The Challenge of Standardization for Shipyards in Developing Countries

by

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Abstract

This thesis describes the current standardization program within the Indonesia shipbuilding industry developed from personal interviews, questionnaires, and published information. Standardization in designs, modules, and interfaces for entire fleets, class, and vessels, in production planning, and in control will reduce acquisition and life cycle costs and increase the industry competitiveness in the domestic and international market.

Currently, the government supports the development of the shipbuilding-related industry and promotes the establishment of marine-related plants in cooperation with both domestic and foreign makers and manufacturers. This condition is supported by the construction of standard-type interisland ships of the interisland with the same capacity, and operational requirements of material, machineries, and equipment.

Similar to shipyards in other developing countries, the industry is having difficulties applying generic components, interfaces and designs. A standardization approach will bridge differences among shipyards, marine-related manufacturers, shipowners, and government in technical, economical, and producibility aspects.

Thesis Supervisor: Henry S. Marcus
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LIST OF ACRONYMS

ABS	American Bureau of Shipping
ANSI	American National Standards Institute
APL	Allowance Parts List
ATC	Affordability Through Commonality
BB	Building Berth
BD	Building Dock
BPIS	Agency for the Development of Strategic Industry
BRT	Dead Weighted Tonnage (in Indonesia language terms)
BUMN	Government Owned Corporation/State enterprise
CAD	Computer Aided Design
DKB	Dok Kodja Bahari
DSN	Standardization Council of Indonesia
DWT	Dead Weight Tonnage
FD	Floating Dock
GC	General Cargo
GD	Graving Dock
GT	Gross Tonnage
HME	Hull, Mechanical and Electrical
ILS	Integrated Logistic Suport
INSA	Indonesian Shipowners Association
ISO	International Standard Organization
JIT	Just In Time
JSQS	Japanese Shipbuilding Quality Standard
JSS	Japanese Standard System
LIPI	Indonesia Science Institution
NAVSEA	Naval Sea Systems Command
PAKNO	November 1988 Regulation
Perum	Corporation owned by a department
PT	Corporation

RB	Repair Basin
SC	Semi Container
SII	Indonesia Industrial Standards
SL	Ship Lift
SNI/NSI	Indonesia National Standards
ST	Side Track
SW	Slipway
VFI	Vendor Furnished Information

Chapter 1

Introduction

1.1 Overview

The Indonesian shipbuilding industry is facing a fierce international competition from other developing countries, weak negotiating ability relative to strong suppliers, and less purchasing power from the domestic market, even though the overall Indonesia industrial base is increasing and the potential market demand is promising. These circumstances require the industry to strive harder than ever before to reduce the costs associated with commercial ship design, process production, acquisition, and operation. Methods to reduce the total cost of ownership must be developed and implemented.

As the title of this thesis suggests, the objective of this study was to research the role of standardization in Indonesia shipbuilding industry, particularly the role of equipment and component standardization in shipbuilding and acquisition activities. The ways in which standardization of equipment and components at both the equipment and ship module levels can be beneficial in the four areas above will be explored. The main objective of this research was to examine the appropriate degree of and approach to standardization. Processes and approaches which may prove effective in dealing with the standardization function will be studied and suggested.

The utility of these and other tools that have developed will be discussed. Prior successes in standardization of equipment and other industries will be studied. A broad review across equipment categories will be conducted to demonstrate that opportunities for saving through standardization exist. Modularity will be studied as a means of reducing construction costs and time to delivery. Information and data were collected from published information, questionnaires, and interviews with officers in shipyards and managers in marine related manufacturing in the country.

Chapter two starts with the terms and general definition of compatibility and standardization. Explanations of standardization types in shipbuilding activities are given as well. These keywords will be used throughout the thesis.

Chapter three analyzes the benefits that developing countries and shipbuilding industry can reap from implementing standardization. The role of a national standard agency is discussed as well in respect to marine-related manufacturers and suppliers, and the industry.

Chapter four starts with the general condition of Indonesia shipbuilding industry and other supporting groups such as marine-related manufacturers, suppliers, ship buyers, the national standardization agency, and government. The shifts and key determinants of the demand and supply in the industry become a topic of major discussion.

Chapter five shows how standardization has been applied in the overall industry and specifically the marine-related sector. It also reviews the coordination among agencies and shipbuilding in setting the common standards. It describes the application of standard design in commercial and navy ships. Analysis of the relationships between shipyards and their customers provides a simple and effective framework for understanding the competitive environment of shipyards and standardization approaches. Complex internal and external forces that influence shipyards and ship owners are the following:

- price : the final payment for vessel by the ship owner. after all subsidies and financing utilities have been conducted;
- promotion: the method by which a shipyard identifies its customers, and influences decisions;
- position: relationship of a shipyard to its competitors. as perceived by the market place;
- product : a vessel characterized by its capability, quality. and timely delivery.

Chapter six describes the quality partnership to identify the best practice in the supplier selection and quality control. Then, it discusses the application of Integrated Logistic Support in a shipyard. Later on, it shows how the government stimulates shipyards through subsidies and transfer technology related to standardization activities.

Chapter seven: summary and conclusions

Chapter 2

Standardization and Compatibility

2.1 General definition

The word "standards" has several interpretations and differs in form and type depending on the particular aspect of a subject that may be covered. The following definitions are compiled from National Bureau of Standards (NBS) publications [19], Standardization Council of Indonesia(DSN) [18]. and other sources:

1. A set of nomenclature, or definition of terms;
2. A specification for the quality, composition or performance of a material. an instrument, a machine or a structure;
3. A method of sampling or inspection to determine conformity with a specific requirement of a large batch of material by inspection of a smaller sample;
4. A method of test or analysis to evaluate specified characteristics of a material or chemical;
5. A Scheme of simplification or rationalization, i.e. limitation of variety of sizes, shapes, or grades designed to meet most economically the needs of the consumers. This also includes dimensional stipulation of component designs to ensure interchange ability, as also methods of grading and grade definitions for natural products, such as timber or minerals;

6. Code of practice dealing with design, construction, operation, safety, maintenance of a building, and installation of a machine:

7. A model form of contract or agreement.

Standardization as one of the means in an industrial development and transfer technology is applied extensively in developing countries. Indonesia has had a national standardization program since 1928 beginning with an organization called "Fonds voor Normalizatie". Over the years, it becomes the Standardization Council of Indonesia and functions as the national coordination body. The organization which is concerned with standardization and metrology operates and cooperates with other institutions to recognize, establish, and improve standardization and metrology in Indonesia.

The standardization programs become a part of infrastructure development and rationalize production of industry, service, trading, and agricultural activities in the country. The shipbuilding sector through the Department of Industry also defines general and technical terms and develops specifications as part of standardization as well. The broad spectrum of the process and activities contains some basic characteristics, which are similar to the ones in other developing countries:

1. Scope:
    (a) internal decision, as when there is only one relevant vendor.
    (b) mutual agreement by manufacturers, either formal or informal, binding or voluntary.
    (c) the standardization process may be one of follow the leader. The leadership role may be taken by a buyer or by a seller.
    (d) there may be direct government regulation.
    (e) the international standardization commissions.

2. Administration:

(a) to decide on the technical content of a standard. Decisions on the various questions arising in the formulation of a standard:

(b) to cast the standards that are being developed into the most effective form as specifications - that is to make the wording of the standards specific, clear, and complete, and to keep them as brief as possible;

(c) to supervise and coordinate action of a body which does not take an active part in the formulation of standards but serves exclusively to keep order in the flow of work by making decisions on the significant phases in the handling of standardization projects:

3. Compatibility as a direct result:

As products or services are standardized, the ones with the same functions will be compatible (enable them to work together or replace one another). When their designs are coordinated in such ways that similar components are compatible with each other, the standardization creates :

- physical compatibility: physical objects are designed to fit together physically or electromagnetically.
- communication compatibility: two physical devices are able to to communicate with one another.
- compatibility by convention: benefits from coordination that are not physically embodied.

The compatibility creates several benefits [9]:

- Network externalities : Products are often linked in physical or conceptual "networks" whose value depends on their size in a direct way.
- Competitive effects: Producers compete more on price and less on design. This makes the market more of a "commodity" market, and naturally enhances price competition which is in itself a good thing for economic efficiency.

- Variety: While compatibility requirements can limit variety as discussed in Farrel and Saloner (1986)[9], compatibility can also increase available variety by allowing mix and match purchases.

- Cost Savings: By allowing greater scale economies (for instance. by enabling different manufacturers to exploit economies of scale in using a common supplier) and by allowing the use of interchangeable parts. standardization reduces production costs.

2.2 Standardization in shipbuilding industry

There are several interpretations to the meaning of the standardization in shipbuilding industry. Some definitions and terms are slightly different and emphasize certain aspects. Compatibility, which is a standardization result as mentioned previously, is achieved through standardization in parts. components, interface, and overall design of a vessel. This simplification of varieties is designed to meet the designer's need and satisfies technical and economic considerations. Furthermore, as a standardized process, it becomes a production method in a shipyard. The standardized task block incorporates the individual parts and a wide range of packages by applying the modular/zone concept of ship construction. It extends even more to be a set of basis or benchmarks for the industry in management and production activities. The ultimate goals of these programs are to reduce costs associated with a commercial and navy ship design, process production, acquisition, and operation.

These various categories and purposes can be grouped into three major areas:

1. Design and Component Standardization

   The act of minimizing the range of equipment. components, parts. interfaces, and their documentation needed for fleet support is applied within a ship, among vessels in a certain class, and major fleets. Through a program called Affordability Through Commonality (ATC), the United States Navy is involved in this type of standardization, as shown in figure 2.1 [17]. The ATC defines the standardization as:

a concept which will be designed and built using common modules comprised of standard components and/or standard interfaces. These modules will be used across ship types and will be integral with standardization, distributed system architecture and generic build strategies. This policy of increased commonality is intended to reduce the total cost of ownership and is the cornerstone of the affordable fleet. [17]

The following general definitions are specified to ship equipment and commonly used by offices within the NAVSEA organization involved in standardization efforts [13]:

- Intra Navy standardization: The selection of components and equipment based upon already in the Navy inventory.
- Intra Class standardization: The selection of components and equipment for follow on ships of the class, based on a class configuration baseline.
- Intra Ship standardization: The selection of components and equipment to promote the maximum use of identical equipment for similar applications within a ship.
- Interchangeability: Two or more items possessing such functional and physical characteristics as to be equivalent in performance and durability. These items can be exchanged for the other without alteration of the items themselves or adjoining items, except for adjustment.
- HM & E (Hull, Mechanical and Electrical) Component Standardization: The definition of a component to the piece part level by Navy owned manufacturing level standard drawings.
- Standard Hardware Acquisition and Reliability Program: Similar to HM & E except that it is applied to electronic parts and systems.

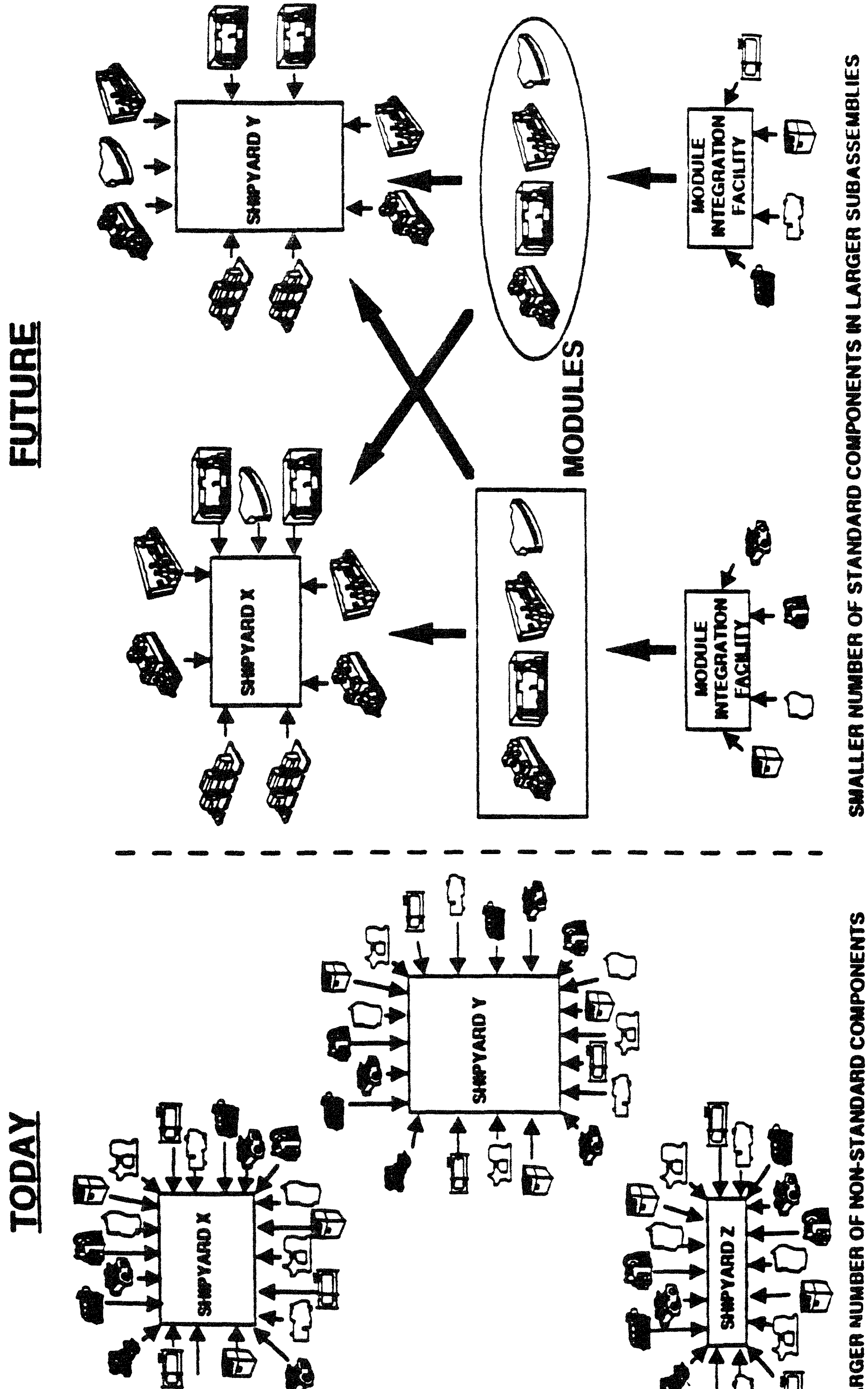


Figure 2-1: Fewer components in larger subassemblies

As an external standardization which requires participation and commitments of all parties within the industry, the component and design standardization is a challenge program for the shipbuilding industry in developing countries like Indonesia. The program can be divided into two major areas - preconceptualization stage and the formal standard process. In the general industry application, the component standardization may take one to five years and be broken down further into four main areas: conceptualization (up to a year), discussion (the same), writing (up to three years), and implementation [5]. Preconceptualization is the stage where the market is examined to determine if there is a legitimate need for a standard. The need must exist -either in reality or in the market perception. The idea for the standard must be applicable to the market in general, must be wide spread enough to be accepted by substantial clientele, and must be contained enough to be adopted.

This type of standardization requires some basic elements to achieve the intended goals. A sufficient number of domestic suppliers and manufacturers is required for setting components at certain levels of compatibility. Otherwise, the identification and specification of standardized parts is not feasible or not competitive in terms of price and quality. In identifying and determining parts, components, and interfaces to be standardized, an extensive and detailed study and tools are required. Furthermore, coordination among key players, such as suppliers, major buyers or government, shipyards, and the ship building industry and national standardization agencies, is another key factor. It extends further to the requirement for skilled designers and engineers to support the technical analysis of compatibility among components. In respect to the current environment in Indonesia, the implementation of similar programs are not fully supported with the basic elements and need extensive studies.

The development and implementation of similar techniques to shipyards in Indonesia are expected to achieve a similar number of benefits as expected by the ATC programs [17]:

- Reversal of Allowance Parts List (APL) proliferation.
- Reduced long term design costs.
- Reduced program acquisition costs. Procurement of fewer unique components and systems will reduce the efforts required for acquisition.
- Reduced construction costs due to productivity improvements reducing both the labor required and the time for construction.
- Reduced infrastructure for spares maintenance and training due to greater standardization.
- Reduced modernization costs due to greater standardization and modularization will simplify future system upgrades.
- Improved industry competitiveness due to productivity improvements.

The component standardization also includes the following:

(a) Modular payload design: standardization of a grand scale, involving whole ship systems instead of singular components. The idea is to establish modules encompassing a range of three dimensional size, each with preestablished interface specifications.

(b) Standard arrangement and components: The idea is similar to the rest of them above, to reduce construction cost. Though not as grand a concept as the modular payload ship, the idea is to standardize production items to increase production runs and increase economies of scale during ship construction. These items are fabricated by the shipyards rather than purchased from subcontractors.

The other two standardization types below are internal standardization which is the creation of a process and/or a benchmark based on either new or an existing routine - to enhance the use of company resources. In a shipyard, numerous processes can be standardized - from paperwork routines. through personal policies to design processes - to ultimately utilize scarce resources, such as labor and facilities more effectively.

