APPLICATION OF LEAN CONCEPT TO SHIP SAFETY INSPECTION: A CASE STUDY AT PORT OF SURABAYA

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ABSTRACT

The Lean Concept is a mindset widely used in various industries seeking for efficiency and effectiveness through improvement of process flow and elimination of waste. This research applies lean thinking to ship safety inspection at Port of Surabaya to investigate the existing procedure and to identify the wastes and non-value-add (NVA) activity. It used a combination of literature review, examination on the data of 520 inspections that have been carried out to 201 ships in the last two years (2009 - 2011), investigation on related regulations and guidelines, observation on the actual conduct of inspection, and interview with 59 marine inspectors and ship officers. Analysis is conducted using Value Stream Mapping (VSM). It is found that the existing procedure lacks significant impact in terms of imposing a reduction in the total number of detected deficiency between the earlier and subsequent inspections. Only 37% of the ships experience a reduction, indicating that the performance of inspection is currently at the level of 37 on a 100-point scale. It was mainly due to severe violation of the regulations, which is demonstrated by the issuance of ship certificate regardless of corrective action undertaken relating to the detected deficiency.

Keywords: Lean concept, ship safety inspection, value stream mapping.

1 INTRODUCTION

1.1 Background

Ship safety inspection at sea port is conducted to ensure safety at sea, to prevent loss of life and to prevent damage to ship and the environment. Thus, all aspects of ship are observed, including nautical, technical and radio equipment. National ship is subject to an inspection called as Flag State Control. On the other hand, foreign ship is subject to another form of inspection called Port State Control. For the sake of simplicity, in this paper Flag State Control is addressed as either 'ship inspection' or 'ship safety inspection'.

In Port of Surabaya, ship inspection is carried out exclusively by marine inspectors stationed at the Seaworthiness Department of the Harbour Master. Despite the presence of an online ship database and manual handwriting-based data of ship inspection in the department, it is unlikely to encounter some sort of documentation and evaluation relating to inspection performance, as to whether the inspection has a significant impact on ship safety or not. Is it merely perceived as routine activity regardless of a decline, if any, on ship safety standard? How does a marine inspector carry out the conduct of inspection in regard to ship safety improvement? These questions build the footing for this study to proceed further.

1.2 Objective

The objectives of this research are:

a) to investigate the existing procedure of ship safety inspection at Port of Surabaya;
b) to identify waste and non-value-add (NVA) activity within the existing procedure;
c) to propose a new future state of ship safety inspection procedure through elimination of waste and NVA activities detected.

2 THEORETICAL REVIEW

2.1 Lean Concept

Lean is a mindset. It is derived from the manufacturing system, in particular the Toyota Production System (TPS), which aims to preserve value with less work. It looks for efficiency through focusing on process flow, elimination of wastes and NVA activities. It critically challenges the pre-existing process or value for the sake of improvement.

Waste is defined as any activity that does not add value to the product or service expected by customers. Removal of waste can be achieved through implementation of five principles called VSM (Duffy, 2006).

a) Specify value: identification of activities that add value from the customer or client standpoint.

b) Specify value: identification of activities that add value from the customer or client standpoint.
c) Map the value stream: visualization of activities to identify both waste and vital steps. It will then enable the elimination of waste.
d) Flow: products and services should move among value-adding activities in tight sequences, uninterrupted by queue, delay, backflow etc.
e) Pull: customer demand should dictate the flow.
f) Perfection or continuous improvement: the improvement is continuously redone in every single step until the lifecycle is perfect, meaning there is no waste found.

2.2 Application of Lean in Various Industries

There were many studies about application of the lean concept in various sectors such as healthcare, construction, aerospace, telecommunication, red-meat industry, public services and port management.

King *et al.* (2006) implemented lean thinking to improve patients flow in teaching general hospital emergency department. Similarly, Dickson *et al*. (2009) evaluated the adoption of lean principles in an emergency department. Weller *et al.* (2006) demonstrated the use of lean manufacturing concepts to optimize drug discovery. Lantelme and Formoso (1999) facilitated construction manager to apply the lean concepts in measuring performance and improve transparency. Ballard *et al*. (2003) applied the lean concepts to improve process flow and productivity on precast concrete fabrication. In aerospace industry, Parry and Turner (2006) used lean to facilitate performance measurement and communication on visual process management tools. In a case study on UK red-meat industry, Simons and Zokaei (2005) used lean paradigm to identify problems and improve productivity. Erridge and Murray (1998) investigated the applicability of lean in Belfast local governments purchasing and supply management.

2.3 The Coverage of Ship Inspection

Ship inspection in seaport is carried out by government officers capable and qualified for the conduct of ship safety inspection, called marine inspectors (Shipping Act, 2002). In Port of Surabaya, the inspection is conducted to investigate ship seaworthiness for voyage (Sailing Act, 2008). From a marine inspector's standpoint, seaworthiness refers to the nautical, technical and radio (NTR) aspects of the inspected ships (see Table 1).

