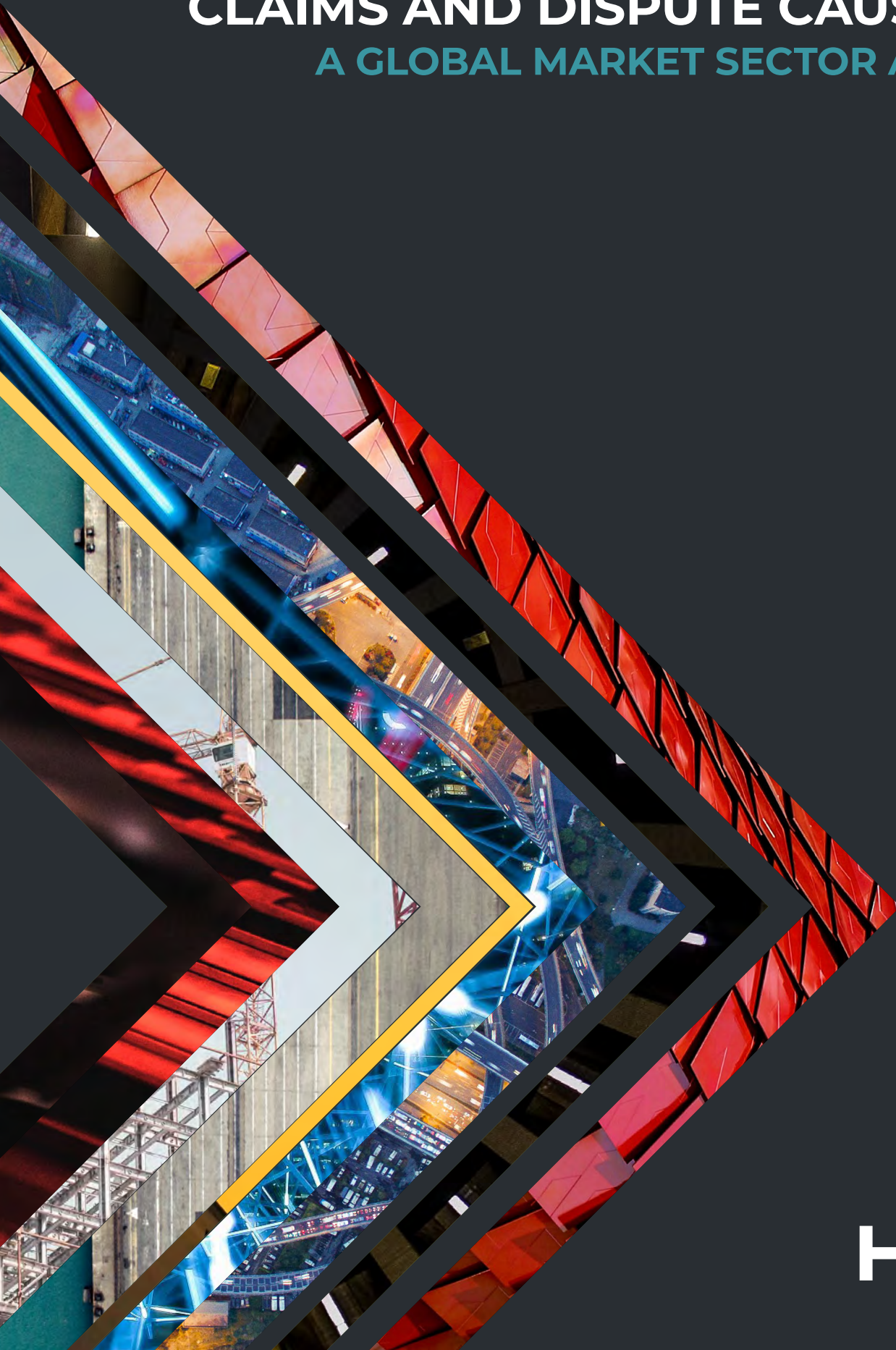


CLAIMS AND DISPUTE CAUSATION

A GLOBAL MARKET SECTOR ANALYSIS



Crux

noun. (kruks)

1. The decisive or most important point at issue.
2. A particular point of difficulty.

CRUX is HKA's integrated research programme providing valuable insight into claims and dispute causation from major capital projects around the world, and is considered the most comprehensive and detailed analysis of its kind in the industry today.

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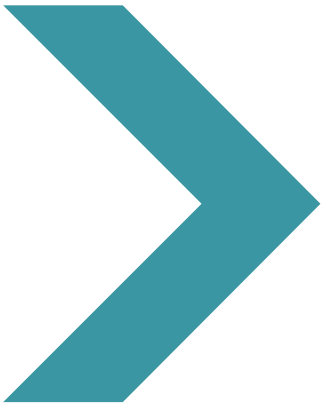
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THE HKA CRUX
TEAM



**“WE ENCOURAGE
GOVERNMENTS AND
PROFESSIONAL BODIES
TO ENGAGE WITH
THE CRUX RESEARCH
PROGRAMME’S FINDINGS
AND ITS IMPLICATIONS FOR
PLANNING, PROCUREMENT,
PROJECT GOVERNANCE
AND CONTROLS.”**



FOREWORD

Resolving disputes on capital projects requires a breadth of expert forensic analysis to navigate the often-complex web of underlying causes.

HKA's integrated research programme, CRUX, draws on our unprecedented bank of knowledge to provide valuable insights into the pattern of causation on engineering and construction projects where our people have provided claims consulting and dispute resolution services on major capital projects across multiple sectors around the world.

As the world's leading construction claims and dispute resolution firm in the industry, we have access to a rich resource of major project data. Our second annual CRUX Insight report is based on the analysis of 700 projects with a combined value exceeding US\$1.2 trillion. We believe this to be both the broadest and most in-depth dataset ever analysed across the industry, and as such provides unique and robust insights.

Last year's report, which was well received by clients and the wider industry, gave a digital perspective on dispute causation. The 2019 CRUX Insight report has a sectoral focus and provides insight into claims and dispute causation factors across all the key major project sectors, that HKA has worked on.

In our work we anticipate, investigate and resolve problems on projects. We know what goes wrong. CRUX confirms that, across all sectors, the lessons are not being learned. The consequences of delay, disruption, lost productivity, higher costs and lower quality are not only significant for projects and for clients, contractors and suppliers. Their impact at national level on the industry and economy should not be under-estimated.

All decision-makers on projects can profit from a clearer understanding of the recurring causes of claims and disputes. Policy-makers and influencers can also contribute at industry level. We encourage governments and professional bodies to engage with the CRUX research programme's findings and its implications for planning, procurement, project governance and controls.

HKA is committed to working with our clients and all stakeholders to that end. A good example may be found in Project 13, which points the way to a more effective procurement model for delivering major infrastructure projects. Recently we have been promoting this UK industry-led movement from transactional to collaborative delivery models in Australia and New Zealand, which may go some of the way to addressing the claims and disputes we witness.

Over the coming months, the CRUX team will also explore how dispute causation varies by geographical region and form of contract, and we look forward to sharing the insights of our ongoing analysis with the industry.

Simon Moon

Partner and Chief Operating Officer





“ALL STAKEHOLDERS SHOULD BENEFIT FROM THE USE OF CRUX DATA TO RE-ASSESS THE RISK PROFILE OF THEIR BUSINESS, INCLUDING BY SERVICE, SECTOR AND LOCATION.”



INTRODUCTION

As part of HKA's integrated research programme, we collect and analyse data on major capital projects wherever we are engaged around the world. CRUX Insight is the product of that research and analysis.

Our first CRUX Insight report was published in 2018, revealing the pattern of causation behind disputes on 257 projects. Since then we have refined our methodology, increasing the rigour of the causation taxonomy and capturing additional information.

In the space of just two years, HKA has created a dataset of 700 projects that is unparalleled in its breadth and detail.

Our analysis confirms that change of scope continues to be the number one causation factor for disputes. While this may be no great surprise, the industry can be confident that this finding is robust, as it is on a critical mass of empirical evidence.

The 2019 CRUX Insight report has a sectoral focus, and this also shows that scope change is a dominant factor across all sectors that we have reviewed.

A telling difference this year is how design issues – late, incomplete or inaccurate design information – have largely overtaken the contract-related causation factors that dominated the 2018 analysis.

Changes across the industry are impacting on the design process. As contractors take on the design function or subcontract it, the designer is increasingly being drawn into disputes. At the same time, projects are becoming more complex, safety requirements and regulations more complicated, and digitalisation is accelerating the pace of design evolution.

Potentially significant variations between sectors also emerge, along with other new insights, from the deep pool of CRUX data. This will allow us to analyse dispute causation by, for example, the type of contract used for projects or the region in which the project is situated.

The application of CRUX insights is beneficial for HKA, our clients and other stakeholders. Last year's research was cited by the UK Government's House of Commons Public Administration and Constitutional Affairs Committee in its work reviewing the government's management of major projects.

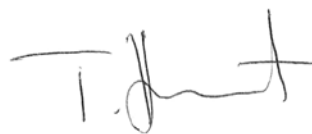
Some of our clients are using our findings to benchmark their performance against their sector peers and other sectors. All stakeholders should benefit from the use of CRUX data to re-assess the risk profile of their business, including by service, sector and location.

I am firmly of the opinion that maximum benefit will come from applying the insights from CRUX with the intelligence and experience of HKA experts and our client teams' knowledge of their organisations and their projects or portfolios.

The result will fundamentally better the commercial decision-making based on empirical data, leading to superior outcomes for our clients and putting the engineering and construction industry on a sounder footing.

Toby Hunt

Partner and
Chief Business Development Officer



METHODOLOGY

Overview

The 2019 CRUX Insight report presents high-level findings from our analysis of claims and disputes on 700 projects worldwide.

This year's publication builds on our inaugural CRUX Insight report published in 2018, and benefits from:

- a refined causation factor taxonomy;
- a new and improved bespoke data collection process;
- an enlarged dataset of project disputes;
- a sector-by-sector review; and
- a series of one-to-one interviews with 20 industry experts to contextualise the findings.

Causation factors – What are the main causes of disputes?

As stated in the 2018 CRUX Report, we committed to rationalise and refine the causation factors to reduce subjectivity and improve reliability. This work also supports the CRUX aim of providing a platform for exploring the relationships between the causes of disputes.