2. Standardized Production Planning [28]

   A shipyard can standardize the production process and planning to monitor performance at all levels of the shipbuilding process using the system proposed by Mr. Michael Wade. He describes a concept called Group Technology which is grouping of manufactured parts and products that require similar methods, tooling, and manufacturing processes in such a way that production labors can handle them efficiently. This standard process ultimately increases efficiency due to reduced tool setup time and improvement of worker productivity by his increased frequency of performance with regard to specific production tasks.

   Furthermore, the module (any three dimensional structural assembly -subassembly, interim products, and piece parts- that will be directly erected onto the ship ways or hull block upon completion) is introduced and becomes the standardized task block. The physical size of the module is related to particular material handling and outfitting capacities in the yard. Benefits come along from fabrication through project completion for example, reduction in the work crew congestion on the hull after launch, reduction in the transit time between worksite and support services, and completion of the Critical Path Method application.

   The standardized production process can be divided into two important parts:

   - Modular Stage includes fabrication, subassembly. construction, pre-outfit, erection.
   - Zone Stage includes fabrication, subassembly, pre-outfit, final outfit, finishing.

3. Production Control and Planning Standardization

A publication of SNAME Panel SP-8 entitled " Production Oriented Planning: A Manual on Planning and Production Control for Shipyard Use" suggests a hierarchy of standards for use in shipyards[23]. This category can be applied in a shipyard as a performance measurement and benchmarks for the basic shipyard productive resources - manpower, time, material, and facilities-. These include the following (in order of the most detailed and lowest level of standards)[22] :

- Process standard covers a single work process which is quite detailed in nature where fractions of seconds in time may be the basis of measurement.

- Production standard covers the work content of a particular production job and might be composed of several process standards.

- Scheduling standard is used for an estimate of the elapsed time for specified operations or workstations as measured in man-hours and for developing schedules.

- Planning standard reflects work package budgets and is used in developing milestone and key event schedules for construction of major modules of the ship.

- Cost estimation standard to estimate costs for ship construction or ship systems.

Chapter 3

Benefits of Standardization

3.1 National Standards Body

The concentration of economic and financial resources within the public sector provides the government of developing countries with means of promoting their industrialization processes. The active roles and initiatives of government bodies in setting industrial regulations and foundations, such as the product. process, and evaluation tools for standardization are important. Even more, the private industrial sector is often weak both in absolute terms and relative to the overall commercial sector. The domestic capital formation may be at a low level as well. Thus. the industrial policies as further actions and programs of the government to support a particular industry are very important.

Standardization as a key element in industrial development is developed through creating a National Standards Body and other specialized standard agencies or certain companies in a specified industry. These agencies contribute the benefits of standardization in following ways:

1. supervise and coordinate standardization work at the national level through co-operation among interested parties with a view to the establishment of national standards;

2. serve as the national channel for co-operation in the coordination of standardization work in two or more countries, including work at a regional or at a general international level;

3. promote standardization as a technical activity and as an integral distinct function of management;

4. keep in touch with foreign National Standards Bodies with exchange of information of common interest;

5. serve as the national center of information on subjects in the field of standardization.

The success story from Japan in developing and mastering its technology for industry applications and shipbuilding in particular is supported by its National Standard Body. Similar steps are followed by developing countries to build a strong industrial base and a particular industry (shipbuilding). The industry utilizes the function of The National Standard Body effectively. According to D.J. Lecraw, Japanese Standard System (JSS) has historically had four interrelated goals [9]:

- to increase efficiency and technological progress of Japanese industry by fostering product compatibility, interchangeability, rationalization, simplification, and upgrading of products and processes,

- to improve quality control,

- for export promotion through the development of a quality image for Japanese product,

- to prevent "destructive" competition based on price between rival Japanese exporters.

The government's responsibility to organize such a National Information System which performs the selection and evaluation of technical information, especially in relation to equipment and processes is very critical. Along the same line, the requirements for technical processes become more intricate and implementation of appropriate standards increases. It is obvious that developing countries like Indonesia will reap tremendous benefits from implementing standardization in the industry. Standardization will increase economic efficiency as Gabel stated [9] that standards in developing countries can lower production and usage costs through economic scale in production, increase the level of competition by promoting interchangeability, compatibility, and coordination, lower transaction costs by lowering information and search costs, and decrease the perceived risk of the purchasers. Other benefits for a developing country are (compiled from interviews, questionnaires, and a publication by National Bureau of Standards [26]):

- improve communication between buyers and sellers;
- increase user confidence in the commodities they buy;
- better understanding of how to use the commodity;
- greater public safety in the use of community;
- reduce inventories for both producer and user through elimination of unnecessary grades;
- speed deliveries due to the ability to stock standard items;
- better performance at lower prices through reduced need for negotiations and more efficient testing and quality control procedures;
- ultimately lower prices to the user because of a more rational basis used through out the design and production of the commodity.

As other developing countries, Indonesia supports a National Standardization Agency which is called DSN (Standardization Council of Indonesia). The body is

responding to the authority given it by the Presidential Decree (of 1984 and revised in 1989) and the Government Regulation on SNI. DSN has decided to have one national standard, called Indonesia National Standard (NSI). NSI are approved by the Standardization Council of Indonesia - DSN forms standards formulated by standards-formulating institutions after fulfilling the DSN procedures and criteria for national standards approval. The catalogue provides a reference for all standards and standard type documents published by standards formulating institutions in Indonesia. From 2918 standards formulated by the standards formulating institutions, 1748 standards have been approved as national standards.
The Standardization Council of Indonesia has following primary objectives:

1. to coordinate, syncronize, and maintain the cooperation among institutions concerned with the standardization and metrology activities.

2. to submit advice and recommendations to the President concerning the national policy and standardization and development of national physical standards;

3. to promote harmonizing and integrating the national standardization and metrology activities and services;

4. to bridge with international organizations in order to accelerate the flow of technology ;

5. to adopt international standards through:

    - receipt of technology during the course of preparation of standards.

    - transfer of technology through the use and implementation of the adapted standards.

One of the functions of the national standardization system is acting as a clearing house of information on standardization. Standards information service, therefore, become a vital component of the system. In the National Standardization System

"Pusat Standardisasi LIPI" as the secretarial unit of DSN serves as the central repository and inquiry point for standards and standards related information in Indonesia, supplemented by technical information centers for the standards-formulating institutions.

3.2 Shipbuilding

Industrial development in Indonesia as a developing country becomes essential because the technological content in production and transfer technology from developed countries are rising. The Progressive Manufacturing Plan. as an implementation of industrialization through technology, has been put together into a four stage processes as discussed by Francois Raillon in a book "Indonesia 2000" [21]. The shipbuilding industry is one of three choices for technological and industrial transformation. The industry is expected to drive upstream. The policy makes it easier for the government to drive the shipbuilding industry and related activities into one direction.

The appropriate actions have been taken to establish national and international systems that will reflect the special needs of Indonesia. In promoting standardization in developing countries in general and Indonesia particularly, it would be important to realize carefully that standardization is basically the outgrowth of natural tendencies to conform and to obtain maximum benefit from existing successful processes; in its absence, it may take longer to develop new processes. The significant player(s) in the industry, in terms of market share and decision/policies making, has more ability to set up standards applied to general usage and participants. Using the existing market and economies of scale, the standard is agreed upon before it is published nationally. On the other hand, if the industry does not have significant elements for reaching standards, the process will halt or not work properly.

Efforts in Indonesia to publish uniform standards for the marine industry began in the late 1980's with the publishing of the Standard Industry Indonesia (SII) by The Department of Industry. This was sponsored by joint work and coordination among parties: Department of Industry, major shipyards, and Society of Naval Architecture Engineers. The standards given by SII are reviewed and approved by SNI for the national level standard. The components and parts standards are divided into four elements: general, hull, engine, and electric parts. The general section covers graphical symbols, glossary terms and common definitions in a vessel. Other sections emphasize dimensional measurements such as length, weight, depth, and width and capacity limits. The detail list of standardized components and parts is shown in appendix A.

Shipbuilding and marine-related industry in Indonesia are characterized by some commonalities applying heavy industry in developing countries. The dominance of the government both as major ship buyers and producers or either one is taking place. Lack of domestic competitive suppliers for certain components becomes obvious as economies of scale hardly exists in the country. Therefore, shipyards are using components from foreign countries and applying national/industry standards from several countries in the design and production process. Many of the shipyards are in a transition phase from traditional to semi modern or modern production process and in a transfer technology phase from modern shipyards in developed countries such as Japan or Germany. At the end point, shipyards are having difficulties in promoting products due to limited cash flows, unreliable delivery time, and inactive marketing strategy.

Considering a wide array of shipyards in the country as shown in appendix A, standardization affects each shipyard differently depending on the capacity, type of products, technological level, and customers. Officers from major shipyards were interviewed and expressed no objection to increase efforts of standardization. The benefits of this standardization activity are multi functional (compiled from interview, questionnaires, and published information [26] [25]):

1. Production

   - Aid workers in adapting standardized process production, components, and planning;
   - Facilitate mechanization that includes process sheets, process specifications, coding of tools and operations, and material handling procedures;
   - Support more routine activity and familiarity with fabrication and assembly;
   - Reduce re-work;
   - Avoid production delays through stocked standard parts;
   - Emphasis on production in standard design accrues benefits with every application of the standard without the need for further design;

2. Procurement

   - Increase purchasing power through procurement of larger quantities of fewer items;
   - Reduce the number of purchase orders, receipts, and payments;
   - Reduce lead time;
   - Provide a common language between buyer and seller reducing time required for negotiations;
   - Facilitate the formation of quality partnerships with vendors which lead to just in time delivery;
   - Use standard dimensions, interfaces, and design requirements to help put all suppliers on a fair competitive basis, includes drafting practice, format, method of coding and numbering, standard parts and material catalogue;
   - Promote purchase by intrinsic value rather than sales-pitch;
   - Facilitate more rapid acceptance of designs which meet a particular standard;

3. Quality Control

    - Facilitate quality control through the use of standard designs of known quality and specifications;
    - Diminish hazard of misunderstandings with suppliers;
    - Provide better control of the end product;
    - Reduce and simplify inspection;

4. Inventories

    - Reduce capital requirements and amount of capital tied up in inventory;
    - Reduce record keeping;
    - Reduce storage area;
    - Reduce material handling;
    - Reduce obsolescence and spoilage hazards;
    - Reduce stockkeeper's time requirements;
    - Reduce stockkeeper training required;
    - Facilitate more accurate and predictable planning and budgeting;
    - Provide quicker service;

5. Engineering

    - Reduce "break-in" time for new technical personnel;
    - Reduce the need for minor supervisory decisions;
    - Reduce the need for waiver and non-standard part testing and approval;
    - Reduce redesign and redrafting effort;
    - Improve interchangeability of parts, design, and packages, etc.;
    - Promote the use of improved methods and products;
    - Help eliminate unsound practices based on prejudice, tradition, advertising, etc;

- Facilitate the development of cost estimating techniques;
- Facilitate and speed the delivery of critical information;
- Reduce technical time in processing product design;
- Reuse of known items improves reliability and reduces debugging;
- Reduce hazard of technical error in judgment;
- Increase time available for work requiring special design or handling;
- Reduce errors arising from miscommunication among engineers, draftsmen, production workers, etc;

6. Maintenance

   - Reduce breakdowns and downtime;
   - Reduce preventative maintenance time;
   - Reduce repair time;
   - Decrease critical expediting;
   - Reduce the number of unfamiliar jobs encountered;
   - Decrease the number of service-spares;
   - Reduce training time;

7. Learning Curve Effects

   The effect of learning is gained when shipyards receive orders for mass production or lead/follow vessels. Even though quantitative data can not be obtained from major shipyards in the country, managers confirmed that the follow ship(s) is relatively cheaper than the lead one /citeinter. Stian Erichsen concludes that past experience as well as the condition of and attitude in the building yard is of importance. He presents the following observations about how the effect of learning influences the average cost of ships [7] in Norwegian shipyards:

   - For yards starting to build ships from scratch and for yards that start building a new and previously unknown type of ship, a doubling of the number of units reduces the average cost to 81% - 83%.

- When a new technology is introduced, a doubling of the number units reduces the average cost to 84% - 86%.
- When changing from big ships in small series to small ships in big series, the average cost is, by doubling the number of units, reduced to 87% - 88%.
- When changing from building rather simple to more complicated ships, the average cost is, by doubling the number of units, reduced to 89% - 90%.
- When building ships of a type that is well known to the yards, the reduction is 92% - 97%, and in yards that continuously strive to improve their products, the reduction is to 96%.

The losses associated with the lead ship and other related start-up cost could be recouped over the length of the contract because of the number of vessels being built. However, in many cases the lead ship is the only ship of that class that will ever be built considering a private party as a buyer. The notion of gaining efficiency due to application of a learning curve to a large number of the same exact ship must be replaced by that of gaining efficiency by learning to build similar components for a greater mix of ship types. Standardization of components, parts, production processes, and designs is therefore the essential step forward bridging the gap between present methods and more efficient forms of ship production.

3.3 Marine-related industry

Standardization in components, interface, and parts is responded to positively by suppliers and other marine- related manufacturers. A domestic manufacturer can sell its products either for new vessels or replacement/spare parts as a greater variety of vessels is compatible to the products. A supplier is able to offer lower product prices due to economies of scale in production. A manufacturer which assembles parts into a product using standardized design from overseas considers the standardization as a positive sign to start its own design for the domestic market. After all, the new design for standardized components is marketable domestically to most shipyards and ship owners. Even more, compatibility among similar products from different manufacturers is achieved such that network externalities are gained. This situation will improve the overall production process and delivery time and reduce acquisition, maintenance, and training costs to other parties.

3.4 Buyer

A buyer or a ship owner supports the standardization idea as well due to benefits that can be acquired:

- Reduce design and production costs for the follow ships
- Reduce training time and cost for operating vessels
- Reduce maintenance and overhaul costs
- Ease of replacing components and spare parts
- Reduce overall acquisition and operation costs

The Deparment of Industry and Transportation and The Indonesia Navy as major consumers can acquire more vessels with similar functions and capability by standardizing the design and components. During the ship operation, extensive training is not required as an employee learns equipment operations from the previous vessel with similar characteristics. A private buyer is more concerned with spare parts and maintenance costs considering a mass acquisition is a rare occasion. A private buyer optimizes the vessel operation during the expected life by minimizing critical parts: maintenance or part replacement and aquisition cost. As components are standardized, the overhaul can be easier and cheaper.

Chapter 4

Indonesia Shipbuilding Industry

4.1 Outlook

Presently, there are 185 shipyards with capacities up to 40,000 GT for newbuildings and repair, of which 155 yards belong to the private sector. The other 30 shipyards are owned by state enterprises, of which three yards belong to the Department of Industry and one (PT PAL Indonesia) to the Agency for the Development of Strategic Industry (BPIS), while the other 26 are affiliated with the Department of Mining, of Communications, and of Agriculture to support the operations of companies owned by these departments. The national shipyards operating in Indonesia have a total repair capacity of 2,250,000 BRTs and a total ship production capacity of 90,000 BRTs. Fifty percent of both the total repair and ship production capacity belongs to the shipyards controlled by the Department of Industry as shown in table 4.1 [12].

The 4.1 figure shows the production trend since 1988 to 1992. It appears that new ship construction during the past five years keeps increasing at a moderate level. The economy booming in some parts of the country has stimulated the interisland transportation vessels, cargo ships, and fishing boats.

