PROJECT EXECUTION EPC, EPCM or IPT:
WHICH METHOD WORKS BEST FOR LARGE SCALE PROJECTS

Torfi Dan Sævarsson

Thesis of 12 ECTS credits
Master of Project Management (MPM)

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ABSTRACT

The final outcome of a project is what owners look at, to determine if a project was successful or failure. The iron triangle is most often used as indicator, the cost (below budget), time (on schedule) and quality (is it fit for purpose). One part that will affect the outcome of a project is the project management method used to control the execution.

The objective of this article is to determine the best execution method for large scale projects, understand what project owners, vendors and contractors consider as the best execution method, and identify the difference between the three main execution methods that are used today in large scale projects.

The research method used in the study was through a questionnaire survey. Data was collected from project owners, end users, equipment vendors, installation contractors, consulting companies, engineering companies and turnkey contracting firms. The results showed that there is a common understanding how a large scale project is defined. There is also a clear trend what execution method is considered to work best for Greenfield and Brownfield projects. Additionally it shows a clear indication which execution method is considered to be the least costly and give the most benefits to the owner.

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1. INTRODUCTION

Large scale projects in the aluminium industry are usually managed and executed either as an Engineering Procurement and Construction project (EPC) (Loots & Henchie, 2007) or as Engineering Procurement and Construction Management projects (EPCM) (Norton Rose Fulbright, 2013). The third option less commonly used is the Integrated Project Team approach (IPT) (Cook & Hancher, 1990).

Project owners or project founders (the term project owner will be used to represent both in this paper) always have concern regarding the cost of managing their projects. In addition they are concerned that the project will or will not give the best benefits regarding operational reliability and duration. The selection of the project management execution method has been pointed out as one of the factors that will affect productivity and efficiency of projects (Ferrada & Serpell, 2014). The selection of execution method is, in fact, considered as one of five highest potentials effecting the productivity loss, schedule delays and cause of rework during the project execution (Ferrada & Serpell, 2014).

Although the three execution methods are similar in many ways, there is a significant difference in the execution methodology and how the overall project management is organized. In this article the aim is to find out how the project owner (the upper management of organization), view the three mentioned execution methods and determine how they actually see the difference and try to understand why projects are executed as is today.

2. LITERATURE REVIEW

When researching literature about Project Management and trying to find topics that relate to project management execution methods it is notable that very little is mentioned about different type of execution methods.

In Harvard Business Essentials book "Managing Projects Large and Small" the following is written and it gives good idea about the difficulties regarding selecting correct execution method. "Naturally, getting a project to deliver on time and on budget requires good management. And the bigger the project, the more challenging good management becomes. A project manager is expected to transform what begins as a vague concept in the collective mind of top management into a measurable and accountable system that directs a broad array of knowledge, skills, and resources to an important organizational goal." (Harvard Business Essentials, 2004) This indicates that it should be very important for project owners to select the correct execution method for their project.

In the book "Project Management" (Kerzner, 2013) it is stated "Achieving project management excellence, or maturity, is more likely with a repetitive process that can be used on each and every project. This repetitive process is referred to as the project management methodology". Here it is pointed out that when using the same method over and over again you will succeed in achieving the goal set. There is, on the other hand, nothing mentioned which or what kind of methodology is available.

According to same book "Project Management" (Kerzner, 2013), it is needed to be recognized by most companies today that there is a need for more than one type of project management methodology to execute projects and maximize the projects value to the company. The question still remains, which project management methodology, shall be used?

In the PMBOOK GUIDE (PMBOK guide - Fifth edition, 2013) definitions the Project Management System is defined as "The aggregation of the processes, tools, techniques, methodologies, resources and procedures to manage a project". In addition the Project Management Team is defined as "The members of the project team who are directly involved in project management activities. On some smaller projects, the project management team may include virtually all of the project team".

Execution Methods

The construction project industry today is mainly using three execution methods to execute medium or large scale projects. Those methods are;

Lump sum turnkey (LSTK) fixed price contracts (von Branconi & Loch, 2004), also known as Engineering, Procurement and Construction (EPC) contracts, where one major contractor assumes the risk and can therefore control the project execution, minimizing interfaces and working with more overlap.

Cost-reimbursable contracts, such as Engineering, Procurement and Construction Management (EPCM) contracts (von Branconi & Loch, 2004) where the project owner must drive the project, investing in more resources and assuming the risk of the project.

The integrated project team (IPT) approach is a development from what was called Partnering (Cook & Hancher, 1990). As in the partnering concept for this method to become an effective tool, the owner-engineer relationship must be reshaped so that they seek the common goals and have the same sets of priorities. The objective of IPT agreement should be to achieve mutual profit and mutual success for each company. The IPT agreement must be based on mutual trust and mutual benefit.

Project size

How industry looks at the definition of project size, is a definition clear to all regarding what is a medium or a large scale project? It is defined that Large Engineering and Construction Projects (LECP´s) are where the capital cost is in excess of 500 million USD. (Berends, 2007) This appears to be a common understanding how the industry defines the size of project.

Execution Method selection

As (Ferrada & Serpell, 2014) describe in their paper, it can be difficult to select the correct execution method for a project. The selection of construction methods is a multi-criteria decision making process. An example of the different decision criteria used to select construction methods during the design and construction stages of a project are shown in the following Table (Ferrada & Serpell, 2014).

Table 1: Decision criteria for execution method

Criteria:	Russell and Al-Hammad 1993	Basha et al. 1991	Youssef et al. 2005	Soetanto et al. 2007	Pan 2008	Udaipurwala and Russell 2002	Pan 2009
Time	X		X	X	X	X	X
Cost	X	X	X	X	X	X	X
Quality					X	X	X
Risk	X						
Resources availability	X	X				X	
Maintenance		X					
Production rate		X			X		
Physical characteristics of the element to build			X	X	X		
Construction method characteristics			X	X			
Environment			X			X	
Site characteristics							
Safety					X	X	

(Ferrada & Serpell, 2014)

The question still remains that there is no clear indication of how and why project owners select certain execution method.

Experience from others

In the paper "Geothermal – Opportunities to support delivering the energy for the future" (Armstrong, McDonnell, & Barratt, 2011) the authors try, among other things, to identify which project execution method would work best for a geothermal project to maximize performance and cost efficiency based on economic fundamentals and project delivery. They state; "The outcomes of a project benefits greatly for "best for project" contractual and working relationship between quality organization and teams" (Armstrong, McDonnell, & Barratt, 2011). They also discuss what project execution method will work most efficiently depending on management, acceptable project risk and how to manage total project cost, time and quality.

They compare the project execution methods, EPC versus EPCM. The overall comparison is in the following table according to their paper.

