Managing and Forecasting Contractor Cash Flow on Construction Projects

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Abstract

Project controls for a construction contractor is a multi-layered undertaking that goes well beyond the challenges of just controlling project cost. While cost is clearly important, equally important to control are revenue, margin and cash flow. A contractor's delivery of a project relies heavily on the careful and concurrent management of all these dimensions for it to be a success. Delivering a project's scope on time and on budget may well be a primary goal; however, if they don't achieve their desired profit, the project, for them, will be a fail, putting their company at risk. It would be an over-simplification to believe that if cost is controlled then profit will naturally follow. Making an assumption like that would presume that project cost and revenue flow roughly the same, are dependent on each other, and are defined by the same structures. This is simply not true as cost and revenue can have very different deliverables, payment schedules, structures and terms. For contractors, the terms of the contract payment schedule with the client will define how revenue will be recognized and claimed, which is typically managed separately from how cost is recognized on the project. The net effect of this can mean that contractors may face weathering the low points of available cash as they await payments from the client, which can result in funding the project for periods of time. This paper will shed light on the importance of how managing and forecasting cash flow for both cost and revenue is critical for contractors as they juggle the finances of multiple concurrent projects. It will show how new technology can help plan, forecast and visualize complex cash flow scenarios, along with the intricacies of various contract types – such as fixed price, unit price, time & materials – and their unique deliverables and payment terms.

1 Introduction

Enforcing strict financial governance on major projects is critical for the control of cost and schedule, along with the careful execution of the project deliverables according to the contract terms agreed-to with the client. These contract terms and deliverables typically define the method and frequency for how the contractor recognizes revenue and gets paid for their work. Getting paid, however, can be subject to any number of conditions that need to be met; and it's the responsibility of the contractor to evidence the substantial completion of a deliverable, milestone or progress prior to the client approving the associated invoice. This can be further complicated when there are change orders, rework, claims or disputes that can get in the way of the smooth collection of billings.

On top of cost and revenue, the contractor has the additional layer of complexity in the human factor of their labor force. Unlike the owner, contractors typically self-perform much of their work and thus face the challenges that their labor force can introduce to the successful completion of a task. More than just errors, labor resources have intricate payment plans driven by pay rates, union collective agreements, shift premiums, overtime, reimbursable expenses, etc. Contractors also incur costs from their subcontractors and suppliers which are on a distinct payment schedule that differs from payroll and other expenses.

All of this leads to the primary challenge that this paper will address, which is the nuance of cash flow. Since project cost and revenue float independently of each other, there can be periods of

time in any project where the contractor incurs expenses that need to be paid long before they are either reimbursed or are able to collect on a payment milestone from the customer. This can put the contractor in financial risk if they cannot adequately forecast and plan for cash flow low points. Further to that, errors, rework and unforeseen costs can lead to non-reimbursable work that erode margins and introduces delays. This can put further financial pressure on the contractor to closely manage and control their project finances.

2 Planning for Cash Flow

In a competitive landscape, most contractors are dealing with tight margins and aggressive deadlines. Costly mistakes or bad planning can eat away at profitability. During project planning, therefore, project controls and finance need to map out the forecasted movement of funds over life of the project. This is vital for planning around any funding gaps and to set expectations around profitability. This is the process of planning a project's forecasted cash flow.

2.1 Project Cash Flow

In its narrowest definition, cash flow describes the movement of funds into and out of a system such as a bank account. It sounds so simple, it's a wonder that it can be so complicated. The complications are rooted in two fundamental issues:

1. Cost and revenue are *recognized* long before they're actually paid-out or received. Cost recognition (accruals) and revenue recognition will be discussed later.
2. Obligations to pay project expenses – i.e., payments made for payroll or accounts payable – can occur prior to receiving the funds to cover these costs. This can cause periodic cash deficits that need to be accounted for and funded.

How this translates in the context of this discussion is this: a construction contractor will incur expenses – such as payroll, equipment costs, materials purchases, subcontracts, and consumables – that will be incurred and paid throughout the life of a project. They will also regularly recognize revenue throughout the life of the project, that they will claim by way of billing the client, who will ultimately pay by transferring the funds to the contractor. Cash flow is thus the intersection of these payments and receivables viewed over a timeline. It's important for those responsible for the financial success of a project to plan its cash flow so as to minimize the impact of any gaps in funding.

2.2 Decoupling Project Cost and Revenue

During the planning phase of a large or complex project, the contractor will derive a price for each deliverable item ("pay item") by first estimating the cost and hours required to complete each pay item, and then applying a markup over that cost. It's not always that simple – and can vary by contract type (see 2.3.1 below) – but that generally defines the method for establishing project revenue. When it comes to planning and executing the activities of a project, however, project controls and project managers will follow a hierarchical work breakdown structure (WBS) that generally mimics the time-driven schedule of the project and its activities. The WBS is typically where cost, schedule and hours are budgeted and tracked on the project. It's common for the list of pay items to have a mapping to the cost activities defined in the WBS and schedule. It may be that the completion of multiple activities occurring across the WBS will need to occur in order to evidence progress on a single pay item.