The ships orders and delivered during the years 1990 - 1992 include:

year	National (millions) in Rupiah	BUMN (millions) in Rupiah	shares
1990	199,300	101,200	51%
1991	302,500	168,200	56%
1992	415,700	231,500	56%

Table 4.1: Sales turnover of shipyards controlled by Department of Industry 1990-1992

S1 = Horse Power

S2 = Gross Tonnage

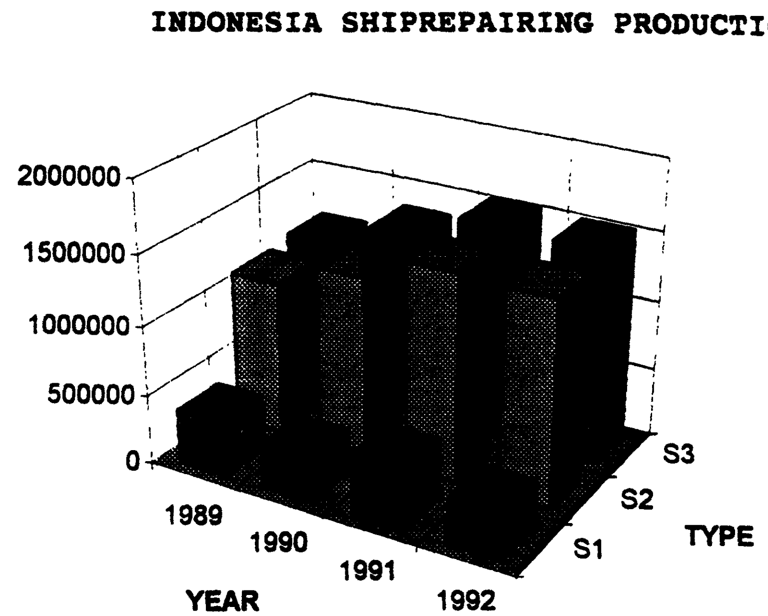
S3 = Total Gross Tonnage

Figure 4-1: Indonesia Newbuilding Production Volume (GT)

amount	type
32	3650 DWT General Cargo and Semi Container Cargo Ships
12	1500 DWT General Cargo and Semi Container Cargo Ships
1	1000 DWT Prototype Combination Motorized Sail Steel Cargo Ship
2	16000 DWT Chemical Tankers
4	6500 DWT Product Oil Tankers
7	3500 DWT Product Oil Tankers
9	1500 DWT Product Oil Tankers
1	18900 DWT GT Ro-Ro Passenger & Trailer Carrier
1	5000 DWT GT Ro-Ro Passenger & Car Carrier
35	200-600 GT Ro-Ro Passenger & Car Carrier
2	5000 Tlc Floating Docks
7	8000 HP/57m/30 knots Fast Training Boats
8	150 GT Fishing & Fishing training vessels
	Tugboats/800 HP - 4200 HP
	Tuna Long-line fishing Boats
	Offshore Supply Boats (3000 HP)
	FRP Passenger Cruises

Table 4.2: Ships ordered and delivered in 1990-1992

As a result of active sales promotion by Indonesian shipyards and also due to the favorable situation of the international shipbuilding market for small vessels, the Indonesian shipbuilding industry has been able to enter the international market by securing orders from foreign shipowners (18,900 GT Passenger & Trailer Carrier, 16,000 DWT Tankers, Tugboats, Barges, etc). On the domestic side, the third phase of scrap and build program of the inter-island fleet was implemented in 1993 which calls for the building of about 30 Container ships of 4,000 DWT. Due to condition of the Indonesian ocean-going fleet and increased demand of container trade, the government is mapping out plans to build ocean-going cargo and container ships of 10,000 - 40,000 DWT. The plan envisages the maximum participation of the domestic yards as they increase in capacity and capability. The shipyards also have maintenance activities shown in figure 4.2 where the shiprepairing and docking sector are relatively increasing in a small portion during the past five years.



S1 = Horse Power

S2 = Gross Tonnage

S3 = Total Gross Tonnage

Figure 4-2: Indonesia Shiprepairing Production Volume (GT)

4.2 Demand

According to Mr. Sularto Hadisoemarto, Chairman of Indonesia National Shipbuilding Association, the Indonesia marine industry has recorded a remarkable development [1]. Many new ships of various types and sizes were contracted and built for domestic as well as for foreign owners. The orders include general cargo and semi container carriers, Ro-Ro passenger and car ferry boats, product oil tankers, fast patrol boats, and fishing vessels. With such a condition, the marine-supporting industries have undergone significant progress through capabilities to manufacture marine-related material, machineries, equipment and component.

Type of shipping	Number of units	Tonnage (000 DWT)
Ocean Shipping	35	448
Interisland shipping	244	379
Special shipping (logs and bulk carriers, timber, oil, nickel, bauxite, and palm oil)	2954	2045
Local shipping (coaster, 100 - 175 DWT)	1036	154
Popular shipping (sailing craft less than 100 DWT)	3807	na

Table 4.3: Indonesia sea transport: commercial fleet (1987)

In the Indonesia archipelago, 90% of the transport of goods is done by sea. In 1984, some 300 officially registered ports were serviced by over 8,000 ships and boats of all sizes which is shown in the table 4.3. Until 1988, carriers of domestic trade were divided into four categories: interisland, special, local, and popular (small units less than 100 tons) shipping. Popular and special shipping become a major domestic demand to transport mining and agricultural productions from remote locations and serve fishermen. The limited number of vessel types and sizes shows a potential domestic demand for replacement and new vessels. The volume of goods carried by the interisland fleet increased from 7.4 million tons in 1983 to 8.3 million tons in 1987, whereas tonnage carried by special shipping grew from 54.8 million tons to 65.4 million tons during the same year. Main commodities transported are :

- (in volume) oil and LNG: (45%)
- timber and by-products: (13%)
- food products: (8%), including rice 4%
- fertilizers: (6%)

- cement: (6%)
- palm oil: (3%)
- various products such as steel, rubber, copra, and tobacco

Since the November 1988 deregulation package known as PAKNO, shipping firms have been divided into only two categories, internal (domestic) and external (international). It was intended to boost more participants in serving the commodity exchanges. Commercial transport is expanding constantly, even though it also depends on overall economic developments. On the military side, the Indonesian Navy with less than 200 ships is still relatively weak compared to the large territorial waters it has to control. The demand for Navy vessels increases in the near future as the thirty year development plan estimates that by the year 2000, the Navy has to renew and increase fleets for a total of 23 ships [21]. This procurement program designed to improve domestic sea control is valued at over $5 billion.

This favorable demand market condition is not supported with sufficient cash flows from financial institutions, shipyards, and even ship owners themselves. Actually, more pressing than the very obvious needs in commercial or military sea transport, is the real problem of financing. Shipping companies, including the state owned shipping company - PELNI and the smaller private companies represented by the Indonesian Shipowners Association (INSA), find it difficult to purchase new ships because of their relatively high cost. They tend to keep operating old, worn-out, low productivity ships.

To improve productivity, a ban on ships over 25 years of age was imposed in 1984 that mainly affected interisland routes. Along with the ban, a joint decree issued by three ministers (Communications, Industry, and Research and Technology) prohibited imports of both new and used ships and required the use of domestically produced ships. Some 200 interisland ships were scrapped from 1984 to 1988. However, problems arose when a 1985 regulation allowed foreign ships to partly operate

Year	Total (Units)	Capacity (BRT)
1993	453	724,264
1994	364	588,127
1995	382	624,975
1996	406	666,784
1997	450	714,092
1998	265	499,165

Table 4.4: Projection of domestic demand

in Indonesian waters in order to facilitate foreign trade. This was new competition for local shipowners who at the same time were purchasing new ships to replace the older ones. On the other hand, a shortage of ships later appeared due to some lags in the domestic building program which can not meet the delivery time.

The rapid growth in the domestic economic activity results directly in the growing demand for transportation facilities. In the sector of sea transportation, the demand for commercial vessels (cargo/container ships and tankers) and fishing vessels has been increasing. According to both the Department of Industry and Transportation, the demand for new medium-size ships – namely cargo ships > 500 BRTs and fishing vessels of > 60 BRTs – is projected at 453 units with combined capacity of 724,267 BRTs for 1993. For 1988, it is projected at 265 units with a combined capacity of 499,165 BRTs [3].

Whatever the purchasing power of private Indonesian shipowners, there is a clear demand for more domestic sea transport as it is pulled by the general stepping-up of the economic pace in the early 1990s. By the end of Fifth Five-Year Plan, interisland shipping capacity should have grown by 35% to 682,000 DWT [11]. This phenomenon is even more clear from the projection of future needs of certain types

Type (Units)	Total (BRT)	Period Year
Caraka Jaya 4,180 DWT	24	1993-1996
Palwa Buana 20,000 DWT	7	1994-2000
Passenger Ship 500	10	1994-2000
Fishing Vessel 170-300 GT	50	1994-1996
Tanker 1,500-85,000 DWT	70	1994-2004

Table 4.5: Projection of domestic demand for various types

type	number
State owned limited companies	5
Private-owned limited companies	123
Owned by Government Departments for own use (Sea Communication, Fisheries, Customs, Mining, Marine Police etc)	22

Table 4.6: Steel/Dock Yard

of vessels (table 4.5). Standardization in design, components, production process and measurement anticipates the domestic demand to create a low cost standardized vessel with replaceable components and parts which benefits all parties in the industry, interisland transportation's needs, and fishing activity.

4.3 Supply

The industry consists of three types of shipyards as follows:

1. Steel Ship/Dock Yard:

These steel shipyards have the following facilities and capacities:

- Facilities for newbuilding (building berths)
    1. up to - 1,000 GT: 108 units
    2. 1,001 - 4,000 GT: 22 units
    3. 4,000 - 8,000 GT: 8 units
    4. 8,000 - 40,000 GT: 4 units
- Total annual capacity: 150,0000 GT (approximately)
- Largest building berth/dock: 40,000 GT
- Largest ship ever built: 12,000 T Dredger
- Largest ship underconstruction:
    1. 18,900 GT Ro-Ro Passenger-Trailer Carrier
    2. 16,000 DWT Chemical Tankers
- Repair/Docking has the following infrastructure:
    1. Slipways up to 1,000 GT: 165 units
    2. Graving docks 1,000 - 30,000 GT: 18 units
    3. Floating docks 1,000 - 20,000 GT: 19 units
- Total annual docking capacity: 2,000,000 GT
- Largest docks:
    1. Floating dock: 20,000 GT
    2. Graving dock: 30,000 GT

2. FRP Boatbuilding Yards:

- Private-owned limited companies: 13 yards

3. Wooden Shipyards:

- Private-owned limited companies, cooperatives, and owned by individuals.

Island	number
on Java island	36%
on Sumatra island	27%
on Kalimantan island	17%
on Sulawesi, Maluku, Irian Jaya islands	20%

Table 4.7: Yard Location and Distribution

The industry structure shows that most shipyards produce small and medium ships due to domestic needs and shipyards' facilities. Similarities in yard specialties and ship production methods are very common. Also, many of these shipyards are owned by departments in the government or affiliates to public enterprises. These facts become valuable factors for standardization programs. On the other hands, a large variance in other characteristics of shipyards such as technological advancements, manufacturing ability, labor skills, facilities, experience, and financial support may reduce the optimal benefits from the programs.

According to the location of the yards (table 4.6), the distribution is concentrated in Java and Sumatra island. It is obvious that modern and large capacity shipyards are located in Java while shipyards producing wood or traditional fishing vessels are spread out in other islands. Shipyards with capacity to build vessels more than 3,000 DWT are limited as appear below, while the complete information for location of others, capacity, types of berth and dock is available in appendix B at the end of this thesis. These major shipyards are relatively more modern and efficient in production process compared to others. As the mass production was initiated from these shipyards, the standardization programs may be begun from them as well.

1. PT DOK KODJA BAHARI

    - 3,500 DWT General Cargo

- 6,500 DWT Product Tanker
- 12,500 DWT Dredger

2. PT INTAN SENGKUNYIT

- 3,500 DWT Product Tanker

3. PT DOK SURABAYA

- 4,500 DWT Roll-on Roll-off Ferry

4. PT PAL INDONESIA

- 3,500 DWT Product Tanker
- 6,500 DWT Product Tanker
- 3,000 DWT Product Tanker

5. PT JASA MARINA INDAH

- 1,500 DWT SPOB

PT PAL Indonesia

PT PAL Indonesia is a major contributor in relation to the supply above. With 6000 employees and a modern facility located in Surabaya - East Java, the company is among the largest and most modern shipbuilding industries in the Southeast Asia region. The shipyard produces many types of vessels and initiates standardized designs for mass production. These activities are discussed more detail in chapter 5. In relation to the shipbuilding industry in the country, the company has significant roles to:

- master, develop, and transfer foreign or national technologies to the other shipyards;
- promote the Indonesia maritime industry;
- supply quality services at competitive prices to the Indonesian Navy and civilian shipping companies;

- improve skills of young Indonesians in maritime technologies;
- provide jobs in shipbuilding and supporting industries.

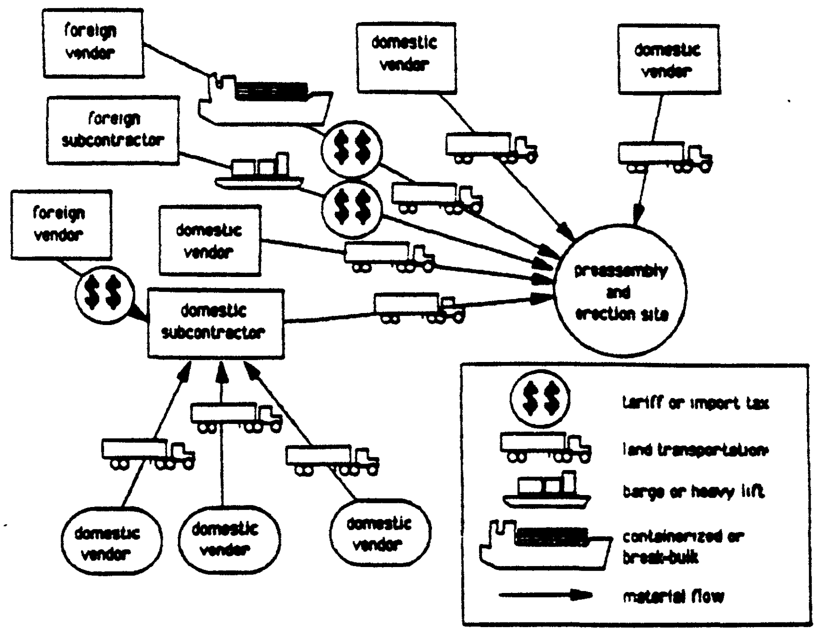
4.4 Industry challenge

The available data indicates that shipbuilding industry has bright prospects for growth. The future demand for replacement and new vessels creates a potential market for the shipyards. To anticipate this potential market, the industry should fully understand the major problems to break the icebergs for future development. The road blocks are the following:

1. Financing and Marketing system:

    - Supporting financial institutions are not available yet for building vessels or ship acquisition.
    - The limited availability of funds for investment and working capital and the high interest rates
    - The role of PT PANN as a Leasing Agency need to be improved. For ten years operating period, PT PANN has contributed in ship acquisition for 171,164 DWT or 17,000 DWT/year.
    - The imposition of a 10% Value Added Tax (VAT) on shipyard products have kept the competitive power of such products low. In Singapore and Malaysia, no VAT is imposed on shipyard products. This implies many Indonesian ship operators prefer using overseas shipyard services. This situation is similar to an illustration by Bruce Bonglorni as shown in figure 4.3 [4] below.
    - The financial weakness of shipping firms caused delays in payment made to shipyards.

    It shows how a shipyard buys domestic and foreign components for an erection site. Import duties on foreign sourced material are incurred at each port of



Typical flow of material and subassemblies from domestic and foreign sources to an erection site. Import duties on foreign sourced material are incurred at each port of entry. Transportation and erection costs are also significant components of total project costs

Figure 4-3: Typical flow of materials to a shipyard entry. This increases the raw material and production costs.

2. Lack of expertise and experience in engineering and technology compared to overseas shipyards, such as Japan and Korea, means the national shipyards are left behind. Improvements are urgently needed in planning, design, and production engineering.

3. Limited capability for capital investment or production equipment modernization. Industrial facilities in shipyards are generally too old and incomplete. Most shipyards have traditional production methods. This fact is closely related to geographical existence (archipelago), domestic demands, and incentives from government. Economies of scale for mass production by one shipyard is very minimum. The exceptions are PT PAL and PT Dok Kodja Bahari (DKB) shipyards.

4. Management problems related to material and component availability, production, cash flow and marketing. Even more, the domestic shipyards are still highly dependent on imported components. This becomes a major disadvantage as suppliers are not available locally.

5. Low productivity and insufficient labor skills cause productivity index of 6 KG/Man Hour while Japanese worker's index is 24 KG/Man Hour.

6. Competition among domestic shipyards tend to slash price which is reflected in quality and time delivery. Also, the competition was not always fair in gaining orders and the price of ships was often below production costs.

7. The re-evaluation of the priced determining mechanism is needed to set a fair price since underbidding becomes a tendency among shipyards.

8. Government orders for ships need to be simplified such that they will reduce bureaucracy and administration time.

It is obvious that the marine industry has multi-facet activities supported by marine related industry and manufacturing. It is estimated that commercial vessels in Indonesia are worth \$ 20 billion. Assuming that every year there is a need for new vessels at 4% for replacement and growth, the market demand for the country is estimated \$ 800 million/year. To develop this potential market demand become a real economic power, there are basic requirements to be filled in:

1. Capital investment
2. Technology application
3. Development of skilled labor, organization and management.

Standardization activities become one of several factors to satisfy those conditions. As discussed previously in chapters 2 and 3, either the individual shipyard or the whole industry may apply standardization in components and designs, process production planning and benchmarks for certain jobs. Several shipyards have successfully implemented a standard task using modules and matrix systems in production as discussed more in chapter 5. More than that, some shipyards have applied cost, specific task, and schedule standards in building a vessel. These efforts have improved the cost structure in ship acquisition and increased facility utilization and worker effectiveness. The difficulties arise as the industry starts doing standardization in design and components even though more benefits are promised.

Chapter 5

Application of Standard Design and Component

Design strategy addresses how a ship buyer plans to translate operational requirements into engineering concepts, identify design alternatives, and translate these into procurement specifications. The designer for the basic design depends on the type of vessels and buyers. A domestic buyer requests a shipyard to do all of the detail design while a foreign buyer tends to make his own design and list all of the major components. This condition forces a shipyard to buy all components as required by a buyer.

