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The Impact from Free Flow of 11 Logistics Services Provider to Overall Equipment Efficiency in Beverage Manufacturing Firm in Thailand

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Abstract: This research studies the impact from free flow of 11 logistics service provider to overall equipment efficiency: OEE in beverage industrial sector in Thailand. The registered letters had been distributed to 293 factories. The analysis process had taken factor analysis for construct factors of free flow of 11 logistics service provider and OEE; in addition, multiple regression analysis had been taken for assessment the impact from free flow of 11 logistics service provider to OEE. Then, the results of 78 firms show that free flow of 11 logistics service provider can be explained by 1 factor; OEE can be explained by 2 factors. Next, the finding suggests that free flow of 11 logistics service provider improves OEE which greatly improve in availability and performance efficiency in term of machine operating time and machine speed. Later, this is an opportunity for logistics service providers should exceedingly develop the transfer service in the machine and tooling supply for which notably improve OEE in beverage manufacturing firms in Thailand.

Key words: Free flow of 11 logistics services provider, overall equipment efficiency, beverage industrial sector, tooling supply, sector in Thailand

INTRODUCTION

Associate of Southeast Asian Nation (ASEAN) sponsor free flow of 11 logistics service provider to boost up the production intra ASEAN. Initially, ASEAN has been set, since 1967 and aims to be ASEAN Economic Community: AEC within 2015. Then, AEC has lunched Roadmap for the Integration of Logistics Services (RILS) to ease 11 logistics service provider can liquidity their goods transfer or freely movement. Next, the movement of material and resources from the point of origin to the point of manufacture is inbound logistics or the logistics of production (Gonzalez, 2002). Mainly, AEC has massaged "free movement of goods and establish ASEAN single production base (ASEAN, 2008); also it can be implied that AEC supports free flow of 11 logistics service provider which aims to enhance the manufacturing intra ASEAN.

Free flow of 11 logistics service provider is a trusted strategic which might promote a coordinate, effectively of goods movement from supplier to point of production. Logistics service providers for production have a major role to bring the right materials to the right place and at the right time (Cochran and Ramanujam, 2006; Chow and Frazer, 2003). Mostly, if they failure the production schedule, manufacturers can not make the final goods to delivery and selling on time (Huang *et al*., 2012; Florian *et al*., 2011). Visibly, RILS open free trade 11 logistics service provider is trusted to make the better for industrial in ASEAN (Chandra and Kinasih, 2012; Llanto and Navarro, 2012; Florian *et al*., 2011). So that the study in free flow of 11 logistics service provider is significant for manufacturing firms.

Beverage manufacturing sector is an important role in nation economic of Thailand. Beverage and food industrial sector had constructed the highest GDP 5.86% in 2012 (OSMEP, 2013). Noticeably, they usually focus on Overall Equipment Efficiency (OEE) to control the effectiveness of production, such as carbonated soft drink, alcoholic drink (DIWT, 2012) and milk (DFPOT, 2007), since OEE has defined as a cross product of machine ability, performance efficiency and quality rate (Bamber *et al*., 2003). So that the school work study in OEE is very important to beverage firms in Thailand.

The study in free flow of 11 logistics service provider communicates with OEE in beverage manufacturers in Thailand is a noteworthy. Then, the raised question is Do free flow of 11 logistics service provider improve OEE in beverage manufacturing firm in Thailand? which have not been investigated. So that this research objects to explore the impact from free flow of 11 logistics service provider to OEE in beverage industrial sector in Thailand. This research may contribute a significantly to beverage industrial sector business in Thailand in the future.

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MATERIALS AND METHODS

Free flow of 11 logistics services provider: Logistics service provider is transferring services contractor whom transfer goods, document issue, serve rent a building and warehousing, distributor; also they are infrastructure user, exist and service according to the regulation (DTN, 2012). Prominently, the key driver is logistic service providers whom take the infrastructure and regulation to gain efficient follow logistics user requirements.

ASEAN has forced logistics service as the business urgent to free trade. The opening in the free trade of logistics services sector is a trusted strategic which might promote coordinated, effectively in traffic which are moving goods from supplier to the point of production or consumption (Chandra and Kinasih, 2012; Llanto and Navarro, 2012; ASEAN, 2011, 2010, 2008; Urata and Okabe, 2009). Then, the policy has been promoted free trade of the logistics service provider in ASEAN is Roadmap for the Integration of Logistics Services (RILS) which object to drive the free trade of logistics service provider to enhance logistics efficiency (DTN, 2012).

