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Traditional Shipping Transport Safety Case Study: Phinisi Fleet
(A study on stability, strength and human resources)

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ABSTRACT: *Phinisi ships are traditional ships which almost entirely built traditionally, in method and equipment, by bugis-makasar people in Indonesia. Its population tends to decrease due to many accidents that should be analyzed, particularly relating to technical and non technical aspects which are supposed to influence its safety performance. Those aspects to be evaluated are stability, strength and human resources of the traditional ships particularly phinisi ships. The results indicated that theoretically phinisi traditional ships in waters conditions under Beaufort Scale 4,5,6, which were generally sailed by traditional ships had adequate stability and strength. Ship stability complied to minimum criteria stated by International Maritime Organization (IMO Resolution A.749(18)) and ship strength to the requirement of wood strength or rules of Indonesian ship classification bureau (BKI). However, in real conditions revealed any discrepancies with the technical requirements such as (i) no watertight bulkhead to separate the cargo hold and engine room; (ii) compaction cargoes which sometimes up to the weather deck; (iii) weaknesses in wooden construction that built traditionally under the influence of engine vibration; and competence of human resources.*

Keywords - *Stability and Strength of ship, Traditional Ship Safety*.

I. INTRODUCTION

Traditional shipping is a traditionally community business and have a unique character to carry freight in waters using sailboats, motorized sailing ship, and / or simple motor vessel of a certain size Indonesia-flagged. Traditional ships in Indonesia predominantly made of wood because of wood resources reasonably available, more economical than other ships and could absorb labor and their ability has proven to sail though made by simple technology. Traditional ships could be built on the beach or in the traditional shipyard usually without rules based naval architecture. Planning and technical and economic calculations are not made in writing but by the experience of building ships for generations. In terms of construction and shipbuilding, traditional ships have an individual character. Generalization of technical rules could not be applied but still need to be preserved [1] so as to meet the market demands, it needed the development that gradually they could adjust their ability to change of technology towards motorization that change hull form and safety prioritized. Consequence of this system is a shifting function towards commercialization that character of traditional management became displaced by the inflow of large capital owners who want modifications. Therefore they could gradually familiarize themselves with the safety culture that by Commander Doug O'Reilly [2] it was necessary to engage fully realized safety of a structured policy framework and implementation of safety management by the entire organization of shipping.

But with the advances in science and technology of sea transport, existence of traditional fleet begin to marginalized in the face of greater market challenge, even their numbers tend to decrease. Therefore it is necessary improvements of ship building that so far has traditionally done without proper documents (drawings design or installation) as guidance of ship building and ship construction. Without this, safety performance of traditional ships continues to decline and evidenced by an increase in ship accidents for the period 2001 to 2009 or average 49.1% per year. Therefore, it is technically necessary to evaluate safety performance of sea transport, both stability and construction strength in order to review their feasibility along with the development of traditional ship technology and Indonesian water condition. This research aimed to evaluate safety performance of sea transport of traditional ships which focused on phinisi ships, so that it could be found the improvement solution in safety performance and to help government in formulating policies related to technical assistance in the establishment of norms, standards and guideline of traditional ships safety.

II. THEORITICAL FRAMEWORK

1. Ship Structure Strength

Traditional ships are generally managed by the middle and lower economic groups, cultivated by indigenous entrepreneurs from Bugis-Makassar, Madura, Mandar, and Buton through accumulating individual or family capitals in relatively small amounts [3]. Advantage of traditional shipping industry is its independence of being able to survive without financial support from the government and other financial institutions. In its operations, the traditional shipping companies could buy certain goods, to do warehouse that sometimes their own cargoes and then brought up the cargoes to final destination [4]. Traditional ships and their building techniques have been frequently discussed scientifically, but effort to analyze the development of wooden ship construction technologies is rarely undertaken. After an introduction of modern technologies such as the engine and hull form since 1970's, wooden ships have run into rapid changes in technology that combines modern and traditional techniques [5]. The attention needed is separation engine room and cargo hold by at least a tight bulkhead in order to have sufficient buoyancy if one of those space to leak. But the most of these things is adoption of technology for traditional ships in an effort to remain able to deal with stress or loads especially in operation at sea.