There are a number of approaches that a buyer can employ to procure a ship design. These basic methods range from a total in house design effort to using an outside contractor for the entire design, or some combination of in-house design with outside contractor support as discussed in more detail in Strong's MIT master thesis [24]. The options are mostly affected by the types of buyer and the shipyard's ability and experience. Buyers from developed countries, tend to choose total in house design while a domestic buyer (both government and private) use the remainder approaches. The methods are the following:

- Total in-house design involves the buyer performing the design phases under consideration - feasibility study through contract design. It encompasses the allocation of internal resources to effectively engineer the translation of operational requirements into a contract design package including setting a list of required component manufacturers. Most of the foreign buyers from Europe and Japan use this approach for Indonesia shipyards. This restricted approach tends to view a shipbuilding as a shop which puts parts and components together, rather than as a "real" shipbuilding activity which starts from a design stage.

- In-house design with contractor support involves the use of outside contractor support - naval architectural firms, shipbuilder design departments, or private design agents - to perform a portion of the in house design and the buyer does the remainder.

- Contractor out ship design is applied by a buyer which contracts out the major portion of the ship design to a single design agent. This strategy is taken by a buyer which does not have design personnel or experience in vessel acquisition.

- Shipbuilder involvement in design is a common practice in Indonesia. This shipyard participation increases a cost saving potential and fulfills a ship construction on schedule and within budget due to a greater flexibility in design and components. The initial step for standardized components and interface appears from this approach. Government supports through assigning specified shipyards to design a vessel for a mass production program.

5.1 National shipyard

In Indonesia, the design standardization has been implemented since 1984 through coordination among government agencies and major shipyards. Due to the government needs for interisland transportation and public service, the demand for ships with the same characteristics and specifications is encouraging the mass vessel production project. Major and leading shipyards are assigned to design and build a lead ship, then follow ships are shared and built in several shipyards. The program has been successful and boosted the industry and marine-related activities. PT PAL Indonesia and Dok Kodja Bahari (DKB) share the expertise and experience with other shipyards through these standardized designs and products. It appears that shipbuilder involvement in design becomes the primary choice for conducting the design standardization. Some of these designed standards by major shipyards are the following:

1. Mass production for "Caraka Jaya" vessels. In 1984, the government regulated that vessels more than 20 years old had to be scrapped for safety and marine industry reasons. More than 400 vessels had to be built to replace unused ones. Currently, 24 units of 3,650 DWT General Cargo and Semi Container ships of Caraka Jaya model have been built.

2. 31 units of 300 GT tuna long line ships (Mina Jaya types).

3. 20 units of 6,500 DWT, 3,500 DWT, 1,500 DWT Product Oil tankers.

4. 35 units of 200 - 600 GT Passenger-Car Ferry Boats.

5. Tugboats of 800 HP, 1,600 HP, 2,400 HP, 3,600 HP, 4,200 HP.

In the "Caraka Jaya" project, the preliminary design was a 3000 DWT general cargo basic design which later on was extended into a 3,650 DWT general cargo and semi container type. Furthermore, it was developed to be 4,180 DWT general cargo and container vessels. The development stage can be described from the table 5.1 [3].

The "Caraka Jaya"'s key drawing was obtained from Mitsui- Japan while its detail design was performed by PT PAL Indonesia, then distributed to other domestic shipyards participating in the project. The vessel distribution and shipyard participants are the following:

Fabrication is done by shipyards based on the distributed detail drawing from PT PAL Indonesia. It uses 4 types of purchased material packages, which are import,

	phase I	phase II	phase III
Amount (ships)	5	24 + 3*	24
Weight (DWT)	3000	3650	4180
Type	GC	GC + SC	SC

Table 5.1: Stages in the Caraka Jaya (3,650 DWT cargo/semi container) project

Note:

GC = General Cargo

SC = Semi Container

3* = 3 additional ships (3000 DWT general cargo)

Shipyard	phase I	phase II	phase III
PT PAL Indonesia	2	12	4
PT Dok Kodja dan Bahari	3	9	3
PT Dok dan Perkapalan Surabaya	-	3	3
PT Intan Sengkunyit	-	2	3
PT Jasa Marina Indah	-	1	3
PT Inggom Shipyard	-	-	2
PT Noahtu Shipyard	-	-	2
PT IKI Ujung Pandang	-	-	2
Total	5	27	24

Table 5.2: Vessel and shipyard distribution

locally-assembled import, local, and shipyard(builder)-supplied local. The first two packages have a standard according to project specifications while the local material package is decided by a team of local material package acquisition specialists. Material supplied by a builder has to follow both Indonesia National Standards and specifications.

The construction of standard-type ships of the inter-island fleet with almost the same capacity, characteristics, and operational requirements of their shipbuilding material, machineries, and equipment becomes an important factor supporting the development of the shipbuilding-related industries. These conditions will serve as a basis to stimulate production on an economic scale. The government promotes investment for the establishment of marine-related factories and plants in cooperation with foreign makers and manufacturers, not only to supply the domestic market, but also for export. This is already realized for certain marine-use products like steel ship plates, ship chains, marine diesel engines, marine paints, pressure vessels, heat exchangers etc.

Assembling and shop testing of diesel engines for power plants (up to 12,000 HP) and marine engines (up to 4,000 HP) had been performed at diesel assembling/manufacturing plants in Indonesia. The government had issued approval for assembling/manufacturing of marine diesel engines of 500 HP and up to 9 foreign marine engine builders in cooperation with local companies. Deck machineries, telecommunication and navigation equipment, marine generators and motors, marine pumps, propellers, marine panels, and switchboards are at present also being manufactured and assembled by Indonesians or joint venture companies. The switch from fully component importing activities into assembling and manufacturing activities supports the standardization program.

The next phase will be setting standards among local producers and shipyards such that products can be compatible among each other. To come up with a standardized component, thorough analysis and comprehensive, on going programs have to be performed. These programs may include: date base, tools for evaluating standards (such as: data ownership analysis, the integrated logistics support cost analysis model, standardization candidate selection criteria), success stories from other countries or other industries, and plans of actions.

The following information appears in a paper by Prof. Henry S. Marcus, Nikolaos E. Zografakis, and Matthew P. Tedesco which discusses data bases and tools used by the US Navy [29]:

Tools for evaluating standards:

1. Database to provide application, identification, physical and performance characteristics, availability of logistics documentation, points of contact with specialists, and reprocurability information on active reserve fleet [10] .

2. Data ownership analysis model to quantify how much the government should pay for manufacturing rights and level III drawings for reprocurement. It offers the following analytical expression for the value of a piece of equipment :

$$DV < \sum_{p=1}^{m}[\{\sum_{y=0}^{n} xy + \sum_{y=0}^{n} xy(BRF)(SL)]\}\{P_p(1+I_f)y\}](SF)(OF)(CA) - \sum_{p=1}^{m}(T)$$

$\sum xy=$ total number of parts added to the part's initial population after initial procurement

$\sum xy(BRF)(SL)=$ replacement population quantity from initial procurement

$P_p(1+I_f)y=$ the effect of inflation on the price

P = part number (identifies which particular part of equipment is being evaluated during this iteration

m = total number of parts making up the equipment

y = year number

$4n$ = total number of years

Xy = number of parts entering the population in the year y

BRF = best replacement factor

SL = system life in years

P_p = price of part at initial procurement

I_f = average annual inflation rate

SF = 0.25 = Savings factor

OF = obsolescence factor

SA = state of the art factor

T = cost of special test equipment in U.S. dollars

DV = data value

3. The Integrated Logistics Support (ILS) Cost Analysis model to develop a logical, rational methodology to accurately evaluate the life cost. The model for HM & E components is summarized below:

   C= 950 + 193.75(P) + 112(P)(L) + (PR)(L) + 1000 (CL) = 20 (POP) - 2(PR)

   C= cost for competitive procurement to performance specifications (in dollars)

   P= number of parts in the original equipment

   L= life cycle of the equipment in years

   PR= price of the original material (in dollars)

   CL= number of classes of ships receiving the equipment

   POP= number of equipment competitive procured

4. Standardization Candidate Selection Criteria (SCSC) to provide for a conservative, objective method for ascertaining the economic benefits of HM & E standardization. The model is divided into four phases:

   - phase 1: Equipment nomination
   - phase 2: Economic analysis
   - phase 3: Design selection
   - phase 4: Rank analysis

The tools and methodology above can be applied in developing comprehensive standardization programs in design, components and interface in Indonesia ship building industry. Adjustment in some variables and additional of inputs may be relevant considering the composition of suppliers and manufacturers. These changes and revisions can be desribed as Progress-Time Curve of Organized Standardization in figure 5.1. [19].

Finally, a chosen product is standardized. In order to describe the product completely among producers and shipyards, individual elements must be addressed. That is, the procurement standard must give information either directly or by reference as to the product's geometric shape, material, performance requirements, associated quality assurance provisions, and part numbering information. This information generally is assembled on a procurement standard by referencing other standards that make up the pieces of this puzzle. This is shown in the Building Block Approach figure [16] .

The application of the standard design applies in many aspects of vessels. Standardization of HM & E Systems will become the the first priority due to their long product life and the maturity of the applied technology. As mentioned previously, PT PAL initiated assembling and manufacturing diesel engines and other parts of HM & E systems. Furthermore, the industry can apply a Standard Hardware Acquisition and Reliability Program. This component standardization is similar to HM & E except that it is being applied to electronic systems.

The principles of commonality involve the use of many standardized components that can be combined in any way to produce a custom design for a particular application. Ships of the future will be designed by taking their various equipment and systems from a group or library of standard modules that have been previously been designed, approved, built and provisioned. However, the work that has been done at this time appears to focus on modules that are basically pre-outfit packages which

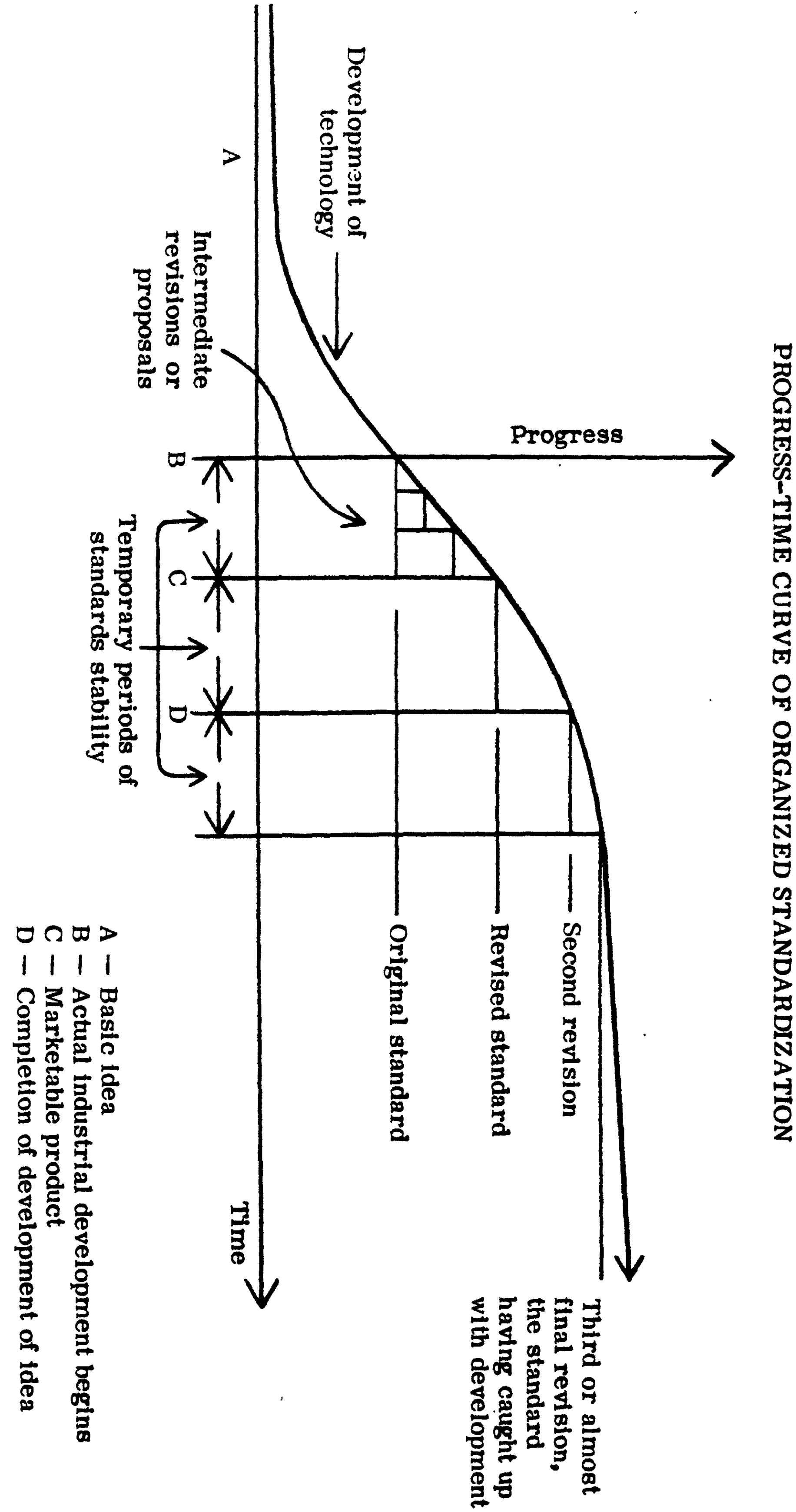


Figure 5-1: Progress-Time Curve of Organized Standardization

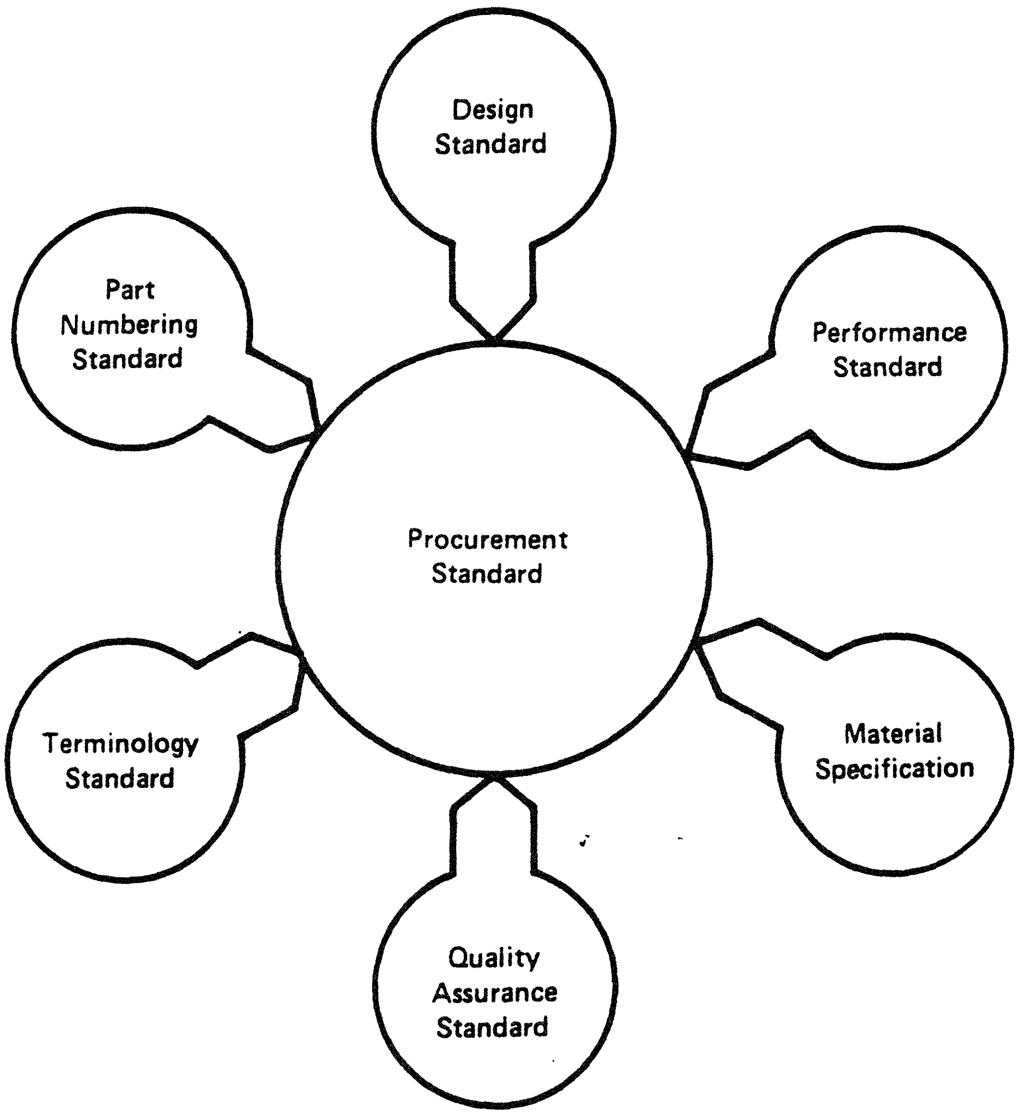


Figure 5-2: Building Block Approach

shipyards typically assemble on a shop floor prior to installation on board a vessel, as done by DKB.