RILS facilitate to the liberalization in 11 logistics service area which enhances the ASEAN production competition base on creation integrated logistics environment. RILS initially object to remove the restriction on trade in services:

- Maritime cargo handling services
- Storage and warehousing services
- Freight transport agency services
- Other auxiliary services
- Courier services
- Packaging services
- Customs clearance services
- International maritime freight transportation excluding cabotage
- Air freight services
- International rail freight transport
- International road freight transport (DTN, 2012)

RILS policy aims to free flow of 11 logistics service provider. This strategy, force to unbound logistics service both of cross border supply and cross border consumption, foreign equity participation does not exceed 49% and almost unbound of business representative (DTN, 2012). Then, RILS might help logistic service provider whom is logistic driven for better liquidity to supply; as a result, this is a trusted intentional to free flow of 11 logistics service provider as inbound logistics to enhance an intermediated goods supply for manufacturing firms in ASEAN.

Manufacturing firms usually require in timely movement which is initially cost reduction and on time delivery system to meet production schedules. The good logistics management is expected to gain competitive advantage within firms and country level; beside, it can be supported the supply chain with the infrastructure and regulation to development supporting (ASEAN, 2011). Then, logistics service provider is an important for delivering the component from point of origin to point of consumption to assembly to final product at industrial firms (Koli and Rawat, 2011).

Logistics service provider is transferring services supplier whom is infrastructure user according to the regulation to reach services buyers requirement. Free flow of 11 logistics service provider is a trusted strategic to liquidity the intermediated physical goods freely movement; as a result, logistics service provider might be gained the higher efficient in operation. Then which can be implied as ASEAN aims to free flow of 11 logistics service provider to enhance an efficacy of manufacturing firms in ASEAN.

Overall Equipment Efficiency (OEE): OEE has defined as a cross product of Machine Ability (MA), Performance Efficiency (PE) and Quality Rate (QR) (Bamber *et al*., 2003). OEE measuring ensures the best utilization of operations because it related losses in operation in addition, OEE is often used as a driver for improving in quality, productivity and machine utilization. Generally, every firm requires a high level of operating equipment efficiency that means lower downtime and process reliability. OEE can be implied as operational efficiency is the right combination of people, process and technology come together to enhance the productivity (Koli and Rawat, 2011).

Machine ability has defined as ability efficiency (Mathur *et al*., 2011). The ability rate measure total time which systems cannot operating cause from breakdown, adjustment and other stop (Richard *et al*., 2000). Then, preventive maintenance is the tool to decrease the losses in the availability mode (Dal *et al*., 2000) which are breakdown losses and bring up to production losses. Breakdown losses are included equipment failure and quantity losses while bringing up to production losses is included set up and adjustment (Anvari and Edwards, 2011; Jeong and Phillip, 2001).

Performance efficiency was defined as speed efficiency (Mathur *et al*., 2011; Nachiappan and Anantharaman, 2006). Then, performance efficiency is cross product of operating speed rate and net operating rate (OSMEP, 2013; Zandieh *et al*., 2012; Kwon and Lee, 2004; Prickett, 1999; Blanchard, 1997). Next, the performance measure the ratio of equipment operating

speed and ideal speed (Bamber *et al*., 2003); the importance of performance measure the ratio of equipment operating speed and ideal speed which measure equipment capacity as well. The losses of performance efficiency include temporary stopping and reduced speed while temporary stopping include minor stoppage and idling (Anvari and Edwards, 2011; Nachiappan and Anantharaman, 2006; Jeong and Phillip, 2001).

Quality rate is quality efficiency which is the ratio of the amount of good product per processed amount (Mathur *et al*., 2011; Nachiappan and Anantharaman, 2006; Kwon and Lee, 2004; Prickett, 1999; Blanchard, 1997). Then, the important of quality efficiency indicate the proportion of defect products per total production volume (Dal *et al*., 2000). Especially, quality efficiency calculation represents the good part from total production. The losses in quality efficiency include defect and work in process and reduce yield (Anvari and Edwards, 2011; Nachiappan and Anantharaman, 2006; Jeong and Phillip, 2001).

