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Risk Assessment of International Logistics in Tunnel Projects — Tunnel Boring Machine (TBM)

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Abstract: Nowadays, it is observed that are preferred underground roads and subways instead of above ground roads in order to interconnect the main road junction points, on account of the urban traffic congestion. Additionally, the Tunnel Boring Machines are utilized to excavate, utility tunnels that are to say such as electrical, water, sewerage, telephone, natural gas installation tunnels, and furthermore underground tunnels such as subway, road tunnels.The logistics and procurement processes of these machines, which are generally known as Tunnel Boring Machines (TBM), have come into prominence role within this context. Based upon experiences acquired in this study, information provided about this study as well as information regarding some risk factors to be avoided will be shared; starting from the success stories about TBM procurement and logistics processes. The entire supply chain; elapsing starting by the requirements' planning of choosing the most suitable TBM by the project management until its disassembly and shipping back at the end of the Project; will be treated. The machine consisted of five main components such as Cutting Wheel (Cutter Head), and Concrete Segment, Gantries, Conveyor Belt and Tunnel Shield. A successful TBM logistics organization requires the delivery of TBM; including heavy equipment of non-standard dimensions with extraordinary logistic processes from one place to another by non-standard methods, alongside with successful loading, transportation and unloading operations and achievement without any problem of the customs clearance formalities and also accomplishment of the assembling works and delivery to tunnelling area.

Key words: Tunnel Boring Machine (TBM) Logistic; spare part logistic; project logistic; international logistic; insurance for tunneling projects

JEL codes: L74, L92, Z21

1. Introduction

The Engineering Construction Projects are well defined and written processes, temporary works and organizations. Tunnelling construction management through TBM works include a) Managing a work programme and giving an instruction to manage the labour works, b) Delivering the goods in the right time according to site plan, c) Organising of Logistic Programme for planning of the delivery schedule, d) Checking all materials delivered to the right point of the construction site. Tunnel projects have the characteristics of high risk, complex

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and uncertain works, also repetitive construction tasks mostly with the large budgets.

The aim of this study is to evaluate the international logistic, foreign trade operations of a TBM construction projects, risks assessments and importance of insurances, for the Tunnelling Projects which will contribute to the economony of the governments all over the world. The logistics and procurement processes and insurance aspects of these machines, tunnelling project management, TBM (re-) design and manufacturing, overall information in general, providing several examples throughout the world and history have been evaluated in this study.

The tunnelling project is getting increasingly important; especially if linking the continents is at stake. Huge machines namely, TBMs are being used to interconnect the mainlands whether under ground or undersea. Mostly, TBM machines are used as best choose for under ground utility tunnellings such as electrical, water, sewerage, telephone, natural gas installations tunnels and traffic tunnellings of Subway Tunnels or Road Tunnels.

Tunneling Projects are important infrastructure projects, which is vital for enhancing the transportation networks, render urban transports comfortable without traffic stress, shall greatly reduce traffic congestion for people's life, especially crowded population cities. Infrastructure projects, utility tunnels, such as electrical, water, sewerage, telephone, natural gas installations tunnels, and particularly big under ground tunnels such as subway tunnels, road tunnels etc. have many advantages for the architectural planning of the city and for the beautiful appearance of the architecture of the city. The infrastructure projects also have gained importance role in prevention of disruption of the architectural structure and of unscheduled settlements and skylines of the world's large and cosmopolitan crowded cities. Tunnelling construction through TBM is a challenging process; and yet ensures successful finalization of the projects, especially in urban life, and will provide important benefits to city life notably in terms of time, comfort and architectural outlook in big, cosmopolite cities.

As is known, the construction of Road tunnel and others etc as well as the under ground subway have risen all over the world in the recent years and new TBM tunnel projects are in progress everywhere.

There are various tunnel excavations every day in the world. A list of TBM Monthly Average Excavation Records of some Tunnel excavations in the world are shown in Table 1.