Even though the total cost for design standardization on the mass production above costs more than the single vessel design cost, the benefits more than compensate. There are many advantages to both owner and to the industry as well. The standard design opens the possibility for mass production of components with a corresponding quicker delivery and lower price. The owner will also have a much better idea of what the ship will look like before he actually steps on board or before he renews the drawings sent for approval. This standardization ultimately reduces production, acquisition,and operation costs of vessels. Thus, the total cost of ownership is much lower than a single design ship.

The design effort depends heavily upon information from suppliers whose equipment the shipbuilder plans to install on the ship. It is not always in the supplier's interest to give out this information, also the supplier may consider the shipbuilder to be a minor and infrequent customer. The frequent phenomenon in Indonesia ship building market is a request from a buyer for using specific components made by certain manufacturers. This causes inflexibility in application of standard designs and modules by shipyards.

Another approach in standardizing components is to accumulate information from a variety of sources and compile it into a data base for further development. The success story from Brazil, one of many developing countries, in its development of a shipbuilding industry is a good example. EMAQ, a major Brazilian shipbuilder, makes effective use of standards from throughout the world [27]. Realizing the fact that domestic suppliers are very limited and do not have economies of scale, Brazilian shipbuilders have to import many kinds of marine components and equipment. This constraint creates side effects such as higher component costs and delays in process production. Under the auspices of the Brazilian Society of Naval Architecture and

Marine Engineers, national standards have been established which define products used by all Brazilian standards. Consensus was then established through the Brazilian standardization institute, ABTN. It also assures acceptance by the classification societies in the country. After all this effort, sufficient market has been established to make it worthwhile for suppliers to produce. Therefore, marine-related component manufacturers are willing to create new standardized designs and products considering economies of scale in the domestic demand.

EMAQ maintains a computerized database of marine standards from major shipbuilding countries of the world. Then EMAQ creates a new company standard by reviewing pertinent foreign and international standards and incorporates the best features in the company standard. The other shipyards follow the direction set by EMAQ, and use the established standardized components. PT PAL Indonesia and DKB which have the same position as EMAQ, possibly take similar approaches in future development. Further study and detail analysis are needed to implement similar steps in the Indonesia ship building industry.

5.2 Individual Shipyard

Standardization in design and products has been implemented both by the Indonesia Navy for war and patrol vessels and by PT PAL as the single domestic producer for Navy's vessels. For example, the Warship Division of the company manufactures two types of Fast Patrol Boats (FTB) under license of Frienrich Lurssen Werf from Bremen: one is 57 meters long (400 tons) and the other 28 meters (60 tons). Using the military and purchase specification (milspecs), PT PAL establishes and maintains a single system of specifications and standards to provide uniform and technically adequate records of the engineering definition of equipment and supplies as a common basis for communication of coordinated defense needs.

The Commercial Ship Division of PT PAL too has entered the second phase of the Progressive Manufacturing Plan. During the first phase, it built two 3,500 - ton tankers and one utility vessel, two 2,400 HP tugboats, and one 3,000 ton general cargo carrier under license from Mitsui. The division anticipates potential demand of commercial ships, caraka jaya model, and fishing boat (mina jaya program). In the near term, mass production with certain types of standardized design and component may be applied. This possibility is supported by the facts that General Engineering of the company designs and manufactures components - heat exchanger, oil cooler, high pressure feed water heater, low pressure feed water heater, gland steam condensor, steam condensor, deaerator-, manufactures other parts -air heater, low pressure drum, tank, coal silo, exhaust gas duct - inlet duct, and piping-, and assembles diesel engines.

PT PAL is successful in doing the standard arrangement with standardized components which ultimately reduces construction cost. Though not as grand a concept as the modular payload ship, the standardization of such production items above increases production runs and increases economies of scale during ship construction. These items are assembled and fabricated by the shipyard rather than purchased from subcontractors. Cost reduction in production process and acquisition increases the domestic market share and competitiveness of the company.

DKB shipyard has significant capacity and experience in building large and modern ships which receive orders for the mass production. DKB builds Ro-Ro Ferry with length 168 meters and width 28 meters for Sweden and LPG Carriers for Germany. The shipyard applies module systems where each block with components and systems are joined together during assembly phase, and erected in finishing stage. For example, the Ro-Ro Ferry above is divided into 296 block units and the Chemical Tanker consisted of 130 blocks. The shipyard applies a modular payload design and production process using standardization of a grand scale. The construction planning builds modules encompassing a range of three dimensional size, each with preestablished interface specifications.

Currently, both companies have set benchmarks as a standard procedure for certain activities that either directly relate to production process or do not. Administrative and other supporting parts as well as cost evaluation have been standardized to achieve the optimum resource utilization. Furthermore, the application of modules and zones in ship construction is underway. Based on information collecting from questionnaires and interviews, it is believed the ship building industry in the country needs to follow both companies in implementing standardized benchmarks and production planning. The success of both types of standardization will be a milestone for the next step, design and component standardization.

The government has supported the programs by giving orders and requesting the usage of domestic components. The mass production orders are started with building a lead ship. Follow ships are shared with other domestic shipyards using the standardized designs. This policy supports the intra ship standardization, improves the production planning process in ship yards, and introduces assembled components to be standardized nationally. Data from the questionnaires and interviews also shows that this intra standardization is applicable and needed in the current development. In plant, component, and design standards are important for reducing costs associated with design, production, acquisition, and operation of domestic shipyards so that (compiled from questionnaire and interview):

- More time may be devoted to the fundamentals of design when prolonged concentration is given to a few good designs rather than hurried attention to a succession of minimally workable ones.

- Product designs may be simplified and the relationship between product and process requirements studied more closely. More specialized equipment may be used, since pay off requirements can be met with long run standardized items instead of a short run of "special" items.

- Fewer varieties of materials may be stocked, so that the total inventory investment is cut down and losses from deterioration or changing market values are minimized through fast moving inventories.

- Work planning, production control, and other management procedures can be simplified and their frequency of repetition reduced.

- Prompter and better service may be offered to customers in respect to original purchase and subsequent recorder, repair, part replacement, or performance under warranty.

The relationship between shipyards and buyers in respect to standardization approaches can be analyzed in terms of "4P" business aspects. These complex forces which are price, promotion, position, and product influence parties in the following ways:

- Price:

  Changes in a ship unit cost can be examined through analysis of the three categories of shipyard costs: labor, material, and overhead. Labor costs are driven by a multiple of the average direct wage rate and productivity. Material costs can be subdivided into steel, propulsion machinery, and outfit. Overhead can be characterized in terms of fixed and variable components. In respect to developing countries, material costs are relatively higher than in developed countries due to lack of upstream industry in developing countries that requires imported components and material. In terms of labor and overhead costs, a shipyard in a developing country may obtain a competitive advantage with cheap labor forces. This benefit may be extended even more as the shipyard applies standardized production planning and a control & planning standardization individually to reduce production costs. The standardized components which create positive externalities to a buyer because of generic spare parts will reduce production, maintenance and training costs. Therefore, final payment for a ship by a buyer (after subsidies and financing methods have been calculated) is competitively low.

- Promotion:

  Promotion is a method by which a shipyard identifies potential customers and persuades them to purchase its products. Shipowners are largely expected to identify their needs to shipbuilders. On the other hand, few shipbuilders take the initiative in defining potential customers' needs or in providing analysis of how these needs can be met. The standardization approach helps shipyards to anticipate a variety of needs of ship designs and types with a faster schedule delivery and affordable prices.

- Position:

  The perception held by potential customers of how suppliers relate to each other arises from communication with the marketplace of strategic choices, and implementation of those strategies by the shipyard. It includes [6] :

  1. National responsiveness - capitalize on shipowner needs or material supplier advantages that are unique to a particular country.
  2. Low-cost leadership - provide the ship at the lowest price, for owners who are not sensitive to the fine points of ship performance.
  3. Product differentiation - establish a market niche based on superior production technology, quality,or financing.
  4. Product segmentation - establish a market niche based on a particular type of ship.
  5. Protected market participation - server markets which are reserved by law or subsidized.

  The standardization approach may become one of the tools to acquire a strong position for an individual shipyard and/or marine industry in the nation.

- Product:

  It is defined as a marine transportation capability that performs as required, is constructed to the quality specified, and is delivered on time (performance, quality, and delivery). In any shipbuilding operations, there are at least three basic areas where principles of standardization can be applied: design, manufacturing, and quality control. Construction of a standard ship design assists in developing reliable schedule information and delineates the source and impact of changes. Module systems as a production method standardize the manufacturing and fabrication activities.

Chapter 6

Quality Partnership

6.1 Vendor structure

Ship building as a downstream industry depends on suppliers and manufacturers of marine-related components in producing a high quality ship using standardized components, parts, interface, and design. The compatibility results in a low acquisition price for a generic or similar ship, timely delivery, and spare-parts availability. The importance of the vendors as part of an upstream industry appears in the cost structure (table 6.1 below) [6] and critical path methods of ship production.

Analysis of the upstream industry structure in respect to design and production activities leads to understanding the roles and characters of a supplier. The structure is differentiated by the level of activities:

- Marine-related manufacturer:
  It produces directly components or parts of ships. Most of the products are made for domestic needs using standards from local industry or an individual shipyard. Otherwise, the producer develops a component from designing and assembling experience in transfer technology projects from overseas.

Cost Group	Content Multiplier	US	Japan	Northern Europe
Labor Wage Index X Prod. Index = Labor Index	0.24	1.0 X 1.0=1.0	1.15 X 0.60 = 0.69	1.38 X 0.90 = 1.24
Material	0.40	1.00	0.85	0.90
Overhead Fixed + Variable	0.36	0.65(1.0) + 0.35(1.0) = 1.0	0.65(0.70) + 0.35(0.7) = 0.70	0.65(0.85) + 0.35(0.85) = 0.85
Total Cost	1.00	1.00	0.75	0.96

Table 6.1: Comparison of cost structures, 1989

- Assembler:

  Having license and approval from foreign manufacturers, a company assembles the products based on design and characteristics from the main manufacturers. The standards that are used in design and production process follow from the main plant overseas. Thus, the local company does not design at all. For example, PT Dayin Prima Paint is a local paint manufacturer operating under license from the Kansai Paint Co. Ltd. The company has an exclusive licensing agreement which makes it the sole manufacturer and distributor of Kansai Paint products throughout Indonesia. Among the many paint products it manufactures, it also makes marine paint which is exclusively designed for use on ships. All products, including marine paints, are made for local consumption only. As a result, the products comply with the JIS (Japanese Industrial Standard) and do not use any standard like ISO 9000 or any other national standard. The company realizes that the paint industry is very competitive and produces a variety of qualities and features. Given this fact, the painting industry's belief is that standardization is not necessary at this moment because it it is not feasible to achieve, especially in the painting materials requirements. This is attributed to the different purchasing standards of the buyers, the different budgets available, the variety of paint products existing, both in terms of price and quality/performance, and the intervention by ship owners in naming a specific brand name because it offers distinctive features.

- Sole Agent:
  A company becomes the only agent for one or several manufacturers in the country or region such that shipyards have to contact this agent in order to order components. PT API (International Trade Association Incorporated) is a company acting as a sole agent for some main engines from European manufacturers (Man B & W, Warsile, Deutz-MWM, Niigata, Daihatsu, MAK, Sulzer, Mitsubishi, and Caterpillar). The components are imported directly from the manufacturers because it is relatively expensive for private companies to invest and they do not have technology capabilities. However, PT PAL has assembled main engines and is in the process of producing them step by step. The sole agent also serves shipyards in supporting activities, such as ordering spare parts, after sales service, technical help, and manual guide.

- Distributor:
  Several distributors carry the identical products from the same foreign manufacturers. A single distributor tends to carry products from more than one manufacturer. The various products may follow different standards based on specifications taken by the producers.

Based on a survey and collected information from interviews and questionnaires, the majority of component manufacturers and suppliers support the idea of design and component standardization. However, most of them feel that private industries can not do much without a real commitment and active role from the government as the primary policy maker in the industrial development. The supporting industry is anticipating that shipyards are going toward standardization in components, interface, and parts according to type, size and class of ships. Specifications intended for recurrent use would have been fortunate if an organized standardization had been introduced when the industry was still in its infancy. It is true that when an industry is young, it is not possible to predict all the details of its future, but planning can do a lot to determine its course with standardization as a powerful and potential approach.

The suppliers are aware of having two types of market to consider. The first target and primary market is the government activities as both a shipyard and a shipowner, and the second is the private sector market. For most of the past the government market has been the larger segment. These marine-related manufacturers and services follow normal and simple procedures in selling products to the private sector. Sales force networks meet with the customer or prospective customer, and through negotiation and cooperation, they are able to receive an order. The government market is different in that it requires them to submit sealed bids. Only a few of them supply shipyards with a complete data base. Communication and information exchange is done through regular visits to the customer's premises. The difficulty arises since a supplier tends to import products from overseas manufacturers due to short term and capital investment constraints. However, in the recent past, many efforts have been made to allow the private sector to become more active, the government encourages suppliers to adapt import components to local standards and demands by assembling, manufacturing, and developing products locally. This step is necessary in order:

- to ease and fasten components, interfaces, and parts evaluation during the bidding process;
- to reduce vessel production time;
- to reduce vessel maintenance time;
- to ease and facilitate spare parts ordering.

6.2 Vendor and shipyard relationship

A quality partnership is a relationship between a vendor and a shipyard which fosters the on-time delivery of high quality goods, service, or information at a reasonably low price. Quality partnerships between two parties create mutual benefits. This section describes current efforts and other suggested methods for the benefits of both parties. There are many ways to create quality partnership.

Vendor/Supplier Product Information Files

Major shipyards such as PT PAL and Dok Kodja Bahari (DKB) maintain and update files of current vendor furnished information (VFI) which include physical dimensions, interface characteristics, and design information. Using the available alternatives as "standard" equipment, shipyards choose a supplier on the competitive basis. The major advantage of this practice is timely access to design information and accurate preliminary price calculations in a bidding process. The fact that some components are imported directly or bought from a sole agent in the country may create delays in delivery. This is even worse for minor shipyards who rarely make contacts with suppliers. This situation can be reduced by updating price and product information on a regular basis with the sole agent of a product in the country.

Just-in-Time

This system approach develops and operates a manufacturing system involving a supplier so that it creates a partnership between the two parties. One of the most powerful aspects of partnership is the ability to develop mutually beneficial systems. A mutually beneficial system requires that a supplier and a customer work in cooperation to achieve a greater benefit than they could achieve individually. This process forms a synergism between the two companies, which further strengthens the relationship. Three mutually beneficial systems are covered in more detail in a book by Richard T. Lubben [15]:

1. Early supplier involvement: Obtaining the best performance from a supplier re-

quires involving the supplier early in the design phase of a new product. When allowed an active role in reviewing designs, a supplier will often make suggestions that will improve the design and reduce the unit cost of the product. Furthermore, the close working relationships fostered by the program have improved design standardization and value engineering.

2. Just-in-Time shipments: A particular program can be developed to improve the material flow, communication, and interaction of companies. The supplier can identify the critical path points in ship production so that it prevents from delays certain phases or delivery time to the ship buyer.

3. Invoicing system : The concept of paying a JIT supplier based on purchasing and production records is one alternative to handle increased invoice load.

Domestic suppliers develop this approach to significant buyers by a regular visit to the yards to offer new products and anticipate new designs. Difficulty arises in ex-import products due to poor communication between a vendor and a yard and delivery time may suffer. Again, the role of a sole agent and distributors as an intermediary is significant for optimizing a JIT approach.

ISO 9000

ISO 9000 as an international standard for a basic management system of quality assurance is intended to equalize quality systems between companies and countries. This standard is a requirement for a management system, not the structure of a quality department within an organization. Therefore, ISO 9000 certification demonstrates the capability of a supplier to control the processes that determine the acceptability of the product or service being supplied [20]. The ISO 9000 is suitable and applicable to most marine related manufacturers and suppliers due to several unique characteristics:

- The standard is flexible: If practices of the industry or organizations do not exactly match a requirement, it is possible to be exempt from part or all of the requirement.

- The standard is not just for manufacturers: Although written with manufacturing in mind, it can be easily applied to service companies and to unique production systems, such as a sole agent who acts as a liaison between two parties.

- The standard looks at how the whole organization assures the quality of the products and services and focuses on the process of assuring quality, not on the final results. The quality assurance of standardized design and components is developed among assemblers and domestic manufacturers.

- The standard is written to be applied world wide. Therefore, the standard represents the minimal system of quality assurance within a company. Import oriented manufacturers use the approach to reach a world wide market. PT PAL as both a marine component manufacturer and a shipyard has been recognized with a ISO 9001 certificate for Division of War Ship, Commercial, and General Engineering [14]. Other suppliers are PT Boma Bisma Indra (ISO 9001) and Krakatau Steel (ISO 9002).

- The standard has broad industry application: Although the original intention of the standard is to serve as a model for the agreements between purchasers and suppliers, the standard is being actively applied to a much broader field of industrial and service situations. Thus, the standardized components may be included as part of the programs.

Red/Yellow/Green Scheme

A shipyard can categorize the vendors as the number increases into levels. A shipyard converts quantitative aspects into measurable criteria and uses statistical data for price, delivery time, and quality performance. The risk factor of each supplier puts components in a priority scale, such that a high risk supplier is placed on the red list, a medium risk supplier on the yellow list, and a low risk supplier on the green list. The experience from U.S. Navy at this program is discussed in more detail in an MIT master thesis by Kristin L. Flecther [8].