Table 2: Comparison EPC v. EPCM

EPC	EPCM
• The construction risk is transferred to the contractor for a premium. • Schedule and performance risk capped at 10% contract value. • Risk of generation forgone due to unavailability is partially mitigated by delay damages up until handover, and then assumed by the developer. • Key decision locked in at contract signing. • Life cycle performance highly dependent on specifications and quality assurance processes. • Developers lifecycle performance objective not aligned with contractors cost minimisation objectives • Less developer resource required and simple contractual interface. • Whole of plant guarantees provided by EPC warp via LDs, plant performance. • Health and safety is EPC contractors led.	• Total construction risk is not contractually capped. • Increased influence over design optimisation and equipment selection achieve life cycle objectives. • Greater flexibility to optimise design outcome during project implementation. • Improved knowledge transfer from design and procurement processes to developer builds lifecycle assessment capability. • More direct access to technology vendors. • Requires greater Developer resources • Developer's performance risk is partially mitigated by guarantee provisions in contracts with EPCM provider and equipment suppliers. • Health and safety is Developer led, providing direct enforcement of safety requirement over all contractors.

(Armstrong, McDonnell, & Barratt, 2011)

Their conclusion is that both methods work for geothermal projects; the EPC project execution method is more often used if the project is dependent on financing requirements. On the other hand the EPCM project execution method has some more advantages to the Owner. They also state that EPCM project execution method is a better match for geothermal projects.

The shift in execution method

From what can been seen in the paper "Engineering and construction projects for oil and gas processing facilities: Contracting, uncertainty and economics of information" (Berends, 2007) is that in the oil industry, small and medium size projects were executed by local in-house teams, larger size projects were managed by corporate central project teams. In both cases there was some sort of EPCM management team. The actual construction work was contracted out locally and manpower for the project was usually direct hire.

In around 1970´s to 1980´s there was a shift from this type of in-house EPCM project management method over to what we know as the EPC project

management method. This was mainly due to the fact that the profits of the oil companies went down, leading to a focus on the core business and cost savings. The result was that they contracted out all detail engineering and in the end getting project management companies to taking over services regarding all oil field projects, larger, medium and small.

The execution methods

To be able to understand better how each of the project execution methods work it is needed to describe in general how each of them is built up and executed.

EPC (Engineering, Procurement and Construction)

An EPC execution method for a project is when execution contractor takes on the project as a lump-sum, turnkey solution to deliver to the owner. When the contract between the owner and the EPC contractor is signed, the project scope is fixed and all requirements set by the owner. (Armstrong, McDonnell, & Barratt, 2011)

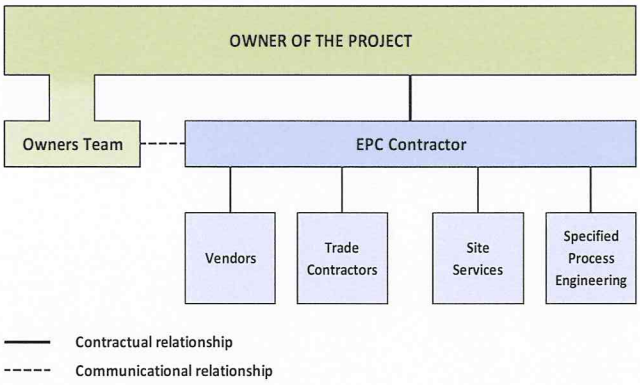

Figure 1: Typical EPC Contractual setup

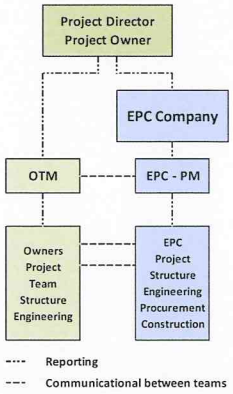

Figure 2: EPC Project Management Setup

The EPC contractor will then be responsible for all parts of the project, the design, procurement and construction. The project must be built according to the prefixed requirements stipulated in the contract between the parties. Apart from ensuring that the project is constructed according to the requirements the owner will not be able to have any influence on the execution of the project without a contractual change order. (Loots & Henchie, 2007)

In an EPC arrangement, the Owner needs to have a large and extensive in-house team (Owners team). Its main functions are, as stated above, to ensure that the EPC contractor is following the project fixed scope and all the pre-set requirements are followed during the execution.

In the EPC construction method, the owner has only a contractual relationship with the EPC contractor, and has no relationship with needed vendors. The EPC contractor is in direct contractual relationship with all vendors.

EPCM (Engineering, Procurement and Construction)

An EPCM execution method for a project can be described as the EPCM Contractor acts in behalf of the Project Owner during the execution. The contract is a pure services contract between the parties. The contractor acts as agent and creates a direct contractual relationship between vendor and the Project Owner. (Loots & Henchie, 2007)

The EPCM contractor is responsible for vital parts of the project such as, the detailed design, design functions, procurement of necessary material and equipment and manages and administrated the construction contracts. (Loots & Henchie, 2007)

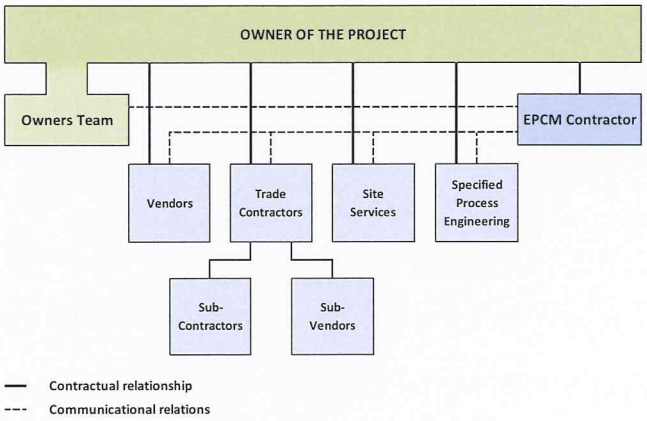

Figure 3: Typical EPCM Contractual setup

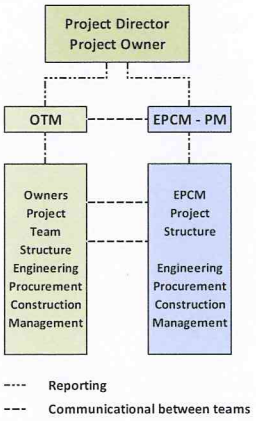

Figure 4: EPCM Project Management setup

In an EPCM arrangement, the Owner should have a large and extensive in-house team (Owners team) to assist and keep careful eye on performance of the execution and contracts. (Loots & Henchie, 2007)

If problem rises under trade contract, such as claims or other contractual matters, the ultimate responsibility is by the Owner and therefore the Owners Team. The EPCM contractor will assist the Owner and the Owner Team as possible, but is officially not a part of the dispute.