Table 1 A list of TBM Monthly Average Excavating Records in the World[1]

Country	Project name	Monthly Average Excavating Record
Australia	Katoomba Carrier	1189 m/mo
China	Yellow River Lot V	1352 m/mo
China	Yindaruqin	1095 m/mo
USA	Dallas Metro	1187 m/mo
TARP, Chicago	USA	770 m/mo
Channel Tunnel, U.K.	U.K.	873 m/mo
TARP, Chicago	USA	715 m/mo

2. TBM Processes

Several tunnelling methods, one is through tunnel boring machine have been developed in the tunnel construction industry. Even though TBM project tunnelling machines have high manufacturing and logistic costs, TBM is mostly preferred for usage at excavation operation due to their ability to avoid undesired under ground movements and vibrations. Besides it is quieter and faster to use. Major Construction Tunnelling Projects use

[1] http://www.therobbinscompany.com/news-and-media/world-records/.

TBM since the excavation/boring speed is quite high. Another advantage is that it does not require so many workers; hence labour costs are getting lower. Dealing with TBM at Tunnelling Projects also reduces the total amount of dust, and this would sustain a favourable working environment in terms of workers' health. There will be low rate of concussion and blasting as dealing with TBM, and it can be easily used in rocky environments, urban areas and this will not create any environmental damage above the ground. Working with TBM will provide less damaged rock mass zone under ground. The regularly improved TBM becomes the first choice particularly in major tunnel projects, because of all those reasons above.

The first successful tunnelling shield was developed by the famous engineer Sir Marc Isambard Brunel in 1825 to excavate the Rotherhithe Tunnel under the Thames, London, United Kingdom. However, this was only the invention of the shield concept and did not involve the construction of a complete TBM. The digging had still to be accomplished by the standard excavation methods which the miners use to excavate the bricklayers. Although the concept was successful eventually it was not at all an easy project[2] (IMIA – WGP 60, p. 9, Michael Spencer & Zurich London et al., 2009, p. 3).

Over the next century following the manufacture time of the first example, the TBMs are improved to become more sophisticated as power was added alongside drills and rotating digging heads. They eventually became common tunnel excavators and were used on some projects like the Channel Tunnel across the English Channel, Japan's Seikan Tunnel from Honshu to Hokkaido, Switzerland's Gotthard Base Tunnel, and the Crossrail Tunnel under London[3].

Nowadays, TBM manufacturing processing uses advanced technology. For example, the world's one of the largest TBM called Bertha; the giant digger has been tasked with the challenge of building a tunnel large enough to carry 4 (four) lanes of motor traffic under the heart of Seattle[4]. TBM Bertha's weight is 7000 tons in total. Considering that the metal structure of the Eiffel Tower has a mass about 7300 tones (Ref. (2018))[5]; Bertha TBM is almost at the same weight of metal structure as Eiffel Tower. The logistics process of a Bertha TBM with a capacity of 7000 tons was a very big logistic operation. It is obviously a matter of concern that these hundreds of parts would be more difficult than a standard transportation processes; simply due to the non-standard shape of disassembled parts of a cylinder-shaped of TBM.

Bertha, also known as Big Bertha, has a 57-foot-diameter (17.4 m) Cutting Wheel (Cutter Head) Unit; weighing 1,700 tons TBM built specifically for the Washington State Department of Transportation's (WSDOT) Alaskan Way Viaduct replacement tunnel project in Seattle Cutting Wheel (Cutter Head) unit weighted 1,700 tones and measured 17.4 meters in diameter[6].

The weight of Bertha's the Cutting Wheel (Cutter Head) part increased to 1700 tons[7], after that the assembling processes of Cutting Wheel (Cutter Head) part of Bertha, the TBM with largest diameter are completed. To carry away carefully the Cutting Wheel (Cutter Head) under the ground into the Tunnel area and without damage is another risky and difficult process.

The maximum length of TBM can reach up to 200 m which is used in the opening of huge tunnels.