First, the CRUX team compared the causation taxonomy against 57 peer-reviewed academic publications, industry reports and other available sources worldwide. This yielded a list of some 1,750 potential causation factors.

Through detailed analysis and mapping for trends and variations in terminology we were able to rationalise these causes into 50 coherent, individual causation factors.

Next, this list went to the HKA Expert Review Panel to test these often-theoretical factors against practical experience of live projects. This exercise produced a refined list, which the panel then ranked – according to frequency rather than gravity – to give the top 30 most common causation factors.

At this point the list was shared more widely with HKA experts from all disciplines and regions to ensure that the causation factors used in the 2019 questionnaire would be comprehensive and representative of the disputes and projects handled across the business.

This led to further refinements before final agreement on the list of the top 30 causation factors for the questionnaire.

Defining factors – How to distinguish between causes?

As our review of the literature showed, a wide range of terminology – with varying degrees of precision and overlap – is used to rationalise disputes.

Via an iterative process, the CRUX team defined each causation factor as these were agreed and ranked. All these definitions were supported with examples both of relevant causes as well as non-applicable examples, which should be correctly be attributed to other factors that might be considered similar or related.

These definitions and descriptions were incorporated in the questionnaire to ensure greater clarity. Respondents had to select from the list which causation factors were a direct (primary) cause or an indirect (secondary) cause leading to the claim or dispute. As the top 30 causation factors could not be an exhaustive list, respondents were allowed to enter their own primary or secondary causation factors. In this report we have identified the top 10 causation factors for each sector.

The CRUX research has generated a wealth of data from what we believe to be the widest-reaching, fact-based analysis of claims and disputes on engineering and construction projects worldwide. This report only shares a sample of the data we have collected as part of the research process. We will be conducting further analysis and sharing the insights into dispute causation – including regional and sectoral trends – with industry and our clients over coming months.

Creating the questionnaire and selecting respondents

A bespoke questionnaire was commissioned to ensure that the research would be conducted efficiently and the data collected in the format most suitable for further analysis.

To ensure the integrity of the data, the CRUX team set a high threshold for hours worked on each project to qualify respondents to complete the questionnaire. Within HKA project teams, the member who had spent most time working on the project was selected. As a result, every respondent had invested in excess of a month on the project they analysed in the questionnaire. Over 400 of our consultants contributed to this report's findings.

The depth of understanding they brought to the research gives us confidence that the CRUX diagnosis of primary and secondary causes of disputes is underpinned by expert and considered analysis of every project.

Project selection and data collection

Only projects for which HKA provided claims and dispute resolution services were eligible for inclusion in the questionnaire. Commissions involving only our Advisory services – a substantial proportion of our business – were excluded.

To maximise the dataset and strengthen the authority of the results, the CRUX team integrated the data from our 2018 report into the analysis. This took the total number of projects evaluated to 700, so the report includes commissions HKA has worked on from January 2017 to end of August 2019. Data from the 2018 questionnaire was mapped, based on our refined taxonomy of causation factors, onto the 2019 database, and 81 projects were reassessed to ensure consistency.

Analysis and assessment of the findings

This year's report focuses on the patterns of dispute causation in six main sectors: Buildings; Defence, Aerospace & Military; Industrial; Infrastructure; Oil & Gas; and Power & Utilities. It should be noted, however, that of the 700 projects analysed in this report, 14 relate to other sectors; and these are accounted for separately in the 'Other' category to maintain the integrity and clarity of the data.

The findings – including the top 10 causation factors for each sector – were presented to our CRUX Ambassadors for review. These sector experts were drawn from all HKA disciplines and offices, and provided expert insights and regional perspectives based on their direct project experience.



CRUX FINDINGS

The causation count

Our analysis identified over 4,000 causes of dispute on 700 projects in 72 countries, with a total project capital expenditure (CAPEX) in excess of US\$1.2 trillion where HKA has provided claims consulting and disputes resolution services.

On average, there were 5.8 underlying causes per project, dispelling the notion that focussing on individual causes is the most effective way to avoid and reduce the prevalence of engineering and construction claims and disputes and reduce their prevalence. With an average of 3.5 primary and 2.3 secondary causes, our research confirms the complexity of causation.

DESCRIPTION	CAUSATION COUNT
Average no. of causes per dispute - all projects	5.8
Average no. of primary causes - all projects	3.5
Average no. of secondary causes - all projects	2.3
Maximum number of causes - single project	30
TOTAL NUMBER OF CAUSES	4,105

OUR ANALYSIS IDENTIFIED OVER 4,000 CAUSES OF DISPUTES ON 700 PROJECTS IN 72 COUNTRIES, WITH A TOTAL PROJECT CAPITAL EXPENDITURE (CAPEX) IN EXCESS OF US\$1.2 TRILLION WHERE HKA HAS PROVIDED CLAIMS CONSULTING AND DISPUTE RESOLUTION SERVICES.

Overall causation factors by type

The analysis shows the top 30 causation factors overall and we provide insight on the top 10 causation factors for each sector as seen later in the report.

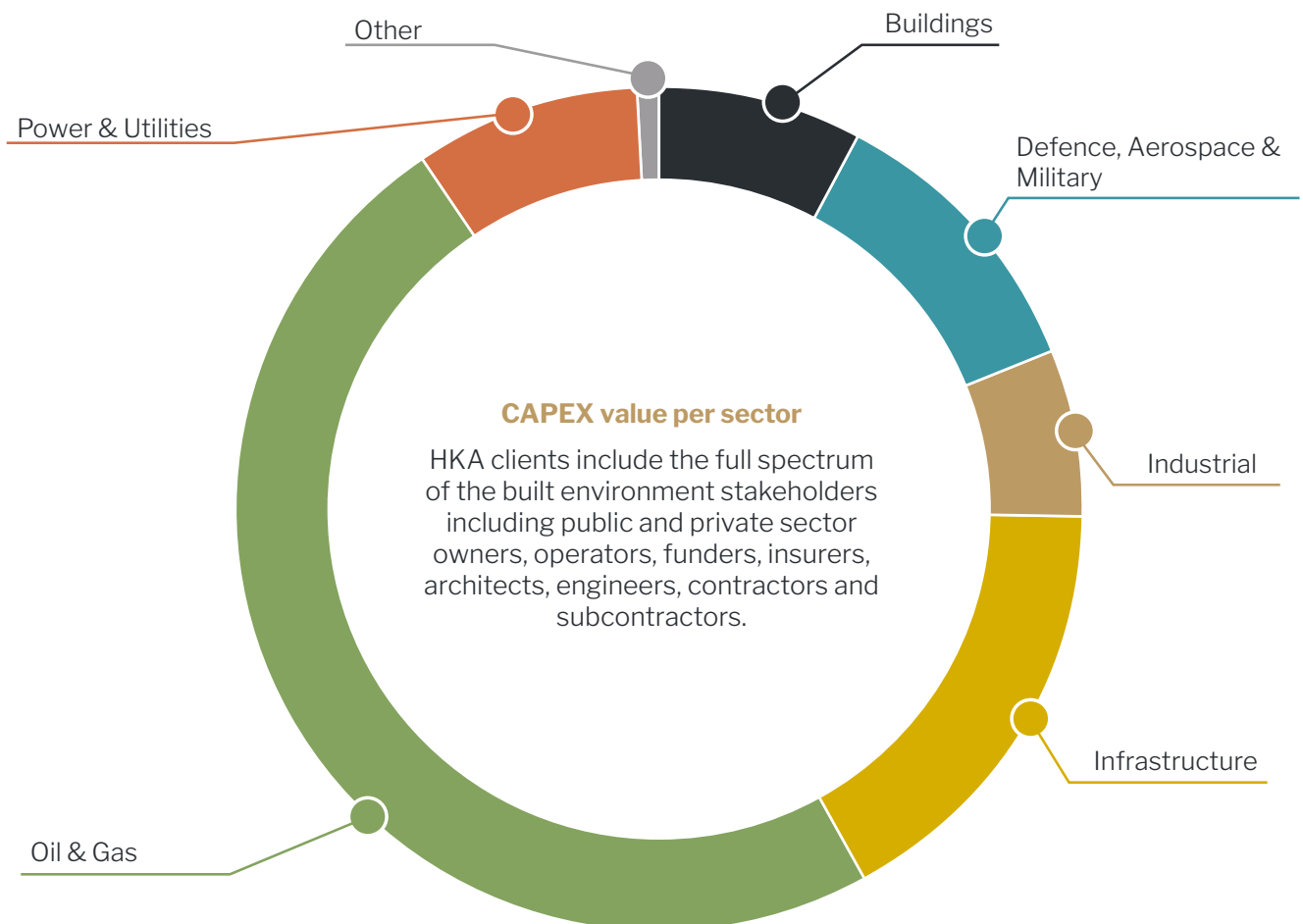
TOP 30 CAUSATION FACTORS	PRIMARY	SECONDARY	TOTAL
Change in scope	293	104	397
Contract requirements were poorly drafted	187	126	313
Contract management and/or administration failure	139	141	280
Design information was issued late	169	78	247
Level of skill and/or experience	111	100	211
Poor management of sub-contractor/supplier and/or their interfaces	102	107	209
Design was incomplete	143	51	194
Access to site/workplace was restricted and/or late	138	47	185
Cash flow and payment issues	97	75	172
Physical conditions were unforeseen	106	60	166
Claims were spurious, over-inflated, opportunistic and/or unsubstantiated	88	76	164
Design was incorrect	114	48	162
Approvals were late	77	66	143
Tender errors and/or inaccurate estimates	59	58	117
Shortage of skilled and non-skilled workers	46	67	113
Workmanship deficiencies	66	42	108
Targets and/or expectations were unrealistic	67	38	105
Operational performance	62	35	97
Inadequate responses to information requests	43	53	96
Materials and/or products were delivered late	60	34	94
Weather conditions were exceptionally adverse	28	49	77
Installation failure	47	25	72
Poor interface management with a third party	39	33	72
Personality and/or cultural differences	24	45	69
Bias and/or failure to cooperate	31	37	68
Other: Sociopolitical/regulatory	33	15	48
Late appointment of sub-contractor/supplier	19	25	44
Reporting was incomplete and/or incorrect	19	21	40
Fraudulent misrepresentation	9	5	14
Expropriation	8	6	14
Fraud	9	5	14
TOTAL	2,433	1,672	4,105

Sectors and values

These projects were selected as representative of the sectors and regions in which HKA operates, and the member of the HKA project team compiling our questionnaire had to have spent more than a month on each project.