IPT (Integrated Project Team)

An IPT execution method for a project is in fact very similar to an EPCM execution method for a project. The difference is that the owner forms the project team and uses some of its own employers as part of the team. In addition the owner will get manpower from engineering firms to assist with the execution of the project, the contract between the engineering firm and the IPT team is pure services contract between the parties. The IPT team acts and is in fact the Project Owner toward the contractors and equipment suppliers during the execution.

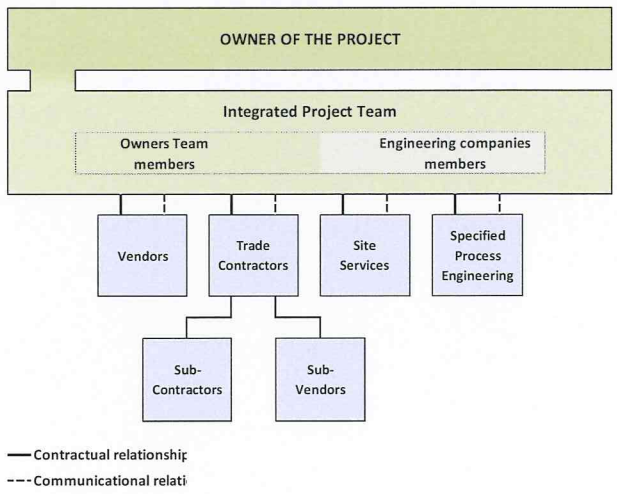

Figure 5: Typical IPT Contractual setup

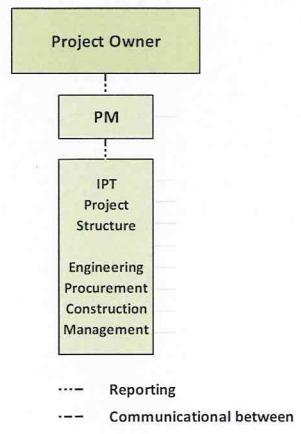

Figure 6: IPT Project Management setup

The IPT team is responsible for all parts of the project such as the detailed design, design functions, procurement of necessary material and equipment and manage and administrated the construction contracts.

There is no need for a specific Owner´s team, since the owner has its own people as part of the project IPT execution team.

If a problem arises under trade contract, such as claims or other contractual matters, the ultimate responsibility is by the IPT team as the Project Owner. The engineering manpower from engineering firms will assist the Owners personnel in the IPT team as possible, but are officially not liable.

3. RESEARCH METHOD

To understand what project execution method, EPC, EPCM or IPT, works best for larger scale projects it was decided to concentrate on the aluminium industry, and to find out how management of companies that are involved in the aluminium industry think about execution methods and what they consider gives the best results for the project owner in the end.

To select how to gather information, two methods were considered. (1) Holding interviews with the managers and asking them direct questions and evaluate their responses and answers. (2) To survey individuals in the industry through questionnaires and based on those answers evaluate the outcome.

The option of having interviews with managers was rejected early, due to the fact that it would not be possible to interview as many managers as needed for the time period allowed. In addition, it would have been very difficult (and costly) to sit down and get views from different places in the world. Therefore it was selected to use the survey method and send questionnaires to the participants.

A survey was used to gather the necessary information. In order to obtain as wide a view of the matter as possible, the recipients all had direct relationships with the aluminium industry in different fields such as "owners & end users", "equipment vendors & installation contractors", "consulting companies & engineering companies" and finally and not least the "turnkey contracting firms".

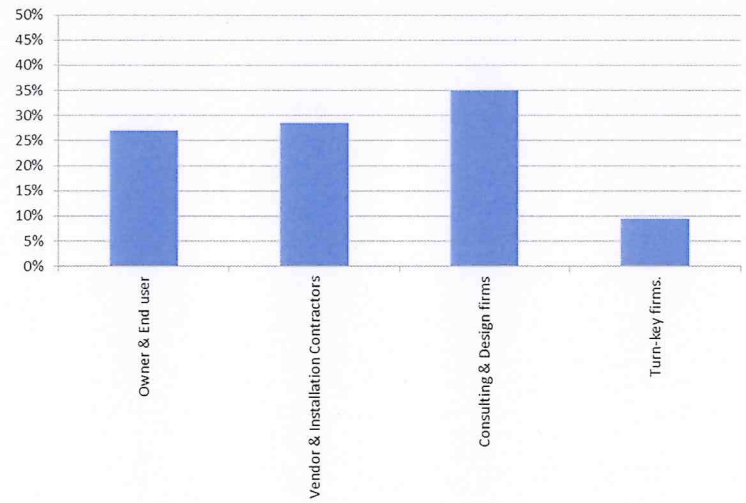

Figure 7: Split between fields.

All of the recipients were selected through personal contacts. A total of 82 survey forms were sent to participants and the response was 78%. To get the broadest perspective on how the recipients look at the project execution method, the recipients were selected from different locations over the world, such as from Europe, North America (USA and Canada), Australia and the Middle East. The questionnaires were sent by email to the recipients and returned via the same routes. The survey was open from 1st February 2015 to 9th February 2015, and respondents were given this time to complete the questionnaires.

Selecting the most suitable project execution method for a large scale project can and will have effect on the project outcome and additionally in many cases the operational reliability after start-up. Therefore it was essential to select the recipients from the senior or upper management from their organizations. In this case all of the recipients have many years of operational and project experience and the majority of them are part of the senior or upper management of their organizations.

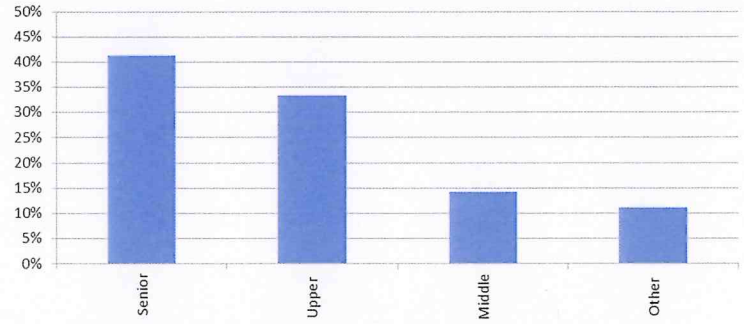

Figure 8: Split between management levels.

