B.4 Critical Issue Research

The procedure to investigating the decisions that industry members make in providing and utilizing new formwork products are as followed:

B.4.1 Research Background

To analyze the decisions behind formworks systems in as much detail as possible; background research has been conducted. One published work that is worth detailing that has the closest impact to the research detailed in this report is: "*An Interactive Knowledge Based Formwork Selection System for Buildings*," by Awad S. Hanna and Victor E. Sanvido, PSU AE CIC Research Program Technical Report #11, August 1989.

In "*An Interactive Knowledge Based Formwork Selection System for Buildings*," by Awad S. Hanna and Victor E. Sanvido, this body of work has the following concepts and goals:

- Selection and design of formwork systems is influenced by:
  - Building Design
  - Site Constraints
  - Contractor's Experience
  - Availability
- Selection of formwork systems has been identified as one of the major problems which a Contractor encounters.
  - Current practices of rapid placement of concrete have forced the Contractor to search for new or modified systems that can facilitate the construction process.
  - Formwork is selected due to the one that typically gives the most efficient construction sequence.

- Decisions are made by a senior member of a Contractor's organization.
  - Decisions are heavily based on individual's experience.
  - Limited experience may create incorrect decision on the selection of formwork system.
- The report presents tool to assist formwork selector/designer in making decision.
  - Conceptual model created for formwork selection.
  - Computer tool created for designer in the selection of optimum formwork system.

In Figure 1 and 2, details the embodiment of what "*An Interactive Knowledge Based Formwork Selection System for Buildings*," by Awad S. Hanna and Victor E. Sanvido.

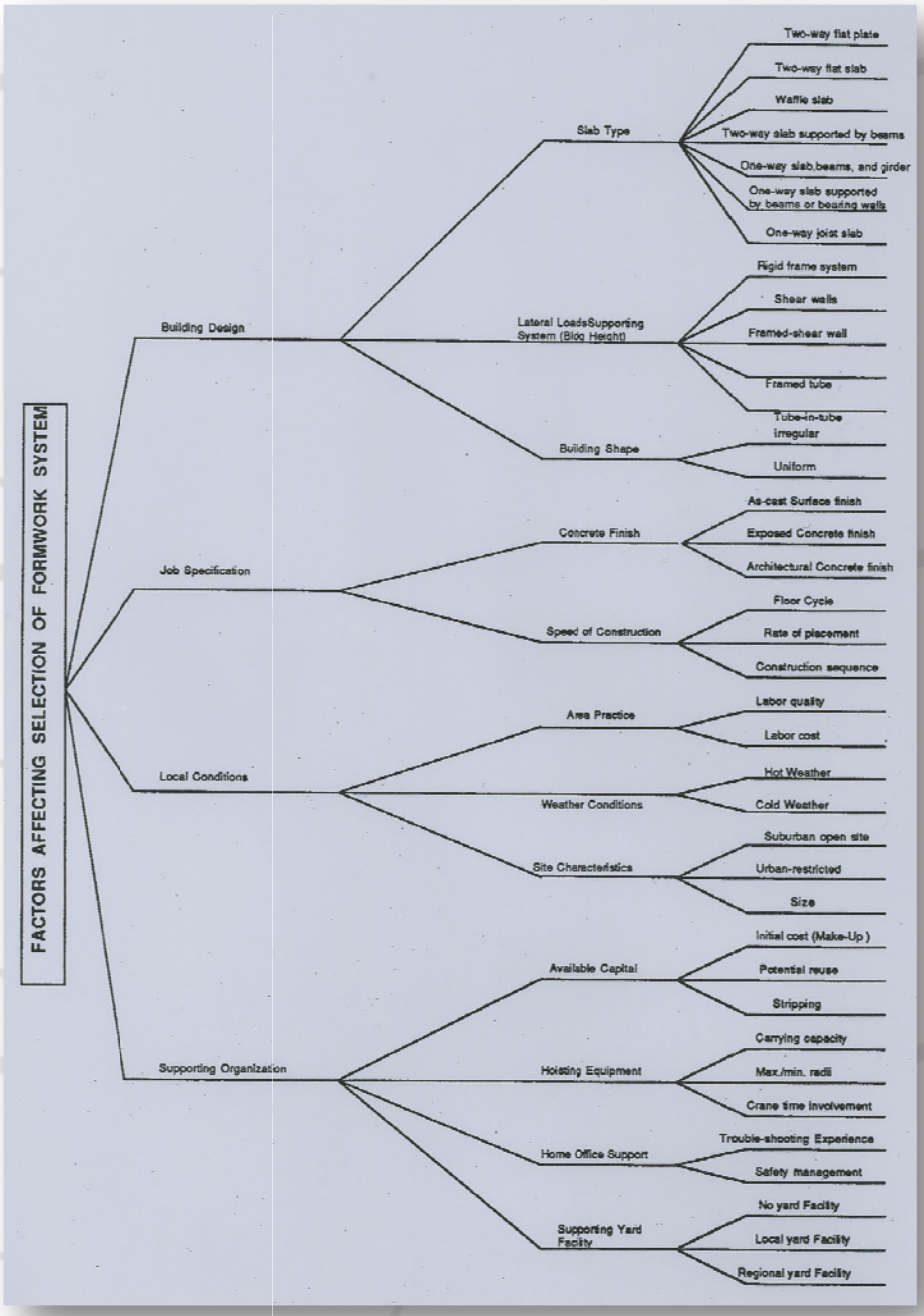


Figure 1: Factors Affecting the Selection of Forming Systems from "*An Interactive Knowledge Based Formwork Selection System for Buildings*

Influence Factor \ Formwork System			Conventional Wood System	Conventional Metal System	Flying Truss System	Column-Mounted Shoring System	Tunnel Form
Building Design	Slab Type	Slab Type	- All slab systems - Most suited for two-way slab supported by beams or one-way slab, beam, girder		- Two-way: flat plate and flat slab - One-way: slab supported by beams or walls and joist slab (standard or skip-joist)		- One-way slab supported by walls
	Lateral Support	Compatibility with lateral load supporting system	- Compatible with all lateral load supporting systems		Generally not suitable for framed tube and tube-in-tube because of the close distance between columns which characterize the tube systems		- Bearing wall
	Building Shape	Horizontal Uniformity / Irregularity	- System can handle variations in beam size and location - System can handle variations in cantilever shape, size, and location		- Beams should be of the same size and location or within 20% difference from floor to floor - Cantilever should be of the same size and location or within 20%difference from floor to floor		- Beams should be of the same size and location - Cantilever balconies should be of the same size and location
		Vertical Uniformity / Irregularity	- System can handle variations of column/wall size and location. - System can handle variations in story height within one floor or from floor to floor.		- Column/wall should be of the same size and location or within 20% difference from floor to floor - Can handle limited variation (20%) in story height		- Walls should be of the same size, location, and height from floor to floor
		High Stories (Higher than 14')	-Not suitable for high stories	-More suitable for high stories (light alum. wt.)	- Limited by truss depth (up to 20')	Height independent system	- Limited height system (up to 10')
	Miscellaneous	Openings	- System can handle variation in opening size and location		- Can handle limited variation (20%) in opening size and location		
		Slopes & Cambers	-Slopes and cambers can be accommodated at additional cost	-System must be designed to accommodate slopes and cambers	- Slopes and camber must be identical from floor to floor		
		HVAC	- Can accommodate extensive HVAC	- Can not accommodate extensive HVAC	- HVAC should be minimal and identical from floor to floor		
		Dimension Limitations	-Used for small building size (less than 100,000 sq.ft.)	-Used for medium building size (between 100,000 and 200,000 sq. ft.)	- Used for large size buildings (more than 200,000 sq. ft.)		

Figure 2: Factors Affecting the Selection of Horizontal Forming Systems from "*An Interactive Knowledge Based Formwork Selection System for Buildings*

From "*An Interactive Knowledge Based Formwork Selection System for Buildings*," by Awad S. Hanna and Victor E. Sanvido, the research is primarily focused on creating a tool for designers as to what formwork system would be best to utilize on a given project. From Figure 1 and 2, each formwork system is outlined with an influence factor. These influence factors then guide the user as to what formwork system would be best for their project.

The research that is conducted here will build off the information explored by: Awad S. Hanna and Victor E. Sanvido in "*An Interactive Knowledge Based Formwork Selection System for Buildings*," by mapping the decision process construction industry members have to make when selecting a formwork system. This research will not focus on the micro level of whether or not a flying truss system is better over a conventional wood system for a project like the Wellington Condominiums. Rather on a macro level of the process in which construction industry members make when determining what formwork system should be selected. An analogy to this research is illustrated below:

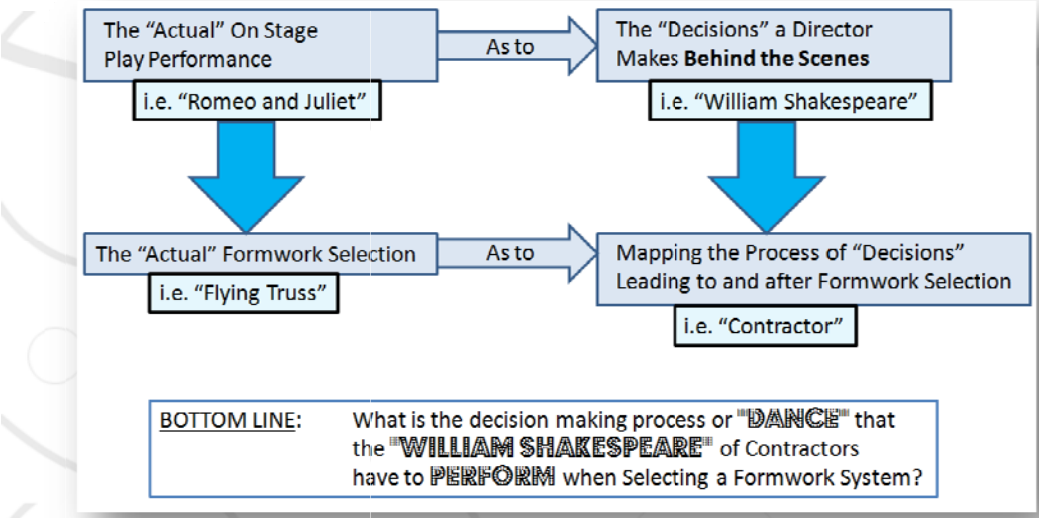


Figure 3: Research Analogy

B.4.2 Industry Perspective

The research analogy illustrates the focus for this investigation and how it will interact with previous research in formwork systems. With the background research outlined and questionnaires completed. The industry perspective can then be explored by conducting interviews with a wide range of industry personnel to gain a view to process of decisions made behind formwork selection. The following construction interviewees that have participated in this research and would like to acknowledge in appreciation are:

- Ray Sowers – Oncore Construction
- Jerry Clayborne – Southland Concrete
- Todd Sody – Sody Concrete Construction
- John Thorsen – Advanced Building Systems
- Randy Green – Southland Concrete

The results of the interviews conducted are summarized and are outlined as followed:

Note:

- Bullet points are different views casted by interviewees when asked the same question.
- For instance, if there are two bullet points that would signal a second viewpoint to the same question.

