# A comparative study on Michinoeki's efficiency in Japan

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**Abstract**

Michinoeki is considered as one of the most successful social experiments in Japan now. A plethora of literature of Michinoeki's have been published over past decades. The authors reviewed many important and typical literatures and found that the quantitative studies are still sparse. Obviously, it is a critical issue to measure the efficiency of Michinoeki's for its further development and revitalization of the local economy. Thus, the data of Michinoeki are gathered from all Michinoeki in Japan, and the relative efficiency are calculated using DEA model for comparison. Furthermore, the managerial implication of the results is discussed in this paper.

*Keywords*: Michinoeki, efficiency, DEA, revitalization, PRC.

## 1. Introduction

One of the unique systems in Japan called Michinoeki started from 1993 with 103 stations now reached 1,193 stations. Michinoeki are well known with its four functions of (1) providing free parking space, restrooms, (2) spreading information, (3) allying with regional society, and (4) preventing disaster [1]. Because of low birthrate and aging society, Japanese economy is facing a serious issue of deflation and economic recession. Thus, Michinoeki is considered as one of the most effective tools for economic recovery, and revitalization of local economy. To our best knowledge, the research papers of Michinoeki using scientific approach are still sparse. This paper attempts to shed light on calculating efficiency and comparing the performance of Michinoeki using DEA model.

This paper is structured as follows: Section 2 introduces the background of this research. In Section 3, the paper explicates data collection and the result using the DEA model. Section 4 shows the analysis and discussions on our findings. The conclusions and managerial implications are proffered in the final section.

## 2. Background

Most of the Michinoeki's research are based on four functions mentioned above. For instance, Yoshida et al.

studied the roles of Michinoeki when natural disaster happened and indicated the detailed reaction if the residents use the Michinoeki nearby their houses [2]. However, much more research focused on economic performance as the important index for their sustainability. Ozuka et al. conducted a questionaries survey and clarified some basic issues of revitalization of local economy [3]. Moreover, Michinoeki are studied from different perspectives such as regional economics and local tourist policies [4-6]. Recently, Ito et al. developed some mathematical models to calculate Michinoeki's efficiency in Yamaguchi prefecture and clarified the characteristics of different areas' Michinoeki [7]. This paper will calculate the efficiency of Michinoeki in Japan and compare the performance of different areas.

## 3. Data collection and Measurement

### 3.1. *Data Collection*

Data including basic information, management style, scale of free parking space, spreading information system, facilities for preventing disaster, population of local areas, and retail shop of local products from 2016 to 2017 were drawn from the internal databases of Michinoeki headquarters. Enot only many missing data, but also logical errors, omission, and errors in writing have been founded. All errors are corrected based on telephone survey and homepage checking. A selected part of collection is shown as in Table 1.

Before efficiency calculation, the variables should be determined. According to the advice from Michinoeki's experts, two variables of passengers of register count (PRC) and sales revenue of register count (SRRC) as description variables, and 20 variables such as square meters of land space (SMLS) and number of the registered farmers (NRF) as the explanatory variables of multiple regression model have been selected. Thus, this leads to the formation of the following regression equation:

$$y = a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + a_6x_6 + a_7x_7 + a_8x_8 + a_9x_9 + a_{10}x_{10} + a_{11}x_{11} + a_{12}x_{12} + a_{13}x_{13} + a_{14}x_{14} + a_{15}x_{15} + a_{16}x_{16} + a_{17}x_{17} + a_{18}x_{18} + a_{19}x_{19} + a_{20}x_{20} + c. \quad (1)$$

where

$y$ … … Passengers of Register Count (PRC)and Sales Revenue of Register Count (SRRC) in H26 or H27;
$x_1$ … … Square Meters of Land Space (SMLS);
$x_2$ … … Number of Standard- Sized Car Parking Lot (NSSCPL);
$x_3$ … … Number of Large Vehicles Parking Lot (NLVPL);
$x_4$ … … Square Meters of Parking Area (SMPA);
$x_5$ … … Total Number of the Restroom (TNR);
$x_6$ … … Square Meters of Free Rest Place (SMFRP);
$x_7$ … … Total Seats of the Free Rest Place (TSFRP);
$x_8$ … … Weekdays' Traffic Near the Station (WTNS);
$x_9$ … … Holidays' Traffic Near the Station (HTNS);
$x_{10}$ … … Population of the City Located (PCML);
$x_{11}$ … … Operating Cost (OC);
$x_{12}$ … … Total Customers (TC);
$x_{13}$ … … Number of the Agriculture Products and Sales (NAPS);
$x_{14}$ … … Number of the Agriculture and Marine Products (NAP);
$x_{15}$ … … Number of the Local Products (NLP);
$x_{16}$ … … Number of the Selling Items (NSI);
$x_{17}$ … … Number of Original Products (NOP);
$x_{18}$ … … Number of the Registered Farmers (NRF);
$x_{19}$ … … Square Meters of the Facilities for Marine Products (SMFMP);
$x_{20}$ … … Square Meters of Facilities Space (SMFS);
c … … constant.