Table 1. Coverage of ship inspection

Main category	Component*
Document	Ship certificates, letter of nationality, letter of measurement, chart and nautical publication (notice to mariners, pilot books, etc.)
Technical	a). Main engine and auxiliaries; b). Engine room cleanliness
Marpol (Marine Pollution)	Oily water separators (OWS) and Oil Record Books (record of disposal of any oil residues)
Nautical	a). Loadline matters (ventilators air pipes, hatch covers); b). Structure stability; c). Sanitary facilities; d). Electrical equipment and emergency lighting: e). Anchoring devices; f). Radar and gyro compass;
Lifesaving appliances	Lifeboat, life-raft and lifebuoys
Fire-fighting appliances	Fire dampers and emergency fire pump
Radio	MF/HF radio installation etc.

* Shipping Act (2002) & MOT (2011b)

Table 2. Type of inspection

Type of inspection*	Condition
Initial	prior to ship registration and/or ship repair which alters ship status
Annual	once a year
Renewal	renewal of ship certificate
In-between	conducted once every 2.5 years
Major	once every 5 years
Occasional	additional, whenever accident occurs, whenever repairs have been made

* MOT (2010b:5), Shipping Act (2002:28-29)

3 METHODOLOGY

3.1 Data Items

This research used primary and secondary data as shown in Table 3.

3.2 Research Sequence

This research was carried out in the following manner (see Figure **1**):

Table 3. Data items and sources

Data items	Sources
Concept of lean thinking and its relation to ship safety inspection.	Peer-reviewed journals in library and online databases
Two years data (2009-2011) of ship deficiency detected during inspections	Report and checklist of nautical, technical and radio (NTR) aspect of the inspections; Internal online databases of harbor master Port of Surabaya
The existing procedure of ship safety inspection.	Ship inspection guidelines and related government regulations; Observation in harbor master station.
Marine inspector mindset and perspective on ship safety inspection.	Interview with 11 marine inspectors (including 1 commanding officer) and 48 ship officers

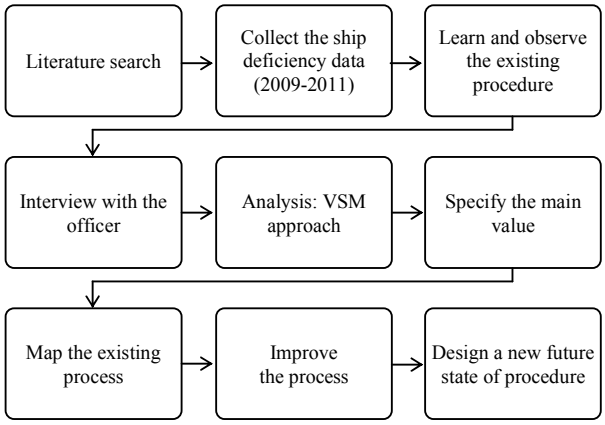

Figure 1. The research sequence

a) A collection of peer-reviewed journal and article concerning lean thinking was reviewed.
b) Data of 520 inspections that have been carried out to 201 ships in the last two years (2009 – 2011) were collected. The data were examined in terms of changes in the number of deficiencies noted between earlier and subsequent inspection (up to six consecutive inspections). Following Cariou *et al.* (2008), a ship that exhibits an increasing number of deficiencies during the next inspection is indicative of lack of significant impact of inspection.
c) The existing inspection procedure described in government regulations such as Sailing Act (No 17 2008) and Shipping Act (No 51 2002) was collected. It was followed by a thorough observation of the actual conduct of inspection and certification.
d) Interview was carried out to 10 marine inspectors, 1 officer in higher echelon (Head of Ship Safety Section) and 48 ship officers comprising ship Master, 2nd Officer, 3rd Officer and Chief Engineer. The interview's main questions are shown in Table 4.
e) The next stage of research was allocated to apply the VSM approach:
   - Specify the main value. The main value delivered by harbour master through ship inspection was examined. This step allowed the author to investigate whether the conduct of ship is in line with the main value or not.
   - Map the value stream. The existing procedure was visualised, detailing input and output of each step in the entire conduct of ship inspection and certification.
   - Improve the value stream (flow of process). In the case where waste and NVA activity were detected, improvement effort was figured out. Improvement aimed to create a smooth flow of process without interruption of waste and NVA activity such as delay, queue, duplication of work etc.
   - Design a future state of procedure. Improvement was implemented through elimination of waste and NVA activity.