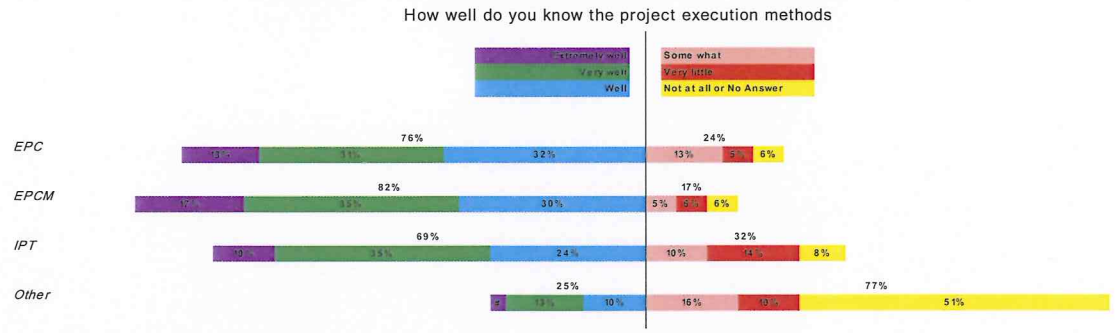

Figure 9: Knowledge of execution methods.

4. RESEARCH RESULTS

The questions in the survey were structured around six main areas: (1) general questions to determine characteristics of the respondents, (2) definition of a project size, (3) project execution method, (4) benefits, (5) project management cost, and (6) strength and threats.

In the aluminium project world most projects, medium or large scale, are defined and considered as a Greenfield or Brownfield projects. Where the term: "Greenfield" (having the meaning new site) and "Brownfield" (having the meaning of change or addition to an existing site) have been used.

> "The term Greenfield was originally used in construction and development to reference land that has never been used (e.g. green or new), where there was no need to demolish or rebuild any existing structures. Today, the term Greenfield project is used in many industries, including software development where it means to start a project without the need to consider any prior work". (Beal, About: greenfield, 2015)

> "The term Brownfield was originally used in construction and development to reference land that at some point was occupied by a permanent structure. In a brownfield project the structure would need to be

demolished or renovated. Today, the term brownfield project is used in many industries, including software development, to mean to start a project based on prior work or to rebuild (engineer) a product from an existing one". (Beal, About: brownfield, 2015)

Definition of a project size

The recipients were asked to clarify what in their mind defines size of a project. The question was: "In your opinion, what defines the size of a project?" Four options were given for answers (1) cost, (2) complexity, (3) combination of cost and complexity and (4) other factors. The outcome was that the majority thought that a combination of cost and complexity is what defines the size of a project. The results were: (1) cost 14%, (2) complexity 3%, (3) combination of cost and complexity 73% and (4) other factors 10%

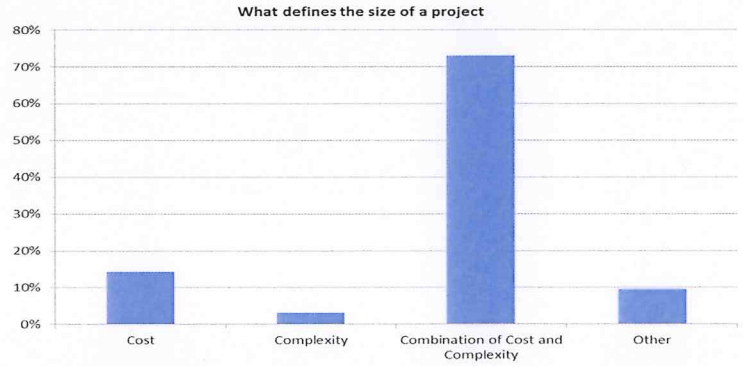

Figure 10: Definition of project size.

The comments given by the participants also indicated that there was another category that could have influence. In addition to cost and complexity; it could also depend on duration (Schedule), risk, and also the ability to execute the project. In addition it was also pointed out that business opportunities, return on investment and earned value analysis could define the project size.

When asked how to define project size based on the total project cost, the range was that small size project can be as high as 1 million USD, medium size project can be from around 500 thousand USD up to 50 million USD, large size project can be from around 10 million USD up to 1 billion USD and Mega projects can start at as low as 100 million USD and up.

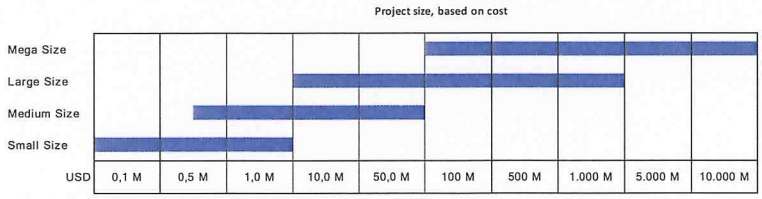

Figure 11: Project size, cost definition.

From the replies it can be seen that there is overlapping in the project cost between categories. That shows there is no uniformed way of thinking in this matter.

When asked how to define project size, based on the complexity (sub-project range) was that small size projects can have up to 15 sub-projects, medium size

are between 10 and 100 sub-projects, large size between 15 and 150 sub-projects and Mega size will have over 100 sub-projects.

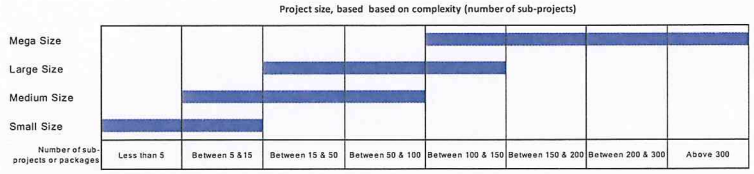

Figure 12: Project size, package definition.

Project execution method

When asked to state which execution method worked best in either Brownfield or Greenfield projects the results were:

For Brownfield, EPC 16%, EPCM 13%, IPT 59%, other 2% and NA 15%.
For Greenfield, EPC 20%, EPCM 52%, IPT 13%, other 2% and NA 13%.

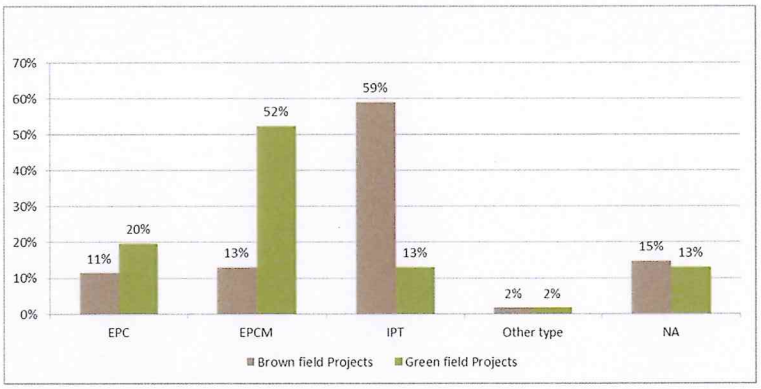

Figure 13: Best fitting execution method.

