CONFLICT AND CROSS EFFECT IN FIRE SERVICES INSTALLATION AND BUILDING CONSTRUCTION IN NEW PROJECTS

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ABSTRACT

Building industry in Hong Kong has been increasingly recognizing the need for more efficient and timely completion. Often, there are numbers of conflict cases such as unexpected problems and variations from original design arise during construction period, leading to cost and time overruns. In this paper, conflict cases between Fire Services Installation (FSI) and Building Construction from two newly completed office buildings in Hong Kong are presented. Based on the findings, the time and cost implication are computed and the factors that cause delay in FSI are identified. In order to have a smoother project run, suggestions for strategies to meet the contract duration and keeping the cost within budget are proposed. The weighting of FSI in new projects and the role of FSI in obtaining the Occupation Permit are also examined.

1. INTRODUCTION

Construction industry in Hong Kong is of paramount importance for employment and economic growth [1]. Project delays can lead to cost overruns due to additional overheads and claims between contractors and client [2]. The aims of this research are to identify methods to shorten the construction period and to improve the time performance.

Fire Services Installation (FSI) is an essential element in new projects. It can lower the fire risk to human lives and properties. Obtaining the F.S. completion certification from Fire Services Department (FSD) will properly shorten the completion time of construction project, as it is a must to obtain the Occupation Permit. Review of literature has revealed that there are limited research on conflict study in fire services installation and building construction. The objective of this research is to identity the major causes of delay in FSI in new projects and to assess the relative importance of these causations [3]. This paper will mainly focus on the factors identified from the findings in two newly completed office building projects in Hong Kong and to compute the time and cost implication generated from such conflict events.

A study on compressing construction duration has been carried out by Chan and Kumaraswamy [2], which highlighted the principle factors affecting construction durations of projects. They are project-scope, project environment, project complexity, management attributes and other factors. The relative importance index and ranking of delay factors were presented by Odeh and Battaineh [3]. They are categorized into client, contractor, consultant, material, labour and equipment, contract, contractual relationship and external factors. Causes of conflict over the life cycle of a project were categorized by Thamhain and Wilemon [4,5] into seven major sources, namely, project priorities, administrative procedures, technical opinions and performance trade-offs, manpower resources, cost, schedules and personality. A more comprehensive list of 13 major conflict sources was presented by Kezsbom [6], they are scheduling, managerial communication, goal or priority definition, resources allocation, reward structure, personality, costs, technical option, politics, leadership, ambiguous and unresolved prior conflict [7].

Viewing the format and the result from the literature, the presented conflict cases from the selected projects basically are: contractual matter, construction cost, client's initiation, architectural revision, design fault, late construction drawing issue, late drawing and material approval, late payment, coordination problem, shortage material, insufficient labor force, site management, workmanship. Based on the findings, some suggestions and methods are outlined to resolving strategies to achieve faster construction duration in limited conflict case.

2. METHOD OF DATA COLLECTION

A series of structured interviews with local public clients, consultants (architect/engineer) and contractors for data collection in project delay were reported [1]. The data are transferred and grouped into eight categories: project related, client related, design team related, contractor related, materials, labour, plant/equipment and external factors. Following this route, two construction projects in building office were selected. Data were collected

by interview and reviewing the letters from client, the architect, engineer and contractors. A total of 76 conflict cases from project 1 and project 2 are identified. The time and cost implication for conflicts are calculated according to the claim from FSI contractor. A precise judgment has been carried out according to the work programs, architectural instruction (AI), site memorandums, fax massages and the unit rates as specified in the contract.

All variables reported were on actual conflict events, which were directly involved in and had first-hand information. The findings from two projects are summarized in Appendix 1.

3. PROJECT DESCRIPTION

Project 1:

The premise is an office building situated in Kwun Tong. It contains 28 office flats, 1 refuge floor in between 10/F and 11/F. Plants are located on G/F, R/F and the refuge floor separately. The gross floor area (GFA) of the building is 1108 m^2 each floor. The total contract sum is HK$118M excluding the contract sum of FSI HK$4.0M. Original contract duration for the project is 400 calendar days. Extension of time (EOT) granted totally 299 calendar days.