Table 4. Main topic of interview

Category	Topic
Process optimization	Understanding on customers and their needs
	Understanding on value provision
	Awareness of vital activity
	Awareness of waste, non-value-add activity and its applicable solution.
	View on responsibility of marine inspector and ship Master/owner/operator upon ship safety improvement
Concept of lean	Awareness of lean concept
	Contribution and commitment on lean should it be applied

4 DATA CAPTURE

4.1 Ship Deficiency

A collection of ship deficiency noted between August 25th, 2009 and October 22nd, 2011 was collected. It represented 520 inspections which have been carried out in that period of time. The data are plotted into Figure **2** which represents up to 6 consecutive inspections that have been undergone by each of 201 sample ships. Inspection I to VI are organised in such a way that it will show a broad view of ship

deficiency status in the given period of time. The arrangement is based on neither the time when the inspection is undertaken nor the type of inspection itself. It is a simplified form representing the accumulation of the detected deficiency in the 201 sample ships.

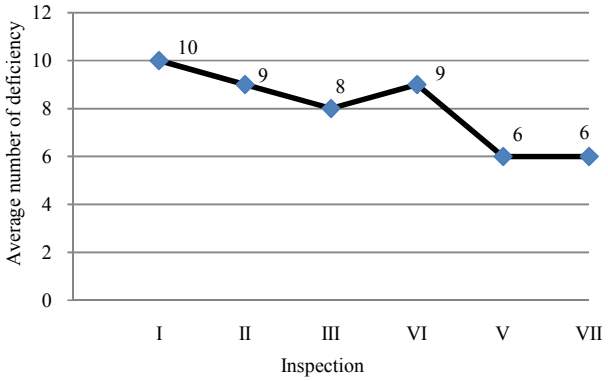

Figure 2. Changes in ship deficiencies noted throughout six consecutive inspections which were carried out between 2009 and 2011

Since inspections I to VI in Figure 2 are the combination of all types of inspection, the total number of ship in each inspection might be different. For instance, inspections I and II represent inspections that have been carried out to 201 ships, while inspections 3 and 4 represent 76 and 24 ships respectively.

Nevertheless, as long as the average number of deficiency is considered, such difference in number should not be a problem.

Among the sample ships, 120 of them (almost 60%) have undergone 2 inspections, while the rest (53, 21, 5 and 2 ships) have undergone 3, 4, 5 and 6 inspections respectively. Considering this fact, it is fairly reasonable to observe the changes in deficiencies at the first two consecutive controls (inspections I and II). At this point, there is a reduction in the average number of deficiency albeit insignificant.

Overall, the reduction achieved between the earlier and subsequent inspections is too small to be considered as significant in spite of the falling trend line shown in Figure 2. In addition, the number of deficiencies found in inspection IV is even greater than that in the earlier inspection.

The individual ship data also support this argument. As illustrated in Figure 3, only 37% (75 ships) of the sample ships experience a reduction in the total number of deficiency detected. The rest, which is 63% (126 ships) in total, experiences either an increasing or a shaky or a constant number of deficiencies. This evidence strongly indicates that the inspections barely have impact on ship deficiency reduction.

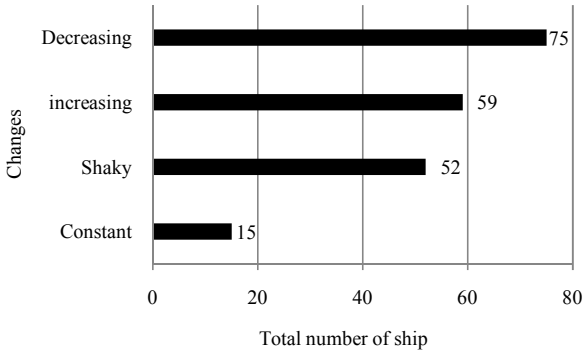

Figure 3. Changes in the number of deficiency among 201 ships

4.2 The Existing Inspection Procedure

The existing procedure in accordance with Shipping Act (2002) and Minister Regulation No. 64 (2010) can be seen in the following subchapter.

4.2.1 Inspection phase

Inspection can be carried out as follows.

a) Pre-inspection: formation of the inspection team, application transfer across departments, confirmation of inspection time and preparation of tools.
b) Field action (on board): boarding the ship, a brief meeting with the ship Master, checking and testing the ship appliances, gathering visual evidence and taking note on deficiency.
c) Reporting: submit inspection report to Hsea, additional recommendation by Hsec if considered necessary.