Ship structure strength becomes very important because loads acting on ship hull of uncertainty due to the influence of ocean waves or cargoes loading unloading. Kuo Hsin-Chuan [6] explained that in general tension arising from internal and external hull loads could be grouped into compressive stress, tensile stress and shear stress. In line with this, loads received by traditional ship hull were calculated and compared to the strength requirements of woods which by Abdurachman [7] have various types such as lagerstroemia for frames, beams, deck planking; *"gerunjing"* for frames, deck beam, deck planking; teak for keel, frames, *"senta"*, mast, hull, decks and the like.

The research was conducted by taking samples of many ship accidents, less than 150 GT (or 425 m^3). Three ships were randomly selected that had lines plans within tonnage of 294 m^3, 386 m^3, and 424 m^3. All lines plan are analyzed from the research of Chairil Anwar [8]. Loads acting on the hull could be divided into 2 groups: structural loads that affected the overall construction (including longitudinal bending due to the pressure of hogging and sagging waves), and the local loads that only affected certain parts of the hull [9]. Longitudinal bending is one of major factors that should be taken into account as during the operation it will receive hogging or sagging condition that could endanger safety of ship and cargo.

Sagging Condition Hogging Condition

Figure 1. Sagging and Hooging Wave Conditions Source : cited from google.

Wave model to be used is trochoidal wave with assumption that the wave length equals to the length of ship, and ship direction also aquals to wave speed and direction. Trochoidal wave can represent the condition of the pressure at the surface and the actual wave profiles ([10], [11]). Wave equation is as follows:

$$X = \frac{L}{2\pi}\varphi + \frac{H}{2}\sin\varphi$$

$$Y = \frac{H}{2}(1 - \cos\varphi)$$

To facilitate wave representive, standard wave height formulae are given as follows [10]:

(i) H = L/20, although this is less commonly used nowadays, particularly for higher wave lengths,

(ii) H = L/10; L < 80m

At the distance of frame above, wave height (H) can be determined by using wave spectrum of Pierson-Moskowitz, refers to wind speed (V) and frequency (ω) (Evans J Havey and Huges Owen F. in Syahrir Husain [11]).

$S(\omega) = 135\ \omega^{-5} \exp(-9{,}7 \times 104\ V^{-4}\ \omega^{-4})$

$Hs = 3{,}5 \times 10\text{-}4\ V^4$

2. Ship Stability

Ship safety is closely related to the ship stability as well as how to operate in some wave conditions. Calculation of ship stability which conducted in the beginning will be very important for the safety of the ship. Barras [12], Surendran [13], Trenhaile [14], Utina [15] and other authors have argued that stability as part of the hydrodynamic should be payed attention because events of ships overturned can be affected by various environmental conditions and the vessel itself. The principles of stability are important to understand for life saving at sea, especially for traditional ship crews. According Trenhaile [14], all segments of the maritime industry surely to pay attention to stability aspects because during their voyage those ships can be reversed, such as too much free surface in the tank will be potential to unstable. Bahreisy [16] also to explain that there are some unfortunate accidents due to the loss of ship stability. Therefore, the International Maritime Organization (IMO) issued a regulation on minimum stability criteria for ships through Resolution A.749 (18) or known as IMO A.749 (18) as follows:

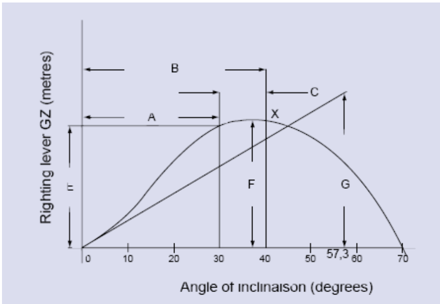

Figure 2. Righting Arm Curve Souce : Ogden Eric [17]

where :

- A - Area under curve up to 30° to be not less than 0.055 metre;
- B - Area under curve up to x degrees to be not less than 0.09 metre-radian;
- C - Area under curve up to x degrees to be not less than 0.03 metre-radian;
- X - 40° or any lesser angle at which the lower edges of any openings in the hull, superstructure or deckhouses which lead below deck and cannot be closed weathertight, wouldbe immersed;
- E - Righting lever GZ to be at least 0.20 metres at an angle of heel equal or greater than 30°;
- F - Maximum GZ to occur at an angle of heel preferably exceeding 30° but not less than 25°;
- G - After correction for free surface effects, the initial metacentric height GM to be not less than 0.15 metre.

