed of the benefits and drawbacks of infrastructure as a stimulus, as politicians may rely on it due to its political signaling power.

However, if the goal is to reverse the effects of a negative economic shock by boosting the economy, proponents of economic stimulus typically agree on three principles for how stimulus expenditure should be structured, in addition to the sheer size of the multiplier in the best-case scenario. A stimulus should be (a) timely, (b) targeted, and (c) temporary to be most effective.

Due to implementation lag, infrastructure construction projects may take many quarters or even years to get off the ground. This means that, regardless of its overall impact, the stimulus may not be timely. Construction spending usually peaks a few years after a project begins, when the economy is already rebounding. This can lead to a pro-cyclical trend, in which expenditure is slowed while the economy is weak and then overstimulates the economy when it isn't needed. The enormous multiplier impact associated with such expenditure can be harmful in this scenario, intensifying rather than smoothing out economic swings. There are a limited number of infrastructure projects that are ready to be completely funded at the time of the crisis. As a result, there

are only a limited number of infrastructure projects that could be used as a stimulus.

Despite project complexity, cost and schedule overruns, civil engineering work continues to meet the insatiable need for new infrastructure. Rework is a significant component that can lead to cost overruns in civil infrastructure projects; nevertheless, research into the core causes and costs of rework in civil infrastructure projects has been limited to date. The following factors almost always influence reworks in such infrastructure projects: (1) ineffective use of information technologies; (2) excessive client involvement in the project; (3) lack of clearly defined working procedures; (4) changes made at the client's request; and (5) insufficient changes initiated by the contractor to improve quality. As a result, this case is presented in order to learn about the causes and avoidance of reworks in Aurora's infrastructure projects.

II. RESULTS AND DISCUSSION

2.1 Background of the Infrastructure Projects

Department of Public Works and Highways in Aurora Province gained 1,449 total of infrastructure projects throughout the province ranging from Dingalan to Dilasag. Out of the 1,449 projects, the department accomplished 674 total projects (46.5%) subjected to the end of October 2021. The remaining percentage of total projects are subjected to fully operational by the end of the year. However, some of the projects which are remaining to be unaccomplished per 100% full capacities are reworks. Construction industry has been a means of expanding economies across the province in recent years. The construction department has been plagued by severe issues such as high project delivery costs, poor financial performance, and an inability to provide value to clients on time. As a result, the industry has been heavily chastised for its poor performance and wasteful output. Rework is a big contributor to this failure. Rework is described as the wasteful effort of performing an activity that was done incorrectly the first time or the process of completing or correcting an item to bring it into compliance with the original requirement. Rework and wastages have come to be recognized as non-value-adding chronic symptoms that have a significant impact on the performance and productivity of construction projects, despite the fact that the problem of rework has been largely overlooked by the industry.

The presence of rework has a clear negative influence on project performance. Rework has a direct and indirect impact on project performance, according to the researcher. For example, in poorly managed projects, the gross impacts of rework, both direct and indirect, may equal or even surpass the expected markup or profit margin levels. There will also be some carry-forward ripple effects on other areas such as stress, motivation, relationships, and reputation in some circumstances.

During the initial comparative case study, it was clear that changes made at the client's and design team's request contributed to the need for rework. Because of the sequential communication structure of supply chains and the absence of coordination and integration amongst design team members, deviations during the design process are sometimes captured too late. This was demonstrated in the case study, when a lack of cooperation among design consultants resulted in large design-related changes that impacted all of the participating design firms. This resulted in adjustments on the job site, affecting the majority of the subcontractors. Setting out problems were also detected as a result of inadequate communication and coordination between the primary contractor and subcontractors, as well as a lack of ability on the side of the artisans. In addition, the leading hand and trades foremen's lack of expertise, as well as their inability to read the structural drawing, contributed to rework throughout construction. Similarly, the study instrument revealed that non-compliance with specifications, laying out errors, changes made at the client's request, poor communication with design consultants, and low labor skill levels were the most common causes of rework. Nonetheless, the causes of rework did not appear to differ considerably among project categories.

2.2 The Rationale of the Reworks

The fundamental causes of rework, according to data from the Department of Public Works and Highways in Aurora, may be divided into three categories:

- client-related,
- design-related, and
- contractor-related variables,

which include site management and subcontractor factors. The following is a simple outline of such rework factors:

2.2.1. Client Related Factors

A lack of experience and knowledge of design and the construction process; a lack of funding allocated for site investigation; a lack of client involvement in the project; inadequate briefing; poor communication with design consultants; and inadequacies in contract documentation have all been identified as client-related factors. Defects in communication between the client and members of the design team can lead to documentation errors and omissions. If projects are to be delivered on time or ahead of schedule, the researcher

underlined that client and their project team members must communicate and work together harmoniously.

2.2.2 Design Related Factors

Design flaws are caused by a lack of design coordination and integration on the part of the design team, which exacerbates the causes of rework. Communication issues are the primary cause of design-related rework in construction. It was also mentioned that ineffective use of information technology in organizing and distributing information increases the amount of rework that occurs in a project. It calculated the reasons for rework in the construction of residential residences and industrial warehouses, as well as the cost of rework. The study discovered that poor coordination and integration among design team members hampered information flow. Engineers employed CAD technologies to document their plans, whereas architects used manual processes, resulting in some drawings being provided with dimensional mistakes and missing information. It was claimed that design professionals lacked professionalism.