One of the world's biggest Tunneling Project is London Crossrail Project today. The world's first

[2] https://www.imia.com/wp-content/uploads/2013/05/TBM-WG60-f-021209.pdf.
[3] https://newatlas.com/bertha-boring-machine-seattle/48862/.
[4] https://newatlas.com/bertha-boring-machine-seattle/48862/.
[5] https://www.great-towers.com/towers/eiffel-tower/.
[6] https://en.wikipedia.org/wiki/Bertha_(tunnel_boring_machine.
[7] https://www.breakbulk.com/mammoet-lifts-tbm-berthas-1700-tonne-cutter-drive-unit/.

underground continues to grow, adding 26 miles of tunnel connecting 40 stations. The estimated cost of construction is $23 billion. The project is scheduled for completion in phases, with the first new track going into service in 2018 and all remaining tracks in service by 2020[8] (Juan Rodriguez, 2017).

TBM materials and equipments, etc, are specially designed and manufactured pursuant to Project requirements and in accordance with the Proposal Technical Specifications for TBM, the Employer's Requirements, geological prerequisites such a Risk Management of Tunnel Works. Because, TBM must be redesigned and manufactured according to geological conditions of design such as soil character, tunnel depth, (rock or soil) overburden, water level, water pressure, unconfined compression strength, class of rock etc.; and technical specifications for that TBM is to be operated satisfactorily in proper use under ground.

TBM designer and manufacturer are responsible for any trouble and inconvenience caused by the remarkable difference in geological conditions or working conditions, resulting from the design presupposition After that TBM is assembled at the construction site, its appearance, dimensions, technical specifications etc. also must be same to that ordered one.

The first step of supply chain operation is the purchasing of the TBM and components. The first step of TBM Procurement process is that, TBM Manufacturers submit their offers incorporating all technical datasheet as per the technical and physical specification of project requirements (diameter of TBM and technical features), geological conditions such as soil character, tunnel depth, (rock or soil) overburden, water level, water pressure, unconfined compression strength etc.; on account of the characteristic properties of Tunnelling Project. Tunnel Construction Management choose the best offer with the best technical specifications, the best lead time, best technical & work service. The contracting firm shall choose the best offer; by evaluating the received bids, with respect to technical demands and physical particularities of the project and contract procedures are initiated with TBM manufacturer. After they choose the TBM Manufacturer, the TBM designed anew in detail, to deal with all conditions anticipated by the site information provided for the construction management of the project is dispatched to contracting company. Following to the signature of the contract, the detailed design of TBM processes are finalized and then manufacturing processes of each component are launched. Following completion of manufacturing processes, "Factory Acceptance Certificate" procedures commence for all test and inspections for assembled of TBM at Factory's Warehouse. Witness of representative of Project Management conduct an inspection after the installation of the TBM is completed at Manufacturer Company' s warehouse. The next step is disassemble TBM and deliver to construction site. Finally after installation of TBM at construction site, "Site Acceptance Certificate" document prepared and fully confirmed that TBM designed and supplied successfully according to contract conditions.

Inspection is also necessary on available TBM parts and equipments before assembling works in order avoid any problems after TBM is assembled by professional and certified inspection organization.

The TBM Manufacturer is also responsible for delivery without unreasonable delay and should also repair and/or remanufacture the components, parts and spare parts of TBM in case of any damage due to the faulty design, defective materials and poor workmanship.

3. Risk assessments of TBM Logistics

In accordance of the time sequence of TBM Tunnelling Project Works, there are some risk factors of each

[8] https://www.thebalance.com/top-ten-largest-construction-projects-844370.

stage period of works at TBM Tunnelling Projects. It mainly to enumerate are; delivery of demounted TBM to site, assemblying operations of TBM at site, construction and excavation works under ground, disassemblying of TBM and re-shipment term to manufacturers company/others.

The other risk categories are “Health and Safety”, “Management”, “Economy”, “Political Conditions” and also “Logistics Risks” for TBM Tunnelling Projects. This study will clearly show that one of the major risk of project is a “LOGISTICS RISK” at operations for the TBM Tunnelling Projects which include the period starting from the picking of TBM’s demounted parts from factory warehouse up to that it is fully delivered to construction site. Effective risk management of logistics operations must permeate all areas, functions and processes of the TBM project. The delivery on time of TBM’s components is very important in the management of the logistics process of the tunnel projects.