HKA clients include the full spectrum of the built environment stakeholders, including public and private sector owners, operators, funders, insurers, architects, engineers, contractors and subcontractors.

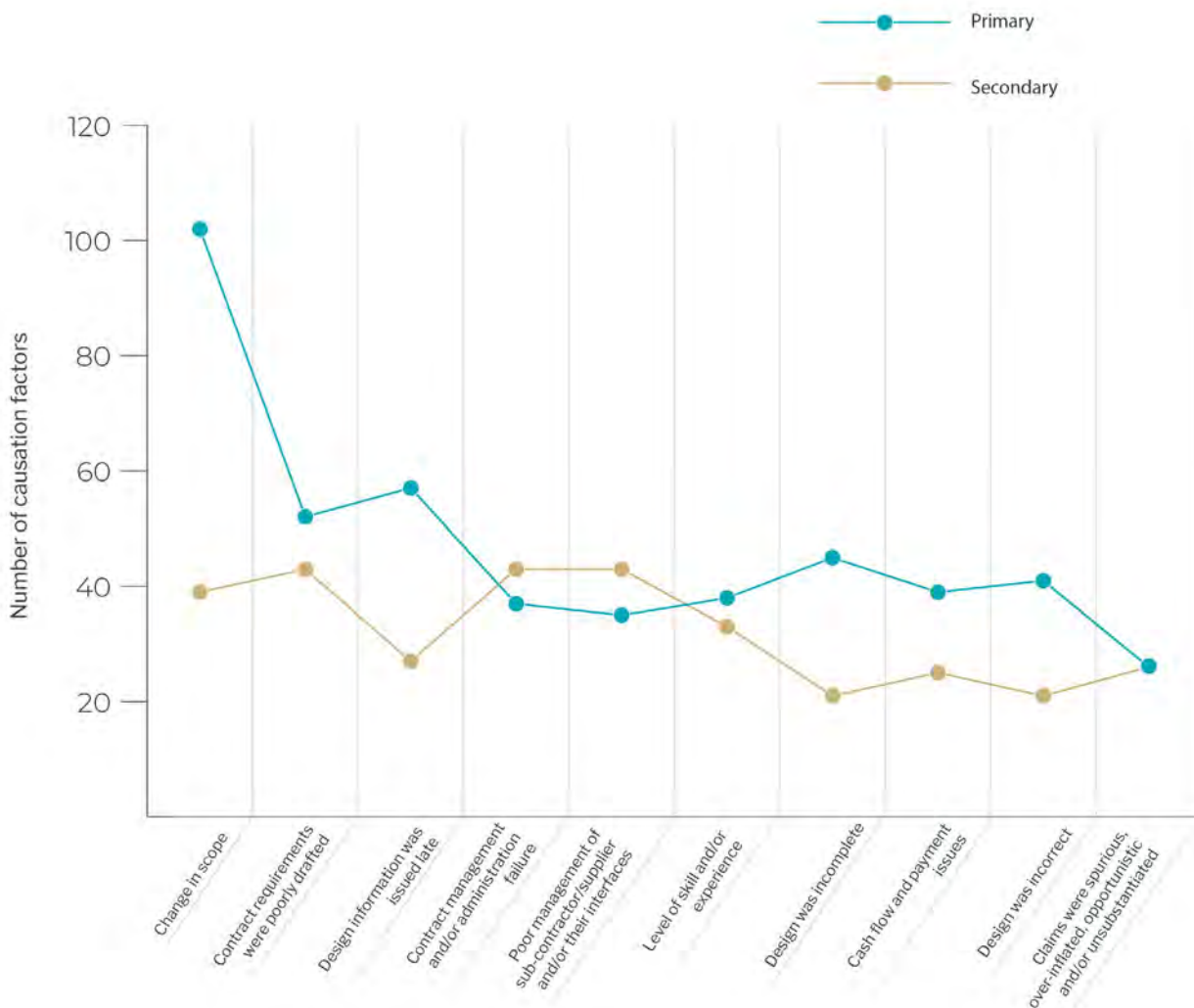
SECTORS	CAPEX IN US\$ '000,000	NO. PROJECTS PER SECTOR	AVERAGE CAPEX PER PROJECT IN US\$ '000,000
Buildings	97,347	232	419
Defence, Aerospace & Military	138,057	14	9,861
Industrial	81,193	57	1,424
Infrastructure	209,075	131	1,595
Oil & Gas	603,700	114	5,295
Power & Utilities	109,203	138	791
Other	7,248	14	517
TOTAL	1,245,826	700	1,779





Buildings

CAUSATION FACTORS	PRIMARY	SECONDARY	TOTAL
Change in scope	102	39	141
Contract requirements were poorly drafted	52	43	95
Design information was issued late	57	27	84
Contract management and/or administration failure	37	43	80
Poor management of sub-contractor/supplier and/or their interfaces	35	43	78
Level of skill and/or experience	38	33	71
Design was incomplete	45	21	66
Cash flow and payment issues	39	25	64
Design was incorrect	41	21	62
Claims were spurious, over-inflated, opportunistic and/or unsubstantiated	26	26	52
TOTAL	472	321	793



Overview

More than 230 construction projects involving a wide variety of building types across six continents were analysed as part of CRUX Insight.

Changes in scope, late design information, and poor drafting and management of contracts form a web of causation that ensnares more construction projects than any other factors that provoke disputes.

Our research shows that a majority of the disputes our experts consult on around the world generally arise from design or building procurement and administration. Few buildings are built to plan, as owners or other key stakeholders change requirements, and various factors outside the parties' control trigger change to the original scope after contract award. Poorly detailed employers' requirements and inadequately considered designs and scopes of work are committed to prematurely.

The multiple effects of failing to manage designs and changes in scope cause disputes that cascade through the programme.

Significant changes to scope are often identified during construction which could have been avoided or reduced if more up-front design work was completed. These changes result in further variations due to vague scoping of design and drafting of contracts, often resulting in delays in issuing design information, or it being incomplete. If these issues were resolved earlier, it is likely contractors' tender prices would be more accurate and the incidence of disputed variation claims would reduce. The multiple effects of these prime causes of disputes cascade through the programme.

A perceived urgency to deliver, we believe, is driving overuse of design-and-build contracts with poor definitions of scope. This is also true of privately financed projects (PFI/PPP), particularly in the UK. In the public sector, annual budgeting is a further catalyst to premature contract awards.

A disproportionate number of the problems our teams encounter stem from the way that construction contracts and the owner's requirements are set out and how risk is sought to be allocated. Many clients and tenants simply underestimate what they don't know, and enter into contract forms and arrangements that are inappropriate for their business. This aggravates the volume of client-led change that we see.

The balance varies with local market conditions and custom, among other factors. Where contractors are chasing work, especially when seeking to break into new areas such as in the Middle East or Asia, or to maintain market share, the balance in power shifts markedly in employers' favour. Contractors are more willing to assume risks posed by ground conditions, unfamiliar contractual terms, or onerous performance securities.

In the US, buoyancy in certain regions has given rise to a tighter market for developers seeking reliable contractors. General contractors there, and design and build contractors in other markets including the UK, have been successfully passing liability to their subcontractors, designers and the supply chain. Offsetting risk may be another explanation why scope of work and contracts are often vague; however, this increases the risk of variations and encourages contractors to cut corners so as to help control costs.

Offloading risk can also backfire on owners as contractors seek to offset what are sometimes cut-throat prices with variation claims. These cannot be rebuffed without more clearly defined scoping of works and tighter project controls. The evidence shows that variations are causing delays, cost overruns and technical failures, as well as damages claims for increased maintenance.

Both negligence and opportunism contribute to the poor drafting of contract requirements, which ranks second as a cause of disputes. Procurement and contract consultant remuneration are rarely driven by project outcomes; they may be perversely incentivised to 'improve' contracts. Those drafting contracts can fail to take account of a document's terms and conditions as a whole. Contracts may even omit express terms, while heavily amended NEC contracts, for example, sometimes no longer serve their original purpose, and include additional or varied provisions that are inconsistent with their standard terms.

Poor administration and management of contracts is another high-ranking factor in disputes. Our experts see the evidence in all jurisdictions. Contract administrators routinely fail adequately to review contract terms – naively believing that is for the lawyers alone – and thus often fail to protect their client’s best commercial interests.

Limited skills and experience are a contributory factor, constituting a widespread problem underlying disputes. If owners are advised poorly on the capabilities needed, they can fail to anticipate and learn lessons from the risks faced by others; and fail to build the relationships and competencies needed to manage risk properly. In western economies at least, the construction industry is failing to attract sufficient talent at all levels and in all disciplines – in the US, for example, from programme schedulers to trades. For the UK, Brexit and tighter immigration controls will reduce supply further.

As the causation table confirms, cash flow and payment issues also continue to trigger many disputes. In many cases, we believe this is due to other events, such as contractors being unable to complete tasks due to late approvals or design information.

Deficiencies in workmanship and installation failures fell outside the top 10 ranking of causation. While this might be lower than expected, we believe it may reflect the wide variety of markets and local conditions. Any suggestion that build quality may be improving is contradicted by the findings of our technical experts, including evidence in the US, where the tighter labour market has increased the amount of defective work by low-skilled contractors – notably in exterior finishes and cladding.

While adverse weather conditions may also not feature among the top 10 causation factors, this is likely to change as extreme events occur with greater frequency. In the southern US, hurricanes, tropical storms and flooding have precipitated many disputes. The impact extends through the aftermath as workers are displaced, or command higher pay, often on other projects. Even six months after a storm, finishing trades have taken eight months to complete what should have been a two-month programme.

The way forward

The pattern of disputes in the sector will remain entrenched until lessons are learnt from the failures repeated across such a broad representation of construction projects.

There are high hopes that digitalisation in the construction industry will facilitate better management of projects and higher productivity. More contractors are embracing BIM and digital tools, but it remains to be seen whether these will reduce design conflicts. Where clients and designers use digital means to test and verify the design intent, before entering into contracts, this may reduce some of the dispute causation related to scope of works. There are positive signs that 3D and 4D models can help people learn more quickly and hone performance on repetitive projects. But there is no easy technological fix to the many causes of disputes that stem from human actions and omissions.