Project 2:

The premise is an office building situated in North Point. It contains 30 office flats, 1 refuge floor on 23/F. G/F to 7/F are the car park floors. Plants are located on 1/F, 8/F, R/F separately. The gross floor area of the building is 1518 m^2 each floor. The total contract sum is HK$152M excluding the contract sum of FSI HK$4.5M. Original contract duration for the project is 420 calendar days. Actual extension of time granted totally 211 calendar days.

4. WEIGHTING OF FSI IN NEW PROJECTS

Actually, as shown in Table 1, the main contract sums of the subjected office building projects are HK$118M and HK$152M. The contract sums of FSI are just HK$4.0M and HK$4.5M respectively. The scaling ratios of main contract sum to sum of FSI are 30:1 and 34:1. The contract cost in FSI is extremely small compared with the main contract sum.

In section 21, Chapter 123 of the Building Ordinance [8], it is stated that, NO new building shall be occupied in any way except that an Occupation Permit was issued by Building Authority. In section 21, 6(d), it is stated that "in the case of a building the plans whereof were certified by the Director of Fire Services in the terms indicated in section 16(1)(b)(ii), the applicant for the permit fails to proceed to the Building Authority a certificate from the Director of Fire Services in such form as may be prescribed certifying that he is satisfied that the fire services installations and equipment shown on the plans aforesaid have been provided and are in efficient working order and satisfactory condition" [8].

With reference to the contract value and taking into consideration the Building Ordinance, a phenomenon shows that, the FSI, with an extremely small cost identification can result in the hindrance in the issuance of Occupation Permit Certification for new building. This strongly reflected its heavy weighting and its extremely important role in a new project.

Table 1: Comparison of main contract sum with sum of FSI

	Project 1	Project 2
Main contract sum (HK$)	118M	152M
FSI contract sum (HK$)	4.0M	4.5M
Scaling ratio	30 : 1	34 : 1

5. FACTORS CAUSING DELAY

Focusing on the findings as summarized in Appendix 1, the conflict cases and the delay factors in FSI are converted and classified into seven categories: client, contract, consultant, contractor, material, labour force and external factors [3]. Categories and factors causing delay in FSI and building construction are illustrated in Table 2.

6. DISCUSSION

The conflict cases, overrun value of time and cost in FSI for two projects are summarized Table 3. Sum of 395 and 236 additional working days, about HK$2.4M and HK$1M extra cost respectively for two projects were recorded. Clearly, the conflict cases come from consultant and contractor were sharply higher than the others. Client's initiation was also a critical factor in project delay. The effects from material supply, labour force and from external factor seemed less serious. Fortunately, there were no findings in contractual matters.

Table 2: Factors causing conflict and delay [3]

Category	Factor
Client	Late payments and financial difficulty Slow decision making
Contract	Mistake in contract document Nuclear specification in contractor's liability
Consultant	Architectural revision, late design drawing issue and design fault Late drawing / material approval
Contractor	Site planning, management and coordination Workmanship and quality control
Material	Shortage of material Late order making
Labour force	Insufficient labour supply Low productivity from labour
External factor	Statutory approval duration Weather condition

Table 3: Conflict, time and cost overrun summary for the two projects

Category	Conflict case		Time overrun (Day)		Cost overrun (HK$)	
	Project 1	Project 2	Project 1	Project 2	Project 1	Project 2
Client	6	3	45	28	281k	169k
Contract	0	0	0	0	0k	0k
Consultant	15	16	266	89	1676k	361k
Contractor	10	15	47	82	212k	311k
Material	2	1	29	17	138k	25k
Labour force	3	1	-	5	-	60k
External factor	2	2	8	15	54k	123k
Sub-total	38	38	395	236	2361k	1049k
Summary	76		631		3410k	