OEE measuring that ensure the best utilization of operation for it related losses in operation. The 10 losses in OEE had shown in Fig. 1. Then, the availability losses are included failure losses, quantity losses, setup and adjustment. Next, the losses of performance efficiency include minor stoppage, idling and speed losses. Afterward, the losses in quality efficiency mode include defective product, reworking and material losses during production. If firms can reduce 10 losses in OEE; it means operational efficiency increasing or it can be implied manufacturing efficiency will be increased.

Beverage industrial sector in Thailand: Beverage industrial sector plays an important role in nation economic of Thailand. Then, beverage industrial sector of Thailand had exported food and beverage 27 billion USD in 2011 also beverage and food industry's growth 3.81% in 2011 which had included non-alcoholic beverage growth 1.52% and alcoholic beverage growth 0.07%. The beverage sector has highly played the stability for economics in Thailand but their critical problem can be explained as follows.

Firstly, beverages firms face to problem of variety of standardization. Thailand have numbers of authorize of beverage safety certifying agencies such as Department of Livestock, Department of Fisheries, Department of Agriculture and Thai Industrial Standards Institute; moreover there are adopt from International Standard, such as Goods Manufacturing Practice (GMP), Total Quality Management (TQM), Hazard Analysis And Critical Control Point (HACCP) and International Standard Organization (ISO) which is all for certain the beverage quality (OIE, 2011). There are effecting on the practice for a business operation to matching a criticism of many food standards that relates cost and investment, therefore, the unit of product cost is increasing.

Secondly, high excise tax is problematic for some beverage manufacturing firms. The alcoholic beverage manufacturing firms in Thailand have to pay excise tax 60%, since the state rule controls the alcoholic drink consumption (ETDT, 2012) which will effect to the high retail price and hardly to sell as well. Then, beverage manufacturing firms in Thailand face to cost of input factors increasing.

The beverage manufacturing firms have to concentrate on increasing the productivity, development the process and practice in the logistics operation. With intention food safety standard and increasing cost of production input factor. Actuality, the material consumptions are hardly to change because their effect on beverage ingredient, thus, it is seems to be a fixed cost per unit. Next, firms should reduce a needless cost in operation; they have to produce a maximum output with minimum unit cost for sustaining the profit which means the manufacturing efficiency improvement.

Research method: The population in this research was top management or company representative in beverage manufacturing firms that had registered with Department

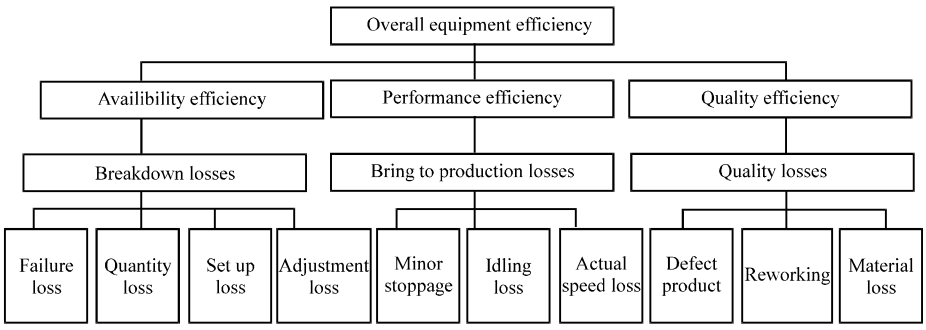

Fig. 1: Overall equipment efficiency and important variable to measure

of Industrial work of Thailand and operated until the year 2013 which was totally 293 factories (DIWT, 2013). The registered mail had been surveyed to all beverage firms in Thailand. The survey queries base on literature review.

The first section of survey questions aims to collect the demographic data of beverage manufacturing firms. That included beverage product type, year of entry to the market; the instrument questions were 4 items as well.

The second section collected the manager's opinion, as a user in various view follows hypotheses model. This section were comprised 2 question groups were rate using 5-point Likert scale ranging from 1: strongly disagree to 5: strongly agree. Normally, a 5-point Likert scale has been used in the survey to achieve higher statistical variability among response (Tsai *et al*., 2012; Tracey, 2004; Lu, 2000). Next, Likert-scale had been used for extent of agreement or disagreement with the statement; item would be interpreted. This section has 21 questions as follow:

The first part aims to instrument manager opinions in "Logistics services provider which has been trusted to improve OEE which had been developed from literature reviews in RILS; there were 11 questions.

The second part objects to collect the opinions in the impact from free flow of 11 logistics service provider to OEE. The instrument question had been developed from literature reviews in OEE; there were 10 questions.