Interview Questionnaire Results Outline:

~ Question 1: My focus is on the method, process, or procedure you conduct when considering the usage of new formwork products or technologies.

Not focused on if you prefer flying truss versus conventional wood systems or the advantages and disadvantages of a system; rather on a deeper behind the scenes outtake on the following:

Who do you talk to?
Who makes the decisions?
Do you have an established procedure you must do when considering new formwork systems or in general new products?

~Discussion 1:

-
  - Project Manager decides on what system to use.
  - Labor has everything to with formwork selection.
  - European forming systems are ahead of the game.
  - Use Perri Forms to do contract documents for formwork systems.
  - It is up to the contractor to follow contract documents.
-
  - Experience and labor controls decision.
  - Try new system on smaller scale projects and if works will use on bigger projects with same crew.
  - Use Lumus Design to create formwork/scaffolding shop drawings.
  - The shop drawings must be approved by architect and structural engineer.
  - Once approved it is up to the contractor to follow according to the documents specified.
-
  - Decisions depend very much on the job, local conditions, and concrete appearance.
  - Cost is also a large factor in deciding on formwork systems.
  - Architects, engineers, or formwork designers create documents for contractors to utilize when constructing a given project.
-
  - Job superintendent decides on formwork system.
  - Get construction drawings from formwork supplier which then must get an engineer's stamp before contractor can begin construction. Or if have the capability can do it in house and assumes the risk and responsibilities.

- Temporary shoring is contractor's responsibility and experienced judgment.
- Like to use Perri Forms.
- If have to use a new formwork system the following process would occur:
  - Salesman comes in and gives pitch about formwork system and why it should be utilized on this particular project.
  - Superintendent is there to discuss options with the salesman and then is to decide if this is a viable option.
  - If it is a viable option, the next course of action is to see the formwork in use.
    - Most of the times have to fly to Europe to see latest formwork systems being utilized.
  - See formwork system in action and talk to superintendents and laborers as to what the advantages and disadvantages are to the system.
  - If that goes well the next course of action is to ease the formwork system into a construction project by renting it.
    - Size does not matter.
    - The same crews do not mater but labor is a big part in the success of the formwork system.
  - Get feedback from crews and superintendents as to how the formwork system works.
  - If the system works great then will buy the system for future projects.
  - If the system works okay or if depends greatly on a selective project then will stick to renting the formwork system to whenever needed.
  - If find something that needs improvement will contact the salesman to see if they can update the system for future use.
  - This process and decision making will continue in a cyclical fashion.

~Discussion 1 Overview: The decisions for utilizing a new formwork system are made typically by the Superintendent or Project Manager. All interviewees are in agreement that the person who decides must be experienced and knowledgeable towards formwork systems and other related issues. The procedure is in agreement that if you do not have your own in house Formwork Designer; a Formwork Supplier and Manufacturer will create shop drawings based off construction documents, get approved by the Architect and Structural Engineer of record, and then get submitted to the Contractor to be built according to what is specified. The last bullet point goes into detail as to how to implement a new formwork system was of great interest. This will be the basis of focus when mapping the decision process of implementing new formwork systems.

~Question 2: As far as the legalities of formwork design during construction; who has the risks and responsibilities?

~Discussion 2 Overview:

- All agree that it is the Contractor's responsibility to ensure that he/she follows the construction documents according to what is being specified. The Contractor assumes liability for problems related to construction on the project. If re-shoring is not specified in the construction documents it is up to the contractor to provide a safe environment to all workers during construction.

~Question 3: Who takes the risk and responsibilities if the formwork system is integrated with the assembly?

During construction a Contractor will not have the ability to decide on whether or not he/she can select to use a particular formwork system. The Contractor has no choice but to use the formwork system selected prior.

If the Designer then decides for the contractor on the formwork selection, do they take on some of the risk and responsibilities?

~Discussion 3 Overview:

- All agree that the Contractor is still responsible for the formwork system in its entirety. Once the Contractor signs the contract with the Owner, it is the Contractor's responsibility as to what is being asked of him to build. Even though the Designer takes away the power of the Contractor to decide what formwork system to use; it is still the Contractor's responsibility to decide on whether or not he/she will build the structure before bidding or signing the contract.

~Question 4: Who takes the risk and responsibility of the formwork system if problems were to occur on the project in terms of schedule and budget?

Do Contractors need to jump in early in the design phase of construction?

Is there a different process in decision making that must take place in the selection of formwork systems?

~Discussion 4 Overview:

-
    - All agree that the Contractor is responsible due to the formwork system being a part of the construction responsibilities of the Contractor. Even though the decision was made prior without the Contractors input; it is still

the Contractor's responsibility to build according to what is being specified. Traditionally, the schedule and budget responsibilities also fall onto the construction project team and not onto the design team regarding the Architect or Engineer.

- To medicate this problem for the Wellington Condominiums Project Team it is best for the Contractor to get his/her input early on in the design. This will reduce the risk and make the construction project a lot smoother in transition between design and construction. Also the Contractor should be experienced or is fully prepared to deal with new formwork systems before construction is ever started.
- There is a different process in decision making regarding the selection of new formwork systems. With designs ever becoming more complicated, proper communication between project members is all so crucial to the success of the project.
  - With Design-Build becoming more prevalent in the construction industry it is ever so important to have effective communication lines between all parties involved on a given project.
  - This process change is what will be explored in the next section regarding the mapping of the formwork decision process.

B.4.3 Mapping the Formwork Decision Process

Based on the gathered research the following formwork decision processes have been modeled:

- **B.4.3.1 Generic Formwork Decision Process Model**
- **B.4.3.2 Wellington Condominiums Formwork Decision Process Model**
- **B.4.3.3 Ideal Decision Process Model for Formwork Systems**

The following **Key** has been assembled to view the following Formwork Decision Process Models:

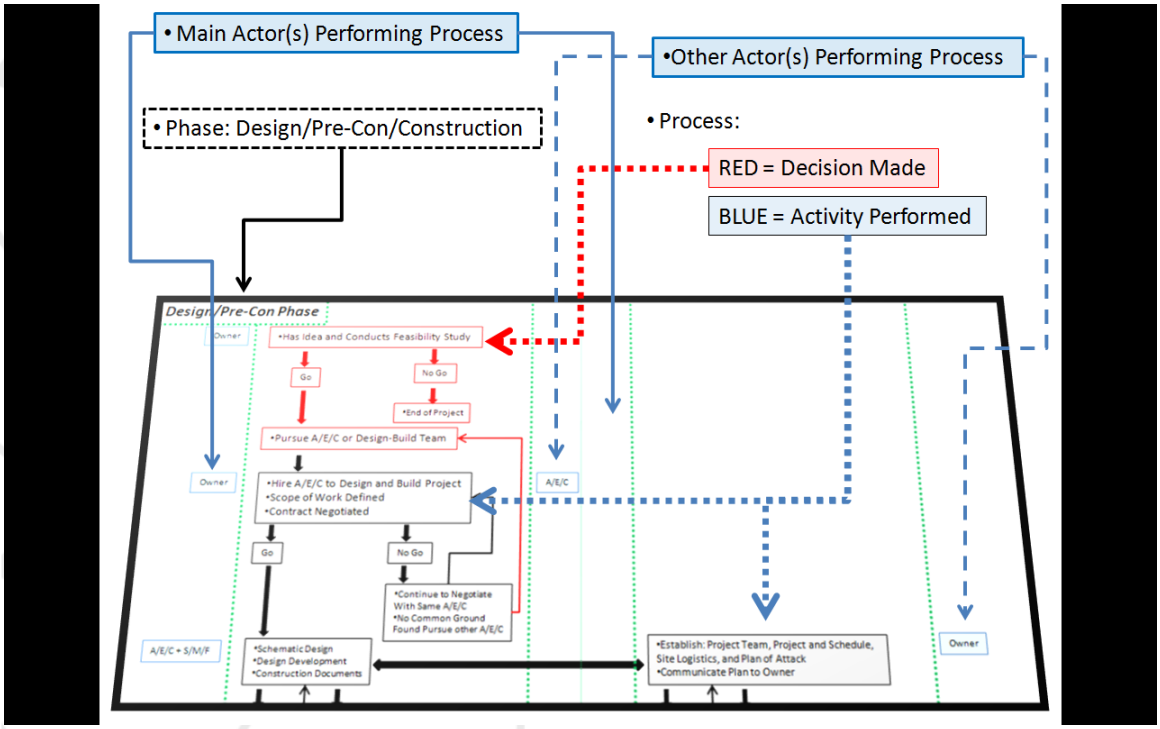
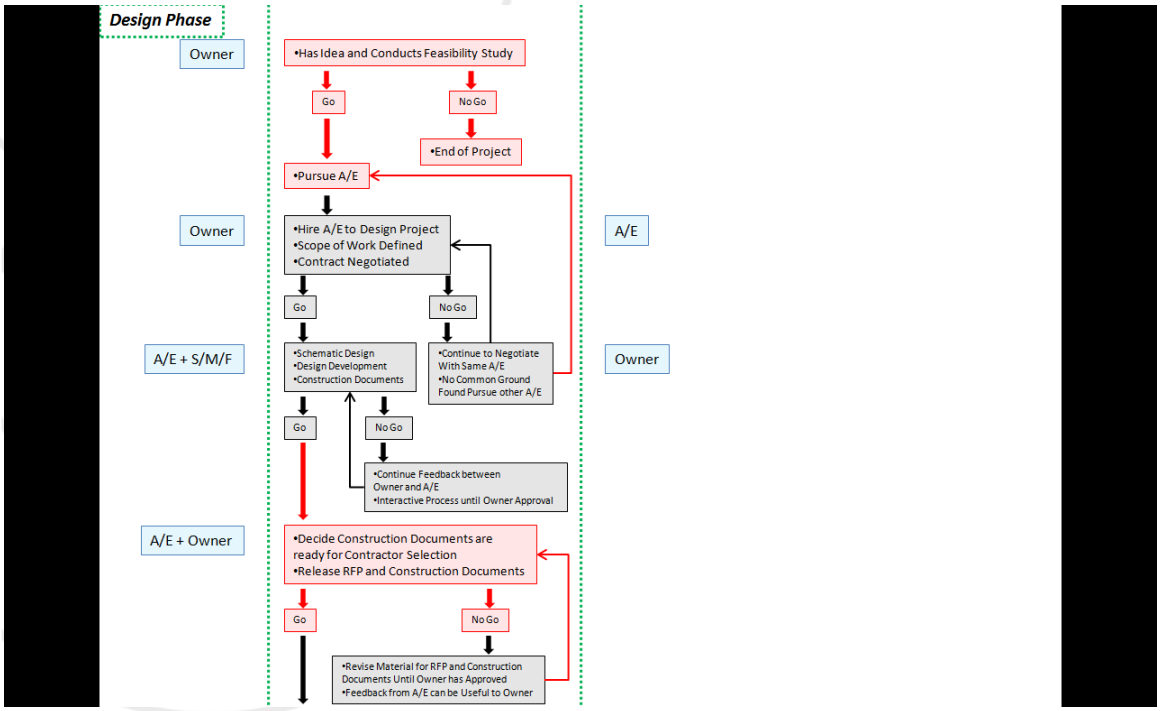


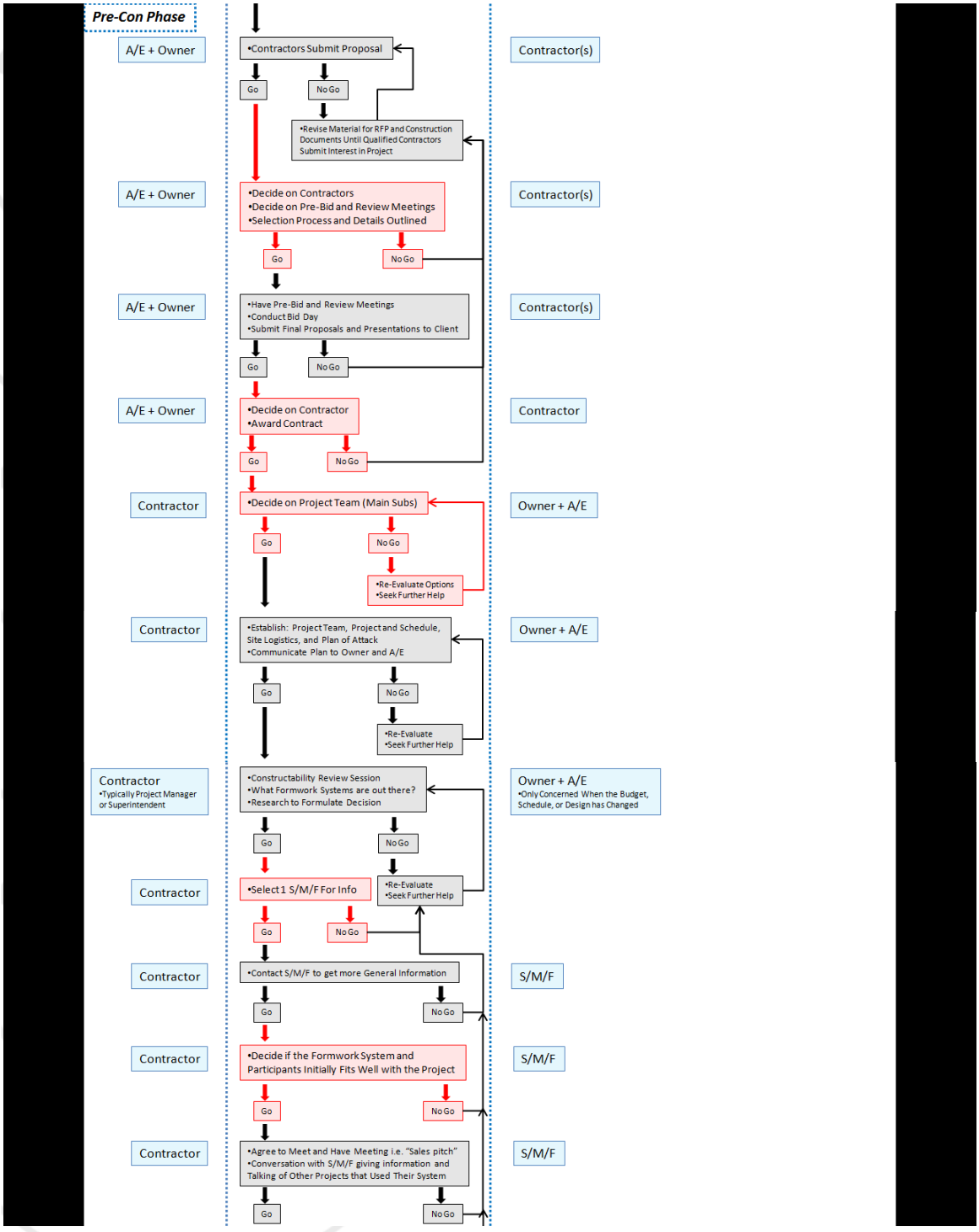
Figure 4: Decision Process Model Key

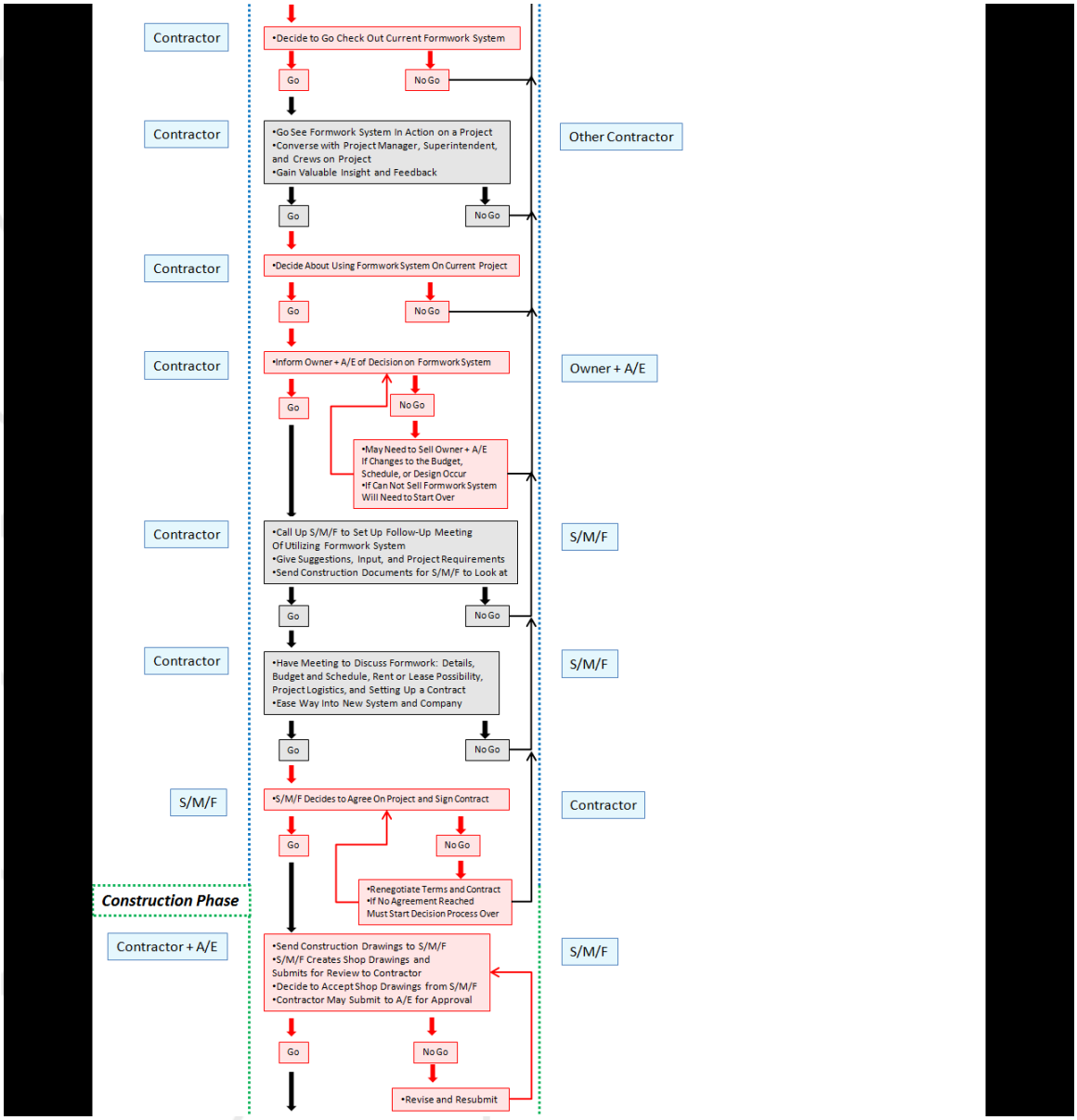
- Key:
  - A/E – Architect/Engineer
  - C – Contractor
  - S/M/F – Supplier/Manufacturer/Fabricator
  - O – Owner
  - D-B – Design-Build
  - Phases:
    - Design
    - Pre-Construction
    - Construction
    - Note: No Operations and Management Phases Have Been Modeled Due to Formwork Being a Temporary Activity for Construction Purposes.