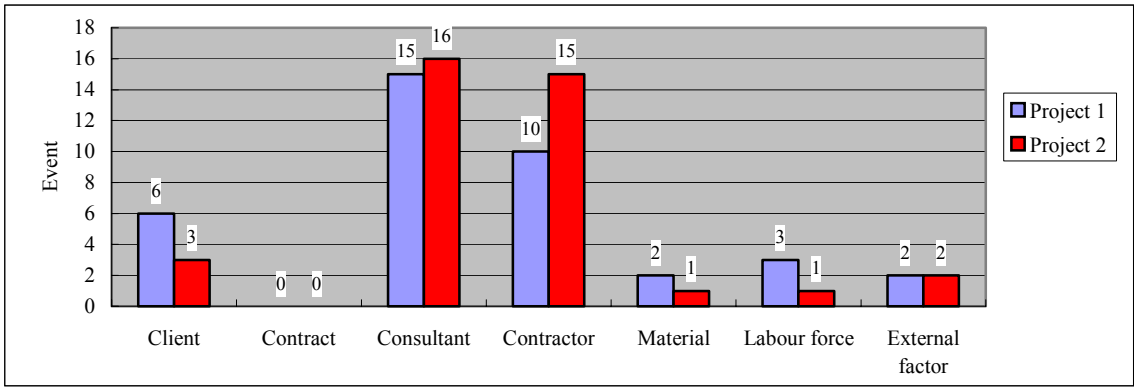

Fig. 1: Conflict summary chart

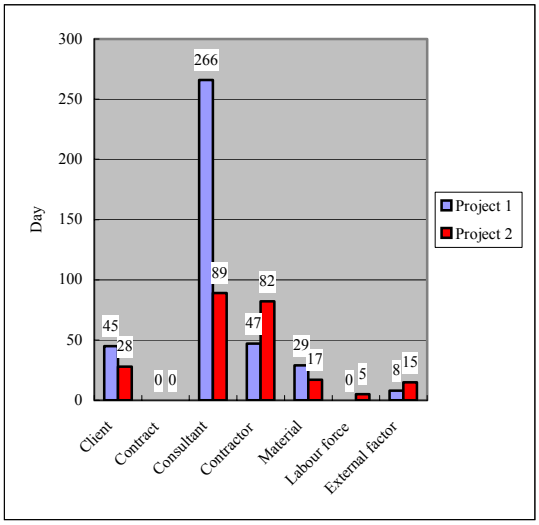

Fig. 2: Time overrun chart

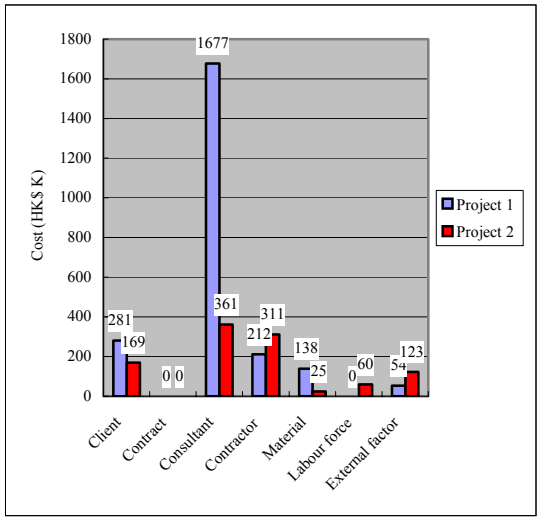

Fig. 3: Cost overrun chart

The findings in conflict evens, time delay and cost overrun for the two projects are more clearly indicated in Figs. 1, 2 and 3. For projects, client plays the most important role due to the finance issue, the initiation and decision making in design characteristic. During the research, nine conflict cases generated from client are directly recorded (excluding cases related to the design revision during construction). This results in 73 day progress delay and a cost of HK$450K for FSI. In view of the contract related, no record was observed. This reflected that a very mature contractual system had been established in the Hong Kong construction industry. Perfect contract is the first score in successful project run. It concluded the liability and what contractors have to be done. It can make the project run smoother and greatly reduce the argument and claim between the client and contractors. Consultants included the architect, the structural engineer and the building services engineer. They are the key persons in project design, construction drawing issue and getting approval to shop drawings and material. The research recorded 31 conflict cases with overruns of 355 days and HK$2M, which related to the design team. It is believed that the design is not properly completed and not ready for commencement of construction. The design state is then delayed to the construction period. It is worth noticing that contractors are mainly concerned with managerial and operational factors such as site planning, site management and coordination. In view of the 25 conflict cases, it clearly illustrated that the planning and communication method of contractors have to be improved. The group of material and equipment is relating to the supplier, the quality and sources. Shortage of material and equipment always received higher ranking than quality. It is particularly true for import that may take a considerable time to proceed and the quality of the material had already specified, they are tested and widely in use. Labour fluctuation in FSI may frequently occur due to the high installation technology needed and high development of construction industry in Hong Kong. Skill-based workers are required to carry out installation works due to statutory regulation on the pipe size and pipe spacing, some people may have knowledge of pumps control, valves setting and wiring in detection systems. The four cases are relating to the labour force, but some cases were generated due to late payment issued from client.