Table 1. Selected part of the corrections.

| ID | Name | Item | Correction |
|---|---|---|---|
| 186 | Jobonnosato | Sales revenue of register count (H27) | Replace "more than 1000" to "1000". |
| 200 | Kisakata | Sales revenue of register count (H26) | Replace "534713390" to "534.713390". |
| 337 | Agatumakyo | Passengers of register count (H27) | Replace "125093(from October to March)" to "250,186". |
| 590 | Utsunoyatouge | Passengers of Register Count (H27)<br>Sales Revenue of Register Count (H27)<br>Total Customers | Replace "66056 (Shizuoka side), 71565 (Fujieda side)" to "137,621".<br>Replace "55 (Shizuoka side), 38(Fujieda side)" to "93".<br>Replace "165140 (Shizuoka side), 178912 (Fujieda side)" to "344,052". |

As result, 8 variables of SMLS, PCML, OC, TC, NLP, NSI, NRF, SMFMP are selected as key factors which have strong impact on PRA and SRRA based on trials and errors.

### 3.2. *Measurement*

Basically, efficiency is calculated as a ratio of output and input. For comparing Michinoeki' efficiency in different areas, a relative efficiency should be calculated. DEA (Data Envelopment Analysis) model is one of the effective tools to calculate relative efficiency. The DEA model (CCR) is defined by the following objective function to find Michinoeki's efficiency as:

Objective function

$$max \quad D_j = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} = \frac{u_1 y_{1j} + u_2 y_{2j} + \cdots + u_s y_{sj}}{v_1 x_{1j} + v_2 x_{2j} + \cdots + v_m x_{mj}}. \qquad (2)$$

where

the Michinoeki's known *r* outputs $y_{r1}, \ldots\ldots y_{rs}$ are multiplied by their respective weights $u_1, \ldots\ldots u_s$ and divided by the *i* inputs $x_{i1}, \ldots\ldots x_{im}$ multiplied by their respective weights $v_1, \ldots\ldots v_m$.

Subject to

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{v_i x_{ij}} \leq 1 \quad (j = 1,2, \ldots, n). \qquad (3)$$

$$u_r \geq 0 \quad (r = 1,2, \ldots, s). \qquad (4)$$

$$v_i \geq 0 \quad (i = 1,,2, \ldots, m). \qquad (5)$$

Using 3 variables selected from above 8 variables: SMLS, NRF, SMFMP, as input, and PRA as output of equation (2), efficiency of 554 stations in H26, and 561 stations in H27 from total 1,107 stations are calculated because of lack of data. The result of 561 Michinoeki' efficiency of 10 areas in H27 is illustrated in Figure 1.

## 4. Analysis and Discussion

Figure 1 shows that the efficiency of Chugoku, Chubu, Hokkaido, Tohoku, and Okinawa is better compared with Hokuriku, Kinki, Shikoku, and Kyushu. For further detailed analysis, mean and coefficient of variation of different areas' efficiency are required. They are shown as in Figure 2 and 3 respectively.

Generally, higher efficiency and lower coefficient of variation, higher performance holds. The efficiency of Okinawa in H27 is higher than other areas, but the coefficient of variation of Okinawa is higher than other areas. Thus, the performance of Okinawa could be considered as one of the best among those 10 areas. Moreover, to clarify the transition of Michinoeki', rank of efficiency and coefficient of variation is illustrated in Figure 4.

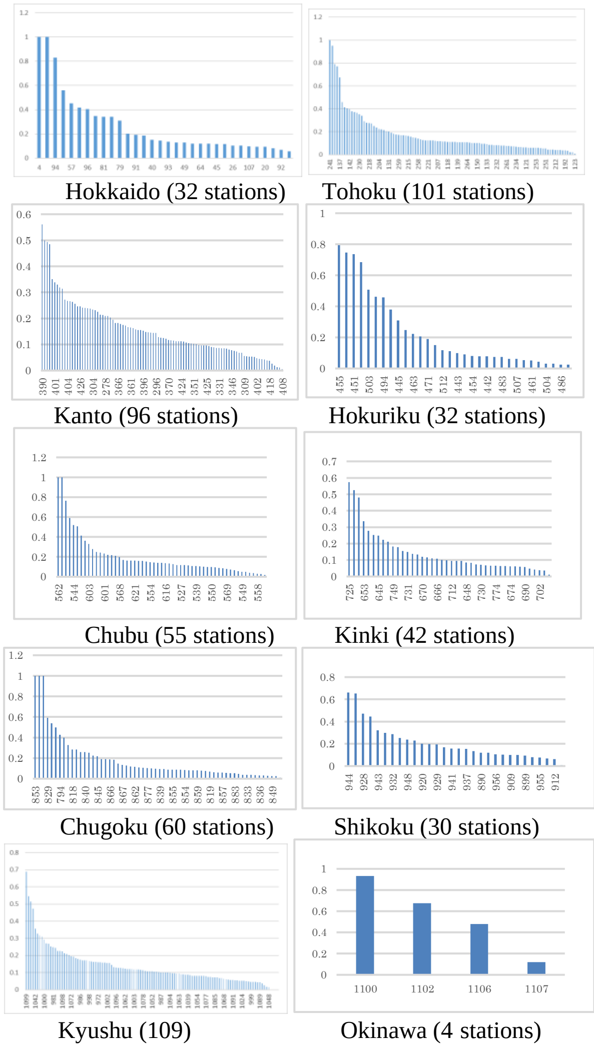


Figure 1. Michinoeki' Efficiency of 10 Areas (H27, 561 stations).

