Multi-functional Factories:  
Survey Study on Japanese Electric and Electronics Companies  

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Abstract: A questionnaire distributed to domestic factories belonging to Japan’s electric and electronics industry revealed three results: (1) regardless of the significant shift of production functions to sites outside Japan, approximately 90% of domestic locations are able to complete production functions to a high degree; (2) approximately 54% of locations are able to complete design functions to a high degree, whereas 24% are able to do so to a low degree; and (3) domestic production sites that are able to completely fulfill multiple functions (design/production engineering/production) have the following traits: 1) they are superior to their rivals at delivery accuracy and speed and better at responding to market needs and 2) they are superior to their transplants in China/ASEAN countries at making proposals and developing new products. This suggests that multi-functional...
factories are superior to their transplants in the area of new product proposal and development.

Keywords: multi-functional factory, performance, mother factory, electric and electronics industry

1. Introduction

Japan’s electric and electronics industry has seen itself fall into a predicament from the latter half of the 1990s into the 2010s, owing to changes in the economy, a strengthening yen, and price pressure from players in emerging nations. Many players in Japan have shifted their mass-production sites to China and other overseas sites elsewhere, shrinking the scale of their domestic factories. As Japan’s firms found their footing overseas, the question of establishing international sites for development, production, and sales functions has become a significant one (Amano, 2005; Oki, 2015, 2016). As this shift overseas continues to be stimulated and incentivized, Japan’s domestic sites have assumingly come to serve the critical role of the “mother factory,” supporting the growth and development of their transplants. However, what functions do these domestic sites actually have?

There is a bevy of existing research that has empirically tested the relationship between a production site’s competitiveness (i.e., Quality, Cost, Delivery, Flexibility [QCDF]) and its organization (organizational structure and coordination process) while considering its degree of cross-functional integration and sampling a wide variety of industries and nations/regions (Enz & Lambert, 2015; Frankel & Mollenkopf, 2015; O’Leary-Kelly & Flores, 2002; Swink & Schoenherr, 2015; Thomé & Sousa, 2016; Turkulainen & Ketokivi, 2012). This body of research shows that the advanced capability of
integrating differing divisions/functions—design and production, production and sales—results in increased competitiveness at the location in question.

This research shall conduct an analysis utilizing the data yielded from a questionnaire survey issued to domestic factories in Japan’s electric and electronics industry.

2. Cases of Multi-functional Factory

Shintaku, Inamizu, Fukuzawa, Suzuki and Yokozawa (2014) note that highly-competitive locations in the electric and electronics industry 1) have multiple functions beyond production, including design and production engineering, and 2) have been able to survive by finding their own new business opportunities and altering product lines and operation structures based on superior productivity and design capabilities. For a production site to gain new businesses autonomously, the production site should possess multiple functions: development, production engineering, and sales. Shintaku et al. (2014) more specifically present examples as follows. Factory A had previously only possessed production functionality but was then given development functionality, with the development department and its related quality assurance department and testing units agglomerated together on the second floor of the factory. Further, setting up the production department on the first floor of the factory allowed smooth partnership between the development and production side as the factory succeeded in rapid development of new products and acquisition of the world’s largest market share in those.

Factory B had been transferred head office functionality, and with the intense function concentration, the factory conducted comprehensive initiatives on product development, quality, and productivity. It succeeded in bringing its total cost of production down to levels commensurate with overseas factories. Factory C had
a wide variety of products, including those that were challenging to produce, and fluctuating production volumes. However, since the factory had been developing production facilities internally since its founding, it was able to react flexibly.

This paper shall use its questionnaire data to quantitatively underpin these traits of highly-competitive locations, particularly 1) the number of functions that can be fully completed within a factory (self-contained functions), 2) factory competitiveness, and 3) the relationship between a factory’s number of self-contained functions and its competitiveness.

3. Method

3.1. Data collection

This paper uses data from a questionnaire survey conducted between December 2013 and January 2014 with factories holding production functionality and employing a minimum of 200 members of the Japanese Electrical, Electronic, and Information Union. Three forms were distributed: the Factory Survey (Study A), the Workplace Leader Survey (Study B), and the Worker Survey (Study C). For this paper, we use data from Study A. Respondents to Study A included factory heads, administrative managers, and others who understand the overall state of the factory. Responses were received from 97 locations (response rate: 59.5%).