Benefits

When asked which execution method gives best benefits for the owner or operation based on future operation reliability and duration, the results were: EPC 10%, EPCM 21%, IPT 59%, other 5% and NA 6%.

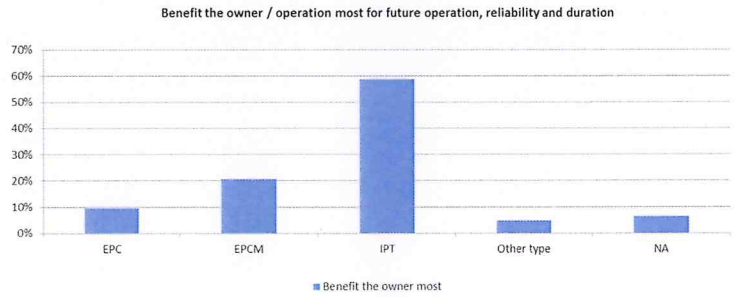

Figure 14: Benefit the owner.

For the stakeholder benefits, the participants gave the following results:

Table 3: Stakeholder benefits score.

	Operation	Owner	Engineering	Execution	Trade	Vendors
EPC	9 %	9 %	17 %	51 %	10 %	16 %
EPCM	11 %	35 %	17 %	28 %	45 %	28 %
IPT	76 %	57 %	4 %	15 %	23 %	33 %
Other	2 %	0 %	0 %	0 %	5 %	5 %
No effect	2 %	0 %	2 %	6 %	18 %	19 %

Lower than 20% | Between 20% & 30% | Between 30% & 50% | Above 50%

A very important question when executing a project is, will the owner be allowed to change and modify the scope during execution. The participants gave the following answers: positive 32 %, negative 24 %, does not matter 29 % and do not know 16 %.

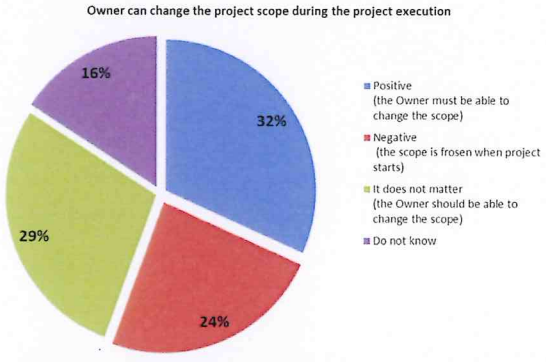

Figure 15: Possibility to change scope.

Project management cost

What percentage the participants considered the project management cost to be (as percentage) of the total project cost was as follows:

Table 4: Project cost.

EPC (If the total project cost is 100 million USD, then the project management cost will be)

	2,5-5,0 %	5,0-7,5%	7,5-10,0 %	10,0-12,5 %	12,5-15,0 %	15,0-17,5 %	17,5-20,0 %	20,0-22,5%	22,5-25,0%	No Ans
	10 %	6 %	10 %	10 %	11 %	5 %	8 %	2 %	5%	35 %
PM cost	*$5 M*	*$7,5 M*	*$10 M*	*$12,5 M*	*$15 M*	*$17,5 M*	*$20 M*	*$22,5 M*	*$25 M*	*$???*

EPCM (If the total project cost is 100 million USD, then the project management cost will be)

	2,5-5,0 %	5,0-7,5%	7,5-10,0 %	10,0-12,5 %	12,5-15,0 %	15,0-17,5 %	17,5-20,0 %	20,0-22,5%	22,5-25,0%	No Ans
	3 %	8 %	3 %	11 %	17 %	13 %	6 %	2 %	6%	30 %
PM cost	*$5 M*	*$7,5 M*	*$10 M*	*$12,5 M*	*$15 M*	*$17,5 M*	*$20 M*	*$22,5 M*	*$25 M*	*$???*

IPT (If the total project cost is 100 million USD, then the project management cost will be)

	2,5-5,0 %	5,0-7,5%	7,5-10,0 %	10,0-12,5 %	12,5-15,0 %	15,0-17,5 %	17,5-20,0 %	20,0-22,5%	22,5-25,0%	No Ans
	5 %	11 %	13 %	11 %	11 %	8 %	6 %	2 %	0%	33 %
PM cost	*$5 M*	*$7,5 M*	*$10 M*	*$12,5 M*	*$15 M*	*$17,5 M*	*$20 M*	*$22,5 M*	*$25 M*	*$???*

OTHER (If the total project cost is 100 million USD, then the project management cost will be)

	2,5-5,0 %	5,0-7,5%	7,5-10,0 %	10,0-12,5 %	12,5-15,0 %	15,0-17,5 %	17,5-20,0 %	20,0-22,5%	22,5-25,0%	No Ans
	5 %	2 %	3 %	8 %	2 %	2 %	3 %	0 %	2 %	75 %
PM cost	*$5 M*	*$7,5 M*	*$10 M*	*$12,5 M*	*$15 M*	*$17,5 M*	*$20 M*	*$22,5 M*	*$25 M*	*$???*

Figure 16: Cost as percentage of total price.

When asked to evaluate if the project management cost is higher or lower than the other execution method, the results state that:

EPC would be:

Table 5: EPC compared to:

Compared to:	Cost Lower	Do not know	Cost Higher
EPCM	43%	25%	33%
IPT	24%	24%	53%
Other	24%	43%	33%

Figure 17: Cost of EPC compare to other.

EPCM would be:

Table 6: EPCM compared to:

Compared to:	Cost Lower	Do not know	Cost Higher
EPC	33%	24%	43%
IPT	22%	29%	48%
Other	16%	48%	37%

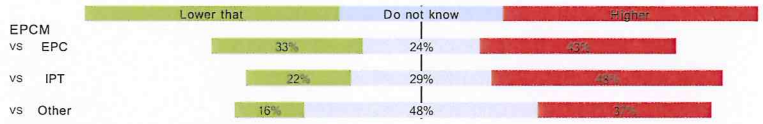

Figure 18: Cost of EPCM compared

IPT would be:

Table 7; IPT compared to:

Compared to:	Cost Lower	Do not know	Cost Higher
EPC	52%	24%	25%
EPCM	48%	29%	22%
Other	30%	48%	22%

Figure 19: Cost of IPT compered

Strength and threats

Regarding strength and threats of each execution method there was one question regarding strength and one regarding threats. The base for the questions was inspired by Gunhan and Arditi article "Factors Affecting International Construction". (Gunhan & Arditi, 2005 March)

For the question on strength, the participants were asked to select at least two points for each execution method. The selections that were available were: Track Record, Specialist Experience, Project Management Capability, International Networking, Technology Advantage, Financial Strength, Field Resources and N/A.