The factors mentioned above can be controlled among project teams. There are some external factors affecting the progress of project such as the approval period of design layouts from government departments and the weather condition. However, the risk from weather condition was specified and included in the contract period.

7. RECOMMENDATIONS

Focused on the findings from the research, a fish-bone diagram (Appendix 2) was created. It aims to indicate the important component for faster project work and to upgrade the performance in FSI and construction team. Specific technological and managerial strategies for conflict restriction and contributing to faster project run are being proposed. Technically, FSI contractors have to enhance the project design team and with early input in system design. Sub-contractor's selection should be based on their past experience and technical performance. The contractor should provide sufficient training to the workers to increase their productivity, ensure adequate labour

supply, adopt the time-saving cycle, employ reliable material suppliers and deliver material to site on time. For the management aspect, the contractor should make close communication among consultant teams to have first-hand information, and help them to make faster decision. Engineers need to compare and control the progress against original schedule regularly, watch out for possible events which may affect the progress and keep close contact with the related government department for the earlier approval of design plans. The critical work content of FSI, communication link among all parties including government departments and critical submission/approval path and time reference are presented in Appendices 3, 4, and 5. These aim to outline a full picture for works in FSI and shorten the works duration.

Other than the effort from contractors, the client and the consultant parties should offer their helpful support to the project. The client should minimize the design variations and issue payment to the contractor on time. Consultant parties shall complete the project design prior to the commencement of site works, provide accurate and high constructability work drawings to the contractor in earlier state, make comment and approve the shop drawings and materials within a short period.

Finally, government support for project works is essential. As promised by Buildings Department, Fire Services Department and Water Authority, the approval period for design layout generally takes 30 days, 20 days and 20 days respectively. Should all government departments shorten the approval period of designed layout, faster construction can be achieved.

8. CONCLUSION AND FUTURE WORK

A successful project means that the project is completed on time, within budget and gets satisfaction from the client, architect and statutory parties. However, some project works were found to be far from successful due to many critical conflict events. It can be concluded that the project handling and management performance from all trades should be enhanced. The senior management should stress the importance of building services installation in the construction project. Further research on conflict events from two or more newly completed projects will be identified in the coming semester by more close measurement. The target result will be a full picture on how to shorten the construction period and to improve the time performance.

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Q & A

Q1: Please explain why in Figures 2 and 3 the peak of time overrun and cost overrun for project 1 is caused by the consultant?

So: It is because there is a design fault caused by the consultant, which required extra time and cost for rectification.

Q2: Is it a special case to have such a high rate for consultant causing time overrun and cost overrun in project 1, as there is significant difference in the two projects for the bar in Figures 2 and 3 of consultant causing time overrun and cost overrun?

So: Yes, it is a special case for project 1 as consultant design fault is a rare case.

Q3: Since the consultant is employed by the client, do you know that does the cause of time overrun and cost overrun relate to the client, not solely to the consultant?

So: I have mentioned that the consultant has a design fault in this particular case. Moreover, the aim of this project is to study the cause of time overrun and cost overrun in the two particular projects, instead of studying the relationship between the client and the consultant.

Q4: How did you collect the data?

So: The data was collected by conducting interviews.