The completed respondents were analysis by Factor Analysis (FA). FA has been taken to define the underlying structure among variable in the analysis, construct factor from variable for explaining and represent the variable set. FA also normally use to reduce the large number of variable to small number variable to construct an index (Hair *et al*., 2010; Neuman, 2006). FA took to construct new factor that ability to measure their value and explain all variation all of variable member. This process covered free flow of 11 logistics service provider, OEE.

After that Multiple Regression Analysis (MRA) has been taken to test hypotheses. MRA is a statistical technique to analyze the relationship between a single dependent variable and several independent variables. The result of MRA will tell how well of independent variable explains dependent variable with R^2, the direction and size of the effect of each variable on a dependent variable (Huang *et al*., 2012; Hair *et al*., 2010; Gujrati, 2003). It had been taken to analyze the relationship between free flow of 11 logistics services provider and OEE.

Hypotheses model: The main research hypothesis (H_1) was free flow of 11 logistics services provider positive impact to OEE in Beverage Manufacturing firms which had been shown in Fig. 2. The relevant hypotheses can be shown as go behind in Fig. 3:

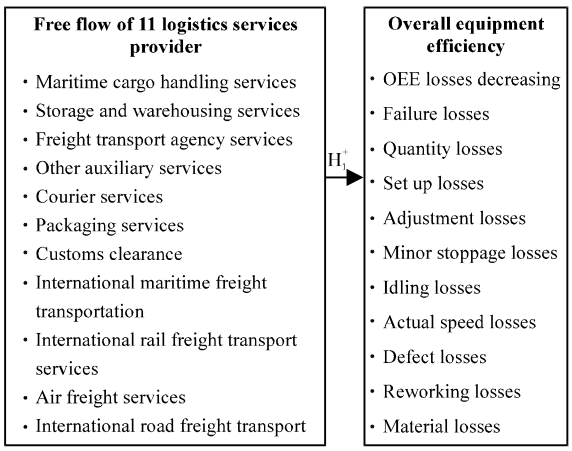

Fig. 2: Hypotheses model (1/2)

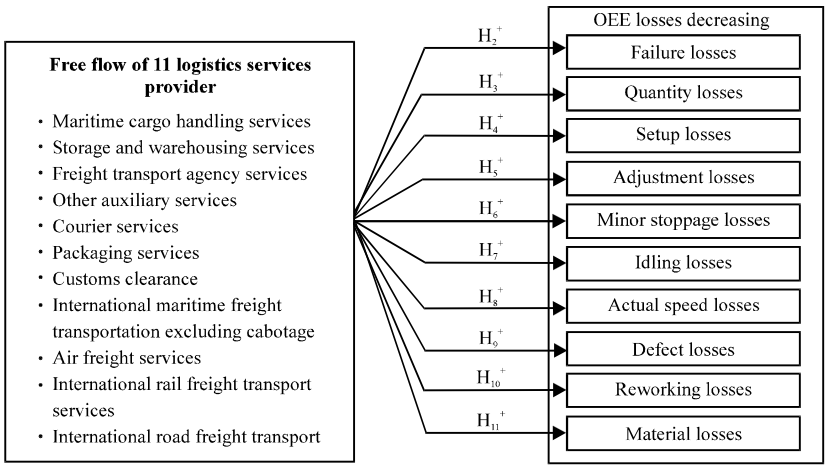

Fig. 3: Hypothesis model (2/2)

- H_2: free flow of 11 logistics services provider positive impact to failure losses decreasing
- H_3: free flow of 11 logistics services provider positive impact to quantity losses decreasing
- H_4: free flow of 11 logistics services provider positive impact to setup losses decreasing
- H_5: free flow of 11 logistics services provider positive impact to adjustment loses decreasing
- H_6: free flow of 11 logistics services provider positive impact to minor stoppage losses decreasing
- H_7: free flow of 11 logistics services provider positive impact to idling losses decreasing
- H_8: free flow of 11 logistics services provider positive impact to actual speed losses decreasing
- H_9: free flow of 11 logistics services provider positive impact to defect losses decreasing
- H_{10}: free flow of 11 logistics services provider positive impact to reworking losses decreasing
- H_{11}: free flow of 11 logistics services provider positive impact to material losses decreasing

RESULTS

Respondent of sampling and firm characteristics: Invitations to this survey participation were lettered to a full amount of 293 firms in the beverage industrial sector in Thailand. From the provocation launched, 35 (11.94%) were undeliverable for they went out of business and had an unfounded address. A total come back 84 participants to rate of 28.66%; nonetheless, the responses 6 (2.04%) were uncompleted and removed. Lastly, the completed responses resulted a total of 78 (26.62%) which were used in this study's data analysis. Normally, the research study manufacturing firms have a low response rate for example, firms reply back 24.24% which is acceptable (Biloslavo *et al*., 2013; Chow and Frazer, 2003).