3.2. Measures

Questions on factory competitiveness were categorized into 1) market competitiveness and 2) productive competitiveness. On

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1 Inamizu (2015), Inamizu, Shintaku, Fukuzawa, Suzuki, and Yokozawa (2015), and Fukuzawa (2015a) base their research on this same survey.
2 The concepts of market competitiveness and productive competitiveness
organization, questions were asked about the degree of the location’s self-sufficiency in fulfilling design, production engineering, production, and sales.

3.2.1. Market competitiveness

For each location’s market competitiveness in its primary business, respondents were asked to measure their degree of agreement with the five items below about the reason why they are rated highly by their customers versus their rivals, domestic and international, for their business with the most sales at that location. For each statement, respondents were given a five-point scale, where one point equals “completely disagree,” three points equal “neutral,” and five points equal “completely agree.”

- MC1: Delivery of low-price products through cost cutting
- MC2: Delivery of unique products/services
- MC3: Accuracy/shortness of delivery times
- MC4: Responsiveness to customization demands from customer
- MC5: Strong customer service

3.2.2. Productive competitiveness

In this research, we inquired about the commonly used QCDF measure, as well as the ability to develop manufacturing and production engineering as a measure of long-term competitiveness (Bhamu & Sangwan, 2014; Fujimoto, 1999, 2003, 2012; Holweg, 2007; Holweg & Pil, 2004; MacDuffie & Pil, 1995; MacDuffie, Sethuraman, & Fisher, 1996; Schroeder & Flynn, 2001; Shah & Ward, 2003, 2007; Turkulainen & Ketokivi, 2012; Womack, Jones, & Roos, 1990).

For the most recent year (from Oct. 2012 to the end of Sep. 2013), respondents were asked to compare their own factory with rival

are based on Fujimoto (2003).
factories within the same company producing the same type of products focusing on the below 10 items. For each statement, respondents were given a five-point scale, where one point represents the comparison site being superior, three points represent equality, and five points represent the respondent’s own location being superior. Respondents made their comparisons almost entirely against locations in China/ASEAN.

PC1: Customer satisfaction  
PC2: External defect ratio  
PC3: Production cost (e.g., personnel, materials)  
PC4: Productivity (e.g., man-hours per single unit of product)  
PC5: Delivery (e.g., time from day of customer order to day of delivery)  
PC6: Flexibility in altering production models/volume  
PC7: Mass-production start-up speed for new products  
PC8: Number of new product introductions (per year)  
PC9: Development of unique production technology (e.g., production refinement, faster processing)  
PC10: New product proposal and development

3.2.3. Self-containment of functions and multi-functionality

Existing research on cross-functional integration (Enz & Lambert, 2015; Frankel & Mollenkopf, 2015; O’Leary-Kelly & Flores, 2002; Swink & Schoenherr, 2015; Thomé & Sousa, 2016; Turkulainen & Ketokivi, 2012) primarily analyzes the relationship between a factory’s integration of the four functions of design, production engineering, production, and sales and the factory’s performance. For each of these four functions, respondents were asked to rate their locations’ self-containment levels on a five-point scale, where one point means the location is entirely lacking the function; three points mean a function can be completed with equal
contributions from HQ, the relevant business unit, or another location; and five points mean the location can entirely complete the function itself.

F1: Product design  
F2: Process design (production engineering)  
F3: Production  
F4: Sales

4. Results

4.1. Factory’s multi-functionality

Figure 1 displays the share of locations with each degree of self-containment for each of the four aforementioned functions ($N = 93$). According to this figure, we find that 1) for design functionality, approximately 54% of locations can conduct design to a high degree (response = 4 or 5), whereas approximately 20% cannot at all (response = 1 and 2) regardless of the significant shift of production functionality overseas, approximately 90% of locations can complete production functionality to a high degree (response = 4 or 5).

