

Selection of Sub-Contractors.

Process and Criteria Considered.

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1. Introduction

The aim of this report is threefold.

- To highlight and analyse the various Sub-Contractor Selection Processes that are in operation throughout the world.
- To highlight and analyse the different Factors relating to the various Criteria within the Sub-Contractor Selection Processes throughout the world.
- To evaluate the findings and define the learning outcomes.

In the construction industry the role of the Sub-Contractor is to provide the Principal Contractor with a niche skill that the Sub-Contractor specialise in. Sub-Contracting allows the Principal Contractor to employ the least amount of personnel for any particular project, whilst having access to certain specialisation services. This could be services like Pile Driving, Crane provision and operation, or Soil Anchoring. The Sub-Contractor may also be the supplier of Aggregate, Concrete or Steelwork etc. It would be impracticable for the Principal Contractor to hold all the specialist Plant, equipment and specialist personnel for every task that may occur during a construction project. Therefore the Principal Contractor hires in Sub-Contractors to undertake the specialist work.

However, Sub-Contractor selection is regularly neglected and underestimated in many industries, including the construction industry (Arslan *et al.*, 2008).

Within a construction environment, Sub-Contracting Companies can be appointed by either the Principal Contractor or they can be appointed directly by the Client. If the Client is selecting the Sub-Contractor, then it is known a 'Nominating' (Thomas, Tang and Palaneeswaran, 2009, p.742). The Client retains control over the Sub-Contractor selection when using the nominated approach (Yik *et al.*, 2006).

Whether the Client or the Principal Contractor selects the Sub-Contractor depends on the structure and requirements of the Project. Other factors also come into play when selecting Sub-Contractors, for example prior knowledge of the Sub-Contracting Companies within that sector.

The definition of a Sub-Contractor is an individual or organisation carrying out work for another individual or organisation. The second and subsequent suppliers of goods and / or services can be considered as Sub-Contractors. This includes suppliers of goods and / or services who are last in the sequence (BSI, 2010). A couple of examples of this may be:

- A Government (Client) appointing a large Multi-National Construction Company (Principal Contractor) who hires a National Construction Company (Sub-Contractor) to carry out designated work, who in turn hire a specialist drilling company (Sub-Contractor) to drill foundation piles.
- A medium size house building company (Client) who directly hires one individual plumber (Sub-Contractor) to carry out plumbing work on one new house build.

Construction projects are fraught with underlying problems that if not managed correctly can at best delay the project, and at worst may put the whole project in jeopardy. Correct selection of a reliable Sub-Contractor is one of the tasks that need to be undertaken to reduce the risk to the project. This can be accomplished by using a systematic approach. Sub-Contractors need to be selected carefully to protect the best interests of the Principal Contractor and all other Sub-Contractors involved with the project (Thomas, Tang and Palaneeswaran, 2009, p.736).

2. Sub-Contractor's Selection Process

The selection process for a Sub-Contractor can take place at many different stages of a project, or at only one stage. This decision as when to involve a Sub-Contractor is 'Project Specific', and may require the Sub-Contractor (Organisation or Individual) to provide input at various stages, for example, the Project Initiation Stage, the Feasibility Study Stage or the Design Stage. This situation might arise if the Sub-Contractor has specialist skills that the Client requires, and the Client needs that information to progress with the Project at its earliest stages. However, the majority of Projects only require a Sub-Contractor to become involved after the selection of the Principal Contractor, and the Principal Contractor then proceeds to select the Sub-Contractor.

To determine the correct and most suitable Sub-Contractor for various projects is fraught with risk. Many countries around the world have different preferred methods for their organisations to select the most appropriate Contractor or Sub-Contractor for a specific project. Table 1 shows a summary collection of information taken from an article by Elsayah, detailing global Contractor and Sub-Contractor selection processes that are available and used by different organisations in different Countries (Elsayah, 2016).

There are other selection processes in use around the world which are not mentioned in Table 1. For instance, 'Multi Criteria Decision Making' (MCDM) and 'Bespoke Approaches' (BA), (Marzouk, El Kherbawy and Khalifa, 2013, p.151).

