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National R&D Project Evaluation and Key Performance Indicator Reengineering

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Abstract. Taiwan industries are largely divided among Original Equipment Manufacturers (OEM) and Original Design Manufacturers (ODM). In order to improving economic development, Taiwan industries hope to shift their business models towards enhancing global brand equity, i.e., transforming their companies into Original Brand Manufacturers (OBM). Increasing competitiveness and successfully pursuing sustainable businesses requires government funding agencies for industrial development to monitor the performances of companies, receiving government funding, with a set of carefully designed Key Performance Indicators (KPIs). This research develops a set of improved KPIs for repositioning enterprises that enhance their competitiveness across the aspects of OEM, ODM and OBM. The research evaluates the validity of currently used industry performance indicators and measurement methods. Case companies from both manufacturing and service industries including precision machinery, chip design and manufacturing. The questionnaire results are analyzed and the suggestions are made to help enterprises improve their project performance and corporate transformation.

Keywords. Original brand manufacturer (OBM), Key Performance Indicators (KPIs), Performance evaluation

Introduction

The Original Equipment Manufacturers (OEM) and Original Design Manufacturers (ODM) modes have greatly contributed to Taiwan's economic development over the last forty years. For more than two decades, Taiwan technology companies have moved their supply chain to other countries to lower costs for original brand manufacturers. Taiwan enterprises have fallen short in creating branded products and, thus, the number of Original Brand Manufacturers does not increase significantly. OEMs are mainly responsible for production. Their main customers may design the products, authorize the production, and market the branded products. Therefore, manufacturing is the OEM's most important task. This study divides manufacturing performance types into productivity and sustainability. The former can directly reflect the effectiveness of manufacturing, while the latter points out that environmental awareness is the key to

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sustainable manufacturing. ODM refers to the production method in which the manufacturers' tasks are from design to production and their customers are mainly responsible for marketing and sales to end-customers. Therefore, R&D is an important task for ODM, which may need to be innovative in R&D and engage in collaboration with others such as academia. OBM refers to that a manufacturer owns and promote its brand and sells its branded products directly to end customers. According to the survey, a successful OBM must have the ability to market products through a good distribution network [1]. Therefore, successful marketing and sales play a pivotal role in OBMs. The majority of Taiwan enterprises in the technology sectors are still limited to being an OEM supplier with low margins and high pressure playing a part in the upcoming new manufacturing hubs [2]. In light of new regional low-cost entrants to the value chain and as part of Taiwan's economic policy, the Industrial Development Bureau (IDB) provides incentives to re-position companies from being OEMs towards being OBMs. For strategically re-engineering companies' business models, KPIs for government sponsored project assessments become crucial to ensure companies' successful endeavors. Thus, this research evaluates and critiques current industry performance indicators and creates new and sustainable KPIs to evaluate Taiwan companies pursuing the OBM mode. The importance rankings of the KPIs were analyzed, and specific KPIs are either deleted or modified in weights depending on the correlation between the KPIs and actual company OEM/ODM/OBM goals.

1. Literature review

The literature reviewed for this research presents a wide range of publications relevant to the OBM business model. Reviewed literature includes World Economic Forum [3] reports on global competitiveness and scholarly publications (journal and conference papers) related to conducting performance evaluations for various industries.

Most companies often rely on quantitative indicators to monitor and evaluate their performance levels and to plan long-term development of their business strategies. KPI is a critical measurement tool used for this purpose. KPIs are important components in converting raw data into decisions [4]. Moreover, the critical success factors are the key driving force behind performance measures [5]. Thus, KPIs are often correlated to the critical (or key) success factors of enterprises. In this section, we review and summarize all types of KPIs and their classifications, which serve as the baseline framework for this research.

Staron et al. [4] developed a quality model for KPIs to increase the reliability and validity of measurement across industries. Contemporary software development organizations rely on quantitative information to monitor products and processes. One of the tools used for this purpose are KPIs. In contrast to generic indicators, KPIs in this sector should allow for customized measurement. The authors conducted their research with data from a computer infrastructure provider and an automotive OEM to develop and evaluate the model.