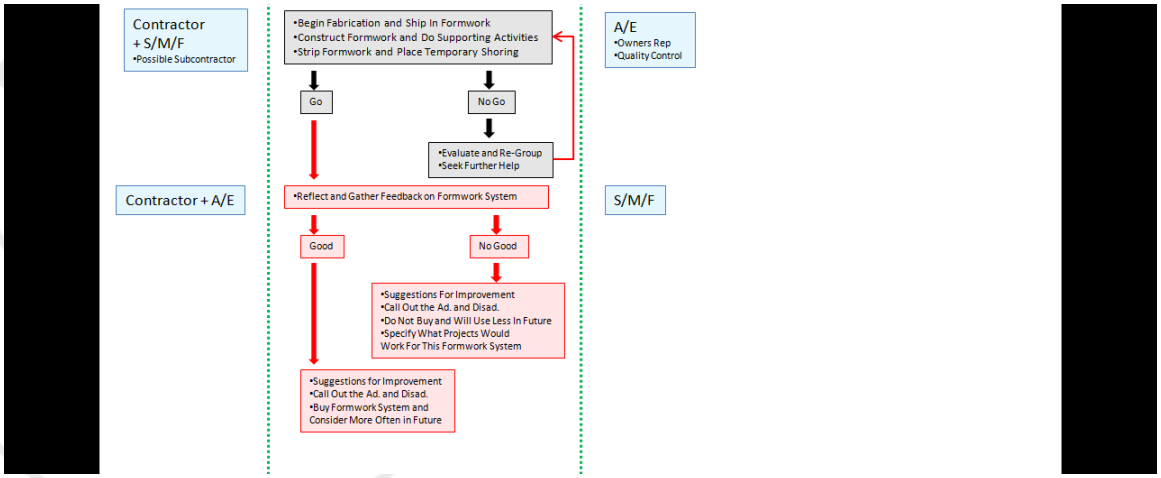
B.4.3.1 Generic Formwork Decision Process Model

The Generic Process Model for Formwork Decisions is important to understand when analyzing the situation at the Wellington Condominiums Project. The generic model is a representation of what a majority of how construction industry personnel decide on what formwork system would work best for their particular project. All phases surrounding the formwork decision process have been modeled and are duly noted.




Pre-Con Phase
A/E + Owner
•Contractors Submit Proposal
Contractor(s)
Go
No Go
•Revise Material for RFP and Construction Documents Until Qualified Contractors Submit Interest in Project
A/E + Owner
•Decide on Contractors
•Decide on Pre-Bid and Review Meetings
•Selection Process and Details Outlined
Contractor(s)
Go
No Go
A/E + Owner
•Have Pre-Bid and Review Meetings
•Conduct Bid Day
•Submit Final Proposals and Presentations to Client
Contractor(s)
Go
No Go
A/E + Owner
•Decide on Contractor
•Award Contract
Contractor
Go
No Go
Contractor
•Decide on Project Team (Main Subs)
Owner + A/E
Go
No Go
•Re-Evaluate Options
•Seek Further Help
Contractor
•Establish: Project Team, Project and Schedule, Site Logistics, and Plan of Attack
•Communicate Plan to Owner and A/E
Owner + A/E
Go
No Go
•Re-Evaluate
•Seek Further Help
Contractor
•Typically Project Manager or Superintendent
•Constructability Review Session
•What Formwork Systems are out there?
•Research to Formulate Decision
Owner + A/E
•Only Concerned When the Budget, Schedule, or Design has Changed
Go
No Go
Contractor
•Select 1 S/M/F For Info
•Re-Evaluate
•Seek Further Help
Go
No Go
Contractor
•Contact S/M/F to get more General Information
S/M/F
Go
No Go
Contractor
•Decide if the Formwork System and Participants Initially Fits Well with the Project
S/M/F
Go
No Go
Contractor
•Agree to Meet and Have Meeting i.e. "Sales pitch"
•Conversation with S/M/F giving information and Talking of Other Projects that Used Their System
S/M/F
Go
No Go


Contractor
•Decide to Go Check Out Current Formwork System
Go
No Go
Contractor
Other Contractor
•Go See Formwork System In Action on a Project
•Converse with Project Manager, Superintendent, and Crews on Project
•Gain Valuable Insight and Feedback
Go
No Go
Contractor
•Decide About Using Formwork System On Current Project
Go
No Go
Contractor
Owner + A/E
•Inform Owner + A/E of Decision on Formwork System
Go
No Go
•May Need to Sell Owner + A/E If Changes to the Budget, Schedule, or Design Occur
•If Can Not Sell Formwork System Will Need to Start Over
Contractor
S/M/F
•Call Up S/M/F to Set Up Follow-Up Meeting Of Utilizing Formwork System
•Give Suggestions, Input, and Project Requirements
•Send Construction Documents for S/M/F to Look at
Go
No Go
Contractor
S/M/F
•Have Meeting to Discuss Formwork: Details, Budget and Schedule, Rent or Lease Possibility, Project Logistics, and Setting Up a Contract
•Ease Way Into New System and Company
Go
No Go
S/M/F
Contractor
•S/M/F Decides to Agree On Project and Sign Contract
Go
No Go
•Renegotiate Terms and Contract
•If No Agreement Reached Must Start Decision Process Over
Construction Phase
Contractor + A/E
S/M/F
•Send Construction Drawings to S/M/F
•S/M/F Creates Shop Drawings and Submits for Review to Contractor
•Decide to Accept Shop Drawings from S/M/F
•Contractor May Submit to A/E for Approval
Go
No Go
•Revise and Resubmit



B.4.3.2 Wellington Condominiums Formwork Decision Process Model

The Wellington Condominiums Project Team ran into some difficulty in budget and schedule and the question is why? Why did the project team run into difficulty? Can the Formwork Decision Process Model show what occurred?

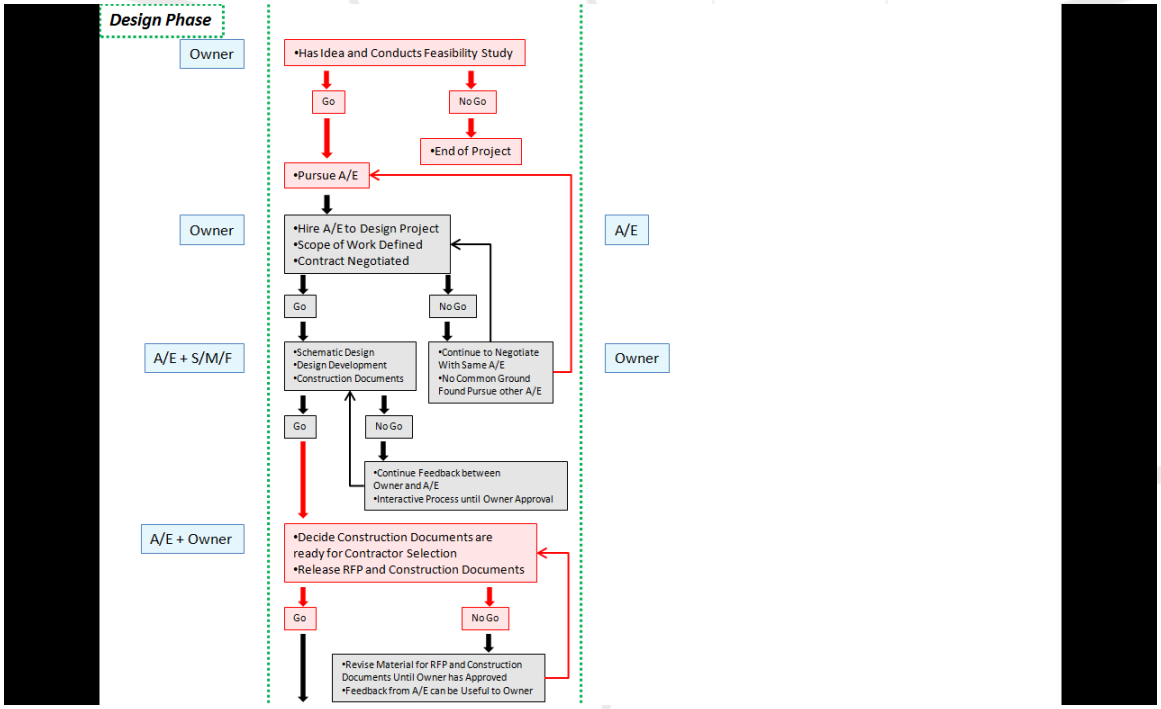
The answer is YES! The difference between what traditionally takes place and what has occurred on the Wellington Condominiums Project is that the decision as to what formwork system was to be utilized was made by the Owner and not the Contractor. In the design phase the Supplier/Manufacturer/Fabricator (S/M/F) presented to the Owner the Hambros Joist Composite Deck System. The Hambros Joist Composite Deck System has integrated its own formwork system that must be utilized with the floor-ceiling assembly. The Owner was sold on the floor-ceiling system and implemented it into the design. As shown in the process, no Contractor input was given into the constructability of the system and therefore the Contractor lost the decision rights on what formwork system should be implemented. When the Contractor was in the constructability review session meetings later on in the pre-construction phase, it was realized that the project team had to utilize the system's formwork or change the entire structural design. Therefore it was decided to stick with the Hambros Joist Composite Deck System and forfeit any rights in formwork decisions that Contractors typically have on a project. This forfeit of decision rights in formwork selection can be seen readily in the model by the decrease in RED ACTIVITIES.