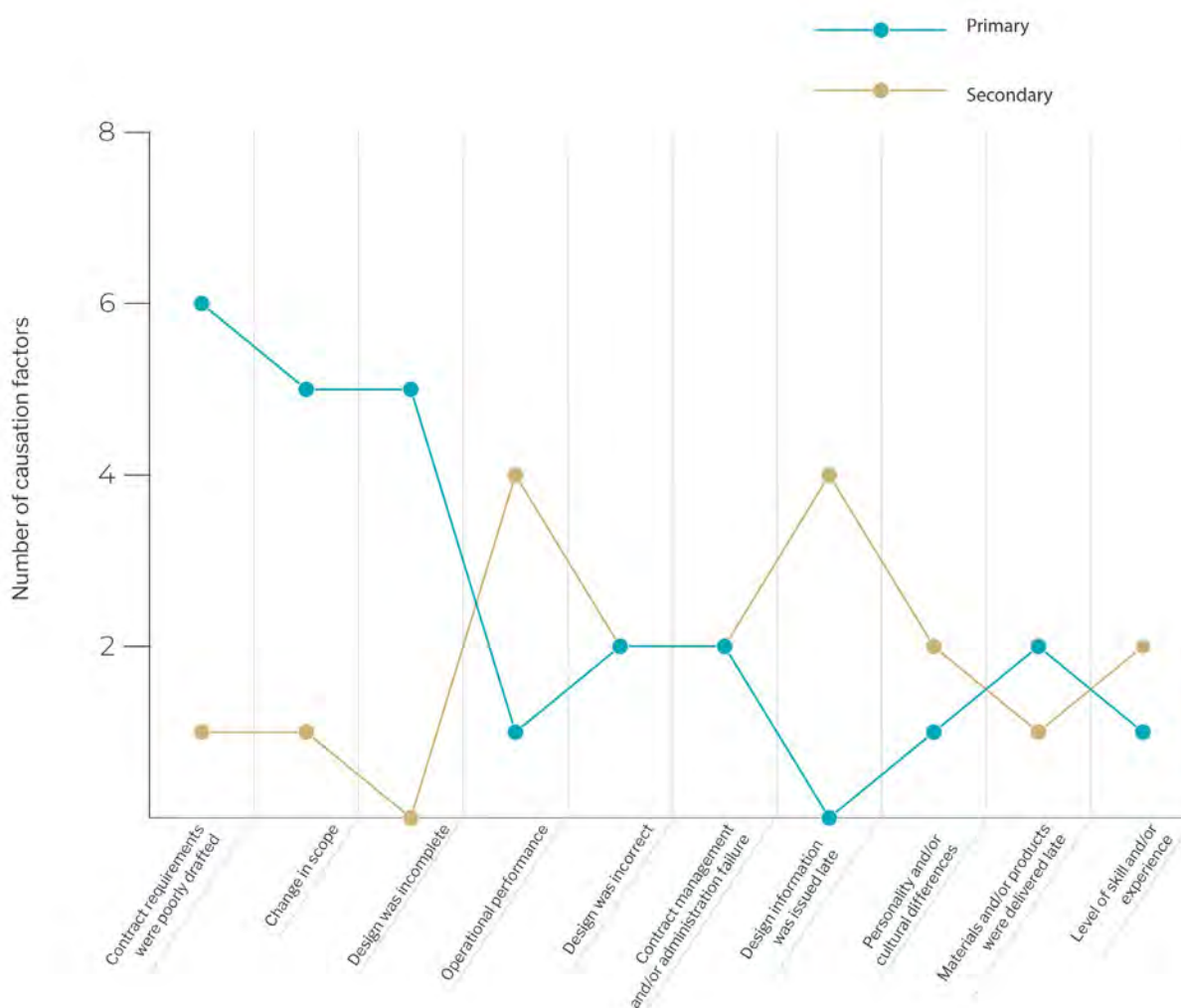
The research suggests that the key lessons learned should include greater clarity in contracts around owner requirements, greater anticipation and sharing of risk, and a more rigorous approach to scoping of works. A higher level of professionalism is also required, particularly among contract administrators. Where failures still occur, interventions are needed sooner, before control is lost, thus managing change more effectively and keeping projects on track.

Digitalisation may facilitate better management of projects and productivity, but there is no easy technological fix for disputes that stem from human actions and omissions.



Defence, Aerospace & Military

CAUSATION FACTORS	PRIMARY	SECONDARY	TOTAL
Contract requirements were poorly drafted	6	1	7
Change in scope	5	1	6
Design was incomplete	5	0	5
Operational performance	1	4	5
Design was incorrect	2	2	4
Contract management and/or administration failure	2	2	4
Design information was issued late	0	4	4
Personality and/or cultural differences	1	2	3
Materials and/or products were delivered late	2	1	3
Level of skill and/or experience	1	2	3
TOTAL	25	19	44



Overview

Despite being distinct in key respects from the other sectors in our analysis, the defence, aerospace and military market shows a similar pattern of dispute causation. The analysis reflects disputes in 14 projects and indicates an overall average of 3.1 primary factors and 2.1 contributory causes of disputes in this sector.

Changes in scope, design incompleteness and contract-related shortcomings dominate the defence, aerospace and military sector.

The fast-moving evolution of the technologies involved makes it harder to predict and manage changes of scope. In combination with incomplete design, this leads to domino effects giving rise to delays and spiralling costs.

This is borne out in the US, for instance, where contractors developing technologies for the Department of Defense, still the world's biggest military spender, frequently find that the development phase overlaps with production because of tight schedules, design changes, and contractual ambiguities. The prevalence of design-centred issues in disputes is more likely in a sector where many projects involve the development of prototypes, and the pressure to deploy the end products can be intense. Deployment will be subject to rigorous safety and security checks, which themselves can lengthen lead times considerably.

The fast-moving evolution of the technologies involved makes it harder to predict and manage changes of scope. In combination with incomplete design, this leads to domino effects giving rise to delays and spiralling costs.

Our research also suggests that the drafting of contract requirements often does not contemplate the inevitability of scope change and evolving design. The trigger for a dispute can lie outside the main contract itself. Supplementary agreements, for example on performance management, may conflict with the main contract; in one case causing a project manager and piling subcontractor to clash over the completion strategy for the works.

A contributory factor to issues in contract management or administration is the government practice in the US, for example, of rotating contracting officers in and out of programmes through their lifecycle, so valuable knowledge and continuity can be lost.

Management of subcontractors and suppliers, and their interfaces, is particularly challenging where the success of projects hinges on the integration of complex systems, and the supply chain itself is highly complex. Therefore, it is imperative that all parts of the supply chain have a united understanding of the objectives to be delivered in each stage of design as early as possible, to avoid costly, lengthy rework.

Supply chains, especially for aerospace projects, are also increasingly international as designers source the most advanced components and systems available from specialist manufacturers worldwide. Differences of culture and ways of working among suppliers can give rise to disputes, as the causation ranking shows.

Regulatory authorities play an important role in aerospace, and lie behind several of the causation factors identified in the research. The US Federal Aviation Administration and European Aviation Safety Agency influence programmes, which can be heavily impacted by subjective interpretations and application of their regulations. These authorities can also cause significant delays in the review and approval process.

Late delivery of materials and components is highly disruptive too. Given that many parts and systems are likely to be one-offs specifically commissioned for the asset, lead times can be long and more uncertain. On defence projects sensitive materials are often required. A government's failure to provide these inputs on time for a missile programme, for instance, severely affected the contractor's schedule.

Constraints on access for workers are another significant disrupting factor for contractors working in the defence sector in various countries. Delays in gaining security clearance for staff can severely hinder progress; strict vetting requirements can raise barriers to participation for smaller companies without the administrative resources of the bigger, established providers. Inevitably, in war zone construction projects, safety and security are overriding factors. The inability to process local workers in a timely way through security checkpoints has prolonged works significantly at military bases.

The way forward

Our specialists do not foresee radical changes in the main causation factors driving disputes in the defence, aerospace and military sector. It's not yet clear what effect, if any, the US military's investment in artificial intelligence and cloud procurement will have on the pattern of disputes.

In other territories there are also initiatives to make procurement of new technologies leaner through closer collaboration with the supply chain. This will require cultural change – and enhanced administrative capabilities – on the part of project owners as well as the supply chain; for example, in commitment from technology companies to work with specialists in other fields. Without strong incentives, members of the supply chain may be unwilling to share intellectual property for the sake of advancing a project, if it would diminish their competitive advantage. If this approach is to succeed, we believe that new contractual frameworks and procurement procedures must be devised.

Up-front arrangements could be put in place to agree collaborative ways of working in line with the international standard ISO 44001. This can take the form, for example, of a Joint Relationship Management Plan to agree combined ways of working between all parties. The risks and investment in the development of joint intellectual property (which may end up as foreground IP owned by the client) can also be agreed.