TBM has more than hundreds of various large, small, shapeless and large-scale parts of all units such as Cutting Wheel, Drive unit, Shield, Tail skin, Erector, Segment feeder, Segment Crane, Bridge, Gantries and other materials. All of these demounted parts constitute the main part of Cutting Wheel (Cutter Head), Gantries, Conveyor Belt and Tunnel Shield etc. The TBM, which is purchased with international trade, is shipped to the construction site in demounted form. The shipment of these TBM equipments and parts having non-standard size and dimensions is a very difficult and risky logistic operation as well.

Planning for delivery to the construction work site and starting the assembly of the high diameter TBM, that of all of its associated back-up equipment allowing the excavation works, haulage system and removal equipment are very complicated and difficult to dispatch.

International Logistics, foreign trades and distributions of heavy materials such as TBM, logistic operations are kind of a multi-disciplinary processes, including all parts, equipments, fittings materials, machineries and all kind of construction materials etc. It is only possible to complete TBM tunnel project through a good management of the procurement, logistics and excavation works and completion of construction process on the agreed time at agreed quality and without any extra charges, damages, losses etc. All TBM parts and Equipments, machineries etc. must be delivered to the right point in the shortest time without any damage, loss, breakdown etc. Delivery of TBM equipments on time, completion of the tunnelling project without additional costs and damages reflect success story of logistic management.

All TBM parts, equipments, materials required to be delivered should be coordinated in sequence so that the road-use limitations during rush-hours of main motorways which are even more restricted at working hours are taken into consideration. It may be necessary to close some roads, streets etc in some cases. Due to the size of the TBM and oversize load restrictions, the delivery of this TBM equipments have to be performed very carefully to construction site without any damage.

TBM Manufacturer are responsible to manage necessary works for design, engineering, supply, testing, transportation operations, assembly of TBM together with all ancillary equipment according to the contract and agreements with Contractor. Contractor mostly prefer TBM Manufacturer who organise all necesarry shipping procedures and delivery of TBM equipment and materials to construction site and/or closest customs. TBM plants, materials and equipment must be free from defects and deficiencies in design and manufacturing before arrival to construction site before assembly operations. TBM Manufacturers’ obligations are connect with delivery of the equipment include undertaking and complying with the formalities in the country of departure. If applicable customs formalities, with due allowance for the same in scheduling timely delivery of the Equipment to the closest the seaport and/or Projects sites.

As well known, one of the most important issue is time management of tunnelling project. Time Management skill allows the people to organize the logistic operations efficiently and to complete the TBM construction project without financial loss, delaying and/or any trouble.

The completion of a TBM logistics transportation processes can be explained first of all through a solid and good packaging and labeling etc of the TBM parts and equipments and then their loading onto the vessel or trucks/lowbeds etc. and into the containers, reaching the port of destination, completing the customs procedures and domestic/inland transportation to the construction site with special machines, equipment and trucks.

All parts and materials of TBM should be properly and securely packed, stacked and stored by the TBM supplier in conformity with the technically requirements and international regulations at all stages of manufacturing and also of transportation until fully delivered to construction site. All TBM parts, equipments, spare parts should be crash proof and weatherproof wherever possible with the best export practice known to avoid and damage during transportation. Marking should be made water-resistant. Logistic risks from Manufacturer to construction site include packaging and labelling/lashing, dunnaging and securing processes/Loading and unloading operations. The lashing of the TBM components must be properly conducted by the Certified professional experienced Lashing Service Company. The lashing arrangements must be performed properly for the heaviest units, including the Centre Boring Shield and the Gear Drive, etc. There are odd size of TBMs parts and really good lashing, dunnaging ve securing processes are very important to not cause any damage to them as well as their Equipments during the transportation. The stoppers must be used to secure the units in transversal direction. The TBM cargo should be further secured with using steel link chains or, nylon webbing, rubbers, wooden parts etc is to be used as for lighter units.

Electrical, electronic devices, motors, etc. must be loaded into DC containers (Dry van/dry cargo) or cube truck taking all necessary precautions in terms of dampening risk, by trucks, vessels etc.