A	B	C	D	E	F
Work Breakdown Structure	Cost Code	Current Budget (Cost)	Cost to Date	Percent Complete	Pay Code
1 Project Development	**100**	**$ 1,360,089**	**$ 1,186,270**	**77.30%**	
1.1 Preliminary/Detailed Engineering - FEL-1	**Q10**	**$ 297,344**	**$ 247,544**	**53.71%**	
1.1.1 Civil Engineering - Design to 2D Plan	321	$ 14,000	$ 17,870	100.00%	
1.1.2 Electrical Engineering - Power Supply	322	$ 21,844	$ 132,525	100.00%	
1.1.3 Geotechnical Engineering	323	$ 20,400	$ 5,814	100.00%	
1.1.4 Mechnical (&Process) Engineering	5560T	$ 32,212	$ 20,094	100.00%	
1.1.5 Onsite Engineer	290	$ 208,888	$ 71,241	34.10%	TM90
1.2 General Procurement - FEL2	**P90**	**$ 1,062,745**	**$ 938,726**	**83.91%**	
1.2.1 Civil Materials Supply	501	$ 15,240	$ -	0.00%	TP2772
1.2.2 Injection Pumps Procurement	5041	$ 289,846	$ 134,049	46.25%	
1.2.3 Purchase Piping Materials	609	$ 757,659	$ 804,677	100.00%	TP2772
1.2.4 Valves and Exchangers	515	$ -	$ -	0.00%	TP2772
2 General Requirments	**200**	**$ 754,792**	**$ 469,466**	**62.20%**	
2.1 7.5% Management Fee	401	$ 61,640	$ 52,000	84.36%	TM90
2.2 Environment, Climate, Water management	402	$ 499,764	$ 317,588	63.55%	TE3410
2.3 Mob and Demob	403	$ 121,388	$ 85,500	70.44%	TS168
2.4 Expenses and Travel	404	$ 72,000	$ 14,378	19.97%	TM90
3 Facility Construction	**300**	**$ 4,129,399**	**$ 986,739**	**19.91%**	
3.1 Phase 1 - Structures	**S1**	**$ 2,476,697**	**$ 399,305**	**14.14%**	
3.1.1 Main Facility Construction	502	$ 1,659,935	$ 12,252	0.74%	TS12-9Y
3.1.2 Clearing, Grubbing and Site Prep	503	$ 66,360	$ 36,623	18.93%	TS168
3.1.3 Onsite Engineer	504	$ 121,203	$ 105,213	86.81%	TM90
3.1.4 Pipeline Culvert Construction	505	$ 197,339	$ 149,022	58.44%	
3.1.5 Control Systems Hardware	506	$ 207,601	$ 79,756	50.49%	
3.1.6 Install Small Bore Pipe and Supports	508	$ 92,259	$ 16,439	0.00%	TS775
3.1.7 Civil Works - Excavation, Hauling and Gradir	898	$ 132,000	$ -	0.00%	
3.2 Phase 2 - Elevation	**E1**	**$ 876,847**	**$ 426,905**	**42.58%**	
3.2.1 Install Small Bore Pipe and Supports	508	$ 354,593	$ 44,236	45.11%	TS775
3.2.6 Pipeline Culvert Construction	505	$ 263,344	$ 376,774	78.79%	
3.2.7 Control Systems Hardware	506	$ 82,677	$ -	0.00%	TP2772
3.2.8 MCC Installation	515	$ 176,233	$ 5,895	3.35%	
3.3 Phase 3: Environmental Management	**M16**	**$ 558,563**	**$ 160,530**	**17.63%**	
3.3.1 Geo-Liner Construction	601	$ 120,280	$ -	0.00%	TE3410
3.3.2 Geotechnical	602	$ 6,840	$ -	30.00%	TE3410
3.3.5 Supply pipe drainage components	608	$ 196,099	$ 70,794	40.00%	
3.4 Final Commissioning	**R1**	**$ 217,292**	**$ -**	**0.00%**	

Figure 1 - Sample Extract from a WBS Showing Pay Code Mapping

Figure 1 above shows a snapshot of an example WBS that has certain activities mapped to pay items through the pay code shown in column G. It demonstrates a typical way that WBS activities (cost) relate to pay items (revenue). Notice that multiple WBS activities can map to a single pay item. Depending on how the contract with the client has been written and negotiated, some or all of the related WBS activities will represent the list of terms and milestones by which the pay item is progressed, and evidenced as complete, according to the contract terms. Figure 2 below is an example that shows the associated list of pay items with their pay code to which the WBS activities are mapped. The item and code are usually extracted from the client contract.

J	K	L
Pay Item	**Pay Code**	**Price**
General Conditions	TS168	$ 122,839.00
Management and Travel	TM90	$ 57,822.00
Environmental and Dewatering	TE3410	$ 138,209.00
Storm Servicing	TS775	$ 98,633.00
Domestic Water Servicing	TM2320	$ 72,379.00
Fire Water Servicing	TF1-299	$ 217,209.00
Electrical and Communication Services	TE49B	$ 318,008.00
Materials Procurement	TP2772	$ 847,566.00
Site Finishes	TS12-9Y	$ 58,298.00
		$ 1,930,963.00

Figure 2 - Sample Pay Items With Associated Pay Codes

This method of project planning shows a clear separation of cost and revenue on a project, and how they are connected to each other. It enables project controls to plan, budget, monitor and report cash flow without the nuisance of trying to comingle them together. The costs, hours and progress of the WBS activities that are related to pay items will roll-up separately to those pay items to indicate margin, productivity, and progress towards the deliverables defined by the pay items. Figure 3 below shows how the system will pivot the view to roll-up the associated WBS activities to the pay item. This demonstrates how the cost, progress, hours, etc. of specific cost-driven activities (and milestones) can feed into the revenue-driven pay item deliverables. It's important to remember that progress – physical progress – will cross-over to function as purposeful for both cost and revenue.