Different Global Contractor and Sub-Contractor Selection Processes (CSP)
Price-Quality Method (PQM)
Dimensional Weighting Method (DWM)
Multi-Attribute Utility Theory (MAUT)
Multi-Attribute Analysis (MAA)
Artificial Neural Networks (ANN)
Analytic Hierarchy Process (AHP)
Fuzzy Analytic Hierarchy Process (FAHP)
Partial Least Squares (PLS)
Simple Additive Weight (SAW)
Simple Additive Weighting with Grey Relations (SAW-G)
Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)
Technique for Order Preference by Similarity to Ideal Solution with Grey Relation (TOPSIS-Grey)
linear Regression Model
Integer Programming Model
Fuzzy Analytical Hierarchical Process and Simple Multi-Attribute Ranking Technique. (Fuzzy AHP-SMART)
Performance Assessment Scoring System (PASS)
Multinomial Logit (MNL)

Table 1: Various Contractor and Sub-contractor Selection Processes (Elsayah, 2016).

Although the selection process is devised to evaluate all criteria and factors linked to a Sub-Contractor, it is of interest to discover that in certain countries around the world, cost is a main influence in the decision making process. For example, in table 2 it shows that in Turkey, Canada, USA and Lithuania the Sub-Contractor with the lowest bid is selected. Whereas, in France, the Sub-Contractor who submits an abnormally low price is rejected (Marzouk, El Kherbawy and Khalifa, 2013, p.151).

<i>Author</i>	<i>Country</i>	<i>Selection attributes used</i>	<i>Modelling approach</i>
<i>(Lam, et al., 2000)</i>	Hong Kong	Quoted financial stability, management capability, health and safety, reputation, relationship, claims & disputes, project-specific criteria	ANN
<i>Al-Harbi (2001)</i>	UAE	UAE Experience in handling similar types of projects, financial stability, quality performance, manpower resources, equipment resources, and current workload	AHP
<i>Enyinda et al.,(2011)</i>	Ghana	Past experience, manpower resources, relevant equipment, Financial stability	AHP
<i>Hatash and Skitmore (1998)</i>	UK	Quoted bid price, financial soundness, technical ability, management capabilities, safety performance, and reputation	Multi-attribute utility theory
<i>Lambropoulos (2007)</i>	Greece	Quoted cost, quality of work, and completion time	
<i>Liu, et al.(2014)</i>	China	Quoted finance capability, tendered price, technological capacity and Health/safety/environment (HSE) management ability	Two-Stage Partial Least Squares (PLS)
<i>Watt, et al.(2010)</i>	Australia	Quoted Organizational experience, Project management expertise, Tendered price, Technical Expertise, Past Project Performance, Reputation,	Multinomial logit (MNL) model
<i>Zavadskas, et al. (2010)</i>	Lithuania	experience of executives, number of constructed houses, turnover, number of executives, market share, production method	SAW-G & TOPSIS-Grey
<i>Huang (2011)</i>	China	Financial Standing, Technical ability, Management capability, Quality, Current projects	Theoretical method
<i>(Aje & Ogunsemi, 2006)</i>	Nigeria	Quoted Past performance, Contractors' experience, Workmanship quality, Tender sum, Plant and Equipment, Contactor's reputation, Management capability, Project complexity, Quality assurance, Contract period , Health & Safety policy , Financial standing , Response to instructions , Project size , Location , Project type , Current workload , Competition , Length of time in business , Procurement system , Relationship with client ,	The linear regression model

Table 2: Various Global Contractor and Sub-Contractor Selection Process Methods (Elsayah, 2016).

It can also be seen in table 2 that the UK uses the 'Multi Attribute Utility Theory' (MAUT) Method. This method consists of first completing a Pre-Qualification Questionnaire (PQQ) and if the Principal Contractor or Sub-Contractor is successful at the questionnaire stage then they are invited to Interview.

The British Standards Institution (BSI) has developed Publicly Available Specifications (PAS) to help Organisations or Individuals to improve standardisation documented process for certain business situations (BSI, 2018). A PAS defines good practice standards for a Product, Service or Process (British Standards Institution, 2018).

PAS 91 is a process developed by The British Standards Institution specifically for use in the construction industry to test compliance of Sub-Contractors (and Contractors) with specifications required for the successful participation in, and completion of, a construction project. By following this process an organisation (or individual) who is struggling to compare one Sub-Contractor from another at the selection stage, can present a Pre-Qualification Questionnaire to each Sub-Contractor (or Contractor) for completion, On the return of the Pre-qualification questionnaire the hiring organisation may make an informed selection decision from a uniformed response (BSI, 2010).