2.2.3 Contract Related Factors

The incapacity of many managers to properly organize work, communicate with employees, and direct operations is fundamentally tied to rising rework volumes and costs. The success of the project for the site management team and subcontractors is determined by the primary contractor's construction planning efforts. Rework typically adds 10% to the cost of projects that do not have a quality system in place, according to the study. In the case of subcontractors, the following problems contributed to rework: insufficient supervision, thoughtless damage to other trade work, low skill level of construction artisans and labor, and poor material selection.

2.3 The Implementation

During the questionnaire survey, it was discovered that the majority of respondents do not have mechanisms in place to manage and document rework incidents and their economic impact, as it is difficult to precisely calculate. This was also evident in the case studies, where respondents stated that they had a lot of reworks on the job. However, there were no systems in place to track instances of rework and their associated costs. To avoid rework, it's critical to identify and assess occurrences as soon as possible. According to the findings, reducing rework in building projects must be a constant activity. Improvements must now be implemented in order to prevent such failures in future initiatives. The following are some tips for reducing rework in building projects based on data analysis:

- Rework can be decreased through raising understanding about the causes and types of reworks, as well as applying a systematic approach to measuring rework.
- A full-time supervisor will be stationed on the job site, who will be well-trained to prevent mistakes by the inexperienced laborers.
- The use of unskilled labor should be minimal, and if it is used, it should be provided sufficient training to minimize errors. Senior management or senior staff must undertake inspections on a daily or weekly basis to prevent errors from occurring early on.
- Improved and entire dedication to quality control would result in and ensure a reduction in rework. Site documentation should be completed as early as possible and at every stage to check work done and indicate rework. Supervisors must receive formal training in order to develop their skills in areas such as work planning, communication, leadership, and motivation.

2.4 Legal Basis for the Reworks

Documents necessary for the project methodologies of infrastructure are governed by the: (a) Notice of Award (NOA) with the Contractor’s signed “conforme”; (b) Contractor’s Bid in the Form of Bid, including its Technical and Financial Proposals, as calculated by the Procuring Entity and conformed to by the Contractor through the NOA; (c) Instructions to Bidders (ITB) and Bid Data Sheet (BDS); (d) Special Conditions of Contract (SCC); and (e) General Conditions of Contract (GCC).

The Contractor shall post an additional Performance Security following the amount and form specified in ITB Clause to cover any cumulative increase of more than ten percent (10%) over the original value of the contract as a result of amendments to order or change orders, extra work orders and supplemental agreements, as the case may be. The Contractor shall cause the extension of the validity of the performance security to cover approved contract time extensions. In case of a reduction in the contract value or for partially completed Works under the contract which are usable and accepted by the Procuring Entity the use of which, in the judgment of the implementing agency or the Procuring Entity, will not affect the structural integrity of the entire project, the Procuring Entity shall allow a proportional reduction in the original performance security, provided that any such reduction is more than ten percent (10%) and that the aggregate of such reductions is not more than fifty percent (50%) of the original Performance Security. Unless otherwise indicated in the SCC, the Contractor, by entering into the Contract with the

Procuring Entity, acknowledges the right of the Procuring Entity to institute action pursuant to Act 3688 against any sub-contractors be they an individual, firm, partnership, corporation, or association supplying the Contractor with labor, materials and/or equipment for the performance of this Contract.

The Contractor shall pay liquidated damages to the Procuring Entity for each day that the Completion Date is later than the Intended Completion Date. The applicable liquidated damages are at least one-tenth (1/10) of a percent of the cost of the unperformed portion for every day of delay. The total amount of liquidated damages shall not exceed ten percent (10%) of the amount of the contract. The Procuring Entity may deduct liquidated damages from payments due to the Contractor. Payment of liquidated damages shall not affect the Contractor's liabilities. Once the cumulative amount of liquidated damages reaches ten percent (10%) of the amount of this Contract, the Procuring Entity may rescind or terminate this Contract, without prejudice to other courses of action and remedies open to it.

The Contractor shall assume full responsibility for the Works from the time project construction commenced up to final acceptance by the Procuring Entity and shall be held responsible for any damage or destruction of the Works except those occasioned by force majeure. The Contractor shall be fully responsible for the safety, protection, security, and convenience of his personnel, third parties, and the public at large, as well as the Works, Equipment, installation, and the like to be affected by his construction work.

After final acceptance of the Works by the Procuring Entity, the following shall be held responsible for "Structural Defects", i.e., major faults/flaws/deficiencies in one or more key structural elements of the project which may lead to structural failure of the completed elements or structure, or "Structural Failures," i.e., where one or more key structural elements in an infrastructure facility fails or collapses, thereby rendering the facility or part thereof incapable of withstanding the design loads, and/or endangering the safety of the users or the general public.