Pay Items	Cost Code	Percent Complete	Pay Code
General Conditions		**53.71%**	**TS168**
2.3 Mob and Demob	403	70.44%	TS168
3.1.2 Clearing, Grubbing and Site Prep	503	18.93%	TS168
Management and Travel		**83.91%**	**TM90**
1.1.5 Onsite Engineer	290	34.10%	TM90
2.4 Expenses and Travel	404	19.97%	TM90
2.1 7 5% Management Fee	401	84.36%	TM90
3.1.3 Onsite Engineer	504	86.81%	TM90
Environmenntal and Dewatering		**62.20%**	**TE3410**
3.3.1 Geo-Liner Construction	601	0.00%	TE3410
3.3.2 Geotechnical	602	30.00%	TE3410
2.2 Environment, Climate, Water management	402	63.55%	TE3410
Storm Servicing		**19.91%**	**TS775**
3.2.1 Install Small Bore Pipe and Supports	508	45.11%	TS775
3.1.6 Install Small Bore Pipe and Supports	508	0.00%	TS775
Site Finishes		**0.74%**	**TS12-9Y**
3.1.1 Main Facility Construction	502	0.74%	TS12-9Y
Materials Procurement		**22.00%**	**TP2772**
3.2.7 Control Systems Hardware	506	0.00%	TP2772
1.2.1 Civil Materials Supply	501	0.00%	TP2772
1.2.3 Purchase Piping Materials	609	100.00%	TP2772
1.2.4 Valves and Exchangers	515	0.00%	TP2772

Figure 3 - View of pay items pivoted to show WBS deliverables rolled-up

2.3 Revenue and Cost Recognition

To understand contractor cash flow, it's first important to tackle how cost and revenue are recognized on a project. The accounting rules for how cost is recognized versus how revenue is recognized are roughly similar except that one refers to income and the other to expenses. Revenue is recognized on a project when a performance obligation per the customer contract (such as an agreed-to deliverable – pay item) has been completed, and that event can be easily measured and evidenced to the client [1]. Revenue is most often recognized (or earned) prior to receiving payment for the work, so it can sit in receivables for a duration of time prior to the cash hitting the bank account. That is an important distinction to remember; that revenue is frequently recognized (or earned) before it's paid. Additionally, how revenue is recognized on a project is dependent on the contract type of the project, and the terms set out by the client (see section 2.3.1 below).

Cost, similarly, is recognized when an event that will generate an obligation to pay, or a liability has occurred. Unlike revenue, cost can come from many different sources on a project, whereas there is typically only one source of revenue on a project. Example cost sources include:

1. Direct and indirect labor hours
2. Contractor labor hours
3. Materials purchases
4. Equipment rentals
5. Subcontractor services
6. Labor-related expenses such as meals, subsistence, credit card expenses, travel, etc.
7. Consumables
8. Land purchases
9. Legal fees
10. Taxes and financing costs
11. Other miscellaneous expenses

It's important to note that the timing of the cost recognition will differ by the type of cost. Labor costs for example, could be recognized daily, whereas the purchase of materials will happen when ownership of the materials passes to the contractor at various points throughout the project, and other expenses can be one-time fees. Like revenue, cost will appear as an expense (accrual) on the project for a duration of time prior to it being paid and the funds leaving the bank account. Payroll could be bi-weekly, for example, and subcontractor payments that go through accounts payable (AP) will require approving a received invoice, then paid subject to the payment terms for that vendor. A subcontractor expense could sit on the project as an accrual (recognized cost) for weeks or months prior to paying that expense. This delay is important to consider when planning for cash flow.

In his 2011 paper on revenue recognition methods, Francisco Blanco provides a succinct summary of this same topic, "Why is revenue recognition able to influence and be influenced by cash flow? Because at some point in time – and depending on the payment and collection terms and conditions – recognized revenue will have to be collected (cash-in), and recognized costs will have to be paid out (cash-out). In an unbalanced situation between recognized revenue and collection of that revenue, and between recognized costs and payments for those costs, it could happen that a company could be performing well from the recognized revenue point of view, and at the same time be undergoing if that company is not able to collect the cash of those recognized revenue or sales. That is why, in order to understand the real situation of a company, it is necessary to pay attention not only to its financial statements (costs and sales), but also to the

company's treasury situation (cash-in influenced by collectability; and cash-out influenced by payments)." [2].

2.3.1 Contract Types

The type of contract will influence how revenue is recognized, as well as how it is billed and collected. There are a variety of standard contract types that contractors will engage in with their clients. Four of the most common types are:

1. **Time and Materials (T&M)**. For T&M, the contractor will submit their charge-out rates and mark-ups for the various types of activities they will provide on the project, such as labor, equipment, materials, etc. They will bill the client on a transactional basis itemizing all the hours and expenses incurred over a period.
2. **Fixed Price**. Also known as *lump sum* or *fixed fee*, this is where the contractor bids the project as an all-in price that is estimated and agreed-to up front.
3. **Unit Price**. Also known as *schedule of rates* or *remeasurement*. For this type of contract, the contractor will bid a price for each unit of completion for each pay item. Pay items in this case need to be quantifiable in discrete units of measure, such as cubic-feet, linear-meters, welds, each, etc.
4. **Cost Plus.** Cost plus contracts apply a markup over cost for every cost transaction incurred on the project. They will bill the client on a transactional basis showing the cost, markup and billable for each transaction.