Table 8: Most important strengths:

	Track record	Specialist Experience	Project Management capability	International networking	Technology Advantage	Financial Strength	Field Resources	N/A
EPC	19%	16%	26%	3%	8%	11%	16%	2%
EPCM	16%	16%	36%	3%	11%	5%	9%	2%
IPT	5%	27%	23%	5%	19%	8%	6%	3%
Lower than 10%			Between 10% & 20%			Above 20%		

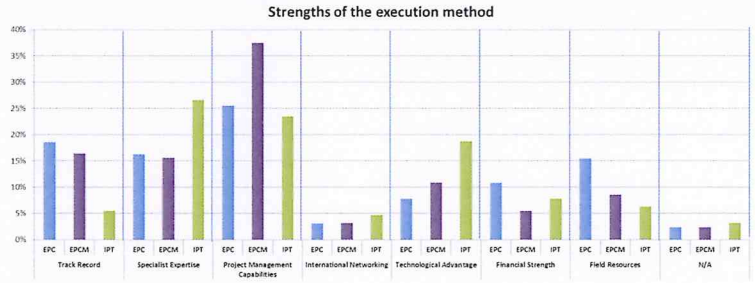

Figure 20: Strengths of execution methods.

For the question on threats, the participants were asked to select at least two points for each execution method. The selections that were available were: Loss of key employees, Shortage of Project Financial Resources, Inflation or Currency fluctuation, Increase in Interest rate, Cultural Differences, Local Competitors, Difference in Ethical Practices and N/A.

Table 9; the most important threats:

	Loss of key employees	Shortage of Project Financial Resources	Inflation or Currency fluctuation	Increase in Interest rate	Cultural Differences	Local Competitors	Difference in Ethical Practices	N/A
EPC	19%	25%	11%	4%	12%	6%	9%	7%
EPCM	25%	19%	7%	3%	19%	6%	11%	7%
IPT	28%	14%	5%	2%	16%	4%	7%	8%
Lower than 10%			Between 10% & 20%			Above 20%		

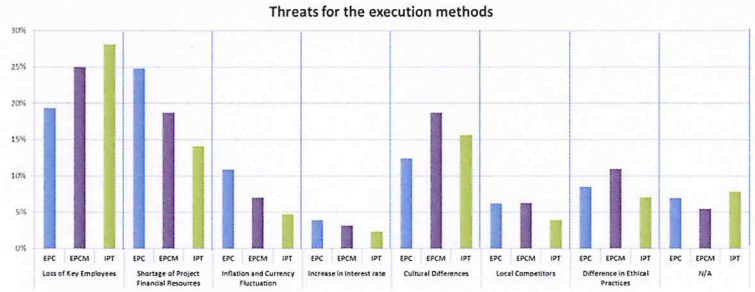

Figure 21: Threats of execution methods.

Comments from participants

The participants were asked to give their opinions regarding, what are the main reasons why Project Owners should choose any particular execution method for projects. For each execution method (EPC, EPCM or IPT) they should give two reasons. The replies were as many as the participants.

For the EPC there where three major points from the participants:

1. Securing the project cost. Having fixed project price in the beginning could help financing the project. Fixed scope, not possible to do scope changes.
2. The owner wanting to reduce its own project risk, moving the risk to the EPC contractor at a cost.

3. The owner has not available management resources to execute large size project.

For the EPCM there where two major points from the participants:

1. The owner will have more flexibility to change the scope and management of the project.
2. The owner has limited management resources that can be involved in the execution of large size project.

For the IPT there where three major points from the participants:

1. The operational knowledge is important for the success of the project.
2. Establishment or cooperative and common relationship between operation and project. Also better communication and long-term relationship development with vendors would be gained.
3. There would be leaner project management and lower project management cost.

The complete set of participants answers are in the Appendix.

4. DISCUSSION

How owners of projects select project execution method for their large scale projects is not very clear. Most likely they have at some point selected a project management methodology to execute projects. The selection was most likely at that time based on evaluation regarding maximizing the projects value to the company. But is the project execution methods the most efficient and gives best results. It should be beneficial for project owner to re-evaluate their execution of large scale projects.

It is clear that majority of all those involved in the industry have a similar views regarding what defines project size; the combination of cost and complexity. But how do we measure complexity? In this paper the number of sub-projects or packages linked together to form the final end result is considered as the complexity. As a guide-line for defining size of a project the industry shows that it would be possible to define the project sizes as follows:

- Small size:
  - Project cost as high as 1 million USD
  - Have up to 15 sub-projects.
- Medium size:
  - Project cost from around 500 thousand USD up to a 50 million USD
  - Between 10 and 100 sub-projects.
- Large size:
  - Project cost from around 10 million USD up to 1 billion USD
  - Between 15 and 150 sub-projects.
- Mega size:
  - Project cost can start at as low as 100 million USD and go up as high as needed
  - Will have over 100 sub-projects.

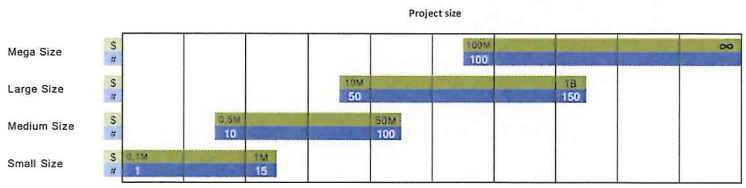

Figure 22: Definition of Project Size.

When considering Brownfield and Greenfield projects it looks like the industry has similar tendencies regarding which execution methods works best. It is, in fact, very interesting to see that less than one fifth (11% and 20%, see Figure 13: Best fitting execution method.) think that EPC project execution methods works best for either type of projects. Still there is a number of large or mega scale projects executed as an EPC in both Greenfield and Brownfield sites. In the comments from the participants, it can be seen that mostly likely it is due to a number of factors. One major factor is that the project risk is moved over to the EPC contractor if the EPC execution method is used. Another point is that the price is usually fixed (Turnkey Lump Sum Contracts (TLSC)) as long as the scope does not change.