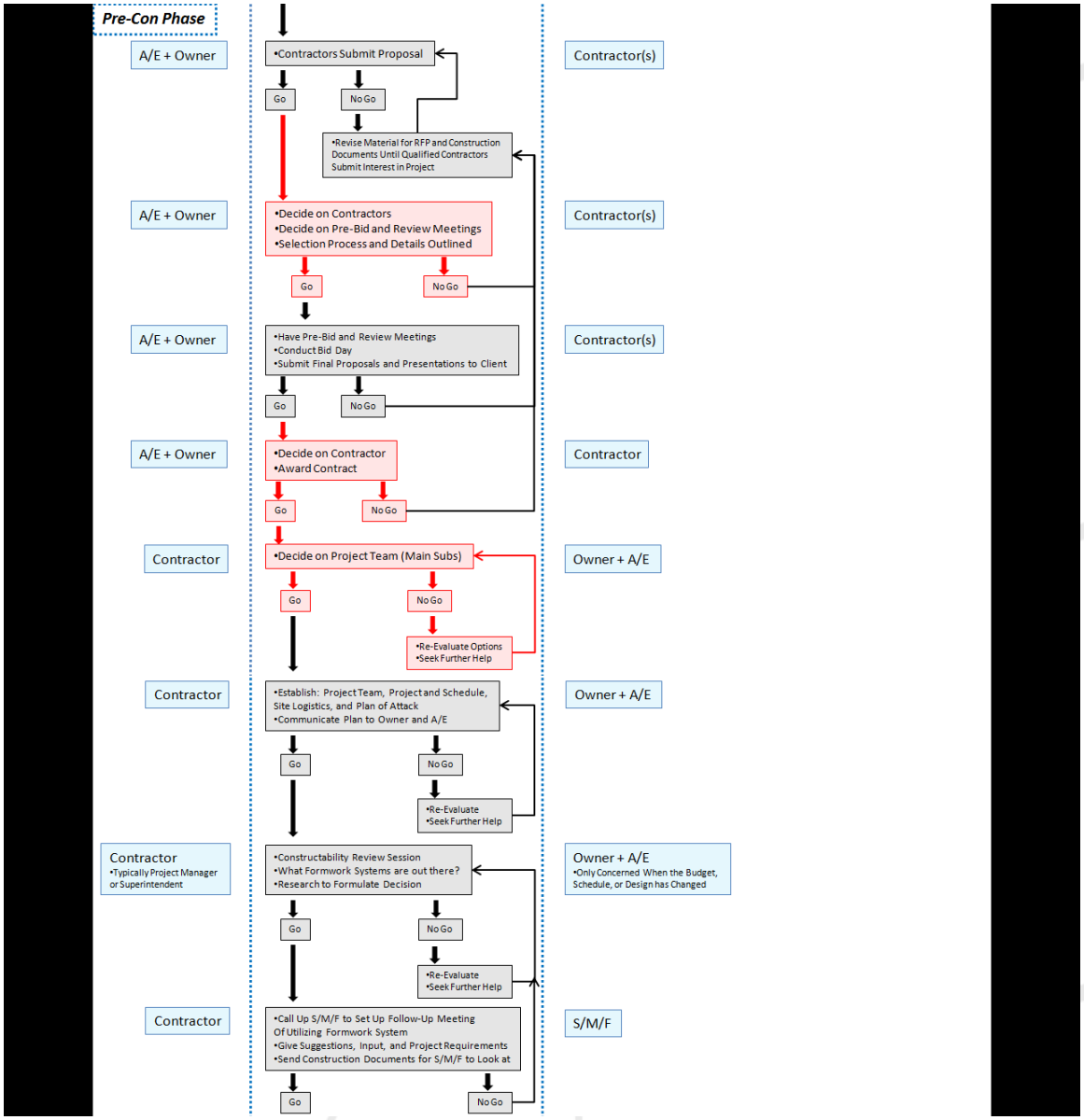
RULE OF THUMB: LESS RED ACTIVITIES = LESS DECISIONS MADE

From this decision process model we can determine that due to the project teams inexperience with the system and losing the decision rights based on the Owner has set

up vulnerability for the project budget and schedule to become inflated. How to solve this problem? The solution is to be answered in the **B.4.4 Results and Recommendations** Section.

As a side note: The Contractor selected on the project is really a part of the Owner's company as a whole. Even though the Contractor is a part of the company it still acts as a separate entity and does not collaborate in owner roles and decisions. This puts the Contractor in a tough spot because your work depends on the continual construction of the Owner's developments. By suggesting to the Owner to change the entire design and send mixed signals that the Contractor does not want to construct the project a certain way would create tension between parties. Therefore it was decided by the Contractors to do their best to please the owner in constructing the project as best as they can when utilizing the Hambros Joist Composite Deck System for the very first time. The decision model process shows what minimal options the project team had and which lead to problems in construction and ultimately reflected in the budget and schedule.