Stability calculations are determined according to six loading conditions among others: condition I for full loaded ship depart from the port of origin; condition II for ship arrived at the port of destination still with full loading and 10 % fuel and supplies; condition III (ship departed from the port of origin with 50% cargo and 100 % fuel and supplies); condition IV (ship arrived at the port of destination with 50% cargo and 10 % fuel and supplies); condition V (ship departed with empty cargo but 100% fuel and supplies), and the condition VI (the ship arrived with 0% cargo and 10% fuel and supplies).

III. RESULTS AND DISCUSSION

1. Review of Ship Construction

Government policy particularly related to motorization, has resulted in changes to the original form of traditional sailing ships because they have adapted to the need for space and installation of inboard engine. Modifications are made on stern profile, rudder and number of mast considering no longer function as ship prime mover. Installation of propulsion engine makes the screen just as the identity or characteristics of traditional ship. The observation showed that the installation of main engine overrided main function of screen, tend to less consider safety aspect because it generally didn’t have watertight bulkhead to separate cargo hold and engine room other spaces, even engine room tend to be minimized to increase volume cargo space. Some cargoes are also placed beside engine room, where there is no watertight bulkhead between the engine room of the cargo hold especially for vessels below 150 GT.

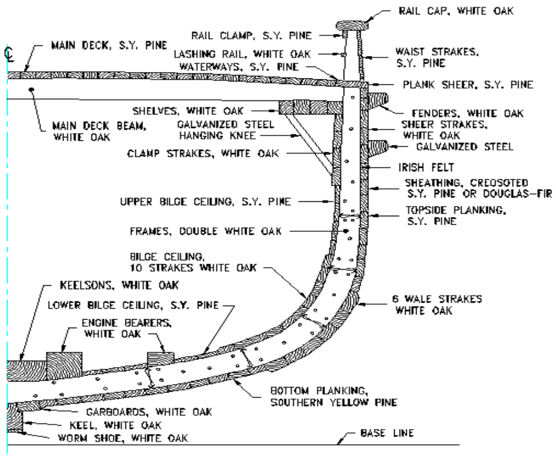

Figure 3. Midship of Traditional Ship
soruce : report of National Transport Safety Committee (NTSC)

Structure of ship construction to hold forces and moments acting on the three sample of vessels are as follows:

Table 1. Results of the calculation of the traditional ship construction

Description	Tonnage Ship Capacity		
	294 m^3	386 m^3	424 m^3
Length of Ship (m)	22,7	26,4	27,1
Breath of ship (m)	8,75	9,9	10,2
Height of ship (m)	3,8	4,3	4,7
Distance of frame (mm)	467	496	500
Height of *wrang* (mm)	381	406	410
Frame size (mm)	116 x 230	128 x 256	130 x 260
Deck Beam (mm)	130 x 150	130 x 150	130 x 150
Deck Planking (mm)	314 x 57	345 x 64	350 x 65
Galar balok (mm)	153 x 165	182 x 208	185 x 210
Galar kim (mm)	130 x 120	179 x 104	180 x 105
Section Modulus:			
Deck Beam (m^2)	2,67	2,88	2,91
Frame (m^2)	5,88	9,32	11,99
Bottom Frame (m^2)	8.05	12,77	16,42
Bending Stress			
Deck Beam (t/m^2)	0,055	0,066	0,069
Frame (t/m^2)	0,336	0,416	0,439
Bottom Frame (t/m^2)	0,256	0,307	0,326

Furthermore, strength of ship to be calculated by determining critical conditions that (hypothetically) may occur that is : (i) on crests of wave just in the midship (wave propagation assumed equals vessel centerline of ship); or (ii) in the troughs also just in the middle of ship, while wave length approximately equals to the length of the ship. Bending moment is obtained by calculating weight of ship distributed along throughout the ship. Weight of ship distribution that cause a bending moments is sum of weight of empty ship, cargoes, stores, crews, fuel, lubricating oil, fresh water and other items, which is the total weight of ship befor sails. Calculating the weight distribution is usually in planning stage that it is calculated by the approach methode.