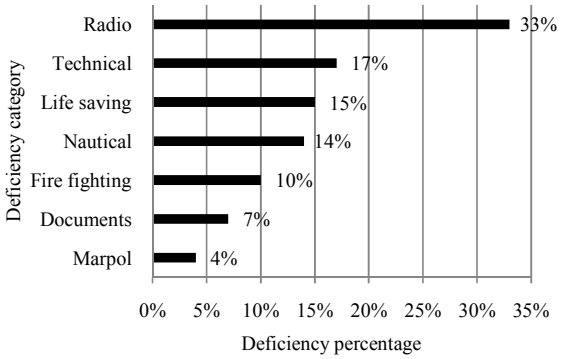

Figure 4. Ship deficiencies found between 2009 and 2011 by category

4.2.2 Certification phase

A certificate was prepared by the staff in the Seaworthiness Department, approved by Hsec, signed by Hsea and finally transferred to the Administration Department for numbering and registration. The ship owner/operator picked up the certificate afterward. It is found that the actual conduct of certification differs from the inspection guidelines. Table 5 and Table 6 illustrate such differences.

4.2.3 Interview outcome

The outcome of interview with 59 respondents is summarised in Table 7 in respect to the majority of answers.

Table 5. Condition for issuance of certificate based on regulation*

Deficiency	Initial inspection	Other inspections (Renewal, Annual, In-between, Major and Occasional)
Major	Certificate shall not be issued. Need correction of deficiency	1). Certificate shall be suspended. Certificate will be restored after corrective action is completed within 3 months; 2). Failure to correct deficiency will lead to withdrawal of certificate. Penalty will also be applied.
Minor	Interim certificate will be issued (valid for 30-60 days); Actual certificate shall not be issued unless corrective action is undertaken within a given period of time	1). Interim certificate can be issued (valid for 30-60 days); 2). Correction of deficiency within 30-60 days; otherwise certificate will be suspended.

* Shipping Act (2002); MOT (2010a)

Table 6. Actual condition for issuance of certificate

Deficiency	Initial inspection	Other inspections (Renewal, Annual, In-between, Major and Occasional)
Major	Interim certificate was issued (valid for 30-60 days); Actual certificate was issued as soon as the interim one expired regardless of correction on deficiency.	Suspension and withdrawal of certificate was ruled out regardless of deficiency detected. Instead, interim certificate was issued and the same process as in initial inspection was applied. However, penalty was applied if the ship failed to renew its certificate within 3 months before expiration date.
Minor	Certification was kept going. Actual certificate was issued regardless of corrective action undertaken.	Certification was continued. Suspension and withdrawal were ruled out. Actual certificate was issued regardless of corrective action undertaken.

Table 7. Summary of the interview outcome

Topic	Marine inspector / Ship officer
Understanding on service provider/customers and their needs	High / High
Understanding on value provision	Moderate / Very High
Awareness of vital activity	Moderate / High
Awareness of waste, non-value-add activity and its applicable solution.	Moderate / Moderate
View on the responsibility of marine inspector and ship Master/owner/operator upon ship safety improvement	Disagree / Agree
Awareness of lean concept	High / Moderate
Contribution and commitment on lean should it be applied	High / Very High

5 ANALYSIS OF SHIP SAFETY INSPECTION PROCEDURE

5.1 Specify the Main Value Delivered by Harbour Master

Vision of the harbour master Port of Surabaya is derived from that used by the Ministry of Transportation, that is: to provide a reliable, competitive and value-adding transportation service to the community (MOT, 2011c). This remark is supported by several missions such as to maintain the level of transportation service, to consolidate transportation modes and infrastructures through restructuration and reformation, to improve the accessibility of transportation service, and to improve the quality of transportation service towards reliable and value-adding services.

The statements emphasise three main values provided by the Ministry of Transportation, which are also delivered by the harbour master: reliability, competitiveness and value-adding.

Reliability encompasses the ability of a system to perform and to maintain its functions in routine circumstances, whereas, competitiveness refers to the ability and performance of a system to supply services in the given market or sector. On the other hand, value-adding represents the aggregate of value added throughout the activities. It refers to an extra feature of service that goes beyond expectation without adding any cost to the production (Free Dictionary, 2011).

As was found in the interview, while many of the marine inspectors acknowledged the importance of reliability, only a few are concerned about value-adding and competitiveness. Unlike ship officers whose job is highly influenced by the speed and accuracy of inspection and certification service, many marine inspectors undervalued these attributes of service, within which reliability is incorporated. This indicates that the understanding of such values is still underrated. As the consequence, vital activity is not really recognised along the lifecycle of procedure, let alone waste and NVA activities. Moreover, it influences the way marine inspectors look upon their responsibility for ship inspection.

For instance, any change or variation in ship deficiency between one inspection and another is left undocumented. This restricts any effort to carry out evaluation and measurement of inspection performance. Thus, education for performance improvement which has been provided for marine inspector, if any, did not work as expected. Meanwhile, duplication or redundancy of work, as well as complicated bureaucracy (red-tape) which hampers communication and coordination between the marine inspector and the ship officer/owner/ operator, is considered as a common matter. In addition, marine inspectors denied responsibility upon delay on the issuance of certificate. They also refused to be blamed if a ship exhibits increase in the total number of deficiency detected during the next inspection.