T&M, cost plus and unit price recognize revenue on a transactional basis. For example, every hour or unit that is completed will result in a billable transaction that will then be invoiced to the client. On an agreed billing cycle, a collection of transactions will be batched up and billed to the client. Fixed price contracts, on the other hand, are billed per the contractual terms with the customer, frequently on a progress or milestone basis. Regardless of the type of contract, earned revenue will be recognized by completion of contract pay items and subject to the frequency and terms of the billing and collection cycle. This cycle is represented by a payment schedule that defines the planned dates and events that invoices are estimated to be submitted and collected (more on payment schedules in sections 2.4.2 and 2.4.3 below).

2.4 Time-Based Cash Flow Scheduling

Major projects need to be setup so that cash flow can be forecasted during planning and then again in incremental measurement periods throughout the project. To get started on this, the budget needs to be time-phased according to the project schedule. The project schedule in this context is that which represents the timing, dependencies and critical path of work activities according to the WBS (such as would be found in Oracle P6 or Microsoft Project). Merging the

budget and project schedule enables the budget to be visualized over a timeline such as can be seen in Figure 4 below.

Figure 4 - Time-Phased Project Budget

Time-phasing the budget, however, is used more for activity scheduling, progress, accruals and cost control rather than actual cash flow, as a time-phased budget is not a true indicator of cash flow. As will be shown further down in this section, to achieve an accurate reading of cost cash flow will require more input from procurement and accounts payable *payment scheduling*.

2.4.1 Time-Phased Planning

An important responsibility of project controls is to be able to merge project budget and schedule to visualize the budget over a timeline (as shown in Figure 4). This is critical for evaluating key metrics such as planned value (PV, or BCWS) which shows the scheduled amount of budget that was planned to be spent on the project at any point in time (more specifically, when the cost was planned to be *recognized).* Further to that, project controllers have the option to override the default schedule and use a "time-phasing" algorithm for certain activities on which the anticipated spend is not expected to follow a pro-rated, linear pattern, but may have a flow that is skewed to be front-loaded, rear-loaded, bell-curved or follow some other formula. By doing this during planning, the project budget timeline curve will give a strong indication of how cost will be recognized on the project over time. Note again that this is used primarily to monitor the status and completion of activities according to the project schedule, and not specifically to

represent cash flow. Rather, this will indicate when cost is planned to be recognized on the project. Additionally, time-phasing the budget is typically confined to cost and hours, not necessarily revenue. Revenue is scheduled separately as will be shown below in section 2.4.3. To get a clearer picture on cash flow, an extra step is necessary; a step that accounts for when the recognized costs will be paid. This is payment scheduling.

2.4.2 Payment Scheduling: Accounts Payable

To plan for how recognized cost expenditures will be paid, input from procurement, payroll and AP are required. Each purchase order and subcontract committed on the project will have details around its individual payment schedule. Depending on the nature of the subcontract – or receiving plan for the purchase order – each contract can have a unique agreement for the basis of payment, known as a 'payment schedule'. The payment schedule is split up into payment *events*. Examples of payment events can include:

- Advance payments
- Scheduled payments for events such as progress, milestones, receipt of goods or other
- Retainage or holdbacks

Some payment schedules can be received on a recurring instalment plan for items such as equipment rentals.

A scheduled date will be attached to any of the payment events setup for the purchase order or subcontract, along with predefined payment terms for when the contractor is obligated to be paid for the completion of the event. Example payment terms can be net-30, net-45, etc., meaning they have 30 or 45 days to pay. Both the payment schedule and the payment term for each contract need to be factored into the cost cash flow of the project.