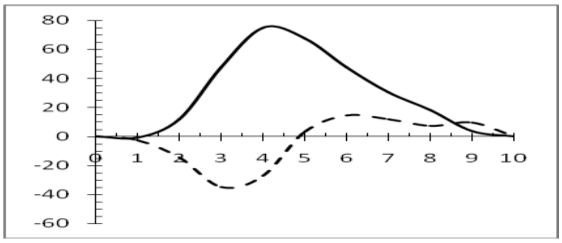

Figure 4. Curve of Bending Moment and Shear Force for ship with capacity 294 m^3

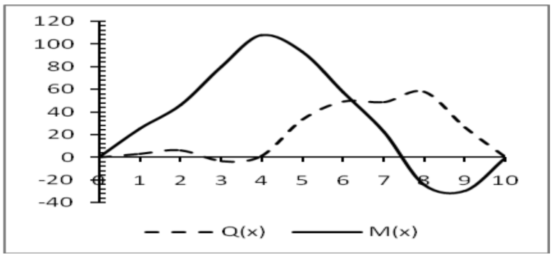

Figure 5. Curve of Bending Moment and Shear Force for ship with capacity 386 m^3

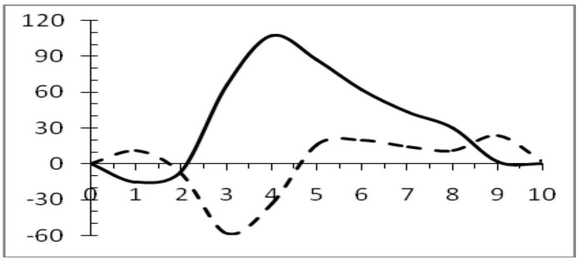

Figure 6. Curve of Bending Moment and Shear Force for ship with capacity 424 m^3

The results of longitudinal strength calculations based on wind speed 13 knot and wave height 2,74 m are as follows:

Tabel 2. Result of longitudinal strength calculations

Description	Units	Result of Calculations		
Ship capacity		294 m^3	386 m^3	424 m^3
Wind velocity	(knot)	13	13	13
Wave height	(m)	2,74	2,74	2,74
Sheraing Force, Qx	(ton)	27,25	11,15	33,43
Bending moment, Mx	(ton-m)	74,97	76,69	100,38
Moment of Inertia (I_0) :				
I_0	(cm^4)	526.414,21	534.996,22	573.798,74
$I_{N\text{-}A}$	(cm^4)	429.420.968,08	485.026.262,20	645.647.528,30
$Z_{B\text{-}T}$	(cm^4)	173,7	167,1	186,8
Section Modulus (W):				
W_{deck}	(cm^3)	1.855.016,03	1.844.380,97	2.283.608,59
W_{bottom}	(cm^3)	2.891.563,69	2.900.832,68	3.462.481,13
Stress on *deck*, σ_{deck}	(kg/cm^2)	4,04	4,16	4,40
Stress at *bottom*, σ_{deck}	(kg/cm^2)	2,59	2,64	2,90
Maximum deflection	mm	0,0013	0.0012	0.0012
Moment of torsion (MTrs)	(ton-m)	68,13	75,91	96,06
N_{deck}	(kg/cm^2)	3,67	4,12	4,21
N_{bottom}	(kg/cm^2)	2,36	2,62	2,77
Permitted Stress				
$\sigma_{bending}$	(kg/cm^2)	120-130	120-130	120-130
$\sigma_{\text{compress and tensile parallel to wood fiber}}$	(kg/cm^2)	110-120	110-120	110-120
$\sigma_{\text{compress and tensile perpendicular to wood fiber}}$	(kg/cm^2)	25-30	25-30	25-30
σ_{shear}	(kg/cm^2)	14-17	14-17	14-17

The above calculations show that theoretically longitudinal strengths of ship sample constructions are strong enough where their results varied between 4.04 to 4.40 kg/cm^2 on weather deck and 2.59 to 2.90 kg/cm^2 at bottom. These are smaller than the standards required for wooden ship. However, traditional ships generally can not comply with the technical requirements of the modern ship safety because of their designs and constructions still using traditional methods. These weaknesses should be compensated with other technology in order to provide safety appropriate. Referred technology is operational of ship to achieve the expected level of safety. Application of the principles of safety management system as implemented on modern ships could be considered.