Pre-Con Phase
A/E + Owner
•Contractors Submit Proposal
Contractor(s)
Go
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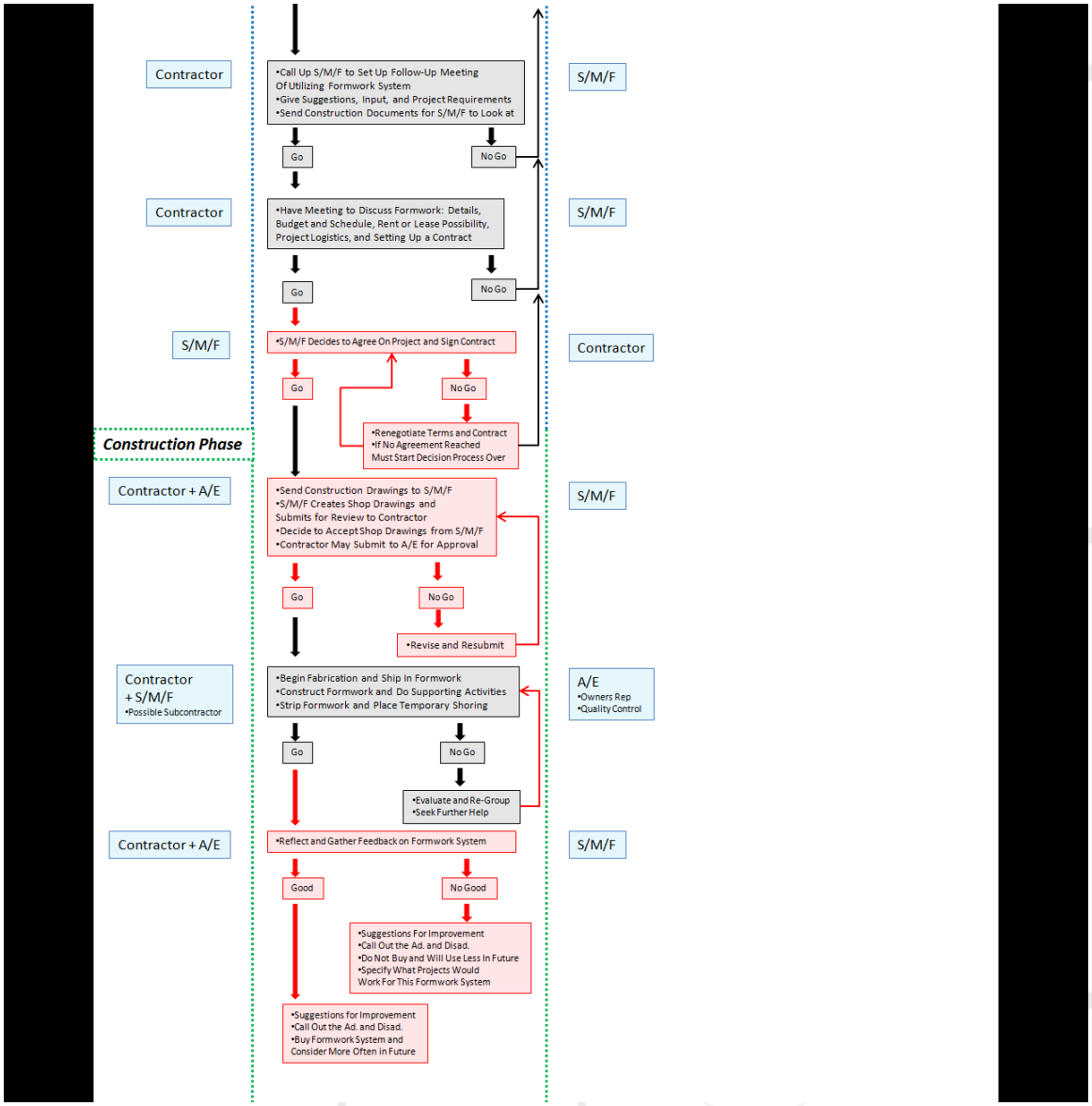
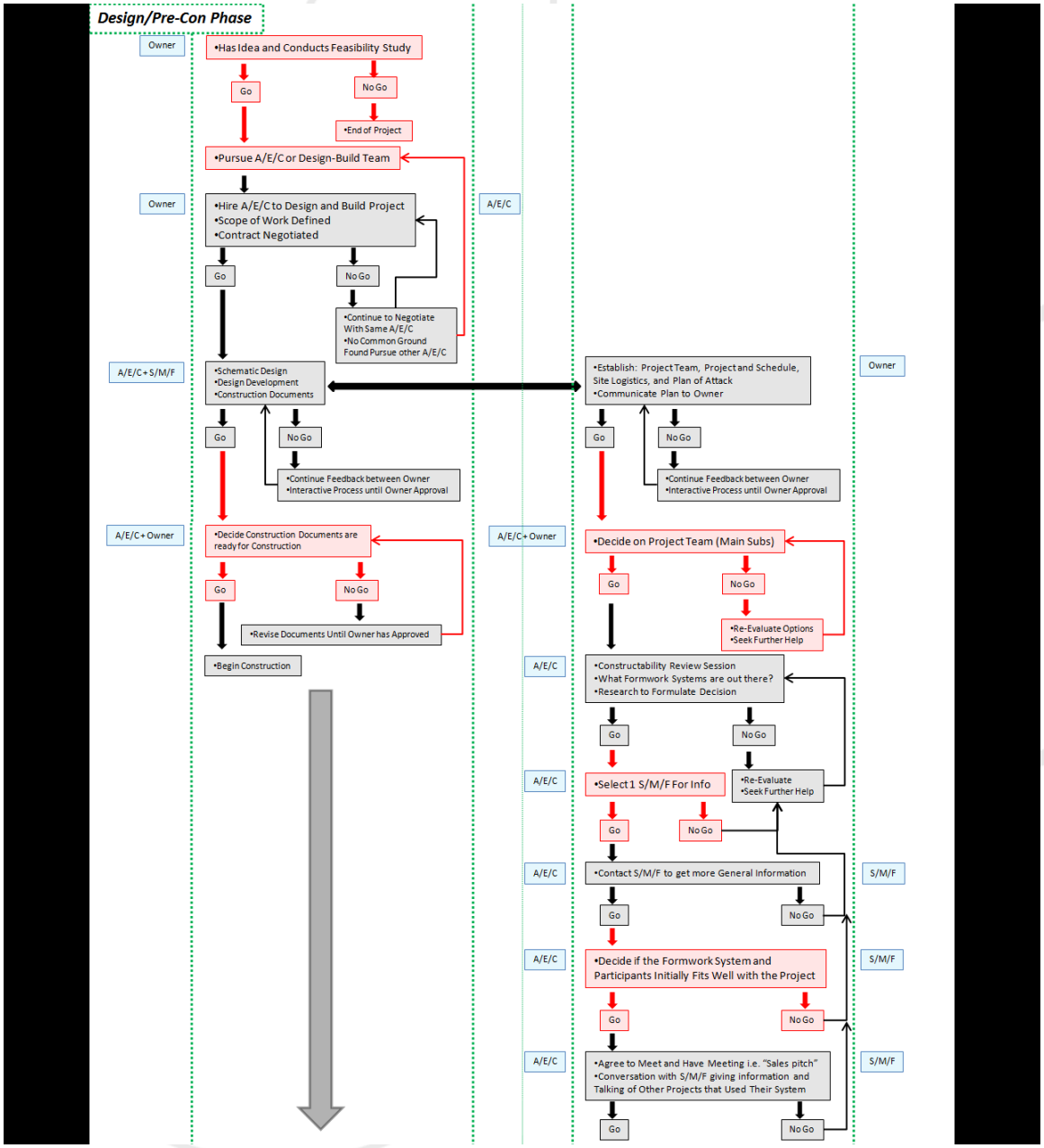
•Revise Material for RFP and Construction Documents Until Qualified Contractors Submit Interest in Project
A/E + Owner
•Decide on Contractors
•Decide on Pre-Bid and Review Meetings
•Selection Process and Details Outlined
Contractor(s)
Go
No Go
A/E + Owner
•Have Pre-Bid and Review Meetings
•Conduct Bid Day
•Submit Final Proposals and Presentations to Client
Contractor(s)
Go
No Go
A/E + Owner
•Decide on Contractor
•Award Contract
Contractor
Go
No Go
Contractor
•Decide on Project Team (Main Subs)
Owner + A/E
Go
No Go
•Re-Evaluate Options
•Seek Further Help
Contractor
•Establish: Project Team, Project and Schedule, Site Logistics, and Plan of Attack
•Communicate Plan to Owner and A/E
Owner + A/E
Go
No Go
•Re-Evaluate
•Seek Further Help
Contractor
•Typically Project Manager or Superintendent
•Constructability Review Session
•What Formwork Systems are out there?
•Research to Formulate Decision
Owner + A/E
•Only Concerned When the Budget, Schedule, or Design has Changed
Go
No Go
•Re-Evaluate
•Seek Further Help
Contractor
•Call Up S/M/F to Set Up Follow-Up Meeting Of Utilizing Formwork System
•Give Suggestions, Input, and Project Requirements
•Send Construction Documents for S/M/F to Look at
S/M/F
Go
No Go