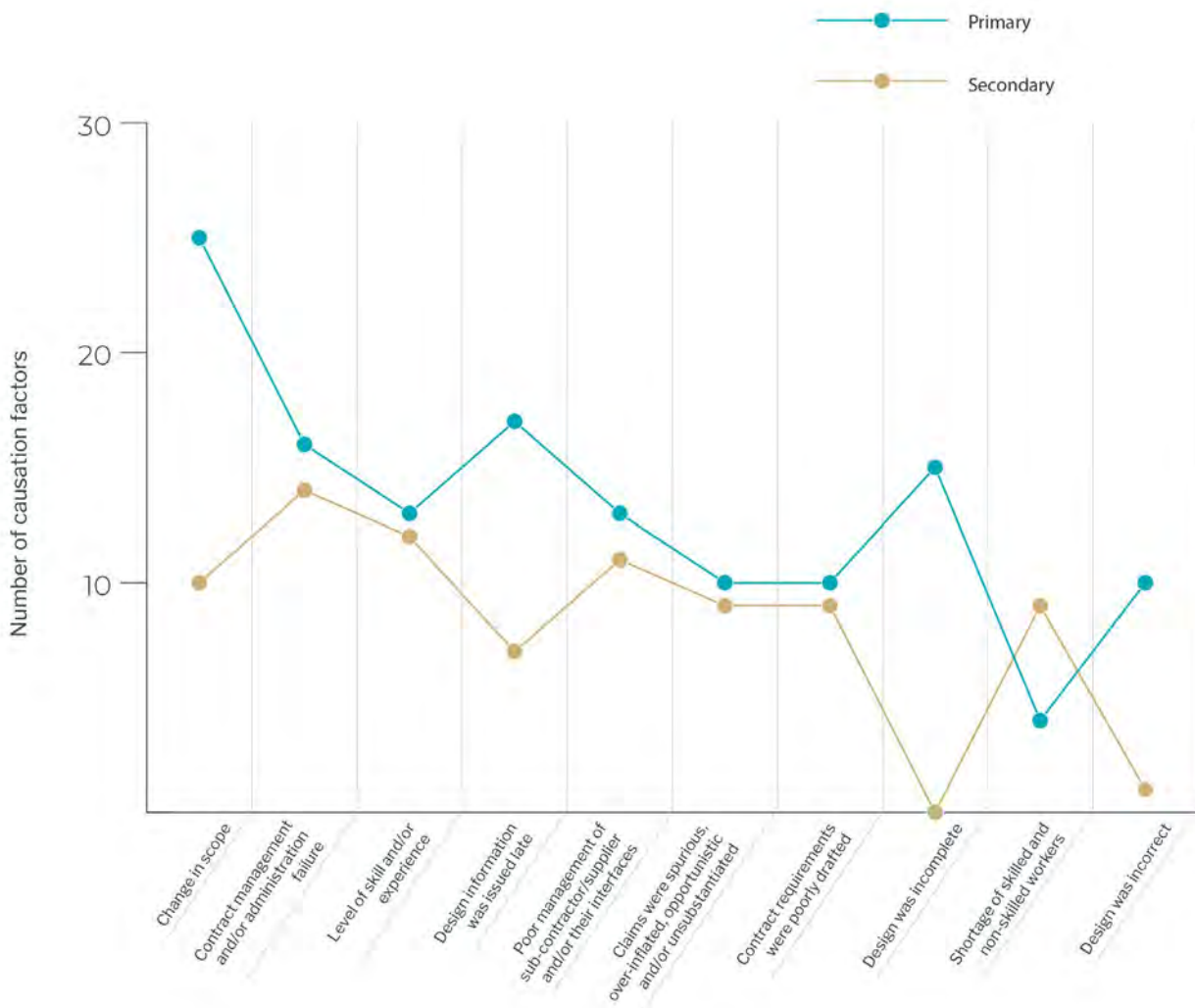
More effective contract management and timely expert interventions can also help de-risk these alliances, and projects generally. Impartial engineering reviews to vet design changes and pre-empt project bottlenecks, as well as prompt analysis of claims, will minimise the disruptive and costly impact of disputes.

Any radical reduction in disputes would require better contract management, expert interventions to manage risk, and impartial engineering reviews to vet design changes.



Industrial

CAUSATION FACTORS	PRIMARY	SECONDARY	TOTAL
Change in scope	25	10	35
Contract management and/or administration failure	16	14	30
Level of skill and/or experience	13	12	25
Design information was issued late	17	7	24
Poor management of sub-contractor/supplier and/or their interfaces	13	11	24
Claims were spurious, over-inflated, opportunistic and/or unsubstantiated	10	9	19
Contract requirements were poorly drafted	10	9	19
Design was incomplete	15	0	15
Shortage of skilled and non-skilled workers	4	9	13
Design was incorrect	10	1	11
TOTAL	133	82	215



Overview

The industrial sector is susceptible to the perennial problems that are generally found on large and complex projects. While the headline causes may be familiar, the repeating pattern of disrupted delivery, and the underlying points of failure, require thorough investigation if this cycle is to be broken.

Our evaluation of 57 projects uncovered an overall average of 3.1 primary causes per dispute and 1.9 secondary factors. This analysis reveals a recurring failure to allow for the challenges posed by changing scope. As fast-track construction commonly leads to contracts being let before designs are complete, the impacts are felt down the line in technical conflicts and contractual disputes – from factory upgrades that do not fit their new production systems to arbitration costing more than the sums at stake.

Our consultants have also observed first-hand the project pinch-points and compromises when, for example, long-standing assets – from train sheds to factories and offices – are upgraded to house new and more sophisticated systems and equipment. Strong administrative capability is emerging as a necessity to achieve the smooth integration of systems in complex projects. Employers must design facilities from the inside out to avoid any mismatch between the building and the processes it will accommodate.

Other high-ranking factors in the industrial sector's disputes – such as weak management of contracts and the supply chain, late or incomplete design and reporting, and poorly drafted contracts – are companion symptoms of contract mechanisms not fit for the purpose of managing change.

Poor management of subcontractors and suppliers is another more frequent cause of disputes in this sector than others. Our experience shows that interface management most often breaks down at second- and third-tier levels of the supply chain.

Incomplete and inaccurate reporting is a by-product of these failings in managing subcontractor interfaces and administering contracts, as well as design changes. We find that reporting between multiple parties on complex projects is often inconsistent and disruptive as different suppliers follow their own practices. While some high-level reporting may be excellent, essential detail is often obscure. Or others try to deflect potential problems back up to the client. Clarity on reporting requirements from the outset is essential to make suppliers take ownership of their responsibilities and avoid the knowledge gaps that promote disputes.

Many high-ranking factors in the industrial sector's disputes are companion symptoms of contract mechanisms that are not fit for the purpose of managing change.

Compounding this challenge of managing and administering industrial contracts is a lack of skilled and experienced workers, which is evident in the causation ranking. Such shortages are most pronounced in growing economies and other territories where industrial markets are overheating. Ways of working among their more experienced counterparts, meanwhile, are often not suited to the speed of execution or complexity of the projects they are required to manage.

Industrial projects fall in line with other sectors when it comes to the prevalence of cash flow and payment issues in dispute causation. Even in buoyant markets where investors and developers readily funnel money into projects, the cash does not necessarily filter down to contractors as clients determine to get their schemes over the line on budget. New legislation in Canada facilitating immediate recourse to adjudication on payment issues brings the country into line with other jurisdictions, such as the UK. However, payment disputes still arise, and when not resolved by adjudicators, result in litigation, which is a costly concern.

We have seen the gaps in norms and communication between clients and international contracting teams that can escalate disputes. Although cultural differences are not showing as a leading cause in the research, they will become a more frequent trigger as supply constraints and skills shortages in growing markets suck in more foreign resources.

The way forward

Will we continue to see this pattern of dispute causation in industrial projects? Highly likely, as long as weaknesses in contract management and drafting persist in parallel with changing scope and skills deficits – the web of causation factors that dominate in the sector analysis.

The approach of the main contractor – and the client, where it manages projects directly – is critical. Relations with suppliers need to be close, open and consistent to minimise the impact of disputes and achieve a successful outcome.

More rigorous planning and project controls are essential but not necessarily sufficient to keep projects on track. Independent engineering expertise at an earlier stage in projects would pre-empt many of the failures revealed in our research.

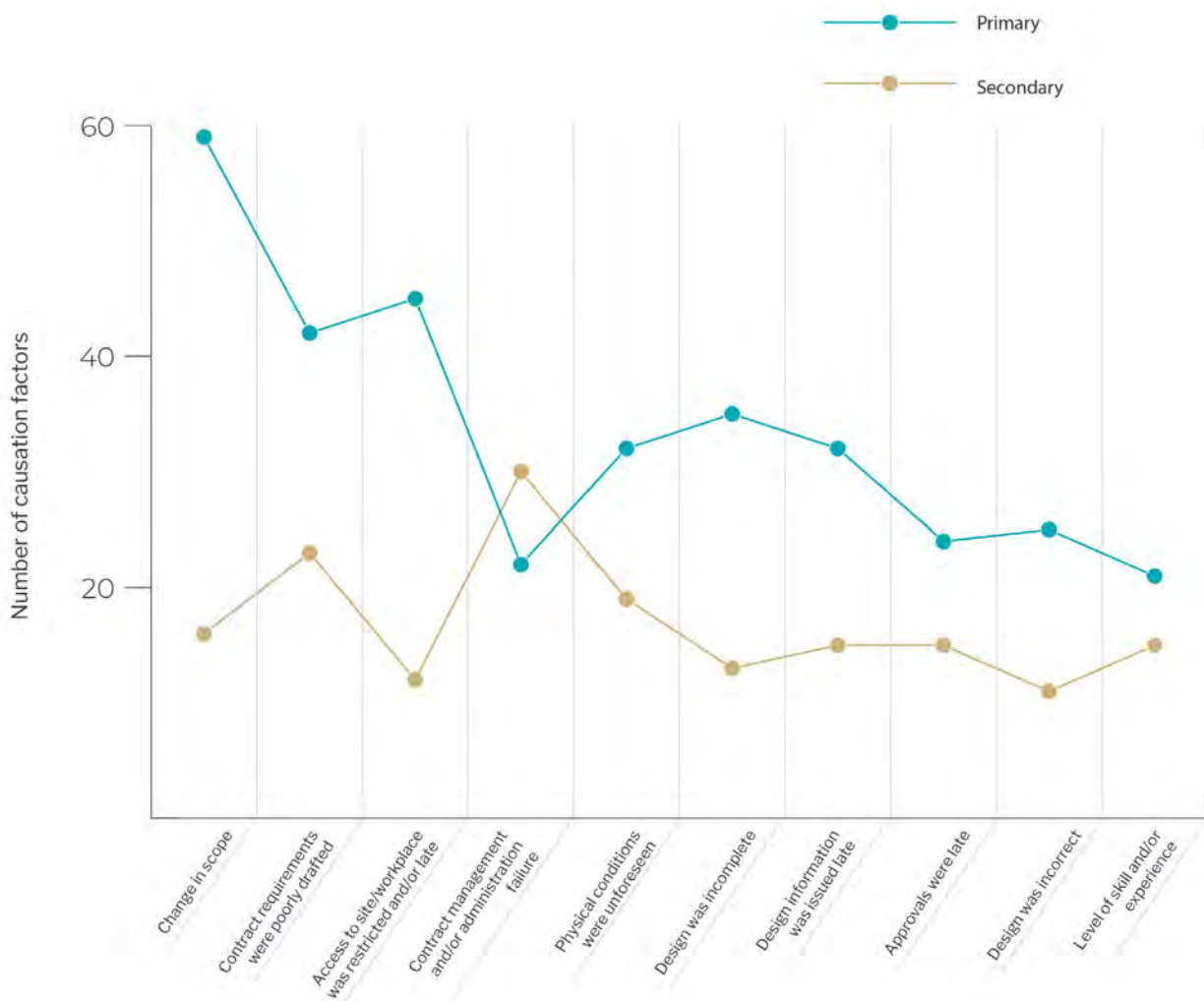
Above all, complex projects demand a strategic, joined-up approach if high performance is to be sustained from pre-construction to completion.