APPENDIX 1: CONFLICT SUMMARY TABLES

Conflict summary for Project 1

	Key conflict	Case	Time (Day)	Percentage	Cost (HK$)	Percentage
			A	(A/400day)*	B	(B/HK$4M)*
1	Contractual problem	0	0	0.00%	$ -	0.00%
2	Insufficient construction cost	0	0	0.00%	$ -	0.00%
3	Client initiation	3	33	8.25%	$ 194,000.00	4.85%
4	Architectural revision	5	36	9.00%	$ 294,400.00	7.36%
5	Design fault	2	198	49.50%	$ 1,168,200.00	29.21%
6	Late construction issue	3	22	5.50%	$ 154,000.00	3.85%
7	Late drawing/material approval	5	10	2.50%	$ 60,000.00	1.50%
8	Late payment/financial difficulty	3	12	3.00%	$ 87,300.00	2.18%
9	Coordination problem	5	20	5.00%	$ 97,700.00	2.44%
10	Material shortage	2	29	7.25%	$ 137,800.00	3.45%
11	Insufficient labour force	3		Included in item 8-		
12	Site management	5	27	6.75%	$ 114,000.00	28.51%
13	Workmanship	0	0	0.00%	$ -	0.00%
14	Other	2	8	2.00%	$ 53,600.00	1.34%
	Total	38	395	98.75%	$ 2,361,000.00	84.69%

*** Note : Contract duration is 400 days and contract sum of FSI is HK$4M**

Conflict summary for Project 2

	Key conflict	Case	Time (Day)	Percentage	Cost (HK$)	Percentage
			A	(A/420day)*	B	(B/HK$4.5M)*
1	Contractual problem	0	0	0.00%	$ -	0.00%
2	Insufficient construction cost	0	0	0.00%	$ -	0.00%
3	Client initiation	2	22	5.24%	$ 117,500.00	2.61%
4	Architectural revision	4	39	9.29%	$ 157,300.00	3.50%
5	Design fault	2	17	4.05%	$ 50,600.00	1.12%
6	Late construction issue	3	11	2.62%	$ 50,300.00	1.12%
7	Late drawing/material approval	7	22	5.24%	$ 103,000.00	2.29%
8	Late payment/financial difficulty	1	6	1.43%	$ 51,200.00	1.14%
9	Coordination problem	4	15	3.57%	$ 78,200.00	1.74%
10	Material shortage	1	17	4.05%	$ 25,400.00	0.56%
11	Insufficient labour force	1	5	1.19%	$ 60,000.00	1.33%
12	Site management	9	58	13.81%	$ 201,200.00	4.47%
13	Workmanship	2	9	2.14%	$ 31,470.00	0.70%
14	Other	2	15	3.57%	$ 123,100.00	2.74%
	Total	38	236	56.2%	$ 1,049,270.00	23.32%