Manufactured as too many demounted parts, equipments, spare parts etc of TBM have to be delivered without damage and loss, with least problems, while passing through customs and border gates so to not lead to turnover losses. TBM logistic operation is difficult process due to its non-standard logistic method. The good management of logistic processes shall provide a great financial benefit to the project.

And at times delay and occasionally the cancellation of project which would result in quite big disappointments may ensue. A failure in such respect can even culminate in the bankruptcy contractor's company. Consequential damage or loss of the machine during transportation will put huge financial pressures on the Project which could cause to fail or delay and induce the company to go bankrupt.

TBM Project transportation is very risky operation; and logistics, transportation needs are also to be managed very well. There are some of unexpected transportation risks which prevent the completion of the project on time and pursuant to specified Contract/Agreement conditions. It is possible to identify different types of transportation risks which can lead to a damage to the TBM, and have an impact upon the undergoing project during this period of transportation time. All or some of TBM parts lost and damaged, breakdown after a shipwreck or accident on the road, accident on loading/unloading, lashing operations and theft etc. and/or any wear of TBM parts; especially cutters and belt conveyors etc. can be demonstrated as examples. Also any wear and tear of consumable such as hydraulic oil, lubricant grease, packing seals, o-rings, filters, elements, hydraulic parts, electrical parts etc. are further examples. There are also political risks etc. such as strikes, lockouts and civil commotions, chaos, malicious acts and terrorism.

Due to such reasons the remanufacturing of a tunnel boring machine is approximately 12/14 months for

special major tunnelling projects, delivery time of basic design of TBM will be minimum 2 months. That means damage/broken/loss/late arrival of TBM signify financial losses for and also, damage to reputation of the company. Mismanagement, negligence or any accident during transportation of TBM will lead to big chaos and trouble for tunnelling Project.

There are several types of downtime which can affect a TBM especially during the excavation such as breakdown/breaking of cutters, breakdown of the main bear ring and other breakdowns. This requires long period of interruption for excavation. TBM Maintenance works are also very arduous while excavation is ongoing.

The TBM equipments and spare parts are frequently damaged/broken down/broken during the excavation/boring works. The spare parts are to be regularly replaced and repaired as quick as possible. And consumable materials, too should be regularly delivered to site. Replacement of the parts must be delivered on right time to the construction sites by manufacturers/suppliers. Otherwise that will cause a big trouble and may stop the TBM excavation works. Lack of in-time delivery of materials shall delay works. And this would result in many penalties. Time is of great importance during TBM excavation in tunnel projects works. Non-stop TBM excavation works will be successfully only in case of a fast delivery of required spare parts, engines, and of equipments, repaired or replaced and also dispatch of the extra new spare parts, engines and equipments according to TBM staff team requirements from manufacturer/suppliers. Cargo turnover for these spare parts and equipments, consumable materials, from foreign manufacturer/suppliers to construction site is quite busy weekly.

The safer shipment method with the least risk should be chosen, and forwarder company, agency and carriers should be selected and cargo must be shipped on most suitable and safe vessels and trucks etc; since some TBM parts are very voluminous and their dimensions are amorphous, odd sized. Thus, the sea freight seems much safer and risk rate there is much lower, notably for large-scale TBM shipments. Working with a shipping company which is experienced as forwarder /carrier company etc. regarding TBM transportation with regards to big scale construction projects must be a priority. It is necessary to deliver the TBM main machine; together with its equipments and spare parts; to the customs at destination closest to construction site on agreed time, each of complete parts of TBM, being undamaged and without problem. This company needs to dispose adequate enough contractual capacities, able to carry out multimodal transportation, which have to be sufficient with respect to both work in the office and operational transportation duties in the site area. It must also have a thorough experience in order to solve any problem at any time with a reliable and an experienced team avoiding problems. All of the preceding factors will help to ensure proper logistic processes at the first step of logistic processes of TBM Tunnelling project and will help to not delay the assembly and excavation works.

The engineering construction part of Tunelling projects are more risky than many other engineering construction projects. Especially in this risky parts of tunnel project, compliance with the health and safety rules during the assemblying works of each TBM component, and the hauling of assembled large-scale of TBM component to the site excavation area under ground constitute other major logistics risk issues.