PQQs are mainly used in some large organisations, the public sector and some utility companies. The questionnaire establishes if the Sub-Contractor is:

- Technically competent.
- Financially sound.
- Legally compliant.
- Have the relevant project skills.
- Have the relevant project experience.
- Have the relevant project resources (plant and manpower).
- Have the desire to complete the project.
- Have a good health and safety record.
- Have a good environmental record.
- Have a good quality record.
- Have a good welfare record.
- Have a good reputation.
- Have a good 'Corporate Social Responsibility' (CSR) record.
- Have a good previous tender performance.

General Example of a Sub-Contractor Selection Process



Principal Contractor invites Tier 2 Contractors (Sub-Contractors) to participate in the selection process (PQQ), which if successful would lead to Tendering (bidding) for Works Packages, for example:

1. Foundation work package.
2. Structural Concrete & steel work package.
3. Glazing work package.
4. Building Services work package
5. Roofing work package
6. Fit-out work package.



Upon successful Tendering the Principal contractor appoints Tier 2 Contractors (Sub-Contractors). They work together to complete

1. H&S assessment
2. Price negotiations
3. Delivery
4. Design

They then sign the Stage Two Agreement



Tier 2 Contractors (Sub-Contractors) select Tier 3 Contractors (Sub-Contractors)

1. Brickwork
2. Scaffolding
3. Roofing
4. Electrical and mechanical work
5. Dry-lining
6. Finishing work

Figure 1: Flow diagram - General example of a Sub-Contractor selection process (Stewart, 2018).

3. Sub-Contractor's Selection Criteria and Associated Factors

Flynn states that Clients or Principal Contractors should pre-qualify Sub-Contractors based upon their *'financial situation'*, *'safety performance'* and *'previous work'* (Flynn, 2009). Furthermore, Hartmann and Caerteling state that *'trust'* and *'price'* are important factors in Sub-Contractor selection (Hartmann and Caerteling, 2010). However, there are more than just these five factors that need satisfying.

Additionally, if the criteria are wrong then the Contractor (or Sub-Contractor) may not be appropriate for the needs of the project (Araujo, Alencar and Mota, 2016, p.2).

The article *'Factors influencing Sub-Contractor's selection in construction project'* (Marzouk, El Kherbawy and Khalifa, 2013) is of interest to the Client or Principal contractor when selecting a Sub-Contractor. It specifies forty six factors within ten main criteria (and one other miscellaneous criterion) that should be considered when choosing an appropriate Sub-Contractor for a certain project. Furthermore, it highlights the importance of correctly selecting a Sub-Contractor which can subsequently reduce project risk, maximise quality and harmonise the different Sub-Contractors on a project site.

Tables 3 to 13 below detail the ten main criteria (and one other miscellaneous criteria) suggested for selecting a Sub-Contractor, which are further sub-divided into forty six factors (Marzouk, El Kherbawy and Khalifa, 2013, p.152).

SUB-CONTRACTOR SELECTION CRITERIA 1 AND ITS RELEVANT FACTORS				
CRITERIA		FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION		
1	COST	1	Cost over-run	Sub-Contractor's ability to provide evidence that project costs will not exceed the expected value during the Project's construction stage
		2	Cost flexibility	Sub-Contractor's ability to provide evidence of flexibility in reducing the cost of one or more items
		3	Tender price	Sub-Contractor's ability to provide evidence that a competitive price will be offered to win the Tender
		4	Payment difficulties	Sub-Contractor's ability to provide evidence of prompt monthly payment to their suppliers of materials and payment of salaries to their employees
		5	Contract completion / failure	Sub-Contractor's ability to provide evidence of successful completion of previous projects and provide details of projects they have failed to complete
		6	Financial stability	Sub-Contractor's ability to provide evidence that they have the funds to undertake the project and have no financial problems
		7	Financial references	Sub-Contractor's ability to provide evidence of sources that make available funding during the project

Table 3: Cost - criteria 1 and its factors (Marzouk, El Kherbawy and Khalifa, 2013).

SUB-CONTRACTOR SELECTION CRITERIA 2 AND ITS RELEVANT FACTORS				
CRITERIA		FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION		
2	QUALITY	1	Quality	Sub-Contractor's ability to provide evidence of the quality of work delivered on past projects
		2	Poor management ability	Sub-Contractor's ability to provide evidence of a robust quality management system to ensure their workforce produce good quality work
		3	QA / QC programs	Sub-Contractor's ability to provide evidence that they have within their organisation, quality assurance and quality control engineers

Table 4: Quality –criteria 2 and its factors (Marzouk, El Kherbawy and Khalifa, 2013).