The largest groups of beverage production type were non-carbonated beverage 87.1%, carbonated beverage 6.4% and carbonated beverage and non-carbonated beverage 6.4%. The largest groups of industrial size were medium enterprises 66.6%, small enterprises 24.3% and large enterprises 8.9%. The largest groups of years of manufacturing were ≤10 years 47.4%, 11-20 years 29.4% and >20 years 23%.

Factor analysis testing: All of initial variable in free flow of 11 logistic services providers had been passed processes of factor analysis testing as a result which were all represented by only 1 factor and every single variable of free flow of 11 logistics services providers were members of new one factor. The new one factor was confirmation of free flow of 11 logistics services providers; also the result of factor analysis testing had shown in Table 1-3. The value of KMO was 0.830 which was >0.6; therefore the collected data in this study suitable for process with factor analysis testing (Burns, 1990). The results of factor analysis had $\chi^2 = 454.337$ with $p = 0.000$ for that reason, total of 11 variable had the good of relation and suitable to development with factor analysis technique. The factor of free flow of 11 logistics services providers had the capability to explain old variable 60.619% which was presented in Table 2.

All of initial variable in OEE had been passed processes of factor analysis testing as a result which were all represented by 2 factors and every single variable of OEE were members of new 2 factors. The new 2 factors were confirmed of OEE; also the results of factor analysis testing had presented as follows Table 4-6. The value of KMO was 0.813 which was >0.6,

Table 1: KMO and Bartlett's test of free flow of 11 logistics services provider

Tests	Values
Kaiser-Meyer-Olkin measure of sampling adequacy	0.830
Bartlett's test of sphericity	
Approx. Chi-square	454.337
df	155.000
Sig.	0.000

Table 2: Total variance explained of free flow of 11 logistics services provider

	Extraction sums of squared			Initial eigen values loadings		
Components	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)
1	8.185	60.619	60.619	8.185	60.619	60.619
2	0.985	7.297	67.916			
3	0.927	6.863	74.779			
4	0.812	6.016	80.795			
5	0.616	4.560	85.355			
6	0.586	4.341	89.696			
7	0.514	3.810	93.505			
8	0.312	2.311	95.816			
9	0.233	1.727	97.543			
10	0.188	1.396	98.939			
11	0.143	1.061	100.000			

Extraction method: principal component analysis

therefore, the collected data in this study suitable to process with factor analysis testing (Burns, 1990). The results of factor analysis had $\chi^2 = 953.758$ with $p = 0.000$ for that reason, total of 10 variable had the good of relation and suitable for development with factor analysis technique. The factor of OEE had the capability to explain old variable 83.369% which was presented as Table 5.

Rotated component matrix had been presented new 2 factor of overall equipment efficiency. Major factor of OEE represented group of minor stoppage, idling, setup, quantity, adjustment, actual speed and failure losses decreasing; also it contained machine availability and performance efficiency which might be called, as availability and performance efficiency. Minor factor of OEE represented group of material losses decreasing during production, reworking and defect losses decreasing which might be called, as quality efficiency.

Summing up, all of initial variable in free flow of 11 logistics services provider and OEE had been tested by factor analysis; consequently, initial variable set in free flow of 11 logistic service providers were all represented by only 1 factor but initial variable set in OEE was presented by 2 factors.

Table 3: Component score coefficient matrix of free flow of 11 logistics services provider

Component score coefficient matrix	Component 1
Maritime cargo handling services	0.197
Storage and warehousing services	0.162
Freight transport agency services	0.145
Other auxiliary services	0.104
Courier services	0.158
Packaging services	0.195
Customs clearance	0.143
International maritime freight transportation excluding cabotage	0.167
Air freight services	0.151
International rail freight transport services	0.168
International road freight transport services	0.135

Extraction method: principal component analysis; rotation method: varimax with Kaiser normalization; component scores

Table 4: KMO and Bartlett's test of overall equipment efficiency

Tests	Values
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.813
Bartlett's test of sphericity	
Approx. Chi-Square	953.758
df	145.000
Sig.	0.000

Hypothesis testing by multiple regression analysis; MRA: All of hypotheses were tested by MRA which recovered the impact of free flow of 11 logistic services providers to OEE. Results of FA testing exposed that free flow of 11 logistics services providers were represented by only 1 factor but OEE was represented by 2 factors as a result, hypothesis H_1 could be rewritten as go behind (Fig. 4).