Completion of the excavation works in minimum time with maximum speed, to not getting stuck at excavation area, are the most important parts of project in some way. The TBM parts are disassemble at destination point after the completion of the excavation process. The last logistic process, after cleaning, lubricanting of the TBM's parts and then re-packaged and selling back (buy-back) again to the manufacturer and/or another company. It may be not possible to use the same TBM for a number of other projects. Manufactured according to employer requests, geological conditions such as soil character, tunnel depth, (rock or soil) overburden, water level, water pressure, unconfined compression strength due to characteristics of the other

Project; may not suit the particularities of other cases. Such a circumstance would seriously affect project profitability if sold back to manufacturer via buy-back option; as the value of used TBM equipment are still very high. TBM equipments and parts may be used as refurbished equipments, parts etc. for the future TBM projects.

4. Insurance

There are several type of insurance for construction works; one is “Contractors' All Risks Insurance (CAR)” for construction site. The insurance policy provides, cover on most risks basis for physical loss or damage to the insured property. The CAR insurance is a non-standard insurance policy that provides coverage for property damage and third-party injury or damage claims; those are being the two primary types of risks on construction projects. Damage to property can include improper construction of structures, damage which happens during a renovation and damage to temporary work erected on-site. Third parties, including subcontractors, may also become prejudiced while working at the construction site. All Risks” insurance not only covers those associated risks, but also compounds these two types of risks into a common policy designed to cover the gap between exclusions that would otherwise exist if using separate policies. The main risks covered by CAR policy which are include construction damages caused by bad weather conditions, sea waves, earthquake, airplane crashes, fire, explosion, flooding, landslide, land subsidence, electrical damages and operational hazard. All Risk insurance also covers theft insurance and the damages during the fire extinguishing, site risks as strikes, lockouts and civil commotions, chaos, malicious acts and terrorism etc.

CAR policy would not be suitable, because such policies are limited to loss or damage caused at one particular construction site only. CAR may not cover all breakdowns, crashes, damages etc, due to the heavy working conditions on machines such as tunnel boring machine/other machinaries, equipments. Because of all these reasons, it can be added as supplementary coverage to CAR policy. It can be also preferred to issue an annually new renewable “Contractors” Plant and Equipment policy (CPE) for TBM. CPE can be issued heavy, specialized machinery, generally temporary construction site facilities like a tunnel boring machine etc. CPE provides insurance coverage for TBM and its equipment when that was used at different locations. CPE covers an “all risks” basis, and is basically for unforeseen and accidental physical loss or damage, machinery breakdown due to external causes, the heavy working conditions of this machine at construction site. Some other type insurance policies can be issued for machine, equipments at construction site as well. In other cases, manufacturer may insure TBM against the damages, breakdowns, crashes etc. at construction site.

The other insurance is “Marine Cargo Insurance” which protects the financial interest of goods during the transportion both domestic and international. A Marine Cargo Insurance Policy can be issue to include not only the materials to be shipped via ocean, but also goods to be shipped via air, truck, rail or other conveyance including international, domestic or inland transit, warehouse coverage and more. Marine Cargo Insurances covers all the risks by the loss, damage, theft and breakdown during the transportation including the loading and unloading operations, due to the default and fault of the transporter company during the international transportation. Also it can be used to handling the equipments to other points and domestic/inland transportation operations etc. It will not be possible to receive the total value of the goods from the insurance company, if TBM equipments are not duly packed, pallettized, makes stacking faults contrary to the specifications of the goods, in accordance with not the international transport regulations. There are some of the most common exclusions includes; 1) Improperly packed cargo or inadequate lashing, dunnaging and securing. 2) Abandonment of Cargo. 3)

Rejection by Customs or other governmental authorities. 4) Failure to pay/collect. 5) Inherent vice.