SUB-CONTRACTOR SELECTION CRITERIA 3 AND ITS RELEVANT FACTORS

CRITERIA		FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION		
3	BEHAVIOUR & EXPERIENCE	1	Energy saving materials & installation	Sub-Contractor's ability to provide evidence that their employees can demonstrate their commitment to energy saving whiles working with equipment
		2	Poor competency of labourers	Sub-Contractor's ability to provide evidence that their employees are competent to carry out the work to a high quality standard and have good time management
		3	Experience of technical personnel	Sub-Contractor's ability to provide evidence that their employees have the 'time service' experience within their work discipline
		4	Conduct of the staff	Sub-Contractor's ability to provide evidence that their employees are able to interact positively and considerately with other personnel on the project
		5	Prevention of vandalism	Sub-Contractor's ability to provide evidence of previous projects they have completed that were vandalism free
		6	Cooperation with other Sub-Contractors	Sub-Contractor's ability to provide evidence of successful collaboration with other Sub-Contractors on the designated project and other projects in the vicinity
		7	Creativity & innovation	Sub-Contractor's ability to provide evidence that their engineers have previously solve complicated ongoing project problems for the Principal Contractor
		8	Labour force memory retention	Sub-Contractor's ability to provide evidence that their labour force can retain vital information when given a specific task

Table 5: Behaviour and Experience - criteria 3 and its factors (Marzouk, El Kherbawy and Khalifa, 2013).

SUB-CONTRACTOR SELECTION CRITERIA 4 AND ITS RELEVANT FACTORS

CRITERIA		FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION		
4	SAFETY	1	Site cleanliness	Sub-Contractor's ability to provide evidence on their workforce leaving the jobsite clean and tidy after their shift and after completion of the project
		2	Prosecution, air or water pollution	Sub-Contractor's ability to provide evidence that they do not cause any air or water pollution during their contracted period
		3	Safety awareness	Sub-Contractor's ability to provide evidence of their safety awareness on site

Table 6: Safety - criteria 4 and its factors (Marzouk, El Kherbawy and Khalifa, 2013).

SUB-CONTRACTOR SELECTION CRITERIA 5 AND ITS RELEVANT FACTORS

CRITERIA		FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION		
5	INSURANCE, REPAIR & WARRANTY	1	Onsite plant maintenance & repair	Sub-Contractor's ability to provide evidence of their planned maintenance and repair regime for their equipment.
		2	Responsiveness to warranty issues	Sub-Contractor's ability to provide evidence that they are keen to maintain 'warranty' on their equipment
		3	No insurance for equipment & employees	Sub-Contractor's ability to provide evidence that their equipment and employees are all covered by the appropriate insurance policies

Table 7: Insurance, repair and warranty - criteria 5 and its factors (Marzouk, El Kherbawy and Khalifa, 2013).

SUB-CONTRACTOR SELECTION CRITERIA 6 AND ITS RELEVANT FACTORS

CRITERIA		FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION		
6	DISPUTES & RISK	1	Incompetent suppliers - deliveries	Sub-Contractor's ability to provide evidence that they can both receive and provide supplies on time
		2	Disputes and arbitration	Sub-Contractor's ability to provide evidence of any previous history of disputes or arbitration arising from any earlier projects they have undertaken
		3	Failure to comply with quality spec.	Sub-Contractor's ability to provide evidence that they are able to abide by quality specifications on previous projects
		4	Lack of readily available utilities on site	Sub-Contractor's ability to provide evidence that they are able to deliver welfare facilities to the site for their employees (offices, washrooms etc.)

Table 8: Disputes & risk - criteria 6 and its factors (Marzouk, El Kherbawy and Khalifa, 2013).

SUB-CONTRACTOR SELECTION CRITERIA 7 AND ITS RELEVANT FACTORS

CRITERIA		FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION		
7	RISK AVOIDANCE	1	Ability to predict risk	Sub-Contractor's ability to provide evidence that they are able to predict risk in different project / work situations

Table 9: Risk avoidance - criteria 7 and its factors (Marzouk, El Kherbawy and Khalifa, 2013).