More than half (52%, see Figure 13: Best fitting execution method.) of the participants think EPCM works best for Greenfield project and 59% (see Figure 13: Best fitting execution method.) think IPT works best for Brownfield projects. On the other hand only one eighth (13%, see Figure 13: Best fitting execution method.) think that EPCM works best for Brownfield projects and the same (13%, see Figure 13: Best fitting execution method.) thinks that IPT works best for Greenfield projects. If this is compared to the evaluation regarding which execution method will give best benefits to the owner or the operation regarding future reliability and duration it can be seen that 59% (see Figure 14: Benefit the owner.) believe that using the IPT execution method will give most benefits. It is not totally clear why IPT does not score higher for Greenfield projects, since generally it will give more benefits to the owner.

The EPCM Project execution method seems to be the one that project owners usually use for management of their Greenfield projects. In the comments from the participants it can be seen that it is mostly due to the fact that the EPCM management contractor usually does have good experience related to the project management and the owner has not sufficient capability to manage the project.

When selecting the most suitable project execution method for a project the cost of managing will play a significant role in deciding the method. It appears that management cost as part of the total project cost is expected to be in the range of 7.5% to 20.0%. Where EPC is expected to be in the range of 12.5%, EPCM in the range of 15% and IPT in the range of 10% (see Figure 16: Cost as percentage of total price.). The results are that from the management cost point it is most expensive to use the EPCM project management method and least expensive is to use the IPT (see Table 7; IPT compared to:).

The strengths and threats of particular execution method are important factors regarding the selection. It should be obvious that they can and will have effect on the decision in the end. In all cases the most important for each and every project execution method is the "Capability of managing projects". If that doesn't exist then the project is bound to fail. For both EPC and EPCM the "Track record" and "Specialist Experience" are important factors. The IPT on the other hand should have "Specialist Experience" and "Technical Advantages". It appears that owners that choose IPT as their method would rather focus on that their IPT management team is more into having knowledge about how to execute projects, the operational process and outcome rather than having long and good track record. This can be due to the fact that there is no special owner team during the execution because the IPT team is combination of owner team and engineering consulting team.

The main threat that all of the executional methods have is if they will lose their key employees, as this can cause a significant risk for the project if that happens. The EPC and EPCM method has additional threat which is if the project

will lose its financial resources. On the other hand, for the IPT method it appears not to affect him as much.

In personal communication to me, after having completed the questionnaire, some of the participants wanted to express further thoughts on the matter. The following are some of their thoughts:

- As it can be difficult to answer or describe comparisons of project methods primarily due to that the owner's upper management's support and knowledge of project execution. This will, of cause, effect the selection of the project execution method, where upper management will often select the method it knows without exploring the possibilities of the others.
- If the project owner has the capability and skilled manpower within his organization, an IPT is the best solution. The owner will benefit from lower overall cost and owner's interests are best represented with his own team.
- By having IPT team, the relationship with suppliers will be closer and in the end the execution of the project has been accomplished at a lower cost with a higher standard.

5. CONCLUSIONS

To be able to deliver a successful large scale project, a strong and well managed project execution method is require. The execution method needs to seek maximum performance and best cost options with regards to giving the project owner the most benefits regarding future reliability, operation and performance.

Based on the information gathered and the fact that majority of the participants do have more or less the same understanding and views regarding values of each execution method, the following are the main points needed to have in mind when selecting an executional method:

- It is important to consider which one gives the best benefits to the owner and operators regarding reliability for future operation. As can be seen, the majority of participants favour the IPT approach. In addition it appears IPT will give better relationships and benefits to equipment vendors.
- The cost of project management is a large factor in executing a project. The actual cost is believed to range from 7.5% to 17.5% of the total project cost. All points toward that EPCM is the most costly method. The EPC on the other hand is believed to be somewhat less expensive than EPCM. With the IPT considered to have the lowest management cost. That is due to the fact that there is just one management team, unlike the other where there are parallel owner's team overseeing the work of EPC or EPCM.
- All the execution methods need to have the project management capability to be able to work. For the IPT it is important to have specialist expertise and technological advantages rather than the good track records that the other two need.
- The threats are the similar for all three methods, main issue is the loss of key employees, shortage of finance and cultural differences.

As the Integrated Project Team (IPT) approach seems to, according to the survey, give the owner most benefits and cost less for project management, it should be considered as a viable option for large scale Greenfield projects as much as for Brownfield projects.

6. ACKNOWLEDGEMENT

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8. List of tables and figures

9. Appendix

What are the main reasons why Project Owners or Funders should choose EPC (Engineering, Procurement and Construction) as an execution method for projects? Name two (2) reasons. Reason EPC #1	Reason EPC #2
Cost control	Better alignment of scope and resources to changing circumstances
Earlier good experience	Commissioning performed by the project group
Effective	Concurrent engineering
Everything under 1 package (Turn Key)	Coordination
Existing practice	Cost
Expertise and capability of the contractor to complete successfully	Do not have resource for management
Fewer boundary and battery limits	EPC contractors tend to place A-players on EPC projects enabling successful outcomes
Financial issues	Experienced method
Financial security	Expertise from EPC contractor
Fixed cost expectations	Financial issues
Fixed costs executed by experts	For control
For best result	Has potential to be fastest delivery method
Funders may require fixed cost EPC bids before financing	Interfaces
If project is well defined and the owner is not changing scope	International network --> Many specialists
If they are not used to execute projects	Lack of industry skills within Owners team
Insufficient number of available qualified sub-contractors for the size of the project.	Less Owner's oversight at detail level
Lack of qualified people "in house"	Less risk if good supervision
Lower Cost	Little as no Risk
Lower Cost	Lower costs
Lowers overall risk	More accuracy in cost and schedule
No in house expertise in Proj Mgmt. or Process Design	No risk to the owner
On repeat style projects, where no changes are perceived, surety of cost	Owner does not have sufficient recourses to manage the interfaces.
One contract for each package	Owner has limited resources
One contractor	Owner requires less of own recourses on project
Potentially lower cost through Owner management	Owner willing to pay more for less risk
Predictability of cost	Project resources that the contractor is able to commit to the project
Project management strength	Project risks moved to EPC Contractor - at a cost
Puts delivery risk with the party with track record in delivering	Risk analysis expertise
Resource draining not from Owner is less of an issue	Risk reduction
Risk is on EPC firm	Safety
Risk taken by the contractor	Secure the Project FUNDING
Scope will not change	Security for investors
Secure the Project cost	Shorter lead time
Short of project management skills which unable him to go for IPT	Shorter project schedule possible since no bid cycle for construction contracts
Simple green field project	Significant on-the-ground construction personnel available from the selected EPCM firm
Simplicity	Specialization by Turn-key contractors
Simplifies responsibilities	The Cost is known at the beginning of the project
Single point accountability for complete engineering and construction scope	They have specific expertise
Single point of contact for the owner	To externalize all activities
Single point of responsibility	Total project cost
Specific knowhow	Transfer risk over to the EPC contractor
Technical skills	Transparency
The Contractor carries the project risk for schedule and budget	Very clear scope and past experience on such scope
To pass over the Risk	Wants to stay focused on his daily business and wants to leave the Project to an external EPC
Turnkey contracts	well defined processes