Based on information gathered from interviews and questionnaires, suppliers for marine related products compete with each other in selling components to the local shipyards. Each supplier has to be able to give important decisions related to shape and characteristics standards and specifications. A domestic supplier sets its own standards, while a sole agent or a distributor follows the parent company overseas. The question is whether the products are made according to a standard, and if they are, which standard is used and what is the relation to products from other vendors. In developing countries, like Indonesia, the relationship among vendors, standards, and shipyards can be described as shown in figure 6-1 [2].

Balance Participation

The user-oriented approach must not neglect the expertise of the supplier industry. Any standard developer must recognize that, when dealing with procurement items, the technical input of the supplier industry is of great value as shown in figure 6-2 [16]. The fact that a standard is technically sound means little if it describes an item or assembly that either can not be manufactured or which requires a manufacturing practice that is economically prohibitive or otherwise inappropriate for the application.

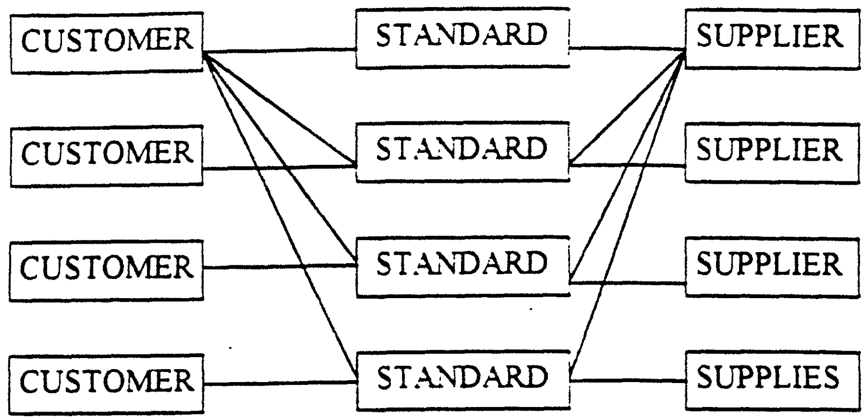


Figure 6-1: Standard relationship between a vendor and a shipyard

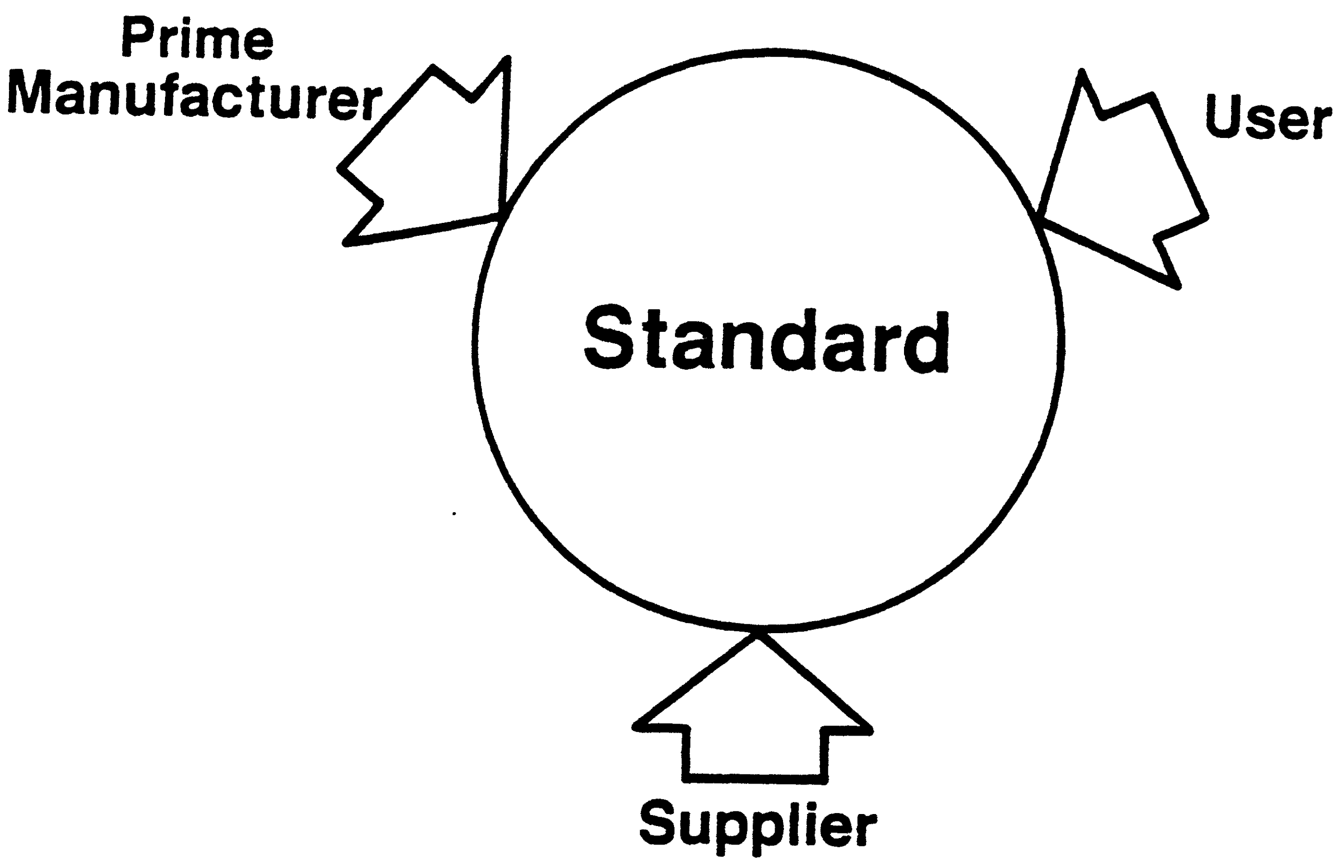


Figure 6-2: Balance Participation

6.3 Technology transfer

Technology transfer by several key parties to support standardization activities is done in many different ways. Government through the Department of Industry and SNI develops production standards for components, parts, and interfaces. Most of the production standards are proposed by the Department of Industry, and later on approved by SNI as a national standards. SNI as a national standardization agency in the country issues brochures and manual books containing sea trial standards, marine components, and DSN-adopted international standards. For example, a control and quality assurance book (PPJM) which contains quality standards in material and process production, adopted from JSQS (Japanese Shipbuilding Quality Standards). becomes a manual guide for shipyards and suppliers in Caraka Jaya programs. However, interviews and questionnaires results show that shipyards and marine-component suppliers and manufacturers have not obtained optimum benefits from the DSN. Communication and coordination among parties is minimal such that information flow is not done properly. The same situation exist for PT PANN as a financial institution that supposedly helps shipyards and shipowners in an acquisition process. Due to limited funds and bureaucracy, the program can not satisfy small and medium groups.

Useful component and design standards in terms of market share and economies of scale would encourage a supplier to transfer skills and production methods from overseas. Furthermore, the supplier adjusts to local needs and serves the domestic market at a competitive price, reliable delivery time. and sufficient quality control. The government sets a technology transfer policy through stages in the marine industry transformation:

1. stage I: Using existing technology from modern shipyards in developed countries to produce current type and model vessels in the market.

2. stage II: Integrating existing technology into the design and production process to build potential and marketable ships.

3. stage III: Developing technology to create ships for the future (technology innovation).

4. stage IV: Implementing basic research for science and technology.

The stage has been implemented successfully at PT PAL Indonesia and developed further to other yards. The company accelerates technological advancement and transfer skills from modern yards (table 6.2), such as Mitsui (for commercial vessels), Lursen - Germany/Belgium (for war vessels), and Mitsubishi (for general engineering). Along the stages, identification of generic vessel types and potential demand for mass production introduce the development of design and component standardization. The transformation process is made through several means/tools. such as:

1. technical assistance (TA): Expert and skilled labors are needed for shipbuilding activities, such as developing systems and new applications towards a type of one or several products, designing and building new ships.

2. license: Right to build a vessel or marine components acquired from other companies by paying a royalty as part of technology transfer and added value process.

3. consultant: An agency or individual which is needed to give consultation or technical advice related to system development and applications in general.

4. training: Education and training to employees to develop technical and non technical skills

5. software: Acquisitions of software or programs to support shipyards' activities in design, production, and management.

Program	Partner	Origin	Type	Benefit
War vessels				
Fast boat 57 M, 400 T	Fr. Luersen	Germany	license TA training	production process design(partial) manufacturing
Fast boat 28 M, 60 T	Fr. Luersen Belgium Sc.	Germany Belgium	license TA training	production process design(partial) manufacturing
Commercial vessels				
Tanker 3500 DWT	Mitsui	Japan	TA training training	production process design(partial) manufacturing
Caraka Jaya 3000 DWT	Mitsui	Japan	TA training training	production process design(partial) manufacturing
Floating Dock 5000 TLC	Mitsui	Japan	TA training training	production process design(partial) manufacturing
Maruta Jaya 900 DWT	Weselman	Germany	TA	design
Modular design 3000 DWT	Meirform	Germany	TA	design

Table 6.2: Technology transfer by PT PAL

Chapter 7

Summary and Recommendations

7.1 Summary

The study of this research is to assess standardization programs in the Indonesia shipbuilding industry. Efforts to develop a standardization approach in the country has been initiated. The potential demand for certain types of vessels in the country is a major determinant in implementing astandardization approach later on. It is hoped that the author has provided the reader with key players and factors, challenges, and prospects associated with the standardization of component, design, modules, and production planning in the Indonesia shipbuilding industry. To optimize the benefits of design, component, control and production planning standardization, the detail plans and actions are needed. Some positive steps to be taken can be summarized briefly.

Coordination and commitment among parties

A team consists of representatives from shipbuilding, suppliers, DSN, shipowner, and marine experts is formed to develop a long term and detail standardization plan. Initially, the team collects all of the important inputs and data by :

1. compiling background information on the present status of standardization in the country.

2. working with the government agency most likely to be responsible for standardization.
3. reviewing standards from other countries as source material.
4. visiting industries for a survey of their activities falling within the orbit of in-plant standardization, which may not have been recognized as such.
5. recognizing the human problems in standardization, in-plant, and industry. Ways suggested by ATC programs [17] have to be taken as well:
6. collecting and analyzing comments from vendors and shipbuilders for specific components.
7. conducting a survey to establish that there is sufficient manufacturing capacity to provide specific parts meeting standard requirements and in the required sizes.
8. reviewing for many aspects of the components
9. performing detailed life cycle cost comparisons between the proposed items and imported ones.
10. refining and optimizing module design and arrangements to reduce module size and cost. Develop 3D CAD drawing package of the module to support the module design and ship integration studies.
11. consulting with prospective module builders and packagers to develop cost estimates for module fabrication and test, and to solicit comments on module arrangements and configurations.
12. conducting human engineering and maintainability studies to confirm module arrangement is adequate for operation and maintenance.
13. consulting with shipbuilders to develop estimates of cost savings due to utilization of modules.

Pro-active roles of Standardization Council of Indonesia

DSN should consider adapting foreign and international standards and communicate actively with shipyards and suppliers as the end-users by:

1. cutting and pasting into Indonesia format;
2. copying the standards with Indonesia conventions for measurement and language and applicable second-tier reference documents:
3. reviewing the data from other countries which have recently organized for standardization;
4. prepare lists of standards preferred by the marine industry to define those areas that urgently need new or updated standards, provide a useful tool to yards and design agencies, most of which do not have standardization activities to perform this basic task, to assist suppliers and distributors to identify those types of products that should be in inventory.

Later on, the extensive studies of design and component standardization programs are developed and planned. The major challenges to be met in the standardization application can be described as follows:

Lack of suppliers

The limited number of domestic manufacturers requires an incentive to create a sufficient long term demand for new entrants and existing parties.

Differences among shipyards

The variety in experience, facilities, and labor skills among shipbuilding requires transfer technology, training, and additional capital investment to support standardized products.

Communication among parties

The lack of communication among DSN, shipyards. suppliers. and government agencies requires tools to ease and facilitate information flow and decision making processes such that standardized designs and parts are agreed to by all parties.

7.2 Conclusion

In respect to the present condition of the Indonesia shipbuilding industry for standardization approaches, decision making tools and reliability of technical analysis are lacking. The minimum requirement for the synthesis process to select modules for development needs to be studied in more detail. Standardization of components is feasible for some parts and needs further evaluation for other items. Standardization of the production process and control within a shipyard will reduce acquisition costs.

The long term outlook for shipbuilding appears to be in the commercial sector. One major improvement to the current situation is that of building mass production and standardizing designs. In conclusion, standardization is one means for the Indonesia shipbuilding industry to offer lower construction, operation, and acquisition costs than at present time. Great efforts and commitments from shipyards, government agencies, suppliers, and buyers must be made to succeed with these programs.

Appendix A

MARINE COMPONENT

NO.	PRODUCT	COMPANY	LOCATION
1.	Steel Plate & Angle	1. PT Krakatau Steel	1. Cilegon, West Java
		2. PT Jayapari Steel	2. Surabaya, East Java
2.	Anchor	1. PT Barata Indonesia	1. Surabaya
		2. PT Loka Metal	2. Jakarta
3.	Anchor Chain	1. PT Indonesia Magma Chain	1.Semarang,Central Java
4.	Life Boat	1. PT Fibrite	1. Jakarta
		2. PT Young Marine	2. Jakarta
		3. PT Adiguna Fibrindo	3.Jakarta
		4. PT Dok Kodja Bahari	4. Jakarta
5.	Pump	1. PT Oyama	1. Jakarta
		2. PT Barata Indonesia	2. Surabaya
		3. PT Rutan Machinery	3. Surabaya
		4. PT Jardam	4. Jakarta
6.	Fire Extinguisher	1. PT Mugi	1. Jakarta
		2. PT Kartini Utama	2. Jakarta

7.	Cast Steel	1. PT Barata Indonesia	1. Surabaya
		2. PT Dendrite	2. Jakarta
		3. PT Bina Usaha Mandiri	3. Jakarta
		4. PT Loka Metal	4. Jakarta
8.	Deck Crane	1. PT PAL Indonesia	1. Surabaya
		2. PT Berca Indonesia	2. Jakarta
		3. PT Barata Indonesia	3. Surabaya
9.	Shafting & Stern Tube	1. PT Tesco Marine	1. Jakarta
		2. PT PAL Indonesia	2. Surabaya
10.	Propeller	1. PT Tesco Marine	1. Jakarta
11.	Wire Rope	1. PT Wonosari	1. Surabaya
12.	Al Window, Accomodation, Ladder, etc	1. PT Barata Indonesia	1. Surabaya
		2. PT Wijaya Karya	2. Jakarta
13.	Al Anode, Zinc Anode	1. PT Wijaya Karya	1. Jakarta
		2. PT SAP Corrosindo Engineering	2. Pangkal Pinang, Bangka
		3. PT Incore Pratama	3. Jakarta
14.	Hatch Cover	1. PT Dok Kodja Bahari	1. Jakarta
		2. PT PAL Indonesia	2. Surabaya
		3. PT Loka Metal	3. Jakarta
15.	Pipe & Fitting	1. PT Citra Tubindo	1. Batam
		2. PT Puma Bina Nusa	2. Batam
		3. PT Hymindo Petromas Utama	3. Jakarta
		4. PT Petracindo Nusa Pertiwi	4. Jakarta
16.	Windlass & Winch	1. PT Pindad	1. Bandung
		2. PT Barata Indonesia	2. Surabaya

17.	Main Engine	1. PT Nisdemi	1. Jakarta
		2. PT PAL Indonesia	2. Surabaya
		3. PT Boma Bisma Indra	3. Surabaya
18.	Generator Engine	1. PT Marine Power	1. Jakarta
		2. PT Cummins Hardaya Indonesia	2. Jakarta
		3. PT Boma Bisma Indra	3. Surabaya
		4. PT PAL Indonesia	4. Surabaya
		5. PT Natra Raya	5. Bogor
		6. PT Mesindo Agung	6. Tangerang
19.	Generator/Motor	1. PT Taiyo Indonesia/PT Agrindo	1. Surabaya
		2. PT Natra Raya	2. Bogor
		3. PT Pindad	3. Bandung
20.	Main Switchboard	1. PT PAL Indonesia	1. Surabaya
		2. PT Taiyo Indonesia/PT Agrindo	1.Surabaya
21.	Magnetic Log	1. PT Inti/JRC	1. Bandung
		2. PT Elnusa	2. Jakarta
		3. PT RFC	3. Bandung
22.	Echo Sounder	1. PT Inti/JRC	1. Bandung
		2. PT Elnusa	2. Jakarta
		3. PT RFC	3. Bandung
23.	Radio & Telecommunication Equipment	1. PT Inti/JRC	1. Bandung
		2. PT Elnusa	2. Jakarta
		3. PT RFC	3. Bandung
		4. PT Khatulistiwa	4. Jakarta
		5. PT Indisi	5. Bandung
		6. PT Dharma Dwi Tunggal Putra	6. Surabaya