Transversal strength of ship construction as shown in Table 2 is strong enough to withstand forces received by ship samples because stress occurs is smaller than permitted stress. Nevertheless, weaknesses were still occurred on ships below 150 GT which in general did not consider importance of a watertight transverse bulkhead to separate cargo hold and machinery room. There seems no real understanding of the importance of the transverse bulkhead as a factor of transverse ship strength. Cargo hold used as much as possible and even utilizing some machinery space for placement of cargoes. Reduction of machinery space for cargoes will disrupt crews' activities to control engine operation.

2. Stability of the ship under some conditions

Moments that may affect or even destroy the static stability of ship to be calculated based on six alternative loading conditions as described above, together with the influence of water conditions such as wind velocity in between 12 and 26 knots; wave height in between 0.6 and 7.7 meters, and described by Beaufort scale 4,5, and 6. Static stability calculation results as shown in Table 3 and 4. Results of calculation shown the table prove that those ships actually comply with IMO resolution A.749 (18), where areas of ships righting arm curves are larger, metacentric height (MG) are greater than 0.15, righting arm are larger that could be said ships are seaworthy.

Table 3. Calculation result of stability for ship 294 m^3

Description		Seaworthy Criteria	Loading Conditions					
			I	II	III	IV	V	VI
Displacement	(ton)	-	269	262	179	172	89	82
Draft	(m)	-	3,20	3,15	2,51	2,46	1,61	1,52
Height of KG	(m)	-	2,19	2,09	2,05	2,03	2,52	2,51
Q_{range}	(degree)	≥ 40°	46,8	47,3	50,7	55,4	48,7	52,9
Righting Arm (GZ)	(m)	≥ 30°	30	30	30	30	30	30
Metacentric Height (MG)	(m)	≥ 0,15	1,23	1,21	1,07	0,88	0,64	0,61
Area of righting arm curve	(m-rad)		0,139	0,153	0,205	0,237	0,198	0,218
*) 30°≤Q ≤ 40°	(m-rad)	≥ 0,030	0,033	0,035	0,052	0,060	0,048	0,054
*) 0°≤Q ≤ 40°	(m-rad)	≥ 0,090	0,132	0,145	0,181	0,198	0,183	0,191

Source : Data analysis.

Table 4. Calculation result of stability for ship 386 m3

Description		Seaworthy Criteria	Loading Conditions					
			I	II	III	IV	V	VI
Displacement	(ton)	-	320	312	212	205	104	97
Draft	(m)	-	3,80	3,74	2,89	2,83	1,92	1,84
Height of KG	(m)	-	2,31	2,29	2,32	2,28	2,75	2,71
Q_{range}	(degree)	≥ 40°	52,45	53,15	54,19	56,91	54,51	54,56
Righting Arm (GZ)	(m)	≥ 30°	30,20	30,50	30,00	30,00	30,00	30,00
Metacentric Height (MG)	(m)	≥ 0,15	1,49	1,44	1,36	1,32	1.09	1.02
Area of righting arm curve	(m-rad)	-	0,193	0,211	0,343	0,366	0,380	0,414
*) 30°≤Q ≤ 40°	(m-rad)	≥ 0,030	0,050	0,055	0,090	0,092	0,092	0,103
*) 0°≤Q ≤ 40°	(m-rad)	≥ 0,090	0,165	0,179	0,288	0,299	0,326	0,354

Source : Data analysis.

Table 5. Calculation result of stability for ship 424 m3

Description		Seaworthy Criteria	Loading Conditions					
			I	II	III	IV	V	VI
Displacement	(ton)	-	416	409	276	269	136	129
Draft	(m)	-	4,10	4,02	3,15	3,11	2,07	1,37
Height of KG	(m)	-	2,64	2,63	2,16	2,13	3,14	3,13
Q_{range}	(degree)	≥ 40°	52,1	52,6	55,21	60,7	53,7	55,8
Righting Arm (GZ)	(m)	≥ 30°	30,1	30,0	30,0	30,0	30,0	30,0
Metacentric Height (MG)	(m)	≥ 0,15	1,29	1,22	1,56	1,55	0,86	0,80
Area of righting arm curve	(m-rad)	-	0,216	0,237	0,390	0,425	0,351	0,396
*) 30°≤Q ≤ 40°	(m-rad)	≥ 0,030	0,058	0,064	0,108	0,110	0,185	0,107
*) 0°≤Q ≤ 40°	(m-rad)	≥ 0,090	0,185	0,200	0,309	0,312	0,294	0,315

Source : Data analysis.