SUB-CONTRACTOR SELECTION CRITERIA 8 AND ITS RELEVANT FACTORS

CRITERIA		FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION		
8	TIME	1	Delays - flexibility and cooperation	Sub-Contractor's ability to provide evidence that they are able to cooperate with the Principal Contractor to resolve any delays in the project
		2	Delays	Sub-Contractor's ability to provide evidence that they are accustomed to dealing with delays in a positive manner
		3	Length of time in the industry	Sub-Contractor's ability to provide evidence of how many years their company has been working in the industry
		4	Flexibility in critical activities	Sub-Contractor's ability to provide evidence that they are competent at dealing with critical activities during the construction stage
		5	Flexibility in non-critical activities	Sub-Contractor's ability to provide evidence of how they will deal with non-critical activities during the construction stage

Table 10: Time - criteria 8 and its factors (Marzouk, El Kherbawy and Khalifa, 2013).

SUB-CONTRACTOR SELECTION CRITERIA 9 AND ITS RELEVANT FACTORS

CRITERIA		FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION		
9	EXPERIENCE OF THE COMPANY	1	Reputation	Sub-Contractor's ability to provide evidence that they have a good reputation in the surrounding area (costs, time, quality)
		2	Geographical area familiarity	Sub-Contractor's ability to provide evidence that they know the local area (probably due to being based in the area)
		3	Construction regulations knowledge	Sub-Contractor's ability to provide evidence that they are familiar with construction regulations e.g. CDM Regulations 2015
		4	Previous volumes of work	Sub-Contractor's ability to provide evidence that they have undertaken work of the same volume or larger
		5	Experience in 'Tendering' in the local area	Sub-Contractor's ability to provide evidence that they have previously submitted Tenders in this area of discipline and details of Tender's won in this area
		6	Previous project sizes completed	Sub-Contractor's ability to provide evidence that they have previously worked on projects of the same size or larger

Table 11: Experience of the company - criteria 9 and its factors (Marzouk, El Kherbawy and Khalifa, 2013).

SUB-CONTRACTOR SELECTION CRITERIA 10 AND ITS RELEVANT FACTORS

CRITERIA		FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION		
10	TENDER	1	Quality of the submitted tender	Sub-Contractor's ability to provide evidence that they have previously submitted high quality Tenders in the past
		2	Willingness to tender	Sub-Contractor's ability to provide evidence that they show a willingness to win the Tender

Table 12: Tender - criteria 10 and its factors (Marzouk, El Kherbawy and Khalifa, 2013).

SUB-CONTRACTOR SELECTION CRITERIA 11 AND ITS RELEVANT FACTORS

CRITERIA		FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION		
11	OTHERS (MISC)	1	Site proximity	Sub-Contractor's ability to provide evidence of the distance between their main offices and the construction site
		2	Ongoing work commitments	Sub-Contractor's ability to provide evidence of the number of other projects they are working on that will coincide with the proposed project
		3	Physical resources	Sub-Contractor's ability to provide evidence of all their physical resources (equipment, tools, labour, materials)
		4	Relationship with the Client	Sub-Contractor's ability to provide evidence of any previous positive or negative relationship between themselves and the Client

Table 13: Others (misc.) - criteria 11 and its factors (Marzouk, El Kherbawy and Khalifa, 2013).

4. Analysis

It is recognizable that the Client or Principal Contractor ranks some factors to be of greater significance than others. Table 14 shows statistical analysis information extracted from a research article and converted into a different format. It indicates that there are twelve factors which are more important to Clients or Principal Contractors when selecting a Sub-Contractor (Marzouk, El Kherbawy and Khalifa, 2013, pp155-158).