*** Note : Contract duration is 420 days and contract sum of FSI is HK$4.5M**

APPENDIX 2

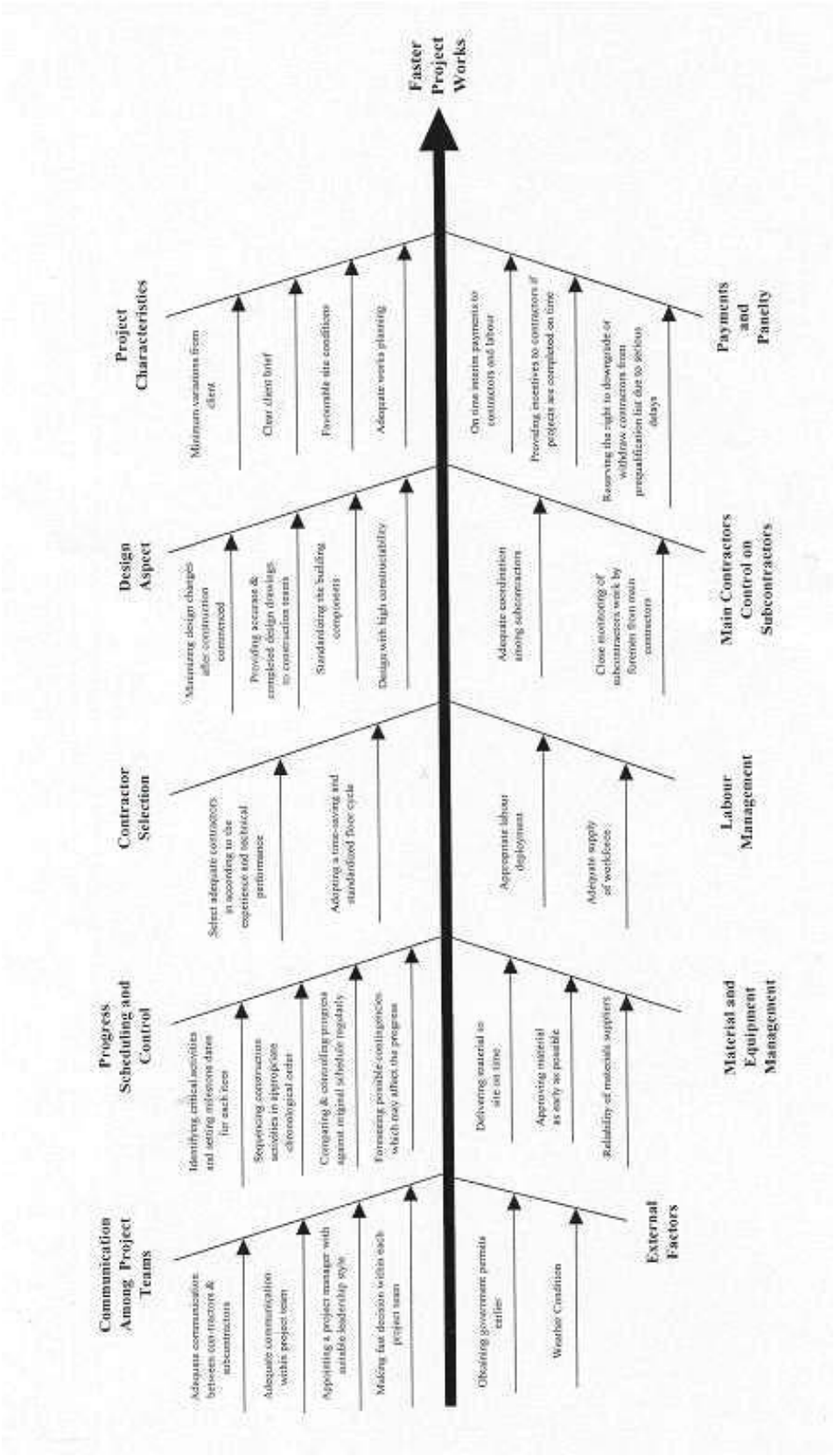


Fig. 4: Fish-bone diagram indicating the important component for faster project work [2]

APPENDIX 3: CRITICAL WORK CONTENT AND SEQUENCE FOR FSI

A. System design and submission teams
   1. Pipe route layout
   2. Boxing out/sleeves/plinth detail
   3. Schematic diagrams : -
      - Sprinkler system, Fire hydrant/hose reel (FH/HR) and Automatic fire alarm/manual fire alarm (AFA/MFA)

B. Other drawing submission items
   1. Pumps loading calculation
   2. Water tanks capacity calculation
   3. Pump room arrangement detail

C. Statutory submission
   1. Water Authority (WA) submission
      - Pipe route layout and schematic diagrams
      - Material schedule
   2. Fire Services Department (FSD) submission
      - Pipe route layout and schematics

D. Material/sample submission
   1. Water pipes and fittings
   2. Valves
   3. Wires
   4. FH/HR
   5. Pumps, motors
   6. Control devices – AFA, MFA, Pumps
   7. Electrical provisions