Initially, hypothesis (H_1) was set as the first hypothesis for this study, however, it had been had to proof by sub-hypothesis which are H_{1a} and H_{1b}:

- H_{01a}: free flow of 11 logistics services provider does not positive impact to availability and performance efficiency in beverage manufacturing firm
- H_{1a}: free flow of 11 logistics services provider positive impact to availability and performance efficiency in beverage manufacturing firm
- H_{01b}: free flow of 11 logistics services provider does not positive impact to quality efficiency in beverage manufacturing firm
- H_{1b}: free flow of 11 logistics services provider positive impact to quality efficiency in beverage manufacturing firm

The testing results of H_{1a} inferred that free flow of 11 logistics services providers was a significant predictor of increasing availability and performance efficiency (Adjusted $R^2 = 0.675$, $t = 5.552$, $\beta = 0.573$, $p<0.001$). Free flow of 11 logistics services provider explained 67.5% of change in availability and performance efficiency. Based on these results, the null hypothesis H_{01a} was rejected and the alternative hypothesis H_{1a} was accepted.

Next, the testing results of H_{1b} inferred that free flow of 11 logistics services provider was a significant predictor of increasing quality efficiency (adjusted R^2 =

Table 5: Total variance explained of overall equipment efficiency

	Initial eigen values			Extraction sums of squared loadings			Rotation sums of squared loadings		
Components	Total	Variation (%)	Cumulative (%)	Total	Variation (%)	Cumulative (%)	Total	Variation (%)	Cumulative (%)
1	7.245	72.452	72.452	7.245	72.452	72.452	4.626	46.264	46.264
2	1.092	10.917	83.369	1.092	10.917	83.369	3.710	37.105	83.369
3	0.531	5.312	88.681						
4	0.300	3.002	91.684						
5	0.273	2.729	94.412						
6	0.213	2.126	96.538						
7	0.166	1.657	98.195						
8	0.091	0.913	99.109						
9	0.056	0.560	99.669						
10	0.033	0.331	100.000						

Extraction method: principal component analysis

Table 6: Component score coefficient matrix of overall equipment efficiency

	Components	
Component score coefficient matrixs	1	2
Failure losses decreasing	0.070	-
Quantity losses decreasing	0.126	-
Setup losses decreasing	0.277	-
Adjustment losses decreasing	0.095	-
Minor stoppage losses decreasing	0.314	-
Idling losses decreasing	0.356	-
Actual speed losses decreasing	0.112	-
Defect losses decreasing	-	0.255
Reworking losses decreasing	-	0.327
Material losses decreasing during production	-	0.520

Extraction method: principal component analysis; rotation method: varimax with kaiser normalization; component scores

0.278, t = 0.338, β = 0.338, p<0.01). Free flow of 11 logistics services provider explained 27.8% of change in quality efficiency. Based on these results, the null hypothesis H_{01b} was rejected and the alternative hypothesis H_{1b} was accepted.

With the intention that free flow of 11 logistics services providers has a significant positive impact to OEE for free flow of 11 logistics services providers have significant positive impact to both of availability and performance efficiency and quality efficiency. Based on these result, the null hypothesis H_{01} was

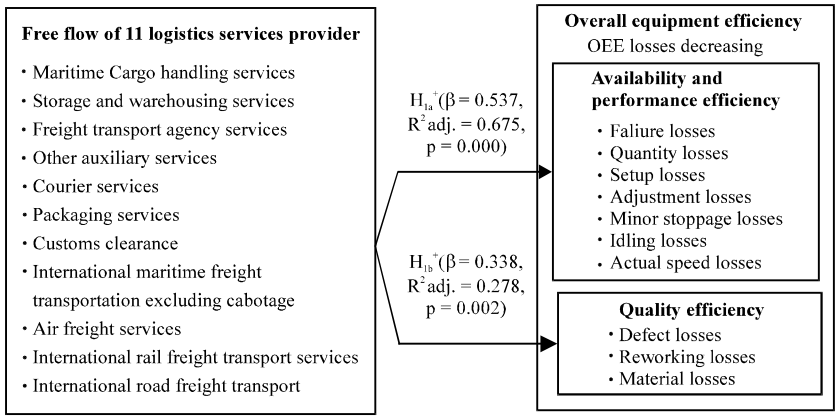

Fig. 4: Hypothesis tested result (1/2)