SUB-CONTRACTOR SELECTION: RANKING OF SIGNIFICANT FACTORS			
IMPORTANCE	CRITERIA	FACTORS THAT INFLUENCE SUB-CONTRACTOR'S SELECTION	
1	EXPERIENCE OF THE COMPANY	Reputation	Sub-Contractor's ability to provide evidence that they have a good reputation in the surrounding area (costs, time, quality)
	TIME	Delays - flexibility and cooperation	Sub-Contractor's ability to provide evidence that they are able to cooperate with the Principal Contractor to resolve any delays in the project
2	TIME	Delays	Sub-Contractor's ability to provide evidence that they are accustomed to dealing with delays in a positive manner
3	DISPUTES & RISK	Failure to comply with quality spec.	Sub-Contractor's ability to provide evidence that they are able to abide by quality specifications on previous projects
	QUALITY	Quality	Sub-Contractor's ability to provide evidence of the quality of work delivered on past projects
4	COST	Contract completion / failure	Sub-Contractor's ability to provide evidence of successful completion of previous projects and provide details of projects they have failed to complete
	DISPUTES & RISK	Incompetent suppliers - deliveries	Sub-Contractor's ability to provide evidence that they can both receive and provide supplies on time
5	OTHERS (MISC)	Physical resources	Sub-Contractor's ability to provide evidence of all their physical resources (equipment, tools, labour, materials)
6	COST	Tender price	Sub-Contractor's ability to provide evidence that a competitive price will be offered to win the Tender
7	COST	Payment difficulties	Sub-Contractor's ability to provide evidence of prompt monthly payment to their suppliers of materials and payment of salaries to their employees
	TIME	Flexibility in critical activities	Sub-Contractor's ability to provide evidence that they are competent at dealing with critical activities during the construction stage
8	SAFETY	Safety awareness	Sub-Contractor's ability to provide evidence of their safety awareness on site

Table 14: 12 significant factors for Sub-Contractor selection (Marzouk, El Kherbawy and Khalifa, 2013).

The importance of the criteria *Time*, *Cost* and *Quality* for the successful completion of a project occupies over half of the twelve most significant factors. It is no surprise that these three criteria and some of their associated factors were within the top twelve rankings (*Time* = 3 factors from 5; *Cost* = 3 factors from 7; *Quality* = 1 factor from 3).

However, not all of the *Time*, *Cost* and *Quality* factors made the top twelve. This is unexpected, as some factors that did not make the top twelve were deemed to be of more importance by the author. The significance of some *Cost* factors that did not make the top twelve, directly affect other factors that did find themselves in the top twelve. For example, it is the Author's belief that the two factors of a Sub-Contractor providing evidence of their '*Financial Stability*' and providing evidence of their '*Financial References*' is thought to be of more importance than the fact that the Sub-Contractor can provide a '*Competitive Tender Price*'. It does not satisfy Due Diligence if a Principal Contractor accepts a Sub-Contractor to undertake work based on a given project price, if later the Sub-Contractor falters or fails to complete the project due to financial reasons. If the Principal Contractor had ranked the financial factors higher, then this potential project delay situation would not arise in the first place.

Quality is mentioned as being jointly ranked in third place. This is judged to be correctly ranked, as low quality work will affect a Sub-Contractor's reputation and hence will exclude them from future 'Invitations to Tender' with the loss of potential money generating work. One Case Study that reflects this association of the '*Quality*' factor, closely connected to the '*Reputation*' factor, comes from the Author's personal experience from running the Company South Wales Marine (SWM), a rope and rigging business. The Company was Sub-Contracted directly by a private yacht owning Client in Swansea (2009), to commence a small project to replace stainless steel wire 'infill' guardrails. The wire infills were installed on time, within budget and to the correct documented specification. However, as time progressed, it was seen that one strand of the wire had started to dis-colour and the whole installation began to look unsightly. Quality control was checked to confirm the installation process had been done correctly. Quality Assurance was checked to confirm the correct '316 marine grade stainless steel wire' had been ordered and the 'certificates of conformity' had been obtained for the product, and filed. The Client had not noticed the dis-colouration until it was brought to their attention by SWM, with a declaration that the problem would be resolved. Replacement of the whole installation was undertaken at the expense of the SWM, and costs were claimed back from the supplier who supplied the faulty materials.

By being pro-active, business '*reputation*' was maintained. Future work was secured on the strength of this situation. This scenario therefore shows that the '*Reputation*' factor and '*Quality*' factor deservedly sit in the first and third position respective in table 14, as they are both of significant importance in the selection process of a Sub-Contractor. This situation also pointed out one of the *Disputes and Risk* Criteria factors of '*Incompetent suppliers and deliveries*', which ranked as fourth in importance. If the supplier of '316 marine grade stainless steel wire' had a robust quality control management system in place then this situation would not have materialised. South Wales Marine should have checked the suppliers Quality Management System during the supplier selection process.