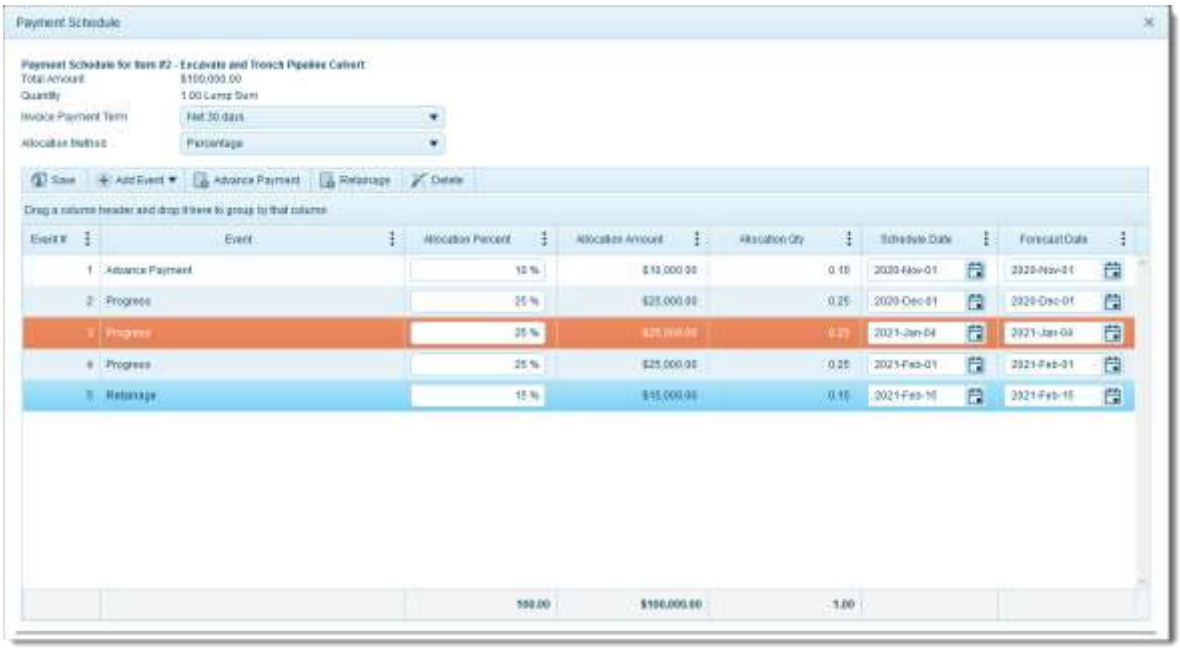


Figure 5 - Example Subcontract Payment Schedule

In the example payment schedule shown in Figure 5 above, five payment events have been created for the lump-sum $100,000 contract item (pay item) for excavation work; each with an amount and estimated date they will be incurred. The 30-day payment term has also been defined to indicate the delay between receipt of invoice and payment. It's important to note that these payment events may bear only slight relationship to the time the work is planned according to the project schedule. This accounts for the difference between when cost is recognized versus actual cash flow.

2.4.3 Payment Scheduling: Accounts Receivable

Payment schedules for revenue operate in a similar fashion to those for cost – it's effectively the flip side of that cost payment schedule shown in Figure 5. Contractors will create a payment schedule for each billable pay item. They will factor-in the amounts, percentages and estimated dates for completion, and how they will claim the revenue once it's been recognized.

The table in Figure 6 shows a simplified example of a 12-month payment schedule for a fictitious project. Although the cumulative cash inflow shows the appearance of a steady inflow of revenue, certain slow months, such as in April, June and November, can cause potential cash flow challenges depending on how the costs play out. This will be exhibited further down.

Month	Receivables Cash Flow Forecast	Cumulative
February 2021	$ 25,000.00	$ 25,000.00
March 2021	$ 50,000.00	$ 75,000.00
April 2021	$ 10,000.00	$ 85,000.00
May 2021	$ 90,000.00	$ 175,000.00
June 2021	$ -	$ 175,000.00
July 2021	$ 45,000.00	$ 220,000.00
August 2021	$ 125,000.00	$ 345,000.00
September 2021	$ 10,000.00	$ 355,000.00
October 2021	$ 75,000.00	$ 430,000.00
November 2021	$ 5,000.00	$ 435,000.00
December 2021	$ 85,000.00	$ 520,000.00
January 2022	$ 50,000.00	$ 570,000.00

Figure 6 - Sample 12-month Project Receivables Cash Flow with Cumulative chart

2.4.4 Intersection of Cost and Revenue for Net Cash Flow

Using the payment scheduling techniques described above will enable project controls to generate a more accurate representation of project cash flow for both cost and revenue. In thinking of a project's finances somewhat like the finances of a business, it's also key to view the intersection of these two cash flow projections to see the net cash flow of the project over time.

Starting with the cost cash flow forecast in Figure 8 below, it's tempting to zero-in on that final budgeted cost of $481k and compare it to the final revenue of $570k in Figure 6 and be rather satisfied that the project will make a good profit. While this may be true in the final balance, the journey to get there has some deep cash flow imbalances that will need to be addressed through effective management of the customer contract, vendor subcontracts and potentially outside financing.

Month	Cost Cash Flow Forecast	Cumulative Cost
February 2021	$ 7,730.00	$ 7,730.00
March 2021	$ 8,980.00	$ 16,710.00
April 2021	$ 157,840.00	$ 174,550.00
May 2021	$ 7,780.00	$ 182,330.00
June 2021	$ 33,880.00	$ 216,210.00
July 2021	$ 7,880.00	$ 224,090.00
August 2021	$ 32,780.00	$ 256,870.00
September 2021	$ 7,760.00	$ 264,630.00
October 2021	$ 97,830.00	$ 362,460.00
November 2021	$ 27,880.00	$ 390,340.00
December 2021	$ 82,860.00	$ 473,200.00
January 2022	$ 7,900.00	$ 481,100.00

Figure 7 - Sample 12-month Project Cost Cash Flow Forecast

The intersection of those cost and revenue forecasts (cash-on-hand) shown in Figure 8 below indicates that the project will suffer a net cash deficit in May of almost $80,000, and again in July of over $31,000. The issue in May, for example, is due to the sharp spike in cost planned to be incurred in April that coincides with a relatively low receivables payment in that same month.

Month	Cash on Hand
February 2021	$ 10,000.00
March 2021	$ 27,270.00
April 2021	$ 68,290.00
May 2021	$ (79,550.00)
June 2021	$ 2,670.00
July 2021	$ (31,210.00)
August 2021	$ 5,910.00
September 2021	$ 98,130.00
October 2021	$ 100,370.00
November 2021	$ 77,540.00
December 2021	$ 34,660.00
January 2022	$ 86,800.00

Figure 8 - Net Project Cash Flow or Cash on Hand

From a financing perspective, this is clearly not an ideal scenario, but since this project is still in the planning phase, finance has several options for how to mitigate that imbalance. Once the project has started, however, and all the contracts are finalized, there will be fewer options, so it's important to include this step as an essential part of project planning. Following are some sample options; some of which are not always feasible, but are worth considering where possible:

- Adjust the schedule so that revenue-generating activities can be completed prior to the outlay of significant purchases
- Negotiate an advance payment from the client that covers early expenses
- Arrange payment terms for costly items to be staggered or delayed

If these kinds of options are not feasible, then:

- Ensure there is sufficient room in the line of credit
- Arrange for bank financing or additional funding from investors
- Evaluate the revenue potential from other projects to see if funding can be shuffled to cover this short-term gap

3 Contractor Financial Risk

Forecasting cash flow projections during project planning is a good starting point for securing the project's *planned* cash flow, however construction projects are well known to never go accurately to plan (or, if one ever has, it certainly was not on *this* planet). As a result, that initial cash flow plan is destined to change, and change regularly. Some changes are manageable and can result in higher revenues or even just a shift in timing. Unfortunately for the contractor, however, they often bear the financial risk for changes which they can't be reimbursed for, if those changes are a result of issues such as rework, poor estimating or misunderstandings of the contract. In addition to changes, claims and disputes are also common, and may cause payment delays that can go on for months.