Further, for the number of fully self-contained functions for a given location, we assign a value of 1 for responses of 5 for function capability (can completely fulfill) and a value of 0 for any other response (1-4), calculating the total of the values for all four functions. This therefore results in a value between 0 and 4 for the number of self-contained functions. Figure 2 shows the respondent distribution for this number ($N = 93$). This shows that production sites with one or less function they can fully complete are approximately 41% (38 sites), whereas those with two or more are approximately 59% (55 sites).
4.2. Independent $t$-test

Once those with missing values were excluded—leaving 68 locations—the data show that i) 10 sites have no fully self-contained functions; ii) 19 sites have exactly one fully self-contained function
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(of which 15 have production as their self-contained function); iii) 19 sites have exactly two fully self-contained functions (with the most common combination as “production engineering and production”, at 13 sites); iv) 17 sites have exactly three fully self-contained functions (all of which are the combination of “design, production engineering, and production”); and v) 3 sites have exactly four fully self-contained functions. To analyze the impact of a location’s self-contained multi-functionality on performance, we split these into two groups—those with only one self-contained function and those with multiple self-contained functions—and calculate the differences of the means for each competitiveness measure as such, the results of which are found in Table 1.

We see the most significant gaps in competitiveness indexes in MC3 (delivery dependability and speed, $t = 2.36, p < 0.5$), MC4 (customer needs responsiveness, $t = 3.6, p < 0.1$), MC5 (customer service, $t = 2.1$,

| Multi-functionality | ≤ 1 (N = 29) | 2 ≤ (N = 39) | t |
|---------------------|--------------|--------------|---|
| MC1: Low-price      | 3.00 0.85    | 3.36 1.18    | 1.46 |
| MC2: Uniqueness of product | 3.24 0.79    | 3.54 1.12    | 1.28 |
| MC3: Delivery dependability and speed | 3.62 0.82    | 4.10 0.85    | 2.36 * |
| MC4: Customer needs responsiveness | 3.76 0.87    | 4.44 0.60    | 3.60 ** |
| MC5: Customer service | 3.79 0.90    | 4.23 0.78    | 2.10 * |
| PC1: Customer satisfaction | 4.03 0.87    | 4.23 0.90    | 0.91 |
| PC2: External defect ratio | 4.21 0.90    | 4.31 0.89    | 0.46 |
| PC3: Production cost | 1.90 1.18    | 1.77 0.99    | -0.47 |
| PC4: Productivity | 3.59 1.09    | 4.03 0.99    | 1.72 + |
| PC5: Delivery | 3.79 0.73    | 4.00 0.89    | 1.06 |
| PC6: Flexibility | 3.90 0.90    | 3.92 1.20    | 0.10 |
| PC7: Mass-production start-up | 4.14 1.06    | 4.33 0.96    | 0.78 |
| PC8: # of new product introductions | 3.59 1.30    | 3.85 1.39    | 0.79 |
| PC9: Development of unique production technology | 4.24 0.91    | 4.46 0.85    | 1.01 |
| PC10: New product proposal and development | 4.03 0.98    | 4.51 0.85    | 2.10 * |

Note: $N = 68$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$
\( p < 0.5 \), and PC10 (new product proposal and development, \( t = 2.10, p < 0.05 \)). Note that we also see a significant trend with PC4 (productivity) at the 10% significance level. In short, responses indicate that production sites that have multiple fully self-contained functions are 1) more highly rated in their accuracy and speed of delivery, as well as responsiveness to market needs, and 2) superior to their transplants in China/ASEAN countries at new product proposal/development.

5. Discussion and Conclusion

From the above-mentioned points, we can form the following conclusions:

(1) Approximately 90% of domestic locations are able to complete production functions to a high degree despite a strong shift of production functionality overseas;

(2) Approximately 54% of locations are able to complete design functions to a high degree, whereas 24% are able to do so to a low degree; and

(3) Domestic production sites that are able to completely fulfill multiple functions (design/manufacturing/production) have the following traits: i) they are superior to their rivals at delivery accuracy and speed and better at responding to market needs and ii) they are superior to their transplants in China/ASEAN countries at making proposals and conducting development on new products.

The third result shows that multi-functional factories are superior to their transplant in the area of new product proposal and development. Our results suggest that to increase global market competitiveness and sustain superiority over transplants in new product proposal and development, it may be effective to build
production sites that are fully self-contained in multiple functionalities. Multi-functionality at a production site may result in greater costs but is expected to also result in better dynamic capability (Fukuzawa, 2015b) to respond to environment changes through increased ability to create new markets via new product proposal/development.

**Acknowledgments**

The authors deeply appreciate the cooperation of Japanese Electrical, Electronic, and Information Union. This work was supported by JSPS Grant-in-Aid for Publication of Scientific Research Results, Grant Number JP16HP2004.

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