This finding shows that the lack of understanding on the value created a snowball effect for marine inspectors. They experienced difficulty in recognising vital activity, waste, NVA activity and even their own responsibility. Every process was taken for granted or as the way it used to be. It seems that lack understanding of value built a brick wall separating the harbour master from his vision and mission.

5.2 Map the Value Stream (Existing Procedure)

The existing value stream (procedure) in Figure 5 shows the following wastes inherited by the existing procedure as well as some violations of the regulations.

a) Application delay: the personnel would usually hesitate to bother the Head of Administration Department (H.adm) by going back and forth to the H.adm room for the approval of every single letter.
b) Application queue: Along the way, the instruction note should be signed by related officers including the Head of Safety Section (H.sec) before it can proceed further.
c) Violation A: In step 6, should deficiency is found, the inspection team is supposed to inform the ship Master on the detail and time within which corrective action should be undertaken. Yet, this step is ruled out, which indicates that the ship Master/owner/operator is not expected to correct deficiency detected. Its absence also strongly indicates the presence of overriding consideration on deficiency detected.
d) Violation B: This violation is directly related to violation A. Should the ship Master/owner/ operator is expected to conduct corrective action, step 9 is supposed to commence after it has been undertaken within the given period of time, which depends on the type of deficiency detected. Yet, as Head of Seaworthiness Department (H.sea) is giving instruction for certificate preparation regardless of required corrective action, this violation is created.
e) Waiting delay: This delay results from the administrative personnel's hesitance in proactively informing the ship owner or its agency upon certificate completion. A certificate which has been transferred to the Administration Department upon approval from H.sea can stay up to a couple of days before the arrival of its owner. It somehow seems that a proactive conduct is rare, if not none.

There are some potential problems which should also be included in the category, such as: duplication of instruction note/letter due to the use of manual handwriting, the loss of the instruction note and application during transfer, the loss of application before reaching the H.adm due to the accumulation of letters and other documents in administrative personnel's desk. It causes discontinuation of application and prolongs the processing-time. There are also some duplications of application registered in the Administration Department which are due to the use of the manual handwriting logbook to list the incoming application. It seems that these problems are

mostly caused by heavy dependency on manual-handwriting method in the processing of application. This time-consuming method is also vulnerable to data loss.