Samsonowa et al. [6] have conducted research in establishing reliable and valid KPIs for research departments of enterprises. The authors established separate measurements for research organizations within the ICT-sector. The study applies a multiple case study methodology to compile KPIs using expert interviews to confirm observations from current literature. The researchers identified over 160 different KPIs for ICT research organizations, so KPI across companies turned out to be difficult to

compare due to differing meanings of the same KPI within these companies. Researchers decided to establish 12 KPI clusters and distribute the 160 KPIs between these clusters. Clustering was based on empirical similarity and benchmarks relevant for research organizations, which enables weighted rankings for each company which would have been impossible for self-reported KPIs from the expert interviews.

Rubinson and Pfeiffer [7] describe specific key performance indicator measures for brands and how to intelligently set targets for each brand measure. The authors propose a measurable framework for brand equity and present a model for linking different dimensions of brand equity with financial goals. The authors propose a brand management system which incorporates financial performance, loyalty, and attitudinal dimensions. This system provides companies a better means to position brands, and establish standard brand references. This system also centralizes brand management and ensures organization-wide consistency in order to improve profitability brought about by increased brand equity and brand performance. More details about the OBM-centric KPIs are discussed in Section 3.

2. As-is key performance indexes

The current architecture is based on the Input, Output, Outcome, Impact (IOOI) model for performance evaluation used by Industrial Development Bureau [8]. The present architecture tracks performance along a set of benefit indicators and measurements. The performance tracking measurements are scheduled in sequence according to project maturity and commence with inputs at the beginning of the project. This is followed by an evaluation of direct outputs during project execution.

The rating mode is of central importance to the current method utilized by the IDB to evaluate the performance of companies. Based on the current architecture model of performance tracking, IDB uses *output, outcome and impact* to measure individual corporate performance. Each of these three parts is then further divided into individual performance oriented measurements that are subject to a set of KPIs. KPIs that achieve a certain benchmark value are ranked on a scale of A to C. Finally, after rating each performance measurement, the IDB calculates the final rating for each project's performance.

In order to establish an objective standard for benchmark values, the annual benchmark values are changed dynamically. Therefore, the IDB in Taiwan uses the IOOI model and establishes a benchmark value to measure the KPIs performance. Moreover, IDB also utilizes this tracking system to promote the development of industrial technology research.

3. To-be key performance indicators

For the OBM model, the subcontractor replaces the buyer and undertakes all functions of the value chain [9]. Therefore, the validity of the to-be model of performance evaluation is fundamentally dependent on measurements and KPIs relevant to moving upwards in the value chain and assuming R&D and brand marketing functions. Since the main purpose of this research is to help Taiwan enterprises transition toward the OBM mode, this section studies literature used to evaluate the importance of performance indicators relevant to measurements and KPIs needed for the transition to

an OBM. Domestic and foreign studies are analyzed to optimize current measures and add valid KPIs to build a new architecture for performance evaluation. Finally, this reconstituted architecture can be used to advance the effectiveness of the existing architecture.

3.1. Incorporate brand measurement for to-be KPIs

This section describes the three most widely used brand measurements: Brand Finance [10] [11], Interbrand [12] [13], and BrandZ [14] [15] as a reference for the to-be brand measurement model. Brand Finance is divided into three indicators: brand strength index, ranking concept, and assigning the company a royalty rate. Interbrand measurements are divided into three indicators: analysis of the financial situation, analysis of the brand's customer impact, and measurement of the brand's strength. Lastly, BrandZ is another measurement method divided into two indicators: the analysis of the financial value of the brand and the measure of the value of the brand. These three methods are described in detail.

Brand measurement is divided into three phases that interact with each other. Brand Finance [10] [11] utilizes the following valuation formula: Brand Strength Index × Royalty Rate × Brand Revenue. The brand strength index is determined by a series of related factors, including emotional relationships, financial performance and sustainability. The index ranges from 0 to 100. Financial brand performance includes the brand revenue, historical brand income, the stock performance forecast, the economic growth rate and the brand specific income including expected income from patents.