2.5 The Appraisal of Its Causes

The primary causes of rework on the building site, according to the current analysis, are : insufficient planning and scheduling; lack of safety; poor resource coordination; lack of management oversight and leadership; deviation from the drawing; and unclear instructions to workers.

There are two sections to the questionnaire. The first section is intended to collect the respondent's personal information, such as gender, educational qualifications, occupation, years of experience, and the type of project that the company undertakes. The objective questions are addressed in the second section. The four key causes of rework were chosen from the literature review and used to create the questionnaire. To determine the critical variables, respondents were asked to rank each factor on a five-point Liker scale. For each set of questions, a Liker scale was provided. A questionnaire survey was sent out to several construction firms, and 20 people responded. Contractors, owners, consultants, design engineers, quality engineers, and project managers were among those who responded.

Table 1. Adjectival Rating of the Project

Item Statement	**WM**	**Adjectival Rating**
Construction Change	3.63	Common
Constructor error/omission	4.13	Common
Design Change	3.93	Common
Design error/omission	3.73	Common
Contractual Change	4.10	Common
Contractual error/omission	3.97	Common
Transportation Change	4.10	Common
Transportation Error/omission	4.03	Common
Vendor Change	4.07	Common
Vendor error/omission	3.93	Common
Others	3.97	Common
Overall Mean	***3.97***	***Outstanding***

2.6 Qualitative Prevention

Reworks produced inter-organizational friction, which led to a reduction in supervision and worker demotivation, according to the findings of the comparative study. Rework was also found to boost project costs, according to the study. Additional materials for rework, subsequent wastage handling, expenditures to cover rework occurrences, and additional labor to rectify activities all contributed to this. In addition, extra time for rework and related extensions of overseeing manpower were discovered, resulting in customer discontent and a decrease in contractor profit. The results of the survey found that respondents were evenly split on whether cost overruns, schedule overruns, and design team discontent as a result of rework had an impact on project performance. Similarly, respondents showed dissatisfaction and neutrality when asked how reduced profit, worker demotivation, and inter-organizational conflict affected organizational performance.

According to the researcher, flaws committed during the design process exacerbate rework, which subsequently manifest themselves later in the procurement process. According to the responders, the longer an error goes unnoticed, the greater the

chance of rework, which has a major cost and scheduling impact. The amount of rework required, in turn, is determined by how long the issue went unreported. For example, a dimensional inaccuracy or spatial conflict in design credentials may not become apparent until the project is physically built on-site. According to the researchers, errors are the consequence of a complex set of interactions, therefore seeking to isolate a single causative component is an unethical method. Only after gaining a thorough understanding of the usual nature and dynamics of errors can error reduction and error restraint measures be adopted in projects.

A change, according to many of them, is essentially a directed activity that affects present established requirements. Changes can affect the building's aesthetics and well-designed characteristics, as well as the extent and nature of work, as well as its operational aspects. Rework that is solely in the form of adjustments, can have a detrimental influence on productivity and project performance. Furthermore, a design-change client, for example, would imply that the client would initiate a change in the building's design, necessitating rework as a result of the redesign. The most common source of rework in construction projects is design-related rework in the form of change orders.

Although most construction projects require rework, there is a growing understanding that it is avoidable and wasteful. Many companies are making a concerted effort to reduce rework by enhancing communication workflows, streamlining operations, and providing detailed documentation.

A building project involves a large number of workers and teams. There's an owner, a general contractor, a slew of subcontractors, and field teams, among other things. Every stakeholder in the communication chain must be informed when someone makes a change. This isn't always the case, though. Communication between crews, contractors, and others is simplified thanks to mobile technology and project management software. The quantity of rework can be drastically reduced by keeping a communication record and establishing open communication.

Change isn't always a bad thing; in fact, making modifications early on in a project might help it succeed. Unnecessary late-stage modifications, on the other hand, confuse stakeholders and frequently result in rework. This is why it's critical to include trade contractors in the planning and development stages of a project. When trade contractors are included as stakeholders, they have access to the doers' professional possibilities. If a design is constructible, it can be determined by trade contractors. Knowing if a project is constructible from the start will help you avoid a lot of change orders and late-stage changes. Stakeholders must also agree on a stop date, which is the date by which all non-essential, non-emergency adjustments must be finished.

2.7 Implications

As observed in the perspectives of the Strengths, Weaknesses, Opportunities and Threats (SWOT) matrix, the researchers coined the following analysis for implications.

Table.2. SWOT Matrix

Strengths	**Weaknesses**
• Timely completion of work • Cost Control • Better quality and output of work • Reduction in wastage of raw materials • Satisfy the demands of manual labor • Material movement at faster mode • Easy execution of bigger size works	• Sudden breakdown of machines • Limited workspace • Non-Availability of spare parts in local markets • Incompatible equipment within the area • Expensive investment • At times unsatisfactory finishing • Equipment idleness in rainy season • Subjected to wind load and lightening.
Opportunities	**Threats**
• Demand for equipment manufacturing • Increased cost-effective productivity • Innovative solutions to meet customer's expectations	• Equipment maintenance constrains • Demand for well-trained skilled operators • Massive accidents • Disappearance of Good craftsman • Collision due to overload

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