E. Material selection
   1. Select reliable suppliers
   2. Select materials as specified in contract

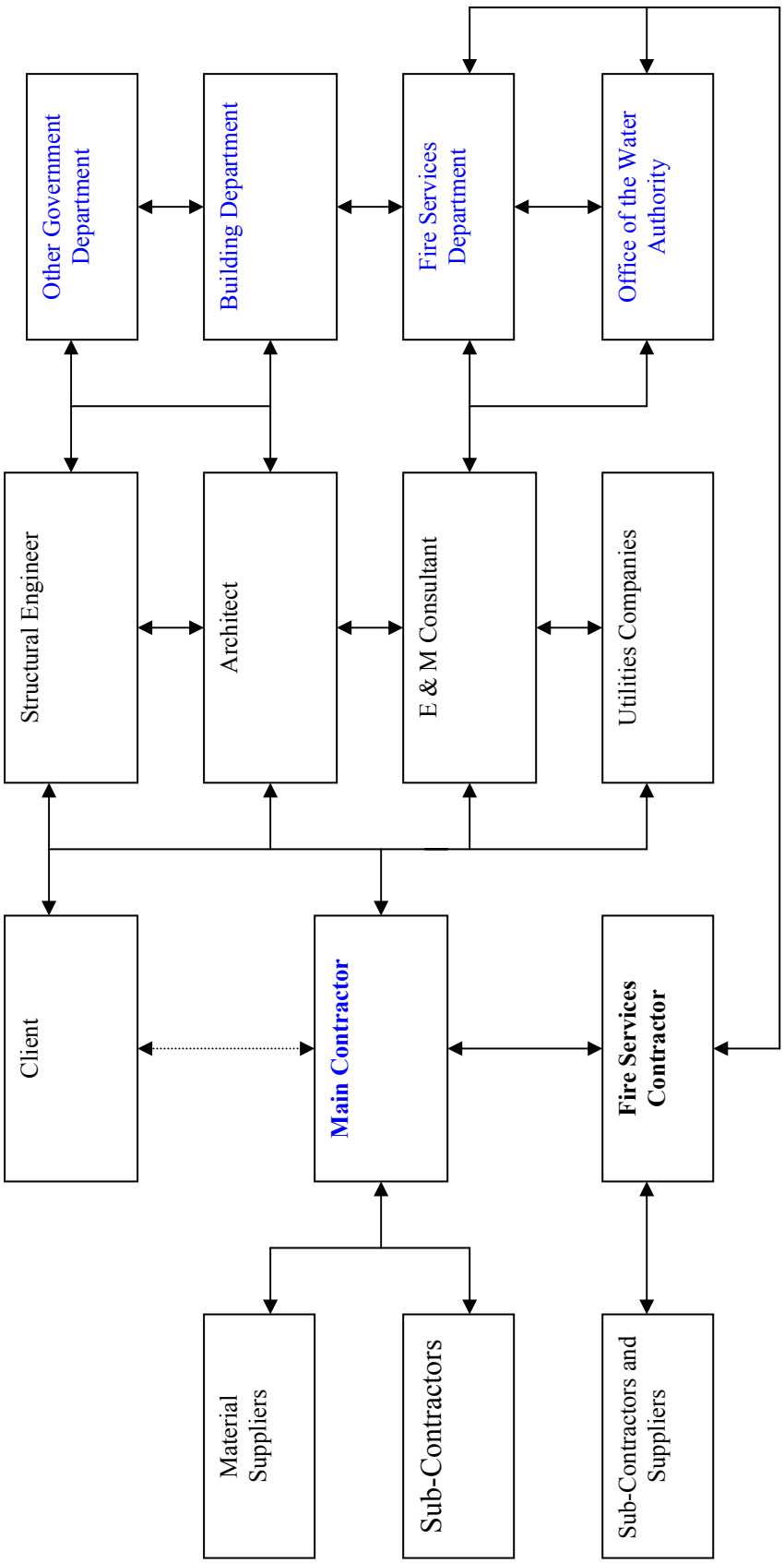
F. Management and coordination
   1. Assist the Building Services Engineer (BSE) work out effective services route layout
   2. Set up critical arrangement and progress for site works
   3. Close site monitoring

G. Inspection / supervision
   1. Take site supervision by supervisor and Engineer frequently
   2. Invite Residential Engineer (RE) inspect the installations regularly

H. Testing and commissioning
   1. Function and control of pumps and valves
   2. Water flow rate and leakage
   3. Function of detectors and manual call points
   4. Function of fire alarms
   5. Fire direct link
   6. Signaling

I. FSD inspection

APPENDIX 4: COMMUNICATION LINK CHART FOR BUILDING CONSTRUCTION PROJECT IN HONG KONG



APPENDIX 5: STATUTORY SUBMISSION/APPROVAL CHART FOR FSI

A. Submission / approval (Fire Services Department)
   1. Pipe route layout plan
   2. System schematics – sprinkler, FH/HR and AFA/MFA

B. Submission / Approval (Water Authority)
   1. Pipe route layout
   2. Water side materials – pipe, valve, fittings.

C. Approval duration (FSD and WA)
   1. FSD take 20 working days for reply
   2. WA take 20 working days for approval or rejection notice