What are the main reasons why Project Owners or Funders should choose EPCM (Engineering, Procurement and Construction Management) as an execution method for projects? Name two (2) reasons. Reason EPCM #1	Reason EPCM #2
Capability and expertise amongst available sub-contractors to complete their scopes of work	Ability to drive quality solutions through ownership of specifications whilst maintaining schedule
Complex project that could affect operation	Better able to address changes
Cost control	Better overview reporting
Deeper implication of the owner	Brownfield environment with material execution impacts forecasted
Earlier experience or company policy	Capacity
Effective	Complexity
Engineering resources	Concurrent engineering
Everything under 1 package (Turn Key)	Construction services for different packages can be bundled
Fixed cost expectations	Consulting by professionals
Flexibility	Cost
Flexibility of project execution	Direct contract with vendors
For cost control	Easier to change scope during the execution
If he is short of skilled people doing it himself, than he has to choose a EPCM	EPCM not aligned/ conflicted
If there is good and reliable contractors available	Financial issues
Integrated management throughout the project	Flexibility
Lack of qualified people "in house"	Flexibility in execution strategy
Large number of qualified sub-contractors available.	Flexibility to develop and improve during construction
Less management cost	Good project management
Local established construction companies can be used	Includes the whole project range
Lower management cost	International Network --> Many specialist
Management of large projects	Lacks in own expertise
Maximize cost advantage by assuming some cost risk	Limited international procurement expertise
Mega projects to large for one EPC contractor	Low cost
More direct involvement throughout execution	Management capability
Multiple breakdown of contracts gives lower overall cost	Minimize workload of own recourses
No in house project management/execution expertise	More flexible approach to scope changes
Potential for lowest cost delivery method	Need management resources
Potential more savings for the Owner by bidding out packages	On time completion
Potential savings	Owner gets a second opinion from the EPCM contractor taken in the owner's interest.
Reduction of complexity	Owners team does not have construction management expertise
Scope is not fully defined and not ready for EPC arrangement	Potential for savings
Scope will vary	Previous track record and experience on similar projects
Secure professional management with demonstrated track record	Project management expertise available from the project management contractor
Security	Quality assurance
Size	Selected EPCM firm does not have significant construction resource.
Size of project is very large and owner does not dare to work with an IPT	Stronger management and tracking records
Specific knowhow	The EPCM Contractor coordinates design, procurement and all construction work
Split between decision making and execution. It can be difficult for the owner to wear two hats in the organization.	The owner team is weak and must be supported by a stronger structure
Strong expertise and project executing knowhow	They are willing to accept larger part of the project risk
Technical complex projects	To benefit from the experience of an EPCM. Depending on the size, owner might not be able to tackle the size of the project.
Technical skills	To keep construction with the owner
The Owner is more involved in overall management of the project	Too complex for one EPC contractor
The Owner selects the head contractor who manages the project on Owners behalf	Transfer of responsibility
To pass over the risk	Turnkey delivery places less demand / risk on Owner performance
Very large projects require vast resources	Well defined processes

What are the main reasons why Project Owners or Funders should choose IPT (Integrated Project Team) as an execution method for projects? Name two (2) reasons. *Reason IPT #1*	*Reason IPT #2*
Access to qualified and experience project and process people	Access to technical implementation
Better collaboration and communication	Availability and experienced owners team
Better Quality and more in line what is needed.	Better cost control and priorities
Brown field projects	Better integration of design, construction, start-up and operations
Brownfields / retrofits where there are critical interfaces with existing operations	Build up knowledge for operation and future
Can develop their initial idea with the vendor	Can't say
Close control by the Owner	Cost
common understanding	Direct contact with vendors
Company policy	Direct relationship with vendors.
Control	Faster response
Cost control	Finance not an issues
For development type projects where flexibility is key	Fully align service provider and owner team during project execution
Funders should not choose this. Only self-funded projects where client wants to drive solution	Future Operations enhancement
Greater part in project development and decisions	If time for execution is short and design is still being developed and owner has reliable contractor
I find it the best solution, if I would be the owner, IPT would be my preferred solution. You can influence mostly the project outcome. An EPCM contractor is looking for his own financial interests, which often distinguish from the owner's interest.	Increased flexibility
If owner on early stage can involve experienced reliable contractor into the project.	Lean project management
If the project is complex	Less likely to have to change after operational start.
Integrate experience from Owner	less process waste
Lowest management cost	Lower cost of project execution and management can significantly affect the NPV
Maximize the involvement of the owners team	Management capability
More focus on end product (operations)	More informed and effective decision process at Owner
No answer	More likely to keep relaxed atmosphere between operation and project.
Not sure	Much more efficient as EPC/EPCM (Less useless processes to follow)
Not too sure how IPT works	No answer
Operation knowhow	Not sure
overall view concurrent engineering	Often, the plant is left alone after the EPCM has left and only then realizes that the installed equipment for example is not the best, but it maybe was the cheapest. From a cost point of view, IPT is the lowest, even if you pay a bit more for better equipment. If the owner has access to good supplier network, that IPT is the way to go.
Owner can affect the project outcome	Operation can be part of project from beginning-easier handover
Owner has deep understanding for the scope	Opportunity for better optimization of design and problem solving
Owner has strong (proven) team and systems.	Owner expertise essential to completion of project
Owner's technology	Owner is closer to the project
Practical brownfield projects	Owner is unwilling to fund the overhead required to maintain a sufficiently sized and skilled project team.
Qualified people available "in house"	Possible cost reduction depending on the people.
Reduction of cost	Project needs strong technical input of specialist employees
Scope of work not well defined and liable to change during course of project	Project too small for mobilization EPCM contractor proper
Smaller projects	Protection of technology confidentiality
Team committed to project	Reduce management cost
Technical	Small and medium size projects with high complexity
Technical skills	The interest of the owners in the project and not in making money.
Technological advantages especially if process is complex	The stakeholders are more involved in decisions and outcome of the project
The owner has a enough people to split into two groups, the Owner and the Project	They are willing to accept most of the project risk
They want to be part of the Project Management team	To enforce owner requirements and owner culture
To save costs	To reduce schedule
To strengthen otherwise weak contractor team	Use existing knowledge
Utilize own forces know how and infrastructure	Want own expertise to influence on the project outcome
Very low management cost	Where client process expertise is essential to successful, outcome