The total value of TBM is very high and in case of any damage, theft, loss, etc. caused during the transportation, the insurance company will be able to pay the total value of losses. However, the remanufacturing of the TBM will take a further 6 months at minimum and the completion of the work will be delayed due to the re-manufacturing and re-shipping of TBM and delay at the project term, agreed upon by the employer and the contractor. And the coverage of any loss by the insuring company would not prevent the delay on the said Project or financial damages, loss of reputation etc. The guarantee limit of Marine Cargo Insurance should be very high due to the high cost of TBM equipment. Marine Cargo Insurance must cover all processes of TBM transportion from the starts of loading onto the trucks/containers/vessels; inland transportation, international transportation until the final destination. Marine Cargo Insurances must cover all damages risk of international transportation and also strikes, lockouts and civil commotions, chaos, malicious acts and terrorism.

Commencement of work, Subscription Marine Cargo Insurance should be issued by total annual value of goods. The scope of the project's Subscription Marine Cargo Insurance covers all amendments and rectifications of the shipment during the transportation such as late notice to insurance company, vessel name, truck plate number, total weight etc. This insurance covers the guarantee limit, conditions, price and etc, as agreed with insurance company at the time of shipment which covers all kinds of probabilities. The duration of subscription policies is usually one year.

During the transportation it must be included the scope of damages are all kinds of breakdowns, defects, quality and color loss, all kinds of corrosion, mould growth, scratch, wear, melting etc. by Marine Cargo Insurance Policy.

Professional drivers must have the qualifications in the International Road Transport Act and the relevant regulations and valid documentation in this context regarding to international truck shipments.

Additional costs shall be applied for Marine Cargo for the vessels, older than 25 years. There will be no supplementary costs for vessels with less than 25 years. Certification such as classified according to Institute Classification Clause 01.01.01 and P&I club insurance are sought for vessels. If vessel does not have Institute Classification and/or P&I or is over 40 years of age, are not covered by insurance.

Unless it stated on the insurance policy, the insurance coverage may not include to loaded open cargo, pallets, boxes etc on the deck of vessel except loading into the containers.

It is also required to pay attention to the fact that some Marine Cargo Insurances was not cover second hand products.

Some Marine Cargo Insurances does not cover used and refurbished products, it might be necessary to take supplementary coverage for them.

5. Conclusion

There are so many risk groups in Tunnelling TBM projects. The logistic risks for TBM projects were explained in this study, together with the evaluations, relying upon to our previous experiences; especially in the logistics process of the TBM in the tunnelling sector. Efficient management of entire logistic processes would positively affect the project's profitability and success. All TBM parts and materials should be transported to the construction site by Marine Cargo Insurance. Priority must be given to choose the best forwarder company which are using the safest shipment method with minimum risk. Shipping companies which must be experienced as

forwarder/carrier company etc. with regards to big scale construction projects. These companies needs to dispose adequate eough contractual capacities, able to carry out multimodal transportation. It has to be sufficient employees with respect to both work in the office and operational transportation duties in the site area. Their employees should also have an experience in order to solve any problem at any time with a reliable and an experienced team.

Since construction projects are fast and temporary works, one of the most important role is time management. Project management should be enjoin the empoyees/personnel the importance of time management. Time management skills allow the people to organize all works and operations efficiently and to complete the TBM construction project without financial loss, delaying and/or any trouble.

Based upon the problems caused by heavy machineries, facilities, materials and equipment, even though workers are required less at TBM, subject to logistic operations must be operated by at least two times more workers. And, they have to be experienced with the best practice in health and safety and construction rules etc. It should be managed meticulously to liftings, holding, putting down, carrying the heavy TBM components, equipments in logistic operations to under ground.

Importance of duly packaging, pallettized, lashing, dunnaging and securing, during the loading, transportation and unloading operations should be emphasized. Spare part logistics and consumable materials should be controlled and checked regularly every week. Replacement of the damaged parts must be delivered on right time to the construction sites by manufacturers/suppliers, to avoid downtime for TBM. Above all, giving priority to human resources must be managed to chosen qualified employees/personnel for Tunnelling Project. It is mandatory to have employees/personnel who must be experienced, detailed, prescient and also must be hard worker in Tunnelling Projects, to minimize the risk factors.

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