In joint first position with the '*Reputation*' factor is the '*flexibility and cooperation with delays*' factor. This is again understandable. If a Sub-Contractor has a good reputation within an industry sector then it can be said that the majority of other important factors will be covered. For example, a delay to a project will cost the Client and Principal Contractor. If a Sub-Contractor can make suggestions to prevent project delays and approach the delay problems with flexibility and cooperation then it goes without saying that the Sub-Contractor's reputation will be enhanced with both the Client and the Principal Contractor, and consequently within the industry sector.

'*Reputation*' can come from 'Word of Mouth' but is usually confirmed by taking up work references provided by other Clients or Principal Contractors who have used the Sub-Contractor in the past. However, there may be potential problems here where Companies providing good verbal or written references may have hidden agendas. For example, there may be family links between the Sub-Contractor bidding for the work and the Company being asked to provide a reference. A good reference would inevitably be supplied so family members can potentially have a better chance at winning the contract.

It was also noted that although the factor of '*Safety Awareness*' in the criteria of *Safety* made it into the top twelve most important factors, it was disappointing to see that only one of the three *safety* factors was selected as important, and its position came last (twelfth). This probably occurred due to the fact that it costs money to successfully implement the *safety* criteria. So by cutting back on safety to the bare legal minimum, allows for greater project profit. However, this could be a false economy, as saving costs in one Criterion (*Safety*) could dramatically increase spending in another Criterion (*Disputes and Risks*) and destroy other factors (*Reputation*).

For example, if the Sub-Contractor fails to provide fall arresting devices for their workforce and one of their employees falls from height and is injured or dies, then this could increase the cost of the project substantially in legal fees and compensation. It could also damage the Sub-Contractor's reputation irrevocably.

Two other important factors within table 14 are '*Contract completion*' (ranked 4th in importance), and '*Flexibility in critical activities*' (ranked 7th in importance). These two factors are judged to be correctly positioned. For example, in another Case Study regarding South Wales Marine (SWM), the Company was approached by 'Metal Masters West Wales Ltd' and asked to Sub-Contract at short notice to undertake installation of balustrade infill wires at the Norwegian Church entrance within the SA1 development in Swansea. SWM could quickly provide evidence of completed similar contracted work ('*Contract Completion*') to high standards and were also able to guarantee '*flexibility in critical activities*' in helping 'Metal Masters West Wales Ltd' out of a time constraining situation by ensuring them that commencement and completion of work could be the following day, and thereby relieving the pressure exerted on them by the Client. This goes to show that it does not matter how big or small a contract, '*Contract completion*' and '*flexibility in critical activities*' are still two important factors in the Sub-Contractor's selection process.

With regards to Sub-Contractor selection around the world, Table 2 shows the preferred selection processes in different countries. It can be seen by analysing the table that different Research Authors have recorded more than one method of contractor selection processes used in certain countries. For example, China is seen to use two different methods of selection. There is a possibility that this may lead to ambiguity and confusion amongst Sub-Contractors, which in turn may reflect on the standard of work produced on a project.

5. Conclusion

It is encouraging to note that there has been statistical analysis undertaken to help a Principal Contractor determine a logical approach in selecting a Sub-Contractor for inclusion in a project. This statistical information can also be used by a Client to select a Principal Contractor or a 'Nominated' Sub-Contractor.

However, the selection process cannot be guaranteed as a 100% certainty to eliminating project risk. There will always be some residual risk remaining. This can be seen by the different types of selection processes in use around the world. If one selection process was deemed to be the superior process then this method would have been adopted worldwide. Furthermore, it can be construed that various Countries and Organisations place many Sub-Contractor selection criteria and factors in different ranking positions.

Consequently, although there are numerous types of processes to help all types of Organisations in the selection of Sub-Contractors, caution still needs to be exercised, as a misjudgement in undertaking 'due diligence' in any of the criteria and factors could cause major financial loss (Cost), project slip (Time) and bad workmanship (Quality). This in turn could lead to project failure, which could damage the organisation's reputation, leading to difficulty in securing future projects, and possible organisation collapse.

Reputation of the Sub-Contractor is considered to be the number one factor in their selection. However, Client reputation and the Principal Contractor reputation are of equal importance. If the Client has a bad reputation then the Principal Contractor will not want to work for them. Likewise, if the Principal Contractor has a bad reputation then the Sub-Contractor will not want to work for them.

Moreover, what can be learnt from this is that a good reputation in all criteria and factors within a given industry is paramount. A good reputation can be a fair indication of organisational conscientiousness towards project Risk, Costing, Timing, Quality and Safety.

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