24.	Direction Finder, Radar	1. PT Inti/JRC	1. Bandung
		2. PT Elnusa	2. Jakarta
		3. PT RFC	3. Bandung
		4. PT Dharma Dwi Tunggal Putra	4. Surabaya
25.	Paint	1. PT Hempelindo	1. Bekasi
		2. PT Danapaint Indonesia	2. Jakarta
		3. PT Toyo Paint	3. Jakarta
		4. PT Kansai Paint	4. Tangerang
		5. PT ICI	5. Bogor
		6. PT Sigma Utama	6. Jakarta
26.	Blower Ventilation	1. PT Arianto Darmawan	1. Jakarta
		2. PT Agrindo	2. Surabaya
27.	Heat Exchanger, Cooler	1. PT Barata Indonesia	1. Surabaya
		2. PT Bosma Bisma Indra	2. Surabaya
		3. PT Dok Kodja Bahari	3. Jakarta
28.	Bridge Control Console	1. PT PAL Indonesia	1. Surabaya
29.	Valve	1. PT Barindo Anggun Industri	1. Surabaya
		2. PT Bantalan Teguh Lestari	2. Jakarta
		3. PT Karti Yasa Sarana	3. Jakarta
		4. PT Barata Indonesia	4. Surabaya
30.	Steering Gear	1. PT Hamson Pelita	1. Jakarta
31.	Steel Door, Davit	1. PT Sumber Piranti	1. Bekasi
32.	Galley Equipment	1. PT Sumber Piranti	1. Bekasi

Appendix B

SHIPYARDS AND DOCKYARDS

NO.	LOCATION	COMPANY	NEW BUILDING		REPAIR	
			BERTH	CAP (GT)	DOCK	CAP (GT)
	SUMATERA					
	SABANG					
1		1. PT Dok & Perkapalan Kodja Bahari	BB	150	SW	1000
	MEDAN/BELAWAN					
2.		1. PT Eka Teknik Abadi	BB	150	-	-
3.		2. PT Karya Delka	BB	350	GD	350
4		3 PT Poseidon	BB	100	SW	100
5.		4 Perum Pelabuhan I	-	-	SW	200
	PANGKALAN BRANDAN					
6		1 Pertamina	-	-	SW	250
	PANGKALAN SUSU					
7		1. Pertamina	-	-	FD	3000
	RIAU					
8		1 Pertamina (Dumai)	-	-	FD	20000
			-	-	FD	15000
9.		2. Dok Navigasi (Dumai)	-	-	SW	100
10.		3. PT Usdha Seroja (Rengat)	BB	200	SW	250
11.		4 PT Internusa (Singkep)	BB	350	SW	350
12.		5. PT Wirastuti	-	-	SW	350
					GD	1000
	TANJUNG PINANG					
13.		1. PT Inocin	BB	350	SW	350
14.		2 PT Aneka Tambang	-	-	SW	150
	BATAM					
15		1. PT Bandar Victory	-	-	SW	2500
16		2. PT Bahtera Mutiara Handalan	-	-	SW	2000
17.		3 Kacaba Marga Marina	-	-	SW	1500
					SW	1200
					SW	1000

NO.	LOCATION	COMPANY	NEW BUILDING		REPAIR	
			BERTH	CAP (GT)	DOCK	CAP (GT)
18		4 PT Sumber Teknık	-	-	SW	100
19.		5 PT Bahtera Tırta Amerta	-	-	FD	
	PADANG					
20.		1. PT Dok & Perkapalan Kodja Baharı	BB	350	GD	600
					SW	300
					SW	100
	JAMBI					
21.		1 PT Cahaya Murni Megah	BB	350	SW	200
22.		2. PT Pura Gunıta Karya	BB	700	SW	500
23.		3. PT Naga Cıpta Central	BB	350	SW	1300
	PALEMBANG					
24.		1. PT Dok & Perkapalan Kodja Baharı	BB	500	SW	400
					SW	400
					SW	200
					SW	200
					SW	100
25.		2. PT Dok Karang Sumatra	BB	150	SW	400
					SW	150
26		3. PT Nırwana Indah	BB	150	SW	150
27		4 PT Kenten Jaya	BB	350	SW	300
					SW	300
					SW	1000
28.		5 PT Sudjaka	BB	150	SW	200
			BB	350		
29.		6. PT Sungaı Selincah	BB	200	SW	700
					SW	350
30		7 PT Sac Nusantara	BB	350	SW	100
					SW	200
31.		8 PT Hidup Sejahtera	BB	200	-	-
32.		9. PT Galpin	BB	150	SW	200
					SW	200
33.		10. PT Trilogaraya	BB	150	SW	200
34.		11. PT Karya Makmur	-	-	SW	200
					SW	200
35		12. Pertamina (Plaju)	-	-	FD	100
36.		13 PT Intan Sengkunyıt	BB	3500	SW	700
			BB	3500	SW	2000
					SW	4000
37.		14. PT Marıana Bahagıa	BB	700	SW	1300
					SW	350
					SW	350
					SW	350
38		15. Dok Navıgası	-	-	SW	100
39		16. PT Karya Mulia Pratama	BB	70	SW	1000
40.		17 PT Aneka Tambang	BB	10000	SW	10000
	PANGKALPINANG					
41.		1. PT Dwı Jasa Mıtra	BB	700	GD	700
42		2. PT Sarana Marindo	BB	700	GD	200
			BB	300	GD	200
43.		3 PT Tambang Tımah	-	-	SW	700
	LAMPUNG					
44.		1 PT Noahtu	BB	700	-	-
			BB	700	-	-

NO.	LOCATION	COMPANY	NEW BUILDING		REPAIR	
			BERTH	CAP (GT)	DOCK	CAP (GT)
45.		2. PT Lampung Andalas Shipbuilding & Engineering	-	-	SW	1000
	JAVA					
	JAKARTA					
46.		1. PT Dok & Perkapalan Kodja Bahari Unit 1	BB	2000	SW	500
47.		2. PT Dok & Perkapalan Kodja Bahari Unit 2	BB	3500	FD	600
			BB	8000	FD	6000
					FD	12000
					FD	3500
					FD	8000
48.		3. PT Dok & Perkapalan Kodja Bahari Unit 3	BD	6000	FD	2500
49			BB	700	FD	1500
50.		4. PT Dok & Perkapalan Kodja Bahari Unit 4	BB	40000	-	-
51.		5. PT Inggom	BB	700	ST	700
			BB	700	ST	700
			BB	700	ST	700
			BB	2500	ST	700
					ST	700
52.		6. PT Adiguna Shipyard	BB	700	-	-
			BB	700		
53.		7. PT Toha Semangat	BB	150	SW	100
					SW	100
54.		8. PT Indomarine	BB	350	-	-
55.		9. PT Daya Laut Utama	BB	150	-	-
56.		10. PT Galsia	BB	150	-	-
57.		11. PT Union Yard	BB	150	-	-
58.		12. PT Tirtajaya	BB	150	-	-
59.		13. PT Marspec	BB	150	-	-
60.		14. PT Daya Radar Utama	BB	350	SW	200
61.		15. PT Wayata Kencana	BB	350	GD	700
			BB	350		
62.		16. PT Fan Marina	-	-	SW	100
63.		17. PT Rukindo	BB	400	GD	700
64.		18. PT Perbakat	BB	100	-	-
65.		19. PT Hamson Pelita	BB	100	-	-
66.		20. PT Pelayaran Adiguna	-	-	SW	150
		21. PT Karya Teknik Utama	BB	300	-	-
	MERAK/CILEGON					
67.		1. PT Diasraya	BB	1000		
68.		2. PT Prima Perkasa Sarana Persada	BB	200	-	-
			BB	100	-	-
69.		3. PT Palwa Minatama Jaladri	BB	200	-	-
			BB	100	-	-
	CIREBON					
70.		1. PT Dok & Perkapalan Kodja Bahari	BB	700	GD	700
	SEMARANG					
71.		1. PT Jasa Marina Indah	BB	3500	GD	5500
72.		2. PT Yasa Wahana Tirta Samudra	BB	700	SW	100
			BB	700	SW	150
					SW	150
					SW	150
					SW	550
73.		3. PT Dok & Perkapalan Kodja Bahari	BB	3000	GD	300
			BB	200	SW	800
					RB	200

NO.	LOCATION	COMPANY	NEW BUILDING		REPAIR	
			BERTH	CAP (GT)	DOCK	CAP (GT)
	TEGAL					
74.		1. PT Menara	BB	700	SW	500
			BB	700		
			BB	100		
			BB	100		
			BB	100		
			BB	100		
			BB	100		
75.		2 PT Bina Baita	BB	100	SW	150
76.		3. PT Gema Samudra	BB	100	SW	100
			BB	200	SW	100
					SW	100
					SW	100
77.		4. PT M.Doesdi	BB	100	SW	250
					SW	200
					SW	200
					SW	200
					SW	200
78.		5 PT Jakarta Lloyd	-	-	SW	100
					SW	100
					SW	100
					SW	100
79.		6. PT Surut Berpantang	BB	100	GD	250
					SW	200
					SW	200
					SW	200
					SW	200
80.		7. PT Tegal Shipyard	BB	200	SW	200
					SW	200
					SW	200
	CILACAP					
81.		1. PT Dok & Perbengkelan	-	-	SW	100
					SW	300
					SW	300
	SURABAYA					
82.		1 PT Dok & Perkapalan Surabaya	BB	3500	FD	6000
			BB	700	FD	2500
					FD	2500
					FD	2000
					FD	4000
					SW	800
83.		2. PT Najatim	BB	300	SW	1000
84.		3. PT Dewa Ruci Agung	BB	100	GD	1000
85.		4. PT Bayu Samudra Sakti	BB	100	GD	1000
86.		5. PT Gresik Jaya Dockyard	BB	100	-	-
87.		6 PT Perikanan Samudra Besar	-	-	SW	100
88.		7 PT PAL Indonesia	BD	13500	SW	100
			BD	1500	FD	1000
			BD	20000	FD	1500
					FD	5000
					F	5000
89		8. PT Wiradata	BB	100	SL	1500
90.		9 PT Blambangan Raya	100	100	SW	100
91.		10. PT Dumas	BB	700	-	-
			BB	700	GD	5000
92.		11. PT Rukindo	-	-		
					GD	350
					GD	350

NO.	LOCATION	COMPANY	NEW BUILDING		REPAIR	
			BERTH	CAP (GT)	DOCK	CAP (GT)
93.		12. PT Aneka Usaha	-	-	GD	350
94.		13. PT Pelni	-	-	SW	700
					GD	1400
	PROBOLINGGO					
95.		1. PT Pelni	-	-	SW	100
	KALIMANTAN					
	PONTIANAK					
96.		1. PT Kapuas Cahaya Bahari	BB	200	SW	700
			BB	300	GD	350
			BB	700		
97.		2. Dok Navigasi	-	-	SW	100
	PANGKALAN BUN					
98.		1. PT Inocin	BB	100	SW	1000
	BANJARMASIN					
99.		1. PT Bina Bahtera	BB	100	SW	100
100.		2. Puskopelra	BB	350	SW	200
					GD	1000
101.		3. PT Samudra Sakti	BB	200	-	-
102.		4. PT Budi Karya Persada	BB	200	-	-
103.		5. PT Permata Barito	BB	200	-	-
		6. PT Dok & Perkapalan Kodja Bahari	BB	2000		
	SAMARINDA					
104.		1. PT Sumber Mas Timber	BB	500	SW	500
					SW	350
					SW	100
105.		2. PT Kaltim Shipyard	BB	700	SW	700
106.		3. PT Mahakam Baja Utama	BB	350	SW	350
			BB	200		
107.		4. PT Rejeki Abadi Sakti	BB	350	SW	300
			BB	350	SW	200
					SW	350
					SW	700
108.		5. PT Kayumas Jaya	BB	350	SW	350
					SW	200
109.		6. PT Dok Bengkel Merdeka	BB	500	SW	350
					SW	350
					SW	350
					SW	200
					SW	100
110.		7. PT Manumbar Kaltim	BB	350	SW	150
111.		8. Dok Navigasi	-	-	SW	150
	BALIKPAPAN					
112.		1. PT Komaritim	BB	350	SW	150
113.		2. PT Panrita Sihpbuilding	BB	150	SW	200
114.		3. PT Teknik Samudra Ulung	BB	150	-	-
115.		4. PT Balikpapan Utama	-	-	SW	150
116.		5. Pertamina Balikpapan	-	-	SW	200
117.		6. PT Gema Cipta Bahtera	BB	150	SW	150
					SW	100
118.		7. PT Dua-dua	-	-	SW	100
119.		8. PT Bataro Teknik Abadi	BB	100	SW	100
120.		9. PT Jujur Utama Sejati	BB	150	GD	150
	TARAKAN					
121.		1. PT Chipdeco	BB	100	SW	100

NO.	LOCATION	COMPANY	NEW BUILDING		REPAIR	
			BERTH	CAP (GT)	DOCK	CAP (GT)
122.		2. PT Inhutani I	-	-	SW	200
123.		3. Pertamina	-	-	SW	100
	SULAWESI					
	UJUNG PANDANG					
124.		1. PT Industri Kapal Indonesia	BB	3500	ST	350
			BB	350	ST	350
			BB	350	ST	350
			BB	350	ST	350
					ST	350
125.		2. PT Tanjung Pengharapan	-	-	SW	100
126.		3. PT Perikanan Samudra Besar	-	-	SW	100
	KENDARI					
127.		1. PT Bontuni Tirtamas	BB	150	SW	150
					SW	350
					SW	500
					SW	700
					SW	100
128.		2. PT Aneka Tambang	-	-	SW	100
	BITUNG					
129.		1. PT I.K.I	BB	150	SW	200
			BB	150	SW	300
					SW	300
					SW	300
130.		2. PT Gala Karya	BB	700	SW	1000
		3. PT PSB				
	MALUKU					
131.		1. PT Perikani	BB	100	SW	200
132.		2. PT Waiame	BB	300	SW	350
					SW	200
	SERAM					
133.		1. PT Seram Prima Jaya	BB	400	SW	1700
	IRIAN JAYA					
	JAYAPURA					
134.		1. PT Yoshiba Shipyard	BB	100	SW	200
135.		2. Dok Navigasi	-	-	SW	200
	MERAUKE					
136.		1. Dok Navigasi	-	-	SW	200
	SORONG					
137.		1. Pertamina	BB	1000	SW	700
138.		2. PT Usaha Mina	-	-	SW	300
					SW	100

Appendix C

COMPONENTS AND PARTS STANDARD

NO.	-General	Standard Number	SNI Number
1.	Life saving appliances of ships, Graphical symbols	SII 1209-84	SNI 0971-1989-A
2.	Fire extinguisher of ships, Graphical symbols	SII 1210-84	SNI 0972-1989-A
3.	Ship's spare-part boxes, Hatch opening	SII 1048-84	SNI 0858-1989-A
4.	Shipbuilding, auxiliary machinery and equipments. Glossary of terms	SII 0903-83	SNI 0747-1989-A
5.	Shipbuilding, electric parts. Glossary terms	SII 0905-83	SNI 0749-1989-A
6.	Shipbuilding, navigation and communication instruments. Glossary of terms	SII 0906-83	SNI 0750-1989-A
7.	Shipbuilding, General terms	SII 0902-83	SNI 0746-1989-A
8.	Shipbuilding, machinery parts. Glossary terms	SII 0904-83	SNI 0748-1989-A

9.	Ships' ventilation system. Graphical symbols	SII 1208-84	SNI 0970-1989-A
10.	Canvas on ships. Application	SII 1370-85	SNI 1094-1989-A

NO.	K1 - Hull Parts	Standard Number	SNI Number
1.	Floating tools	SII 1222-84	SNI 0983-1989-A
2.	Hatch wedges	SII 1357-85	SNI 1081-1989-A
3.	Life jackets	SII 0920-83	
4.	Ships' derrick booms	SII 0909-83	SNI 0753-1989-A
5.	Ships' wooden handrail	SII 1061-84	SNI 0870-1989-A
6.	Hatch locking bars	SII 1358-83	SNI 1082-1989-A
7.	Ships' steel pipe U-bolts	SII 1550-85	SNI 1227-1989-A
8.	Hatch cleats	SII 1359-85	SNI 1083-1989-A
9.	Ships' steel blocks for signal flags.	SII 1551-85	SNI 1228-1989-A
10.	Ships' steel guy blocks for fibre rope.	SII 1552-85	
11.	Ships' cargo lifting block	SII 0912-83	SNI 0756-1989-A
12.	Ships' leading blocks for chain type hand steering gear system	SII 1788-85	SNI 1379-1989-A
13.	Cowlhead ventilators	SII 1053-84	SNI 0863-1989-A
14.	Mushroom ventilators	SII 1553-85	SNI 1229-1989-A
15.	Gooseneck ventilators	SII 1054-84	SNI 0864-1989-A
16.	Ships' "S" ring of chainlet	SII 1360-85	SNI 1084-1989-A
17.	Oil suction bellmouth	SII 1362-85	SNI 1086-1989-A
18	Ships' crane for general use	SII 1363-85	SNI 1087-1989-A
19	Ships' radial type davits for general use	SII 1789-85	SNI 1380-1989-A
20.	Radial type lifeboat davits	SII 1072-84	SNI 0880-1989-A
21.	Sunken link plates	SII 1978-86	
22.	Ships' bells	SII 1073-84	SNI 0881-1989-A
23.	Ships' indicators for watertight sliding doors	SII 1790-85	SNI 1381-1989-A