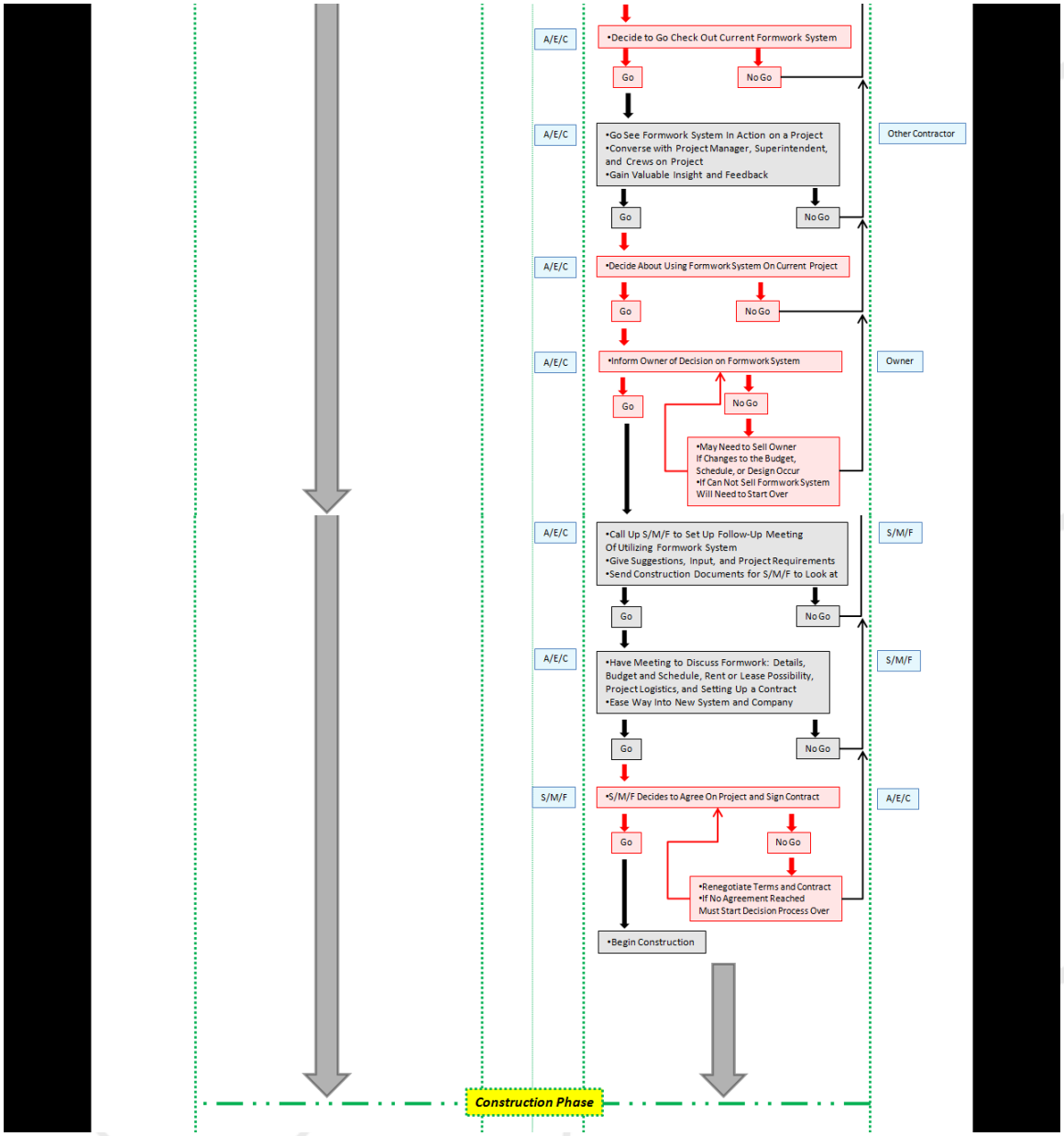


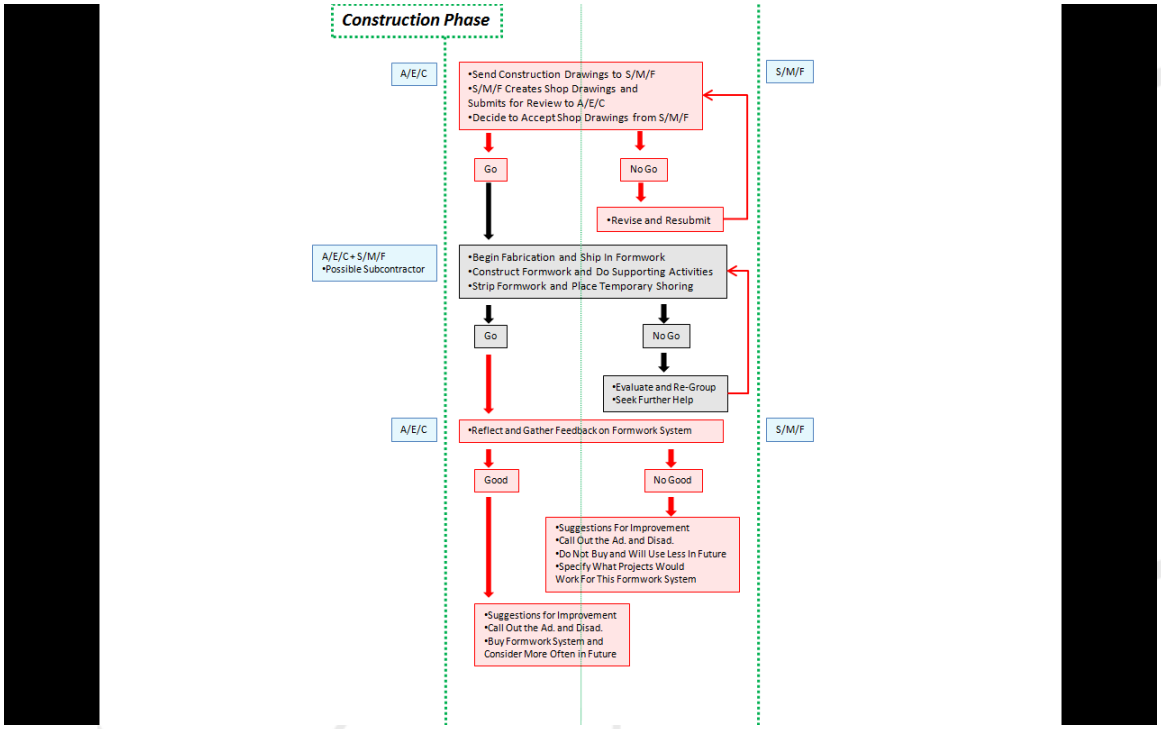
B.4.3.2 Ideal Decision Process Model for Formwork Systems

The ideal decision process has been identified for formwork systems as a Design-Build contractual relationship. With Design-Build, task and activities can be eliminated that are deemed wasteful. This also moves the Contractor early on into design decision making process and at that time perform decisions that would normally occur later on in the pre-construction phase. Doing this will ensure that the correct S/M/F will be on the project and keep the formwork decision process in the hands of the Contractor and not the

Owner. The main process of construction or even the formwork decision process does not change from the generic formwork decision process model; rather the design and pre-construction phases get "fused" together and opens a more fluid communication line between all parties. This leads to speedier construction, more efficient decision process between all parties, and more $$$ in the owners pocket.




A/E/C
•Decide to Go Check Out Current Formwork System
Go
No Go
A/E/C
•Go See Formwork System In Action on a Project
•Converse with Project Manager, Superintendent, and Crews on Project
•Gain Valuable Insight and Feedback
Other Contractor
Go
No Go
A/E/C
•Decide About Using Formwork System On Current Project
Go
No Go
A/E/C
•Inform Owner of Decision on Formwork System
Owner
Go
No Go
•May Need to Sell Owner If Changes to the Budget, Schedule, or Design Occur
•If Can Not Sell Formwork System Will Need to Start Over
A/E/C
•Call Up S/M/F to Set Up Follow-Up Meeting Of Utilizing Formwork System
•Give Suggestions, Input, and Project Requirements
•Send Construction Documents for S/M/F to Look at
S/M/F
Go
No Go
A/E/C
•Have Meeting to Discuss Formwork: Details, Budget and Schedule, Rent or Lease Possibility, Project Logistics, and Setting Up a Contract
•Ease Way Into New System and Company
S/M/F
Go
No Go
S/M/F
•S/M/F Decides to Agree On Project and Sign Contract
A/E/C
Go
No Go
•Renegotiate Terms and Contract
•If No Agreement Reached Must Start Decision Process Over
•Begin Construction
Construction Phase



B.4.4 Results and Recommendations

The results and recommendations as to the formwork process modeling for the Wellington Condominiums and ideal process based off the generic model are outlined in the following sections:

- **B.4.4.1 Wellington Condominiums Formwork Decision Process Model**
- **B.4.4.2 Ideal Decision Process Model for Formwork Systems**

B.4.4.1 Wellington Condominiums Formwork Decision Process Model

The following sections detail what results occurred on the Wellington Condominiums Project and the recommendations of what could be done based off the Wellington Condominiums Formwork Decision Process Model.

B.4.4.1.A Wellington Condominiums Formwork Decision Process Model Results

The following key results that lead to problems for the Wellington Condominiums Project Team are outlined as followed:

- Design Phase:
  - S/M/F convinced Owner of their product would be best for the project.
  - Owner liked the idea of cost and schedule savings and had it implemented into the design.
  - This occurred during the continual feedback design period between Owner and A/E.
  - The ultimate decision rests on the Owner and not the A/E as to what systems will be used in the design. This can be seen where the Owner has the "Go/No Go" decision for if the design is ready for contract documents for contractors to bid on.
  - In this model the Owner can keep sending back the design until satisfied.
  - At this stage the decision has already been made and it is too late for the contractor to give input.
- Pre-Construction Phase
  - Process begins similarly to generic model.
  - Contractor sets budget and schedule
    - No Experience with Hambro but does not look hard to construct based off S/M/F feedback.
    - Approved by Owner
  - Site Logistics and Plan of Attack laid out
    - Approved By Owner
  - Constructability Review Meetings
    - Had two options with formwork
      - Use Hambro's formwork system
      - Change Entire Design
    - Final Decision to use Hambro
      - Would create delays and Owner would not like.
    - No Crews available with experience
      - S/M/F will not be subcontracted to perform work.
      - Had to do themselves for first time
    - Decision made easy for contractor
      - Select 1 contact and set up contract agreement with Hambro.
      - All decision power gone!
- Construction Phase
  - Construction Documents submitted for shop drawings.
  - Large learning curve with system and formwork style.
    - Extra cost and schedule implications on contractor
  - Due to concrete leakage on formwork had to have a special crew to come back to clean.
    - Extra cost and schedule implications on contractor

B.4.4.1.B Wellington Condominiums Decision Process Model Recommendations

The major problem identified in the results is that the entire Contractor's decision making process is eliminated due to the M/F/S in the continual feedback design process between the Owner and A/E. This is where a majority of the incorrect formwork system selections occur in the formwork decision process. Correct formwork system selection most always occurs at the completion of the Contractor's formwork decision process. This is due to the checks in place and gaining feedback from outsides sources. This leads to a rational decision which will benefit all parties involved on the project.

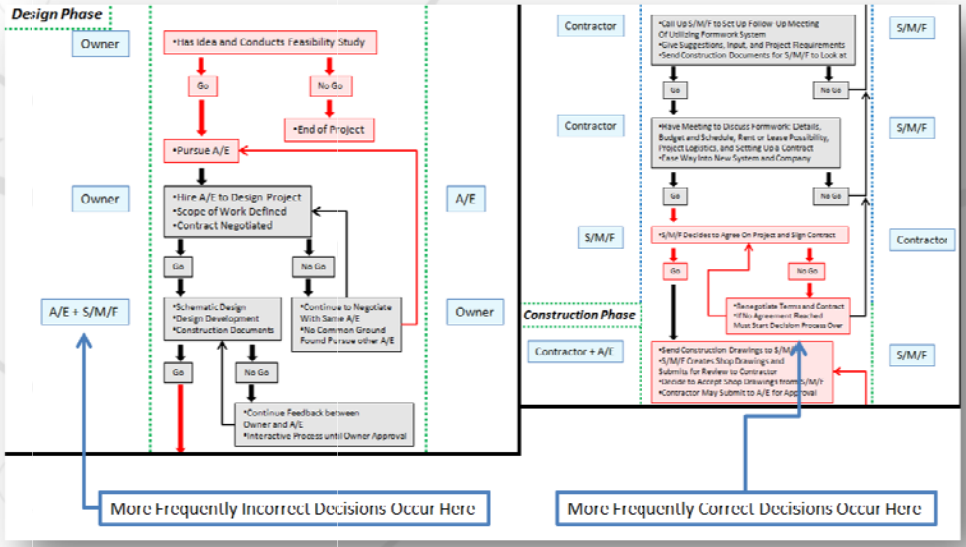


Figure 5: Incorrect and Correct Decision Occurrences

Question: How do we fix or prevent the occurrence on the Wellington Condominiums Project?