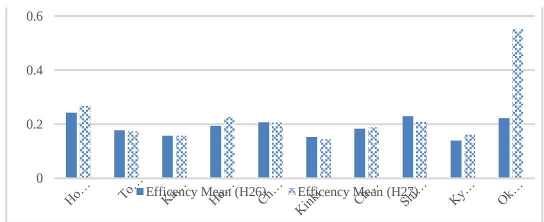


Figure 2. Mean of Michinoeki' Efficiency of 10 Areas.

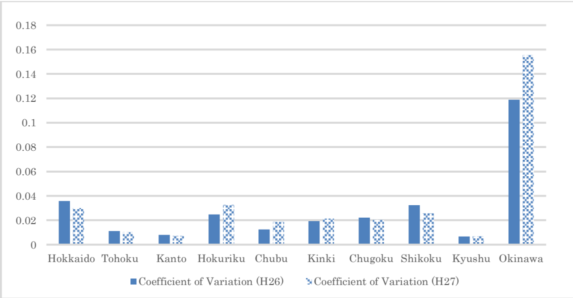


Figure 3. Coefficient of Variation of Michinoeki' of 10 Areas.

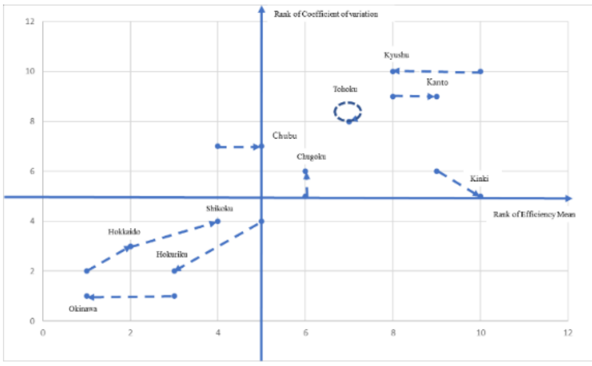


Figure 4. Transition of Michinoeki' Rank of 10 Areas in H26 and H27.

Figure 4 shows that the best Michinoeki is Chubu because of high efficiency and low coefficient of variation. Michinoeki of Shikoku, Hokkaido, Hokuriku, and Okinawa are high efficiency with low coefficient of variation. The rank of Okinawa and Hokuriku in H27 is higher than that in H27, thus Michinoeki in these areas are unstable with high performance. The rank of Michinoeki of Kyushu, Kanto, Chugoku, Tohoku, and Kinki are stable with low efficiency, thus there is room for further improvement for these areas.

## 5. Conclusion

The efficiency of All Michinoeki in H26 and H27 have been calculated in this paper. Tohoku and Chubu are considered as the Michinoeki with best performance. However, it is not enough to analyze transition of Michinoeki only using two year's data. In addition, more variables such as NLP and NSI should be tested as determinants of input for efficiency calculation in future.

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**References**

1. Tsutomu Ito, Minoru Kumano, Takao Ito, Measuring Efficiencies of Michinoeki using DEA Model in Yamaguchi Area, Journal of Robotics, Networking and Artificial Life, Volume 7, Issue 3, 204–207, December 2020, Retrieved December 15, 2021.
2. Satoshi Yoshida, Yasuaki Matsuda, Naoto Takada, A consideration on functions and roles of Michinoeki' for preventing disaster (Japanese edition), Retrieved November 30, 2021.
3. Misuzu Ozuka, A study on finding the relationship between Managerial issues and effects as expected of Michinoeki -resulted from questionaries survey of the Michinoeki in Kinki area- (Japanese edition), Retrieved November 30, 2021.
4. Ryusaku Matsuo and Satoshi Yamaguchi, Michinoeki Economics -Economic revitalization and development of social society- (Japanese edition), Keiso Shobo, August 2019, Retrieved December 15, 2021.
5. Kyosei Sakamoto, kaori Toda, tourist information spreading and revitalization of regional economy from Michinoeki, Retrieved November 30, 2021.
6. T. Hiraoka, H. Nonaka, M. Kumano, S. Nishimura, T. Ito, A Correlation Analysis between Information Related to the Number of Customers and the Agriculture, Forestry, and Fisheries of Michi-no-eki in Japan, Journal of Institute of Industrial Applications Engineers, Vol. 6, No. 4, pp. 173-178, October 25, 2018, Retrieved December 15, 2021.
7. Takao Ito, Tsutomu Ito, Seigo Matsuno, Rajiv Mehta, Makoto Sakamoto, Identifying the Determinants of Michinoeki Performance, Journal of Robotics, Networking and Artificial Life, Vol. 8(3); 165–169, December 2021, Retrieved December 15, 2021.

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