On the reverse side of that, contractors are also exposed to potential issues that can arise with their subcontractors. These can present challenges with subcontractor performance issues, which can have ripple effects to the contractor's ability to deliver to their client according to the contract. This puts the contractor in a tricky position trying to manage more than just the client; they also need to manage their own work, along with the work of their subcontractors. Many failure points that can eat away at margin – and their reputation.

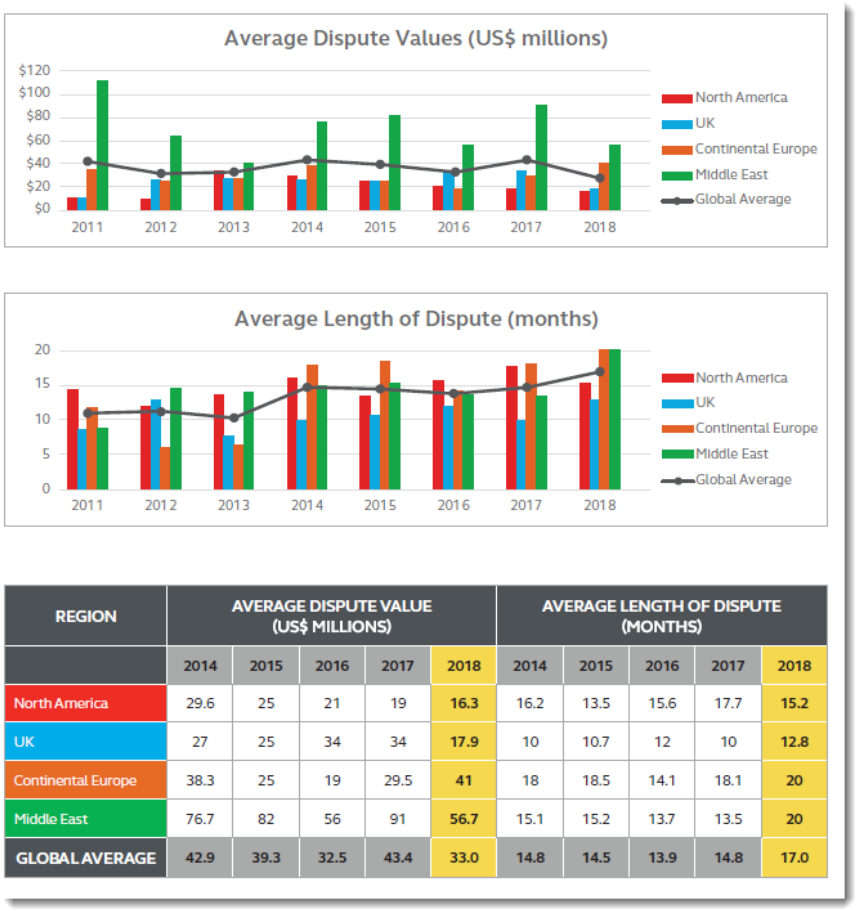
3.1 Impacts of Rework, Claims and Disputes

Contractors endure a human element where errors and oversights can cause unforeseen costs by way of rework, claims and disputes. These can result in unanticipated, non-reimbursable costs to the contractor, or a delay in payments.

3.1.1 Claims and Disputes

The reality of a major project is that unexpected issues should be expected. Despite the rigor applied in planning and project management, construction projects require an agile approach when issues arise and things don't go precisely to plan. Unfortunately, someone needs to cover the cost of these unplanned situations, so when these issues are the result of negligence, faulty work or mistakes, fingers get pointed and the stakes can be high. A common phrase uttered by even modestly cynical contractors sheds some light on how they view it: "The last phase in any construction project is the legal phase." While disputes are clearly avoidable and most end up settled in an equitable agreement out of court, they are a risk that need to be anticipated and managed. Figure 9 below taken from Arcadis global construction disputes report, shows the average value of construction contract disputes in North America was over $16m in 2018; and as many as 30% of construction projects end in a legal dispute [3].

Financially, a contractor facing a claim can be burdened with having to cover expenses while coping with payment delays and additional legal expenses if applicable. All the while running the risk of an unsuccessful claim and losing money on the project. As pointed out by Caldarera's Fundamentals of a Construction Claim, "Getting paid for a *legitimate* claim may be the difference between profitability and a loss." [4].