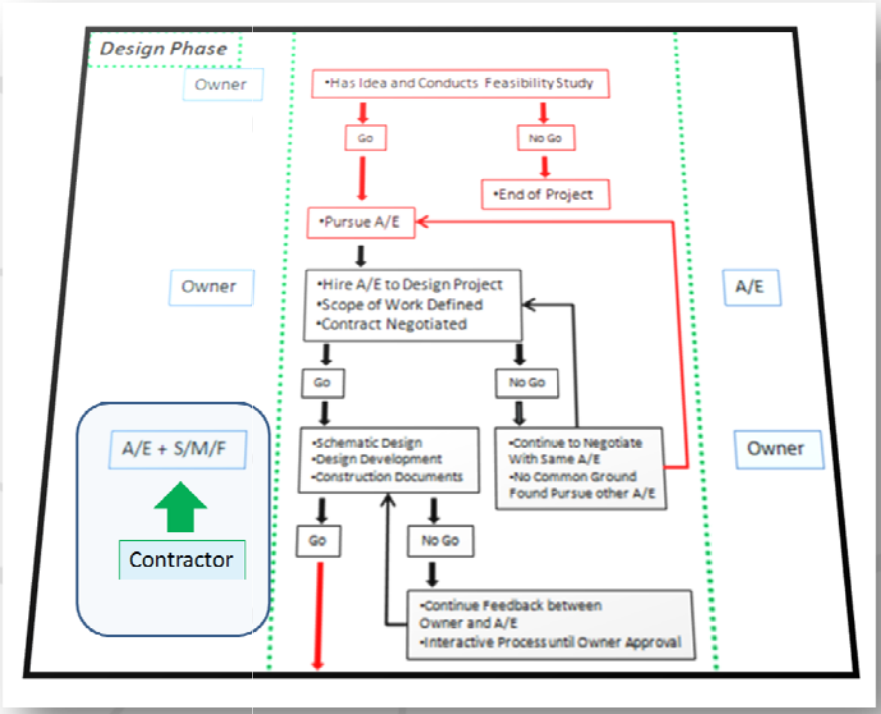


Figure 6: Problem fixed i.e. Insert Contractor into the Process

Answer: Get the Contractor on board early on when the S/M/F comes into the design phase. Employ the services of a CM Agent in the design and pre-construction phases. At a bare minimum, have someone who is knowledgeable on construction to give sound judgment as far as a constructability perspective.

Having input early on can prevent the occurrence on the Wellington Condominiums Project from happening. Having a CM Agent early on will allow the contractor to go through the proper channels of decisions and checks in the pre-construction phase.

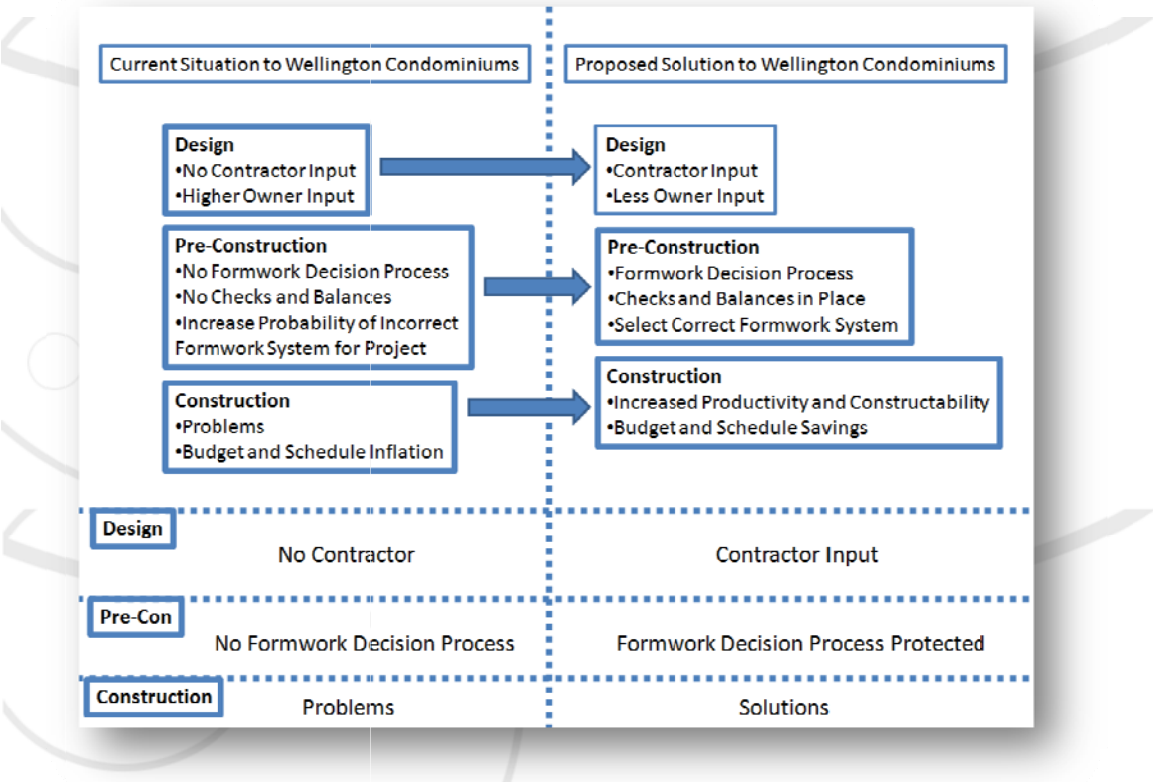


Figure 7: Current versus Proposed Solution to the Wellington Condominiums Project

B.4.4.2 Ideal Decision Process Model for Formwork Systems

The following sections detail what results occurred on researching the Ideal Decision Process Model and the recommendations of what could be done based off the Ideal Decision Process Model.

B.4.4.2.A Ideal Decision Process Model for Formwork Systems Results

The following key results that lead to the creation for the Ideal Decision Process are outlined as followed:

- Design/Pre-Construction
  - The Design-Build contract structure allows the design and pre-construction phases to combine and start construction at an earlier date.
    - This is one of the main reasons for decrease in project budget and schedule.
  - Owner has idea, conducts feasibility study, and hires A/E/C or Design-Build Team.

  - Design and Pre-Construction Services to Owner
  - While design is taking place, the contractor can talk to the S/M/F and not the Owner.
    - Contractor can provide educated and experienced input into decision of design regarding constructability.
  - Once the design has gathered enough level of detail the construction team can begin the formwork decision process.
- Construction
  - Once construction documents and an S/M/F have been selected, shop drawings can then be created.
  - Formwork can then be fabricated and shipped in for construction purposes.

B.4.4.2.B Ideal Decision Process Model for Formwork Systems Recommendations

This decision process model is the most ideal to a project team because it saves time and money, dramatic improvement in communication lines between project participants, less owner involvement in constructability decisions, and S/M/F held in check throughout decision process by experienced industry personnel. Some of the reasons why these statements are true are listed as followed:

- With modeling step by step the Design-Build Decision Process for Formwork Systems, the following selected participants and process are unnecessary and have been eliminated:
  - Participants Eliminated During Specific Process and Decision Activities:
    - Contractor
    - Contractors
    - Owner + A/E (3)
  - **Total: 5 Participants Eliminated**
  - Processes Eliminated During Specific Times
    - Activities Eliminated
      - The need of RFP and Contractor submitting proposal
      - Have pre-bid and other related meetings
      - Submit final proposals and presentations
    - Decisions Eliminated
      - Decide on Contractors
      - Decide on pre-bid and other related meetings
      - Selection process
      - Decide on Contractor and award contract
      - Decide to release design for contractor selection
      - Decide to release RFP and construction documents
  - **Total: 9 Processes Eliminated**

With 5 participants and 9 processes eliminated, it is clear and is proven statically why a Design-Build contract succeeds over a traditional format. Wasteful processes have been taken out of the equation, better communication lines between project participants, and earlier involvement of all project participants leads to success. The Owner will also benefit due to a faster and more productive working environment with the project team. This reduces friction and creates a decrease in budget and schedule.

The only disadvantage is that this will have a little more upfront cost due to the Contractor's early input. It has been proven time and time again that it is well worth the investment of having good feedback, better communication lines, and working relationships. Also due to having the formwork decision process, Contractors are encouraged to explore new formwork products and become educated as to the latest most productive systems on the market today. From the ideal decision process model for formwork systems, an interesting ideology transpires: Wherever a S/M/F enters into the scene; a Contractor is always there in the selected process. This is due to the fact that if an Owner and A/E are not experienced, it will lead to a possible loss in the Contractor's ability to learn and make rational constructability decisions and create an increased vulnerability in the project budget and schedule. Therefore the following rule from this research hypothesizes the following statement:

- For increased project success, a Contractor should be implemented if an S/M/F is to enter a formwork decision process.
- The correct products for a construction project enter under the influence of a Contractor. While the probability of incorrect products for a construction project enters without the influence of a Contractor.

This hypothesis has been proven by the Wellington Condominiums Project and can be served very useful to all construction industry personnel.

Question: What process of action can S/M/F do to promote new products effectively?

Answer: Depends on the decision process! Generic and ideal promote different ways for S/M/F to conduct business. Savvy S/M/F knows this and benefit greatly from it!

Under the Generic Decision Process:

- The generic decision process is what is commonly found in traditional way of construction projects. A step by step method in which the contractor is brought onto the project at a later date.

- The Savvy S/M/F knows this and therefore attacks early on in the design phase with the Owner and A/E. It is a great place for S/M/F to get into a project and have the designs utilize their products.
- By the time the Contractors step into the picture, the design is already completed and is too late for S/M/F to participate in the project.
- The more the S/M/F can offer to the Owner and A/E, the more business and profits the S/M/F will create!
    - Design becomes more of a factor to the decision process.

Under the Ideal Decision Process:

- The ideal decision process is generally referenced to the new style of construction of design-build.
- In design-build the Contractor has more say in the design and constructability of the project.
- Owners tend to play less of a role and A/E relies more heavily on the Contractor's decision as to what systems or products would be best.
- Therefore it is the Contractor that savvy S/M/F now attacks for business and working relationships. The more S/M/F can do for the contractor the better!
    - Subcontracting work become more of a factor to the decision process.

Question: How can this information be utilized in a more readily fashion to construction industry personnel?

Answer: An interactive web tool called: "Formwork Decision Process Model" has been created that any construction industry personnel can interact with to gain a sense of the complicated decisions that go into utilizing a new formwork product.

This tool uses the process models created in this report in an easily viewable web format. The tool can guide any user step by step until the project has reached an end to the decision making process of formwork systems. You can access this interactive web tool on the Pennsylvania State University Architectural Engineering Senior Thesis Website @ www.arche.psu.edu/thesis.