Independent engineering expertise at an earlier stage in projects would pre-empt many of the failures revealed in our research.



Infrastructure

CAUSATION FACTORS	PRIMARY	SECONDARY	TOTAL
Change in scope	59	16	75
Contract requirements were poorly drafted	42	23	65
Access to site/workplace was restricted and/or late	45	12	57
Contract management and/or administration failure	22	30	52
Physical conditions were unforeseen	32	19	51
Design was incomplete	35	13	48
Design information was issued late	32	15	47
Approvals were late	24	15	39
Design was incorrect	25	11	36
Level of skill and/or experience	21	15	36
TOTAL	337	169	506



Overview

The CRUX investigation of 131 infrastructure projects worldwide confirms a nexus of entrenched causation factors behind disputes.

Both primary and secondary causes – averaging overall, 2.7 and 1.4 per project, respectively – also feature several problems that crop up more often than in other sectors. Notably, restrictions on access to worksites and unforeseen physical – typically ground – conditions.

Much of the disruption experienced on infrastructure programmes stems from inter-related causes that coalesce around contract drafting, risk distribution and evolving designs.

Changes in scope – the main driver of disputes across all sectors in our analysis – arise from the tendency of going to market too early and with inflexible delivery models. As project teams cannot anticipate all changes at the outset, it is essential to build in flexibility to respond to the shifting market conditions and requirements of the multiple stakeholders that infrastructure investments typically serve.

Much of the disruption experienced on infrastructure programmes stems from inter-related factors. These coalesce around contract drafting, risk distribution and evolving designs.

The private financing model pioneered in the UK, and its variants in other countries, can exacerbate the design challenges on major infrastructure projects. We have seen how consortia on a fixed price for the design, construction and operation of new facilities squeeze their subcontract consultants to produce more cost-effective designs. When these do not function to the standard clients require, the concessionaire blames its subcontractor for design errors.

Breakdowns in contract management are often attributable to lack of continuity at a senior level over the project lifecycle.

Risk distribution on infrastructure projects tends to be more equitable where the public sector takes a pragmatic stance on procurement. However, a hard-nosed approach, offloading risk under EPC (engineering, procurement and construction) contracts, creates a more adversarial environment. In turn, contractors approach the project with a strategy of maximising variations, often resulting in spurious, inflated and opportunistic claims.

Poorly drafted contracts increase the likelihood of dispute by obscuring client requirements. When the intent behind specific contract clauses are not clearly articulated, the seeds are sown for problems and disputes.

This lack of clarity contributes to failures in contract management, the last of the triumvirate of top drivers for infrastructure disputes. Frequently, the breakdown is attributable to lack of continuity at a senior level over the project lifecycle. Knowledge held by key team members is lost at handover points from the planning phase through to delivery. On transport projects in particular, HKA teams encounter this disconnect between contracts and how they are managed. In developing countries where professional resources are less mature, these frailties in contract management and commercial administration are more acute.

More generally, the genesis of disputes on large infrastructure projects can lie within the client-side organisation. The process-orientated and multi-tiered structures of public bodies (and large commercial entities) often complicate decision-making. This can generate significant frustrations for contractors, overly burdensome administrative practices on a project, and ultimately, delays and disruption.

Skill and experience levels are an important factor in disputes. But aside from weaknesses in the project or delivery teams, this can be more a matter of misalignment and the lack of a collective shared understanding of how contracts should operate, rather than actual expertise.

Poor management of subcontractors, suppliers and other interfaces is another trigger for disputes with its own subset of inter-related underlying causes. Inappropriate packaging of works is a case in point. Bundling together different skillsets that are uneasy bedfellows sets up a project to fail. A classic example in transport is combining rail systems with civil engineering. This reduces the interfaces to be managed at the cost of making them more opaque. Civils contractors take the lead role in consortia as the value of their works heavily outweighs the cost of systems, yet these are critical. Clients should create separate packages for different scopes – so long as they have the set-up and skills to manage these interfaces directly – or structure contracts to mitigate potential conflicts and ensure all parties have a voice at the table.

The nature of infrastructure projects – which tend to be high-profile and disruptive of urban life, travel or other public services – lends itself to opportunism by contractors who may exploit delays and controversy in their variations and claims strategy. For the client team, the political pressures unique to this type of construction also raise the stakes for stakeholder management. How effective this proves can be key to a project's success or failure.

While poor stakeholder management may not be the direct cause of a dispute, often it helps create the circumstances that give rise to it, such as variations. An influx of stakeholder demands and complaints is to be expected during the course of construction, impacting the behaviours of everyone involved in the process. Where the client team is inexperienced or, for whatever reason, unable to manage these pressures, the effects can be dramatic in terms of time and cost overruns.

The way forward

We believe that the industry's digital transformation can provide tools that alleviate some of the underlying causes of disputes. But digitalisation is not a panacea. It will require a step change in the attitudes of clients as well as contractors if the industry is to foster better behaviours and collaboration.

Claims and disputes are unavoidable, not least on complex megaprojects. The challenge is to anticipate, manage and resolve them so as to minimise their impact on the programme and the outcome. Action is required of both client and contractor.

In certain territories we are seeing a greater willingness to explore more collaborative approaches to contracting. We expect to support more clients as they undertake sophisticated exercises in market sounding and engagement. Interactive dialogue with contractors before and during procurement should see fewer surprises at tendering stage and in contract negotiations.

The client model needs to be thought through. From the outset, project teams tend to focus on the infrastructure to be delivered, and not enough on how that will be managed, and the client structure required through construction and the operations phase.

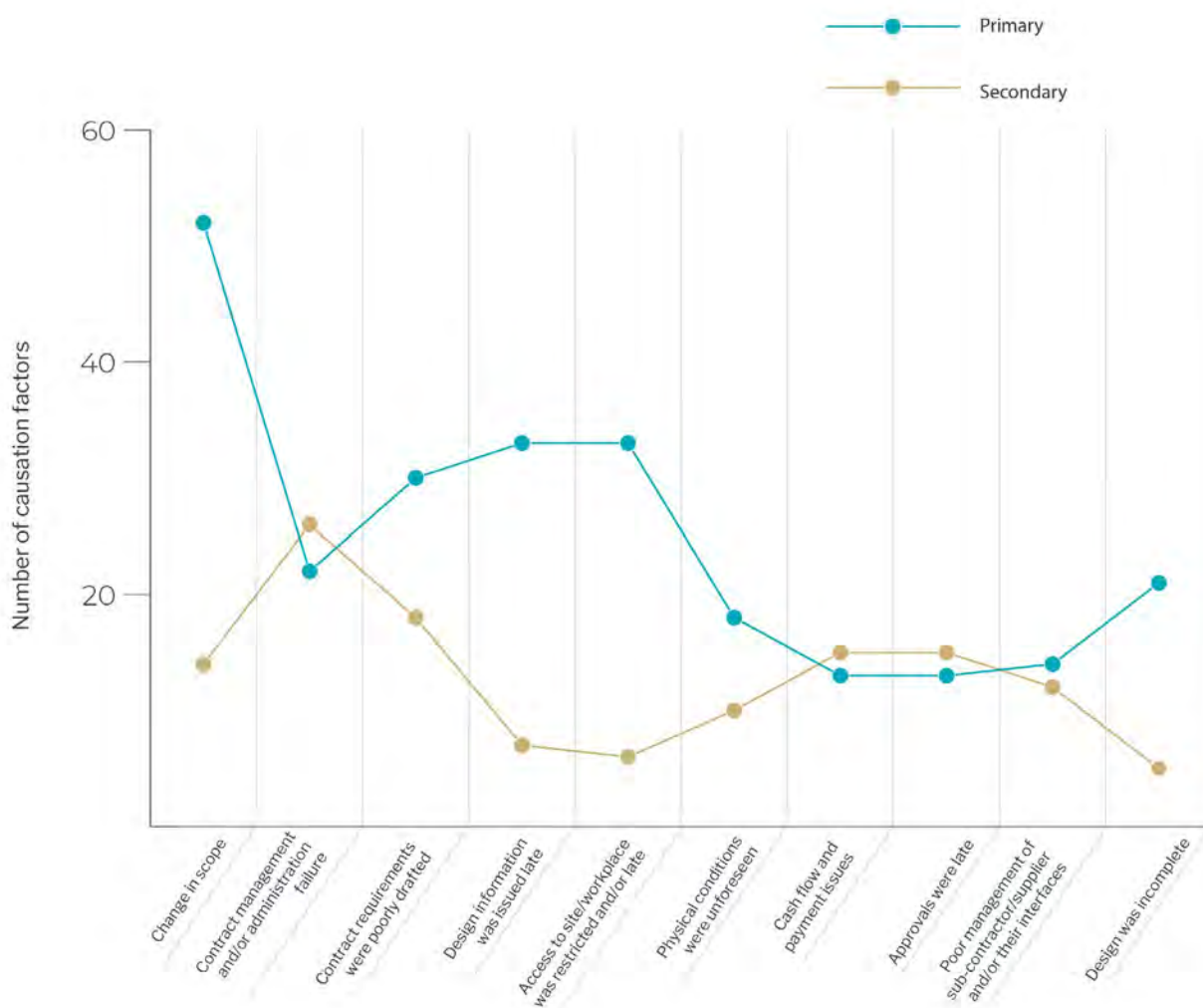
The misaligned expectations that can be highly corrosive of project performance can also be mitigated by adopting new delivery models, such as Project 13, and through expert peer reviews at critical phases over the project lifecycle. Interventions that anticipate scope change, refine specifications, manage design changes and resolve claims have a critical role to play in keeping projects on track.

The client model needs to be thought through. From the outset, project teams tend to focus on the infrastructure to be delivered, and not enough on how that will be managed, and the client structure required through construction and the operations phase.