3. Weather influence to ship stability

Curve stability to be calculated in various conditions and in various heeling angles (0°-70°) proved that those ships complied with the IMO criteria, that those ships don't have any problems when leaving the port. Thus, the ship stabilities to be analyzed are feasible or these ships have enough seaworthiness before operated. Conditions of the waters that influence the stabilities implemented in the calculations are based on Beaufort scale 4.5, 6. Figure 7-14 show that moment stabilities of the vessels are generally larger than the moment effected by wind and waves. Thus, according to the results of stability curve analysis at 6 loading conditions, it could be concluded that the structure of the ship still allow the ships to sail in conditions of Indonesian waters. However, in reality many accidents occurred with greater percentage than other vessels, and then could be assumed as lack competence of human resources in loading system and operation of the ships. And most important to be considered are arrangement of cargoes and excessive amount of cargoes that might result over-draft ship.

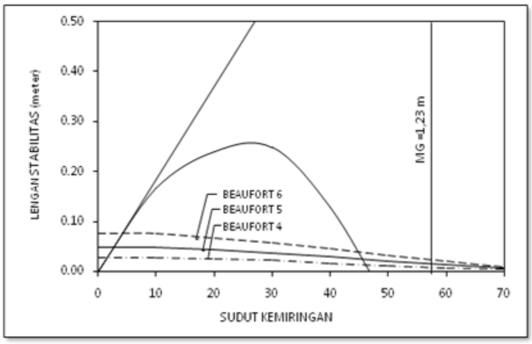

Figure 7. Curve of Stability for ship 294 m^3 (Loading Condition 1)

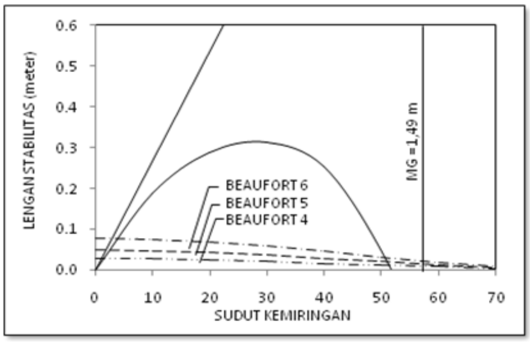

Figure 8. Curve of Stability for ship 386 m^3 (Loading Condition 1)

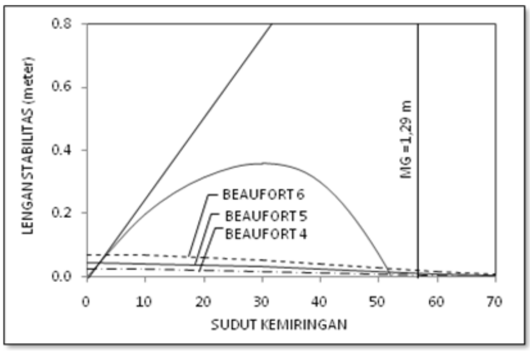

Figure 9. Curve of Stability for ship 424 m^3 (Loading Condition 1)

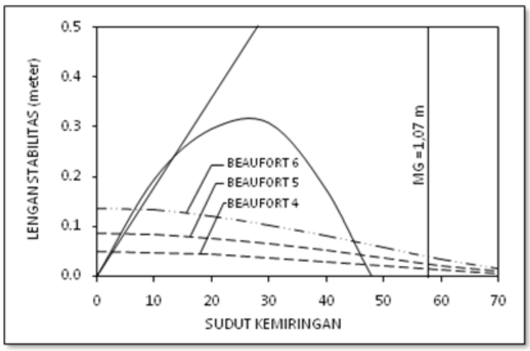

Figure 10. Curve of Stability for ship 294 m^3 (Loading Condition 3)