REGION	AVERAGE DISPUTE VALUE (US$ MILLIONS)					AVERAGE LENGTH OF DISPUTE (MONTHS)				
	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
North America	29.6	25	21	19	16.3	16.2	13.5	15.6	17.7	15.2
UK	27	25	34	34	17.9	10	10.7	12	10	12.8
Continental Europe	38.3	25	19	29.5	41	18	18.5	14.1	18.1	20
Middle East	76.7	82	56	91	56.7	15.1	15.2	13.7	13.5	20
GLOBAL AVERAGE	42.9	39.3	32.5	43.4	33.0	14.8	14.5	13.9	14.8	17.0

Figure 9 - Global Construction Disputes Report [5]

3.1.1.1 Compliance with Contract Obligations

According to Arcadis [5], the primary causes of rework, claims and disputes are principally a result of either a lack of contract clarity, or a failure to complete contract terms as described. As indicated in Figure 10 taken from that report, the following are the top 3 causes for disputes:

1. Owner/contractor/subcontractor failing to understand and/or comply with its contractual obligations
2. Errors and/or omissions in the contract document
3. Failure to properly administer the contract

What this suggests, is that contractors need to invest a sufficient amount of up-front effort during contract negotiations to ensure they have full clarity on the terms of what they have to deliver,

prior to signing that contract. Much of the financial risk they endure can be alleviated long before the project is even awarded.

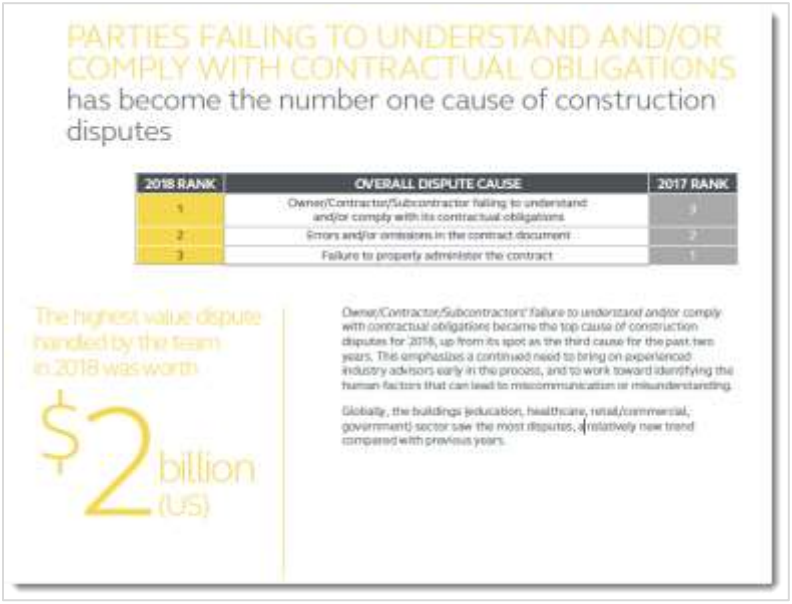


Figure 10 - Primary causes of contract disputes 2018 [5]

3.1.2 RFIs and Change Orders

It's very common for contractors to be confronted with gaps or errors in the information they're provided to complete their deliverables. Issues such as incomplete drawings or out-of-date plans can put a contractor in a position of requiring further clarification or updates. To address these situations, a request for information (RFI) is a best practice for formalizing the process of notifying the owner, client or engineering company of their request. It's vitally important for the contractor to adhere to this process as it is a small amount of effort that can go a long way towards avoiding errors or rework; and can result in a revenue-generating change order that has a high likelihood of being approved. Contractors can also legitimately enter a claim to be compensated for any delays resulting from an RFI. As described by Caldarera, "If the contractor is impacted due to delays in receiving answers to *requests for information* ("RFI"), the encountering of a differing site condition or defective plans, or for other reasons *beyond the control* of the contractor, the contractor is entitled to submit a request (or claim) for equitable relief. In many cases, change orders are issued that cover the cost of additional work. But not all additional work results in an agreement between the owner team and the contractor." [4].

3.1.3 Release of Holdbacks

Most contracts include the provision of one or more holdbacks (also known as retainage). Holdbacks can total to 10% or more of the total contract with the client. This adds another layer of financial risk onto the contractor, especially for large projects that span a long duration such as several years before the holdback is released. For these projects, the contractor will incur costs that can take years to be reimbursed. The amount of reimbursement is reliant on the contractor's ability to evidence substantial completion, along with other contract terms. Rules for holdbacks can differ across jurisdictions, along with the terms of their release and provisos for finishing their obligations. Holdbacks are even mandatory in some areas. [6]

3.2 Using Project Controls Practices to Mitigate Risk on Revenue and Margin

A key element to the application of project controls practices on complex projects, is that it elevates the enforcement of project teams to plan, measure and track their projects; and then analyze them in real-time. These practices result in amassing a lot of detailed information on activities, costs, changes and performance. When this data is housed in a system that provides good reporting and analytical tools, contractors can leverage this data to abate financial risk, reduce the chances of eroding margin, and avoid and defend any disputes or claims.

3.2.1 Performance and Progress Metrics

Central to the information gathering is to include data on productivity metrics. For example:

- Crew productivity. Metrics such as hours-per-unit installed, productivity factor (PF)
- Subcontractor performance
- EVM metrics on activities, phases and the project as a whole. For example, CPI, SPI and PF.

Collecting and reporting on performance metrics is essential for early identification of issues that may have an impact on cost, schedule and the delivery of milestones. Taking corrective action early on is not just a project controls mantra, it's a survival technique for contractors to maximize their profitability. Having a software system in place to collect, analyze and report on these metrics is a fundamental requirement for any contractor so that can be confident in the information they're using to make strategic decisions.

3.2.2 Continuous Client Reporting

Poor or inadequate communication with the client can foster a strained relationship and set the tone for negotiations around the contract, change orders and even disputes. Although most

contracts will set the expectations around reporting, the contractors that are transparent and provide a high velocity of good-quality reporting will endow the client with confidence, even when things go wrong. Some software systems provide a client *portal* where selected reports and documents are made available for the client to browse on-demand thereby reducing the barriers of customer transparency.