Oil & Gas

CAUSATION FACTORS	PRIMARY	SECONDARY	TOTAL
Change in scope	52	14	66
Contract management and/or administration failure	22	26	48
Contract requirements were poorly drafted	30	18	48
Design information was issued late	33	7	40
Access to site/workplace was restricted and/or late	33	6	39
Physical conditions were unforeseen	18	10	28
Cash flow and payment issues	13	15	28
Approvals were late	13	15	28
Poor management of sub-contractor/supplier and/or their interfaces	14	12	26
Design was incomplete	21	5	26
TOTAL	247	128	377



Overview

The highly cyclical nature of the oil and gas industry inevitably influences the pattern of disputes while driving the level of activity. Troughs and peaks in supply and demand shape the behaviour of owners and contractors, fabricators and the entire supply chain.

Our research into 114 projects worldwide reflects the shift in negotiating power and risk in recent years, and overall our analysis shows that, on average, disputes in the sector have 2.8 primary causes, with a further 1.5 contributory factors.

The cancellation and deferral of projects following the slump in oil prices in 2014 served to increase the dominance of the big oil and gas owners as contractors scrambled for a share of the available work.

Historically, the oil and gas majors completed the design and procurement in-house, free-issued equipment, and tendered packages for installation. Now under heavily amended EPC (engineering, procurement and construction) contracts, scope-related risks are passed on to contractors, and along the supply chain in some cases, regardless of the ability to manage them.

Inappropriate allocation of risk, combined with poor drafting of contracts – the second most prevalent cause of dispute after changes in scope – has deleterious consequences for projects and for owners as well as contractors. Contractors can and have understated their costs when bidding for work, then attempt to maximise recovery through variation orders.

The design-related issues highlighted in our research often stem from allowing designs to progress to tender when they are not sufficiently mature. While a rig may follow an off-the-shelf template used multiple times before, bespoke modifications are incorporated without sufficient detailed engineering, resulting in a design that is not robust.

A skills crisis is affecting the performance of project delivery teams as the industry with its ageing workforce struggles to attract and retain talent.

The industry's skills crisis is affecting the performance of project delivery teams in various ways. For at least 15 years, concerns have been raised as an ageing workforce has become increasingly skewed towards those in their late 50s and 60s. Given its image as a 'dirty industry', and the rise of renewables against the backdrop of a changing climate, the oil and gas sector continues to struggle to attract graduate engineers and younger blue-collar workers, and to entice older, more experienced engineers to remain in the industry.

The extent of skills shortages in the oil and gas industry, and their impact on project performance as well as workmanship, may well be understated in our analysis. In the view of our sector experts, this competency gap lies behind at least half of the top 10 causation factors.

Poor contract management and administration is a case in point. The conflicts and interference that result cause serious disruption generally, and more so on sites with unionised workforces.

Another effect of the competency deficit, and the industry's economic cycle, is being observed in the pattern of claims. Opportunism on megaprojects has unleashed claims that are wildly overstated – by a factor of five in some cases. Poor commercial management means that contractors cannot pinpoint the source of their losses, so claims can be over-inflated in a bid to recover as much as possible.

Problems with the quality of workmanship are more prevalent than in other sectors. There is evidence that many contractors are wedded to traditional approaches, and work to their own standards rather than those set at national or international level. This is particularly the case where new entrants (due to lack of capacity) are awarded work that is outside their normal skillset. From the quality of steel to welding, claims over sub-standard materials and defects feature in many disputes.

Unforeseen physical conditions and adverse weather feature more prominently in the causation ranking compared with other sectors. This reflects the challenging environments in which oil and gas projects are delivered. Upstream projects in particular are likely to encounter wide geotechnical variations in the seabed, where surveys are expensive and conditions can vary significantly both by depth and location.

Tight regulations on safety and environmental standards constrain project operations. As well as dovetailing scheduling with their complex supply chains, project managers must secure permits from a variety of authorities. In the US, for example, regulations apply at local, state and federal level. Depending on the terrain and country, projects will have to comply with environmental regulations regarding – amongst other things – water, protected species, discharges to the environment, impact on fishing activities, and seasonal restrictions, in addition to landowners' rights of way.

Delayed access to worksites is another prevalent factor in disputes on oil and gas projects. Congestion occurs when works are not programmed properly, or plans have to change. Productivity suffers when this results in multiple trades having to work in the same areas and the installation of large pieces of equipment overlaps with pipe runs.

Where permissions are delayed the knock-on impacts on linear works can be highly disruptive, as crews and equipment must be remobilised for other sections, sometimes causing congestion or conflicts with adjacent works. On one project, for instance, cancellation of a wetlands work permit due to problems with the owner's paperwork led to long delays and cost overruns.

Similar domino effects can impact entire projects when custom-fabricated plant, such as piping and skids, are delivered late to site, playing havoc with the sequencing of installations to extremely tight tolerances.

The economic environment, and rise of alternative energy sources, is also spurring technological change as producers seek to extract the maximum output from existing facilities rather than invest in new infrastructure such as wells and platforms. Traditionally, the oil majors used their technology development and testing programmes to ensure that new solutions were proven off-project before

application. Smaller companies and joint ventures are increasingly willing to utilise emerging technologies before they are proven. Technology development on projects has also caused major delays as projects become more complex.

The way forward

In regions where industry investment is sustained, we see signs of a more realistic approach to the management of contracts and the supply chain emerging. But the industry remains prey to cyclical swings.

We do not see the patterns of disputes changing radically unless contracts are negotiated with a view to achieving the most effective distribution and management of risks.

Stage-gate audits should be used to ensure that designs are mature and help limit scope changes. These need to involve workers with sufficient experience to gauge the robustness of designs and ensure risks are mitigated to a level that's as low as reasonably practicable (ALARP). Going through the motions without sufficiently skilled workers will not provide the desired outcome.

Effective project controls, more professional administration of contracts and tighter commercial management are also needed to avoid over-inflated claims.

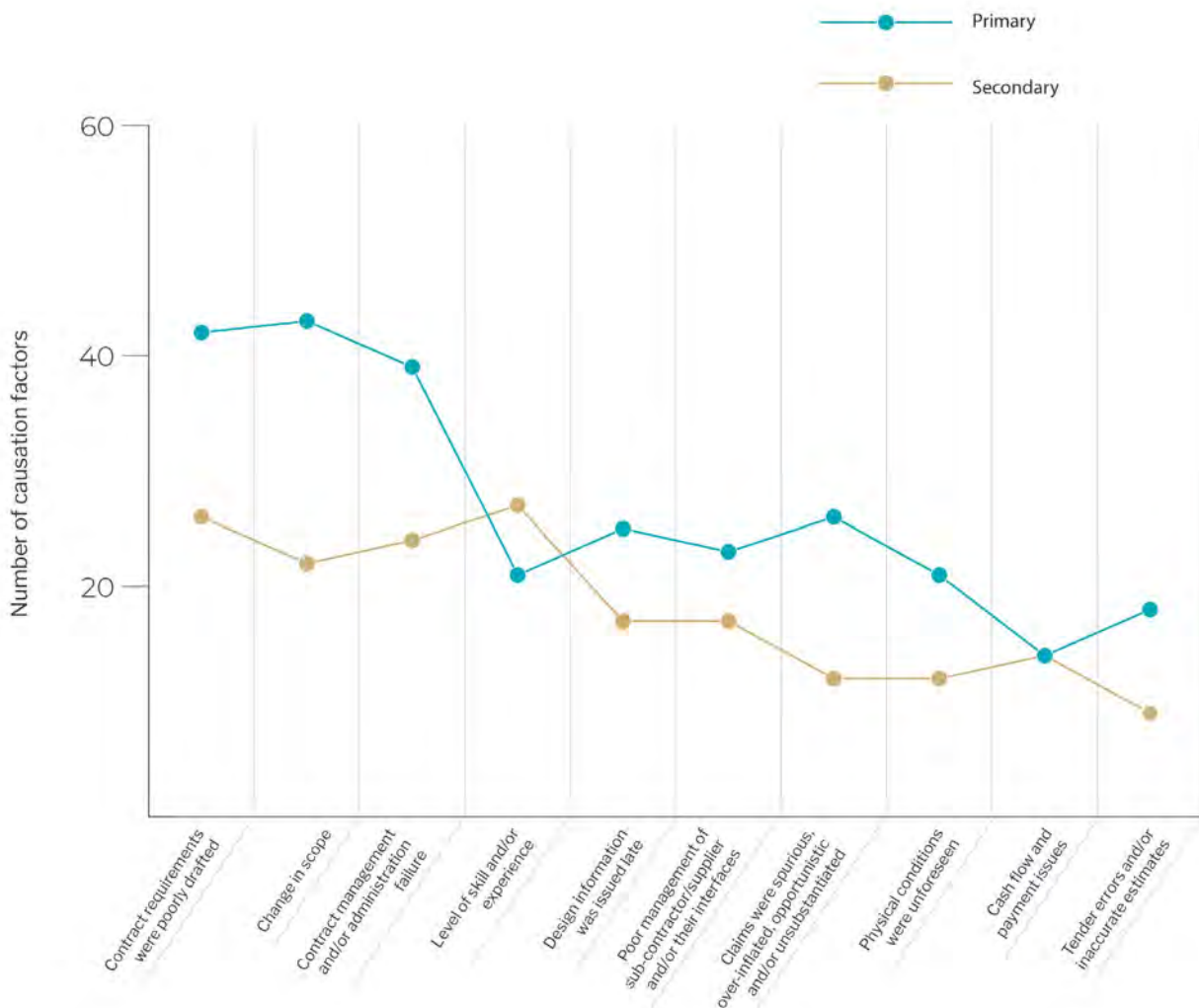
Given the industry's growing skills deficits, project teams can also benefit from war-gaming exercises that flag likely contractual disputes and help them minimise risks in executing and managing contracts.

The pattern of disputes will not change unless contracts achieve a more effective distribution and management of risks, and designs are checked for maturity.



Power & Utilities

CAUSATION FACTORS	PRIMARY	SECONDARY	TOTAL
Contract requirements were poorly drafted	42	26	68
Change in scope	43	22	65
Contract management and/or administration failure	39	24	63
Level of skill and/or experience	21	27	48
Design information was issued late	25	17	42
Poor management of sub-contractor/supplier and/or their interfaces	23	17	40
Claims were spurious, over-inflated, opportunistic and/or unsubstantiated	26	12	38
Physical conditions were unforeseen	21	12	33
Cash flow and payment issues	14	14	28
Tender errors and/or inaccurate estimates	18	9	27
TOTAL	272	180	452



Overview

Our analysis of over 135 power and utility projects captures the causes that are generating disputes. Overall it shows that 2.1 primary factors and 1.4 secondary, on average, lie behind the disputes we are seeing across the sector.