NO.	K1-Hull Parts	Standard Number	SNI Number
24.	Ships' foot step	SII 1063-84	SNI 0872-1989-A
25.	Heat or sweat insulator for pipes in small ship. Scheme	SII 1563-85	SNI 1236-1989-A
26	Thermal insulation work for small ships' aircondition ducts. Installation	SII 1564-85	
27.	Cast steel stock anchor	SII 0914-83	SNI 0758-1989-A
28.	Stockless cast steel anchor	SII 0913-83	SNI 0757-1989-A
29.	Ships'steering wheels	SII 1070-84	SNI 0878-1989-A
30.	Turnbuckles with eye bolts	SII 1554-85	SNI 1230-1989-A
31.	Ships' kitchen windows	SII 1219-84	SNI 0980-1989-A
32.	Ships' vertical sliding window	SII 1220-84	SNI 0981-1989-A
33.	Steel grid window	SII 1739-85	SNI 1355-1989-A
34.	Ships' rectangular windows	SII 0918-83	SNI 0762-1989-A
35.	Ships' aluminium alloy side windows	SII 1216-84	SNI 0977-1989-A
36.	Ships'bronze side windows	SII 1217-84	SNI 0978-1989-A
37.	Non-openable ships' side windows	SII 1218-84	SNI 0979-1989-A
38.	Ships' derrick tappin bracket	SII 0910-83	SNI 0754-1989-A
39.	Ships' short sounding pipe heads, self closing parallel cock type	SII 2216-87	SNI 1634-1989-A
40.	Ships'gooseneck air pipe heads. Ball float type	SII 1555-85	SNI 1231-1989-A
41.	Ships' bonnet type air pipe heads	SII 1556-85	

NO.	K1-Hull Parts	Standard Number	SNI Number
42.	Marine steel gratings	SII 1557-85	SNI 1232-1989-A
43.	Gratings for ships's scupper	SII 1558-85	
44.	Ships' clinometer	SII 1071-84	SNI 0879-1989-A
45.	Ships' ratchet spanners	SII 1792-85	SNI 1383-1989-A
46.	Ships' deck and bulk head	SII 2220-87	SNI 1635-1989-A
47.	pieces for small size copper pipe		
48.	Fittings for small ships' weather tight steel doors	SII 1791-85	SNI 1382-1989-A
49.	Scupper fittings for ships' refrigerating chambers	SII 1559-85	SNI 1233-1989-A
50.	Fittings of ships' small size steel hatch covers	SII 1793-85	SNI 1384-1989-A
51.	Ships' rope holes	SII 1561-85	
52.	Ships' ullage holes	SII 1794-85	SNI 1385-1989-A
53.	Ships' rope store holes	SII 1364-85	SNI 1088-1989-A
54.	Ships' manholes	SII 1365-85	SNI 1089-1989-A
55.	Marine small size manhole	SII 1560-85	SNI 1234-1989-A
56.	Hatch opening	SII 1366-85	SNI 1090-1989-A
57.	Butterfly nuts	SII 1367-85	SNI 1091-1989-A
58.	Anchor buoys	SII 2221-87	SNI 1636-1989-A
59.	Life buoy	SII 1223-84	SNI 0984-1989-A
60.	Ships' eye plates	SII 1979-86	SNI 1480-1989-A
61.	Ships' eye plates for chainlet	SII 1361-85	SNI 1085-1989-A
62.	Ships'eye plates for wire rope stay	SII 1795-85	SNI 1386-1989-A
63.	Ships' toggle pins	SII 1796-85	SNI 1387-1989-A

NO.	K1-Hull Parts	Standard Number	SNI Number
64.	Ships' light load derrick topping brackets	SII 1797-85	SNI 1388-1989-A
65.	Ships' derrick topping brackets	SII 1798-85	SNI 1389-1989-A
66.	Ships' flame arresters	SII 1373-85	SNI 1097-1989-A
67.	Ships' small size anchor stoppers	SII 1799-85	SNI 1390-1989-A
68.	Cast steel bar type anchor chain cable stoppers	SII 1374-85	SNI 1098-1989-A
69.	Cast steel bar type anchor chain cable stopper for small ships	SII 1375-85	SNI 1099-1989-A
70.	Cast steel pawl type for grade 3 chain cable stoppers	SII 1376-85	SNI 1100-1989-A
71.	Rollered bar type for grade 2 anchor chain cable stoppers	SII 1378-85	SNI 1102-1989-A
72.	Rollered bar type for grade 3 anchor chain cable stoppers	SII 1379-85	SNI 1103-1989-A
73.	Rollered pawl type for grade 2 anchor chain cable stoppers	SII 1380-85	SNI 1104-1989-A
74.	Rollered pawl type for grade 3 anchor chain cable stoppers	SII 1381-85	SNI 1105-1989-A
75.	Cast iron bar type anchor chain cable stoppers	SII 1377-85	SNI 1101-1989-A
76.	Roller fair leads for inter island shipping. Specification	SII 0917-83	SNI 0761-1989-A
77.	Cast iron fair-leads	SII 1057 - 84	
78.	Steel plate fair-leads	SII 1056-84	SNI 0866-1989-A

NO.	K1-Hull Parts	Standard Number	SNI Number
79.	Ships' fair-leads	SII 2222-87	SNI 1637-1989-A
80.	Ships' small size fair-leads	SII 1980-86	SNI 1481-1989-A
81.	Ships' deck stands for controlling valves	SII 1565-85	SNI 1237-1989-A
82.	Ships' steel wire reels	SII 1800-85	SNI 1391-1989-A
83.	Ships' small size steel wire reels	SII 1801-85	SNI 1392-1989-A
84.	Ships' steel pipe bands	SII 1566-85	
85.	Ships' derrick gooseneck brackets	SII 1802-85	SNI 1393-1989-A
86.	Ships'oiltight hatch covers	SII-1567-85	
87.	Ships' derrick boom rest	SII 1372-85	SNI 1096-1989-A
88.	Ships' rudder carriers	SII 1568-85	SNI 1238-1989-A
89.	Small ships' weather-tight steel doors	SII 1215 - 84	SNI 0976-1989-A
90.	Weather-tight steel doors Accessories	SII 1371-85	SNI 1095-1989-A
91.	Ships weather-tight steel doors.	SII 1055-84	SNI 0865-1989-A
92.	Non-watertight steel doors for small ships	SII 1214-84	SNI 0975-1989-A
93.	Ships' non-watertight steel doors	SII 1058-84	SNI 0867-1989-A
94.	Ships' expose hollow doors	SII 1060-84	SNI 0869-1989-A
95.	Ships' cabin hollow doors	SII 1059-84	SNI 0868-1989-A
96.	Watertight sliding doors	SII 1213-84	SNI 0974-1989-A
97.	Steel pipes for small ships. Application	SII 1562-85	SNI 1235-1989-A
98.	Ships' chainlets	SII 1382-85	SNI 1106-1989-A

NO.	K1-Hull Parts	Standard Number	SNI Number
99.	Ships' anchor chain cables	SII 1212-84	SNI 0973-1989-A
100	Ships' chain cable for general use	SII 1211-84	
101.	Ships' rope stoppers chain	SII 1570-85	SNI 1239-1989-A
102.	Ships' horizontal rollers	SII 2223-87	SNI 1638-1989-A
103.	Ships' small size stand rollers	SII 2224-87	SNI 1639-1989-A
104.	Ships' cast steel pipe expansion fitting, sleeve type	SII 1977-86	SNI 1479-1989-A
105.	Ships' cast iron pipe expansion fitting, sleeve type	SII 1383-85	SNI 1107-1989-A
106.	Life boat	SII 0919-83	SNI 0763-1989-A
107.	Ships' hatch beam slings	SII 1803-85	SNI 1394-1989-A
108.	Ships' steel wire sockets	SII 1804-85	SNI 1395-1989-A
109.	Ships' bottom plug and spanners.	SII 1385-85	SNI 1109-1989-A
110.	Ships' drain plug	SII 1384-85	SNI 1108-1989-A
111.	Steel wire ropes for small ships. Application	SII 1368-85	SNI 1092-1989-A
112.	Steel wire ropes in ships. Application	SII 1224-84	SNI 0985-1989-A
113.	Manila ropes for small ships Application	SII 1369-85	SNI 1093-1989-A
114.	Sisal ropes in ship. Application	SII 1225-84	
115.	Ships' derrick guy cleats	SII 1052-84	SNI 0862-1989-A
116.	Ships' Panama chocks	SII 1805-85	SNI 1396-1989-A
117.	Open chocks for inter-island shipping, Specification	SII 0915-83	SNI 0759-1989-A

NO.	K1-Hull Parts	Standard Number	SNI Number
118.	Open chocks for ships	SII 1049-84	SNI 0859-1989-A
119.	Closed chocks for ships	SII 1050-84	SNI 0860-1989-A
120.	Horn cleats	SII 1051-84	SNI 0861-1989-A
121.	Steel accomodation ladders	SII 1068-84	
122.	Ships' steel ladders and handrails	SII 1571-85	SNI 1240-1989-A
123.	Steel embarkation ladders	SII 1066-84	SNI 0875-1989-A
124.	Steel deck ladders	SII 1065-84	SNI 0874-1989-A
125.	Bullwarks ladders	SII 1067-84	SNI 0876-1989-A
126.	Pilot ladders	SII 1572-85	SNI 1241-1989-A
127.	Ships'steel vertical ladders	SII 1064-84	SNI 0873-1989-A
128.	Ships' handrail stanchions	SII 1062-84	SNI 0871-1989-A
129.	Double type cross bitts for tug boats	SII 1573-85	
130.	Ships' cross bitts	SII 1574-85	
131.	Steel welded bollards	SII 0916-83	SNI 0760-1989-A
132.	Ships' pipe head spanners	SII 1575-85	SNI 1242-1989-A
133.	Ships' hatch cleats,simple type	SII 1386-85	SNI 1110-1989-A
134.	Ships' hatch cleats	SII 1069-84	SNI 0877-1989-A
135.	Cover for tank cleaning holes	SII 1806-85	SNI 1397-1989-A
136.	Ships' air hatch covers	SII 1576-85	SNI 1243-1989-A
137.	Ships' hatch covers	SII 0911-83	SNI 0755-1989-A
138.	Ships' steel small hatch covers	SII 1807-85	SNI 1398-1989-A
139.	Hinged caps for sounding pipes	SII 1577-85	SNI 1244-1989-A
140.	Deck pieces for sounding pipes	SII 1578 - 85	
141.	Pipe head caps	SII 1579-85	SNI 1245-1989-A
142.	Mushroom ventilator covers	SII 1055-84	SNI 0865-1989-A

NO.	K2-Engine Parts	Standard Number	SNI Number
1.	Marine cast iron 0.49 MPa (5 kgf/cm2) globe valves	SII 1971-86	SNI 1475-1989-A
2.	Marine cast iron 0.98 MPa (10 kgf/cm2) globe valves	SII 1972-86	SNI 1476-1989-A
3.	Marine cast iron 1.57 Mpa (16 kgf/cm2) globe valves	SII 1973-86	SNI 1477-1989-A
4.	Marine self closing gate valve heads for short sounding pipe	SII 1974 - 86	
5.	Marine cast iron 0.49 MPa (5 kgf/cm2) angle valves	SII 2217-87	
6.	Marine cast iron 0.98 MPa (10 kgf/cm2) angle valves	SII 2218-87	
7.	Marine cast iron 1.57 Mpa (16 kgf/cm2) angle valves	SII 2219 - 87	
8.	Manual remote handling fittings for valves on small ships' fore-peak bulkhead	SII 1975 - 86	
9.	Manual remote handling fittings for valves on small ships' cargo oil tank	SII 1976-86	SNI 1478-1989-A
10.	Cargo handling machine. Perfomance test	SII 0907-83	SNI 0751-1989-A
11.	Prime movers on trial run	SII 1047-84	SNI 0142-1989-A
12.	shipping		
13.	Tools, materials and equipment for ships machinery	SII 1297-84	SNI 0969-1989-A
14.	Ships' engine spare parts for ocean and interinsular shipping	SII 1206-84	SNI 0968-1989-A

NO.	K3-Electric Parts	Standard Number	SNI Number
1.	Ships electrical installation Graphical symbols	S.LIPI 018-1978	
2.	Ships electrical installation Cable installation	SLI 007:1984	SNI 1687-1989-C
3.	Ships electrical installation Distribution	S.LIPI 017/5-1978	
4.	Ships electrical installation Generator	S.LIPI 017/6-1978	
5.	Ships electrical installation, Cable	SLI 006 : 1984	SNI 1686-1989-C
6.	Ships' electrical installation: Switchgear, swicthboard, distribution switchboard	SLI 008:1984	SNI 1689-1989-C
7.	Ships electrical installation, Electrical safety	SLI 009:1984	SNI 1689-1989-C
8.	Ships' incadecent lamps	SII 1221-84	SNI 0982-1989-A

Bibliography

[1] *Indonesia sea tranport.* Indonesian National Ship Owners (INSA), 1988.

[2] Ir. Edi Andarto. Interview to marine industry participants in Indonesia. January 1994.

[3] Ir. Naufal Bahreisy. Questionnare to marine industry participants in Indonesia. Compiled data from Technology Assessment and Development Agency, Jakarta - Indonesia, December 1994.

[4] H. Bruce Bongiorni. Maintaining the Shipbuilding Technology Base - Looking at Other Markets. *Ship Production Journal*, 8(1):59+, February 1992.

[5] Carl F. Cargill. *Information Technology Standardization: Theory, Process, and Organization.* Digital Press, 1989.

[6] Jay P. Carson and Barbara Lamb. U.S. Commercial Shipbuilding in the 1990s: The Global Context. *Marine Technology Journal*, 27(6):387+, November 1990.

[7] Stian Erichsen. The Effect of Learning When Building Ships. *Ship Production Journal*, 10(3):141–145, August 1994.

[8] Kristin Fletcher. Identification of Best Practices in Supplier Selection and Supplier Quality Management, 1992.

[9] H. Landis Gabel. *Product Standardization and Competition Strategy.* Publication INSEAD. North Holland, 1987. Fountainebleau France.

[10] T.J. Hibbard. Design Standardization: New Opportunities and Old Problems. 1991.

[11] PT DATA Consult Inc. Development of shipping industry. *Industrial and Commercial Newsletter*, 6(127), 1993.

[12] Ir.Marwoto. Opportunities for Indonesia Shipbuilding Industry in 6th of Five Year Plan. Industry and Technology Dialog, 1993.

[13] Edward T Kinney and Alexander E. Constant. Improved Logistic Support Through Standardization. *Naval Engineers Journal*, 100(2):40+, 1988.

[14] Kompas. PT PAL awarded ISO 9001. 16(278):8, 1994. Indonesia daily newspaper.

[15] Richard T. Lubben. *Just-in-Time Manufacturing.* McGraw Book Company, 1988.

[16] H.L. Mason and H.S. Peiser, editors. *Metrology and Standardization in Less-Developed Countries : The Role of a National Capability for Industrializing Economies.* Number NBS Publication 359. Department of Commerce, Washington DC, 1971.

[17] NAVSEA. ATC Modularity Case Study. NAVSEA Technical Note, 2(051-05R-TN-099), February 1993.

[18] Standardization Council of Indonesia. *Standardization Council of Indonesia.* Booklet. DSN, 1992.

[19] National Bureau of Standards. *Standardization in Support Development.* Publication 507. Department of Commerce, 1978.

[20] John T. Rabbitt. *A Global Competitor's Guide to Compliance Certification.* Quality Resources, 1993.

[21] Francois Raillon. *Indonesia 2000 - industrial and technological chal lenge.* Publication Cipta Kreatif. CNPF-ETP, 1990.

[22] Leon F. McGinnis Robert J. Graves and Rodney A. Robinson. Shipyard Production Standards. *Ship Production Journal*. 4(1):65+, February 1988.

[23] SNAME Panel SP-8. Production Oriented Planning: A Manual on Planning and Production Control for Shipyard Use. 1978.

[24] S.C. Strong. An Approach to Ship Acquisition Strategy Development for US Government Agency. Master's thesis, Massachusetts Institute of Technology, Ocean Engineering Department, 1987.

[25] M.P. Tedesco. An Approach to Standardization of Naval Ship Equipment dan Component. Master's thesis, Massachusetts Institute of Technology, Ocean Engineering Department, 1993.

[26] Robert Toth. *The Economics of Standardization*. National Aerospace Standard 1524 - Standardization Savings, Identification and Calculation. Aerospace Industries Association of America.

[27] Robert B. Toth. Marine Industry Standards of the U.S. and the World. *Ship Production Journal*, 2(3):179+, August 1986.

[28] Michael Wade. Use of Standard Task Blocks to Simplify the Ship Production Process. *Ship Production Journal*, 2(2):101+, May 1986.

[29] Henry S. Marcus; Nikolaos E. Zografakis; and Matthew Tedesco. Building on the Success in Standardization of the U.S. Navy. *Ship Production Journal*, 10(2):110+, May 1994.