Figure 11 below highlights a number of methods for resolving and avoiding disputes. Several of these fall under the umbrella of project controls, either directly or indirectly, for example:

1. **Contractor transparency of cost data**. As mentioned above, continuous detailed reporting is key for nurturing positive relations with the client.
2. **Risk management**. Applying project controls practices to reduce risk.
3. **Project management information systems**. By adopting a dedicated construction project management and controls software platform, contractors can extract and report on the volumes of data and analytics to avoid and defend claims.
4. **Digital field data collection systems**. By implementing a digital method of collecting daily jobsite information, contractors can mine real-time data for the early identification of issues to be actively resolved before they manifest into bigger issues. This also leads to continuous data transparency with the client.

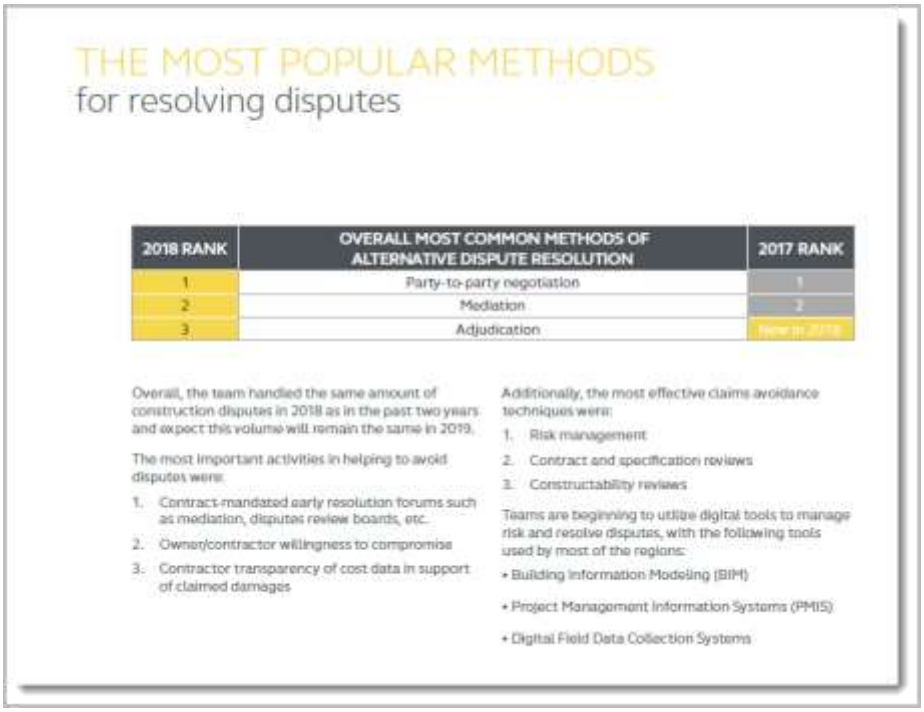


Figure 11 - Popular methods for resolving disputes [5]

4 Continuous, Iterative Forecasts

Not unlike other types of businesses, contractors need to keep an ongoing close eye on cash flow. For contractors, however, they must see cash flow from both a corporate finance perspective, as well as a project finance perspective. Each project on its own can have the complexity and moving parts to warrant the same level of financial governance of an entire company – with the additional layers of meeting the expensive demands of multiple concurrent projects. If it were just one project, cash flow would be relatively straightforward, yet most mid to large contractors will execute on dozens if not hundreds of projects in a year; and each project will endure numerous highs and lows of available capital to fund their expenses. As illustrated in section 2.4 above, contractors can go through regular dry spells in available cash as some projects can drain them with the heavy costs incurred on the project at a time when the expenses have not yet been reimbursed. Costs such as renting major equipment, purchasing materials, hiring subcontractors, etc.

Forecasting project cash flow during project planning is understandably critical to elucidate any funding issues early on prior to project kickoff. Due to the fluid nature of an in-flight project, however, project controls professionals also need to continue to forecast on regular, incremental periods. It's imperative to reforecast, and reforecast again on, for example, a bi-weekly or monthly basis, to expose any shifts or changes to potential funding challenges. A primary role of project controls during project execution is to continuously measure, forecast and recalibrate in iterative cycles.

4.1.1 Real-time cash flow position and projections

What has perhaps become clear from this discussion, is that cash flow needs to be measured and forecasted from a more global context than just a single project. The cash flow projections of each project will need to feed into a more holistic view of a whole portfolio of in-flight and planned projects. No contractor wants to always lean on their lender or investors to bridge the financial gaps of a single project when there is the potential for shuffling the revenues collected on one project to fund the expenses on another project. This is why cash flow must be managed from a more global level where the movement of capital can be visualized comprehensively, taking into consideration the flow of costs and revenues from all projects.

4.1.2 The Importance of Using a Software System

Forecasting cash flow is difficult enough on a single project, expanding that out to include multiple projects is an undertaking that requires far too much effort for most contractors to include in their process if they don't have the technology to do it for them. Spreadsheets fall apart as more and more projects require oversight and analysis. This is where software can do the heavy lifting of aggregating large amounts of data to produce forecasts, trends, patterns, benchmarks and much more to aid the project and finance teams with their business planning. The issue of *over-borrowing* is one that surfaces with many contractors. Clearly no-one wants to resort to borrowing from their bank when it turns out they don't need to; and further, no contractor wants to be encumbered with funding projects on behalf of clients for any periods of time.

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