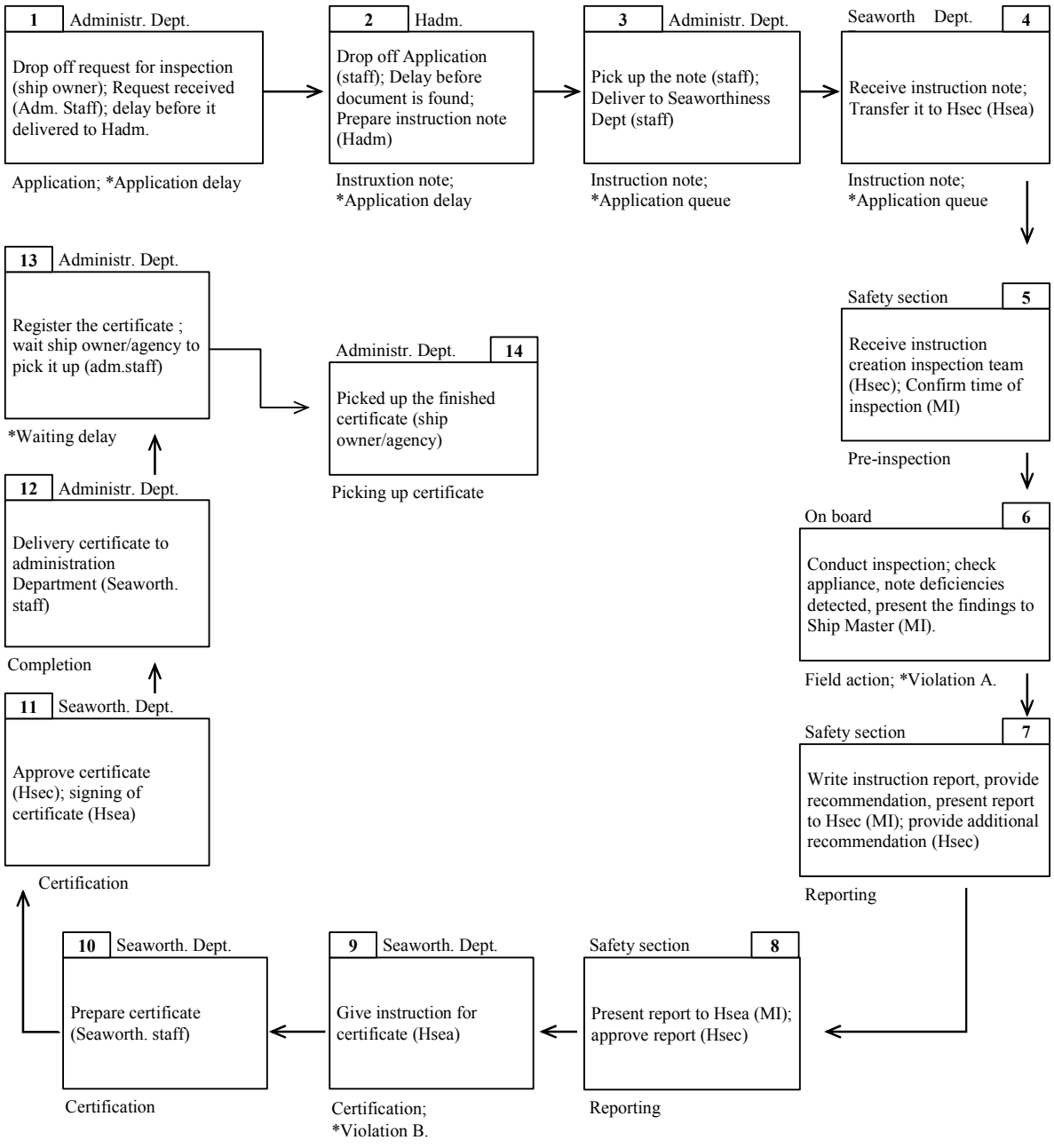

Figure 5. Stream of the existing ship inspection and certification procedure.

5.3 Improve the Value Stream and Design a Future State of Procedure

Some improvements are proposed as in Figure 6:

a) Implementation of a computerised system
The use of email-based working system throughout the conduct of inspection and certification is proposed. As the new system will reduce the use of manual handwriting, it will also minimise other wastes detected such as duplication and loss of instruction note, duplication of application register and loss of application.
The use of email-based instruction note will not necessarily diminish bureaucratic approval as the conduct of checking and forwarding email would likely liable to replace the old system. This new method will not only preserve the officer authority, but also shorten the flow and increase the processing pace. Moreover, the prospect of this new system is exciting, supported by the fact that the harbour master has established a simple online database of ship. Desktop and personal computer have existed albeit limited use and lack internet connection. On the other hand, shipping companies have long been using the computerised system. Therefore, the presence of computerised system on both sides should be beneficial to the improvement of the process.