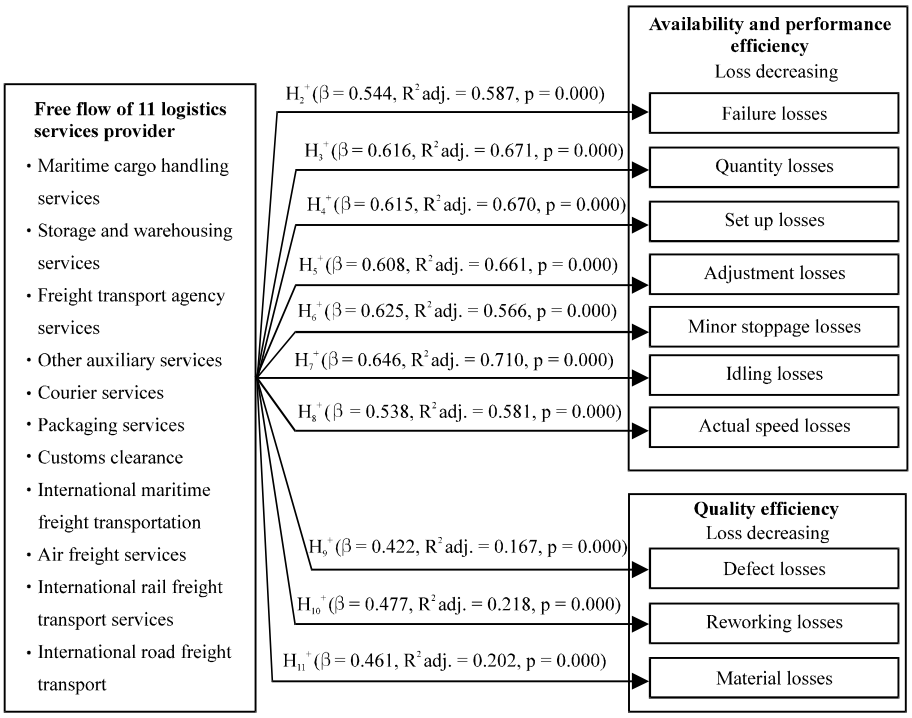

Fig. 5: Hypotheses tested result (2/2)

rejected and alternative hypothesis H_1 was accepted, plus it could be shown in Fig. 4; also free flow of 11 logistics services providers had significant positive impact to all of the variable in overall equipment efficiency and H_2-H_{11} were all accepted which could be shown in Fig. 5.

DISCUSSION

This study is 1st empirical the impact from free flow of 11 logistics service provider to OEE in the beverage industrial sector in Thailand. The finding results support the literature reviews that free flow of 11 logistics service provider positive impacts to OEE in beverage manufacturing firm (H_1). However, free flow of 11 logistics service providers can explain the variation of availability and performance efficiency more than quality efficiency. In exactly, availability and performance efficiency relate the machine and tooling function while quality efficiency is the results from production; consequently, it can be implied that free flow of 11 logistics service providers has a highly relation and machine and tooling function. So that free flow of 11 logistics service provider highly decreases losses time which include failure, quantity, setup, adjustment, minor stoppage and idling losses as well.

The result of this study suggests a strategy which can be taken to improve both of beverage manufacturing firms and logistics service providers. Firstly, beverage firms will get an opportunity to take the better of logistics service provider to improve their OEE also which eases to decrease loss time such as failure, setup, minor stoppage and Idling losses. Secondly, it is an opportunity for logistics service provider; they should highly provide superior transferring services such as machinery, equipment and special tooling for production which are all remarkable need of OEE step up in beverage in beverage manufacturing firms in Thailand.

CONCLUSION

This study was focused on beverage manufacturing firms in Thailand, however beverage manufacturing firms in another country may be different opinion such as logistics providers using, adjustment themselves for the impact of free flow of 11 logistics services provider and the impact to their OEE. Then, a study of the impact of free flow of 11 logistics services provider to OEE of beverage manufacturing firms in Thailand would be based to comparative with beverage firms outside Thailand.

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