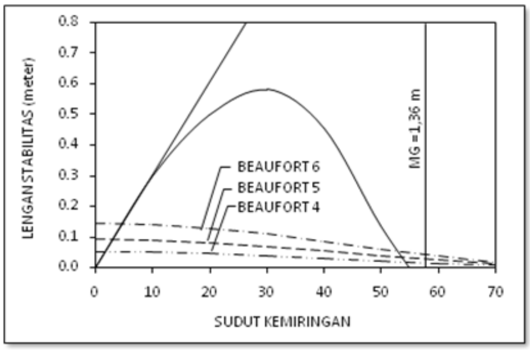

Figure 11. Curve of Stability for ship 386 m^3 (Loading Condition 3)

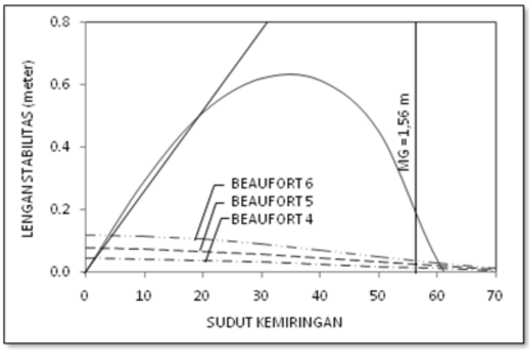

Figure 12. Curve of Stability for ship 424 m^3 (Loading Condition 3)

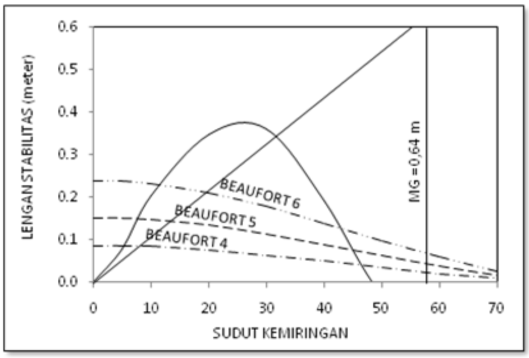

Figure 13. Curve of Stability for ship 294 m^3 (Loading Condition 5)

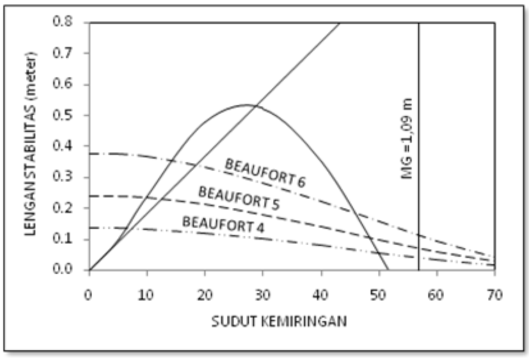

Figure 14. Curve of Stability for ship 386 m^3 (Loading Condition 5)

One cause of the ship accidents at sea is the role of the crews who did not pay attention to the calculation of the ship stability that could potentially difficult to control, unstable and drowned. Once the importance of the knowledge to calculate the ship stability so that all crews must be understanding and skill to maintaining the ship stability conditions in order to achieve safety and convenience of navigation.

Sea transportation services especially by phinisi fleet tend to decrease their quality and quantities including shipping safety assurance. Factors affecting this things are technical issues of the fleet, competencies and commitment of human resources, and, geographic and weather or water conditions. Therefore, to minimize the risk of ship accidents due to human error, the safety management system of the traditional shipping should be fostered and developed. Those could be preceded by the safety regulator and supported by ship operators and ship owners.

4. Non technical aspects

Although technically traditional ships could be categorized seaworthy, but number of ship accident tend to increase with average 49.14 percent per year for the period 2001-2009. Therefore, non-technical factors causing the accident needed to be analyzed. Identification of non-technical factors in order to formulate policies and strategies to improve traditional shipping safety is analyzed by maximizing strengths and opportunities, as well as minimizing weaknesses and threats. The results of SWOT analysis are as follows:

INTERNAL / EKSTERNAL	STRENGTH (S)	WEAKNESS (W)
	- Traditional ships don't require docking facilities for maintenance because it could be done in the coast. - Traditional shipping could be classified as an industry which is not affected by the financial fluctuation. - Traditional ship dimensions are generally small, and could serve remote areas and do not rely on port infrastructure. - Traditional shipping is a self-sufficiency business and is not bound by strict rules, and serving tramper routes. - Stability of traditional ship is basically quite well if doesn't have excess load, and leaking.	- Low level of ship safety and seaworthiness thereby reducing insurance trust and the cargo owners. - Low level of ashore management capability and crew skills. - Low level of education and operation capability. - Traditional shipping has generally no standard of ship classification. - Traditional ships are not equipped with loading and unloading facilities, and communication as well adequate navigation systems.
OPPORTUNITY (O)	**Strategy for Strength-Opportunity**	**Strategy for weakness-opportunity**
- Human resources recruitment process is relatively simple, not required qualified seafarer. - Traditional shipping is given privilege in terms of loading and unloading procedures, port clearance, and low tariff. - There are many undeveloped ports in remote areas of their market potential. - Traditional seafarers have generally followed education for increasing skill of ship operations.	- Improving the quality of human resources that able to take into account traditional ship stability. - Intensifying education and training for ship maintenance. - Increasing traditional ship services productivity to remote areas and their port facilities performance. - Optimizing traditional ship activities within tramper routes patterns.	- Efficiency of loading and unloading in order to improve competitiveness. - Promoting the adoption of technical ship standards through education program and skill enhancement of ship operations - Repairing loading and unloading as well as shipping navigation systems to serve areas of their market potential. - Improving education and human resources operational capabilities after recruitment.
THREAT (T)	**Strategy for Strength-Threat:**	**Strategy for Weakness-Threat:**
- Traditional shipyards have generally no formal standard of ship building - Experience of ship building industry that is only on wooden ship - Cargo owners require secure service, low cost, and regular schedule, which are quite difficult for traditional shipping. - Development of port infrastructure in remote areas could invite competitors to visit the ports.	- Increasing traditional ship building standards and strived to be done in shipyards. - To attempt traditional ship building other than woods in order to improve strength and stability performance. - Increasing traditional ship classification that could provide safety guaranty to cargo owners. - Developing traditional ship infrastructure in areas of market potential in order to improve their services.	- Improving the standard of traditional ship building construction and materials. - Improving human resource capacity and capability of ship building which is not only limited to wood materials. - Increasing ship construction standards in order to overcome weather conditions. - Improving loading and unloading performance to increase productivity of local transport services, and improving performance of navigation facilities by using GPS.

IV. CONCLUSION AND SUGGESTION

1. Conclusion

a. Traditional shipping from the view of stability and strength are considered in well condition and can be categorized seaworthy in accordance with IMO stability criteria (Number A.749(18)) as well as the rules of Indonesia ship classification board or standard requirements strength of wood resources for ship construction.

b. Result of calculations showed that traditional ships were strong enough to withstand wind and wave moments acting to the ships. However, there were unsincronized between technical requirements and real conditions such as no watertight bulkhead between the engine room and cargo hold, compaction cargoes in hold and deck, so that affected to ship construction and changing height of metacentre.

c. Human resources are the key to success or failure of traditional shipping organizing as a non-technical effort to improve ship safety. The role of operational management ashore and its synergy with ship crews to be important in shipping safety improvement.

2. Suggestion

a. Government banned logging due to the exploitation of nature and environment. This affected scarcity of raw materials for wooden ships, induction of technology and business competition, if not matched by a readiness to change in the traditional system (human resources, technology, submission and heartburning social) ultimately disembogue in national poverty and instability.
b. It is time to develop the technology applied by traditional wooden ship craftsmen, among others through a series of wooden shipbuilding technology experiments , as well as the need to improve the understanding of wooden ship technology utilization.
c. Traditional seafarers must comply with the standard regulation of certain positions on board. They are expected to attend specific training prior to operate the ships. Seafarers who understand their duties and functions will be very useful for shipping company, and maintain the technical ship conditions as well.
d. Safety aspect is not only government duty as a regulator, but also should be concerned by ship owners, ship operators and crews. Therefore, in order to improve traditional shipping safety and decrease number of accidents, ship owners or ship operators should have crews that comply with the standard requirement of seafarers. Shipping companies should also be encouraged to facilitate their crews to actively attend education and training so as to maintain and enhance their competences.

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