After the global downturn in 2008, we saw a shift in the balance of negotiating power between owners and prime contractors as they broke into new markets to compensate for their shrinking workloads. We are seeing many disputes where they have taken on excessive risk and not understood the ramifications. This is in line with widening use of forms of contract that pass risk on to the contractor, which is then fed down the supply chain. Where there is an imbalance of power in negotiations, many standard clauses may end up being altered, so that a standard construction contract morphs into what is essentially a bespoke agreement.

The balancing of risk between the project stakeholders remains the cornerstone of a successful project. In disputes where contractors have taken on this added level of risk, we also see many claims coming up the supply chain, which can at times be inflated and spurious.

We are seeing many disputes where prime contractors have taken on excessive risk and not understood the ramifications.

One reason for design information being issued late – a top-five causation factor in this sector – is the increasing urgency from owners to start construction before the fundamental design is complete. Rushing into the construction phase is most likely a consequence of the public funding and political pressures that dominate the sector.

Public money and state bodies bring other obligations, especially in less developed countries where clients are mandating higher levels of local engagement, which can lead to duplication of white-collar roles. Given the complexity of projects, workers from overseas bridge

the skills gap if their market price and budgets allow. Either way, white- and blue-collar productivity suffers. This is often compounded by cultural differences – both within the project team and workforce, and also when managing subcontractors and supply chain interfaces.

Cultural differences play a part too in disputes and not just in developing countries. The many highly specialised pieces of equipment required by modern power and utility networks bring teams from all over the globe to a project site. So that, for example, a Chinese contractor builds a power plant in South America with North American labour and European subcontractors. Differing management styles and ways of working, let alone language issues, are more likely to be at the core of any disputes, which so often spring from failures in communication.

Whatever the cultural mix of the players, when they are lacking in skills and project experience – an even more prevalent factor in the research – a succession of related impacts may follow on site, from weak management of the supply chain to late delivery of material, and poor workmanship to installation failures.

Late delivery of materials or products is far more prevalent in disputes on power and utilities projects than in other sectors. Given the long lead times for large and sophisticated pieces of plant equipment – such as turbines – their late arrival can be a significant disruptor. Again, when designs are not frozen in time, placement of orders can be delayed, and schedule recovery may not be feasible.

Misrepresentation is not evident as a causal factor in our research. However, it can be a hidden driver of disputes. As our commercial damages specialists become involved in more commissions, their investigations can reveal – in collaboration with our quantity surveyors and engineering experts, for example – how contractors have fraudulently misrepresented their competence or relevant experience, as evidenced by poor planning for projects. Misleading information can contribute to various causation factors – from inadequate workmanship to spurious claims, and design deficiencies to poor management of subcontractors. Demonstrating fraudulent misrepresentation can open the way for claims of consequential damages against various project stakeholders.

Another reason for disputes is the surge of investment in new technologies – from renewables to nuclear. The nuclear sector, in particular, is losing its knowledge base. Due to the dearth of new nuclear reactors built over the last two decades, specialist engineers and managers are nearing retirement without a newly qualified cohort to take their place. The future effects may be felt in higher engineering costs or lower labour productivity. Meanwhile, operational factors in wind farms built 10 or more years ago are now coming to dispute. Our sector experts expect to see operational performance problems rise up the causation ranking in future analysis as these lengthy contracts unwind.

The way forward

Commercial misalignment at the outset between client and contractor – often around payment mechanisms – will continue to cause frictions that flare up into disputes. As our work with a major utility shows, better engagement with the market and contractors ahead of procurement can pre-empt such problems.

It is doubtful that we will see the more dominant dispute causation factors change in the short term, unless projects show a more balanced allocation of risk, better-defined client requirements, and clearer communications and common understanding of contract terms. Without these corrections, power and utility projects will continue to be blown off course by the dispute causation factors identified in our analysis.

Better market engagement up front, balancing of risks, and clarity on contract terms are needed to keep projects on course.



**IF THE INDUSTRY IS TO
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CONCLUSION

Overview

Across the engineering and construction industry, the causation footprint for disputes is clear. While there are important variations between sectors, the overall pattern is persistent and the underlying problems evidently deep-rooted.

Inadequate control over scope and design, along with poor drafting and administration of contracts are the dominant drivers of disputes. Skills gaps and spurious claims are also prevalent within the web of interrelated causation factors.

The evidence from our analysis of 700 projects with a total value exceeding US\$1.2 trillion is overwhelming. Lax control over scope and design, along with poor drafting and administration of contracts, are the dominant drivers of disputes. Skills gaps and spurious claims are also prevalent within the web of interrelated causation factors.

If the industry is to break this cycle of repetitive disruption, delay and over-blown costs, employers and contractors must better understand, prepare for and manage the complexity of their projects. Even foreseen risks tend to be far greater than those drafting contracts, and their signatories, realise pre-construction. A more balanced allocation of risk and a greater willingness to consider more collaborative approaches to contracting can help reduce the prevalence of disputes.

CRUX Insight 2019 also calls into question the fitness for purpose of procurement strategies and operating models.

On large, complex projects in particular, the client model needs to be properly thought through. The focus on the project to be delivered should not distract from planning how delivery will be managed, the client structure required through construction and into the operational phase, and how continuity of skills and knowledge will be maintained at handover points.

Earlier and greater engagement with the market can help pre-empt the unforeseen problems that emerge in the tendering stage, during contract negotiations and through the project lifecycle as misapprehensions over contract terms and client requirements blow up into disputes.

Good communication between all parties promotes transparency. Down the increasingly long and transnational supply chains on major projects, open and consistent relations with suppliers can help minimise the incidence and impacts of disputes and help secure better project outcomes.

Advancing digitalisation should improve the information flow. Shared and timely access to data may raise the performance of project delivery teams generally and the design process in particular, not least by verifying designs before contract.

On many projects, disputes and disruption could be limited if not pre-empted by expert and impartial engineering audits to ensure that designs are robust.

However, complexity will continue to be underestimated. On many projects disputes and disruption could be limited if not pre-empted by expert and impartial engineering audits to ensure that designs are robust.

Similarly, at critical phases over the project lifecycle prompt interventions can anticipate scope change, help manage design evolution, and resolve claims in a more cost-effective manner.

Ongoing analysis of the CRUX 2019 research dataset will provide further insights, which we look forward to sharing with clients and the industry.

WHO WE ARE

HKA is one of the world's leading privately owned, independent providers of consulting, expert and advisory services for the construction, manufacturing, process and technology industries.

We also have particular experience advising clients on the economic impact of commercial and investment treaty disputes and in forensic accounting matters.

In addition, HKA supports companies that conduct business with the US Federal Government, providing them with consulting services on complex government contracting matters.

We bring a proud record of excellent service and high achievement – established over more than 40 years – to bear on today's challenges.

As trusted independent consultants, experts and advisers, we deliver solutions amid uncertainty, dispute and overrun, and provide the insights that make the best possible outcomes a reality for public and private sector clients worldwide.

HKA has in excess of 1,000 advisors and consultants – across 50 offices in 19 countries – with the skills and experience that are essential to get to the heart of even the most complex issues.

Our people have vast first-hand experience spanning all major industries and the world's most complex megaprojects, as well as an international track record of achieving successful outcomes. HKA's global portfolio includes prestigious projects on every continent and in market sectors that include buildings, industrial, infrastructure, oil and gas, power and utilities, and technology.

Our forensic accounting and commercial damages teams specialise in areas such as valuations, economic damages, investigations, bankruptcy and intellectual property.

HKA experts' experience in government contracting is profound and covers contract disputes, investigating allegations of false claims and defective pricing, compliance reviews and audit services as well as other tailored support.

Clients have access to thought leaders with diverse skills and the ability to anticipate, investigate and resolve complex challenges.

1,0000

professionals operating in

50

offices in

19

countries

CRUX INTERVIEWS

Below are our CRUX experts, drawn from all HKA disciplines and offices, who were interviewed as part of the research process to provide their expert insights and regional perspectives based on their direct experience from working on some of the world's largest and most complex construction projects worldwide.



Andrew Allen

Director
andrewallen@hka.com



Gerry Brannigan

Partner
gerrybrannigan@hka.com



Conrad Bromley

Director
conradbromley@hka.com



Trevor Butler

Executive Director
trevorbutler@hka.com



Harry Colledge

Executive Director
harrycolledge@hka.com



Anne Connolly

Partner
anneconnolly@hka.com



Tanner Courrier

Principal
tannercourrier@hka.com



Chelsea Cullum

Principal
chelseacullum@hka.com



Alan Currie

Technical Director
alancurrie@hka.com



Hayley Davis

Director
hayleydavis@hka.com



Paul Donato

Director
pauldonato@hka.com



Jonathan Humphrey

Partner
jonathanhumphrey@hka.com



Dawson Jenner

Director
dawsonjenner@hka.com



Sue Kim

Director
suekim@hka.com



Deborah Kirk

Associate Technical Director
deborahkirk@hka.com



Doug Neville

Partner
dougneville@hka.com



Kim Reome

Partner
kimreome@hka.com



William Rule

Associate Director
williamrule@hka.com



Lorna Tardif

Partner
lornatardif@hka.com



Graham Taylor

Executive Director
grahamtaylor@hka.com

THE HKA CRUX TEAM

HKA would like to thank **Simon Moon** (Partner and Chief Operating Officer), **Toby Hunt** (Partner and Chief Business Development Officer), **Franco Mastrandrea** (Partner and Co-Chair, Global Expert Committee), **Jeff Badman** (Partner) and the CRUX Interviewees for their review and guidance throughout the production of this CRUX Insight report.

Methodology: **Justin Axten** (CRUX Lead) and **Josephine Guckian** (Global Brand and Marketing Communications Director).

Editorial: **Eugene Silke** (Silke & Co), **Josephine Guckian** and **Justin Axten**.

Creative design and artwork:
Hufsa Imam-Hushmat Mir (Global Graphic Designer).

If you would like to discuss the CRUX findings or require further insight, please contact **CRUX@hka.com**.



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