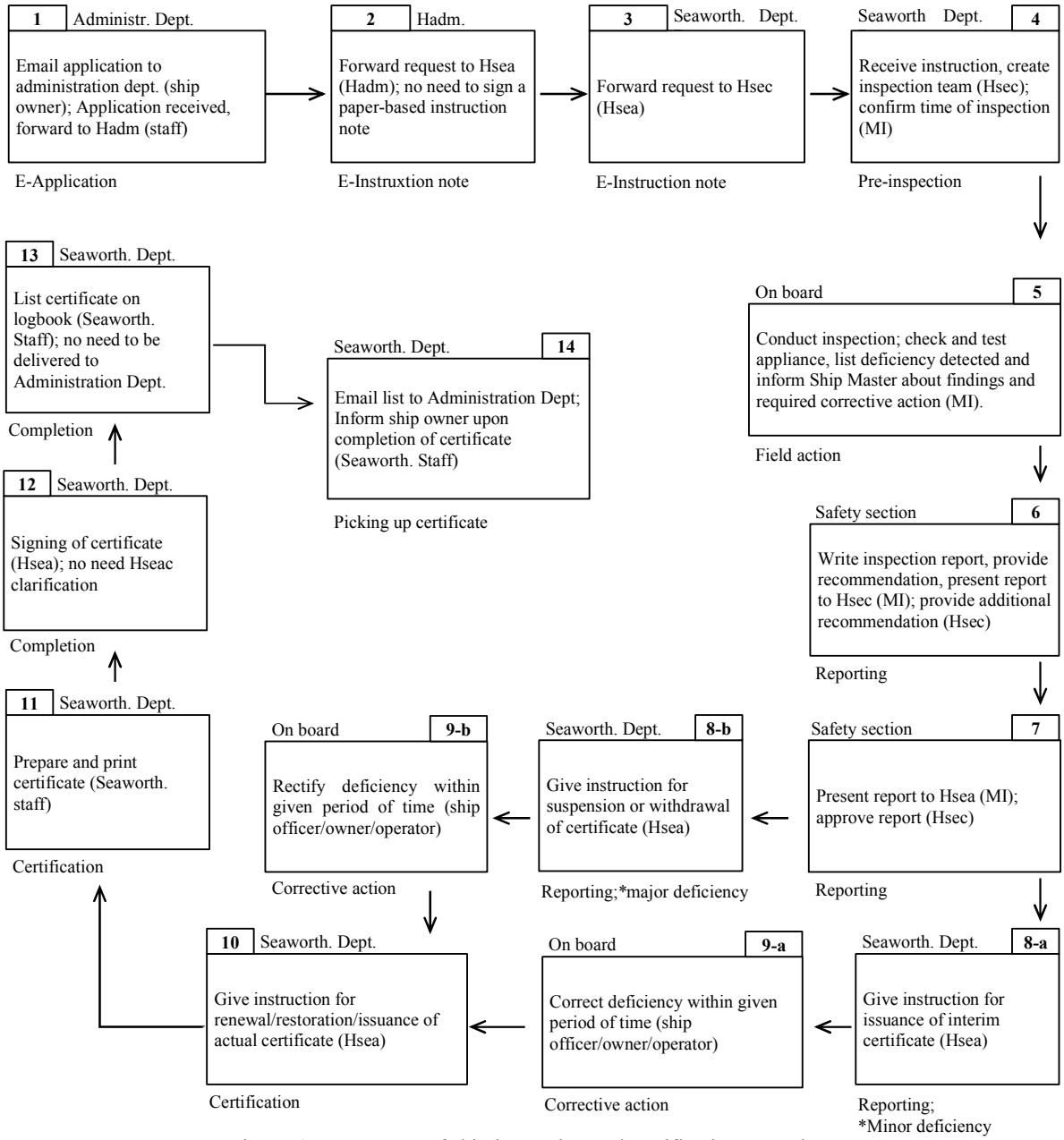

Figure 6. Future state of ship inspection and certification procedure

b) Strengthening the adherence to inspection-related regulation
As described in Table 5 and Table 6, the actual conduct of inspection and certification disregard the regulation. It relates directly to the finding that many ships exhibit increase—instead of a reduction—in the total number of deficiency detected during next control. This means that most of the sample (201 ships) has been given certificates without undertaking the required corrective action.

In addition, violations A and B should be eliminated. The minor deficiency detected should not be underestimated. Meanwhile, in the case of major deficiency is detected, suspension and withdrawal of certificate should be put into consideration.

6 CONCLUSION

In respect to the research questions, the following concluding remarks are drawn:

a) The existing procedure of ship inspection failed to provide significant impact in terms of imposing a reduction in the total number of deficiency detected during earlier and subsequent inspections. The inspection performance is currently in the level of 37 on a 100-point scale. This is due to a complicated maze of bureaucracy and ignorance to the required corrective action relating to the detected ship deficiencies.
b) The application delay and queue, duplication of work and loss of documents (instruction notes) were among the most common detected wastes and NVA activities. Such problem is due to the excessive use of manual-handwriting and manual-delivery system in the processing of application.
c) The conduct of inspection and certification should be managed by a computerised working system and supported by internet connection to establish an email-based processing. This will create a seamless operating method. It will enable a clear and fast communication system both internally (between the marine inspector, other officers and staff) and externally (between the marine inspector and the ship officer/owner/operator). Further, the level of adherence to inspection-related regulation should be strengthened. The issuance of ship certificate should be in accordance with the type of deficiency detected and corrective action required. A combination of these two will increase the efficiency and effectiveness of ship inspection service provided by the harbour master to the client.

By all accounts, these remarks answered the main question stated in the earlier section. However, as it was conceptually designed, the actual implementation of the new procedure will rely very much on a few things such as the following:

a) The financial/economic impact of ship detention.
A strict adherence to the regulations should be cautiously applied. The financial or business impact should be put into consideration when deciding a suspension or withdrawal on a certain ship certificate. For instance, there will be many valuable goods left undelivered in the port should the ship be detained due to a major or some minor deficiencies detected. Accordingly, some exemption should be made without ignoring the safety consideration.
b) A corrupt behaviour of both marine inspector and ship officer has been widely known in the Indonesian maritime industry even though not specifically discussed in the analysis section of this research.
During each inspection, a marine inspector usually received a considerable amount of money from the ship owner/officer/operator which is often dubbed as ‘the administration cost of the ship inspection’. As the consequence, the ship owner/officer/operator was usually not bothered to either rectify or correct the deficiency as the payment has been made to the marine inspector, upon which the issuance of ship certificate was guaranteed. This is one of the biggest challenges related to the effort of strengthening the adherence to regulations.
c) Duration of the new procedure is still unknown. It will need some further studies, observation and examination on the actual implementation (should it be applied) to be able to calculate its duration compared to the old one.

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REFERENCES

Ballard, G., Harper, N. and Zabelle, T. (2003). "Learning to see work flow: an application of lean concepts to precast concrete fabrication." *Engineering, Construction and Architectural Management,* 10(1), 6–14, Emerald (http://www.emeraldinsight.com.dbgw.lis.curtin.edu.au/journals.htm?articleid=845780&show=abstract) accessed on July 22, 2011.

Cariou, P., Mejia Jr., M.Q. and Wolff, Francois-Charles. (2008). "On the effectiveness of port state control inspections." *Transportation Research Part E,* 44(2008), 491-503.

Dickson, E. W., Singh, S., Cheung, D.S., Wyatt, C.C., and Nugent, A.S. (2009). "Application of Lean Manufacturing Techniques in the Emergency Department." *The Journal of emergency medicine,* 37(2),177-182.ScienceDirect (http://www.sciencedirect.com.dbgw.lis.curtin.edu.au/science/article/pii/S0736467908002163) accessed on July 22, 2011.

Duffy, L., Moran, J., and Riley, W. (2006). *Quality Function Deployment and Lean Six Sigma Application in Public Health*, ASQ Quality Press, USA.

Erridge, Andrew and Murray, J. Gordon. (1998). "The application of lean supply in local government: the Belfast experiments." *European Journal of Purchasing & Supply Management,* 4(4), 207-221, ScienceDirect (http://www.sciencedirect.com.dbgw.lis.curtin.edu.au/science/article/pii/S0969701298000124) accessed on July 22, 2011.

Free Dictionary. (2011). *Dictionary and Thesaurus* (http://www.thefreedictionary.com/dictionary.htm) accessed on November 2, 2011

Indonesia. (2002). *Shipping Act No. 51 2002*, Government of the Republic of Indonesia, Jakarta, Indonesia.

Indonesia. (2008). *Sailing Act No. 21, 2008,* Government of the Republic of Indonesia, Jakarta, Indonesia

International Maritime Organisation (IMO). (1974). *International Convention for the Safety of Life at Sea (SOLAS)*. IMO (http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-%28SOLAS%29,-1974.aspx) accessed July 27, 2011.

King, D. L., Ben-Tovim, D. I. and Bassham, J. (2006). "Redesigning emergency department patient flows: Application of Lean Thinking to health care." *Emergency Medicine Australasia,* 18(4), 391-397, Wiley Online Library (http://onlinelibrary.wiley.com.dbgw.lis.curtin.edu.au/doi/10.1111/j.1742-6723.2006.00872.x/full) accessed July 22, 2011.

Lantelme, E. and Formoso, C.T. (1999). "Improving performance through measurement: the application of lean production and organisational learning principles." *Proc. 8th Conference of International Group for Lean*.

Ministry of Transportation (MOT). (1986). *Minister Regulation No. 167, 1986: International certificate of oil pollution prevention*, Ministry of Transportation Jakarta, Indonesia.

Ministry of Transportation (MOT). (2010a). *Minister Regulation No. 64, 2010: Organisational Structure and Procedure for Harbour Master*. Ministry of Transportation Jakarta, Indonesia.

Ministry of Transportation (MOT). 2010b. *Minister Regulation No. 68, 2010: Revision of Minister Regulation No 45 2009*. Jakarta: Ministry of Transportation

Ministry of Transportation (MOT). (2011a). *Organisational chart of harbour master Port of Surabaya*. Harbour Master Port of Surabaya (http://syahbandar-tgperak.net/syahbandar-tgperak) accessed on September 18, 2011.

Ministry of Transportation (MOT). 2011b. *Ship inspection record 2009-2011* (unpublished documents), Harbour Master Port of Surabaya, Indonesia.

Ministry of Transportation (MOT). (2011c). *Vision and mission of the Ministry of Transportation*, Ministry of Transportation, Jakarta, Indonesia (http://dephub.go.id/view/profil/tupoksi) accessed on November 11, 2011)

Parry, G.C. and Turner, C.E. (2006). "Application of lean visual process management tools." *Production planning and control,* 17(1), 77-86, Taylor and Francis (http://www.tandfonline.com.dbgw.lis.curtin.edu.au/doi/abs/10.1080/09537280500414991) accessed on July 22, 2011.

Simons, D. and Zokaei, K. (2005). "Application of lean paradigm in red meat processing." *British Food Journal,* 107(4),192–211,Emerald (http://www.emeraldinsight.com.dbgw.lis.curtin

.edu.au/journals.htm?articleid=1463921&show=abstract) accessed on July 22, 2011.

Weller, H.N., Nirschl, D. S., Petrillo, E.W., Poss, M.A., Andres, C.J., Cavallaro, C. L., Echols, M. M., Grant-Young, K. A., Houston, J. G., Miller, A.V., and Swann, R. T. (2006). "Application of lean manufacturing concepts to drug discovery: Rapid Analogue Library Synthesis." *Journal of Combinatorial Chemistry,* 8(5), 664–669, ACS Publication (http://pubs.acs.org.dbgw.lis.curtin.edu.au/doi/abs/10.1021/cc050164h) accessed on July 22, 2011.

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