Interbrand [12] [13] calculates brand value from three components. The first component is brand strength. This component encompasses both internal and external factors. Internal factors are composed of clarity, governance, commitment, and responsibility. External factors are composed of authenticity, distinction, relevance, consistency, engagement and presence. The second component is the role of the brand. The role of brand is measured as a percentage score and is derived from primary research, expert panel assessment, and a review of the historical role other brands used by companies in that industry sector. The last component is financial analysis. This component is made up of economic profits and the overall financial return for the organization's investors.

BrandZ [14] [15] calculates brand value using brand value and financial value to yield a metric called the attribution rate. Corporate earnings are multiplied by the attribution rate to arrive at branded earnings, which refers to the amount of corporate earnings attributed to a particular brand. Predicting future earnings requires adding another component to the BrandZ formula. This component assesses future earnings prospects as a multiple of current earnings. Information supplied by Bloomberg data helps to calculate a brand multiple. Branded earnings are then multiplied by the brand multiple to obtain the financial value of the brand. BrandZ is distinguished from other brand rankings because it incorporates the consumer's viewpoint which provides meaningful, different, and salient insights.

3.2. A new model for OBM-centric performance measurement

The new model approaches performance evaluation from a strategy-centric perspective, focusing on the transition to OBM for Taiwanese technology enterprises. The model is

applicable to different strategic goals and can be adjusted for different industries. The proposed model identifies OBM-relevant value chain functions and then proceeds to create thematic clusters which are then divided into insightful measurements. These measurements are benchmarked using weighted KPIs.

Marketing and research are recognized as elemental value chain functions needed to transform companies into the OBM mode [16]. R&D functions of enterprises are already developed due to ODM experience. Marketing is recognized as the function lacking most in capability among Taiwanese enterprises [17]. Manufacturing will invariably be influenced by upgrades in R&D and upgrades should be encouraged, albeit with lesser weight than research and marketing. KPIs are given a benchmark score from 1 to 7 depending on their performance. The proposed framework also provides dashboard functionality, allowing for immediate recognition of problem areas. The total performance score is complemented by the function based benchmark scores.

The new KPI model is based on OBM as the core framework and includes the function of manufacturing, research and marketing. The model consists of 7 clusters and 21 KPIs. The productivity cluster includes the labor utilization KPI which effectively measures the productivity of labor and sets the standard from 85% to 95% [18]. The KPI extent of staff training and technology absorption in the cluster of productivity and company spending on research in the cluster of innovation are regarded as important indicators of global competitiveness [3]. The KPI recyclability of the product measured and plant emissions are in the cluster of sustainability. The KPI rate of return on innovation investment is in the cluster of innovation which demonstrates that the wealth of enterprises is partly created from the investment in innovation [19]. The KPI contribution of branded products to revenue in the cluster of brand equity and international retail sales per year in the cluster of distribution are regarded as a solid measurement of brand value [10] [11]. The KPI ratio of advertising and promotion spending on sales is in the cluster of promotion. Rubinson and Pfeiffer [7] note that advertising and promotion play an important role in market competition. The KPI number of international trademark registrations, number of international advertising campaigns, budget for exhibiting at international trade shows and number of international retail distribution agreements are determined by case analysis [6]. Additionally, some KPI's such as number of application patents filed and number of international design awards are based on the IDB's field measurements.

3.3. Categories of KPI validity evaluation criteria using case examples

Threats to the validity of the new performance evaluation are addressed in Table 1 [3] [4] [9]. The main threat to the construct validity is that companies might use different theoretical foundations to construct the KPI model. To ensure construct validity, the KPI model should be evaluated across different industries. Threat to the internal validity is that a company might use KPIs only selected to demonstrate the company is performing well. Therefore, it is better to work with domain experts to evaluate the model objectively within the industry domain. Threats to conclusion validity is that some measurement might be ambiguous and without an exact means to measure so quantification and visualization of the results is necessary. Last, the threat to the external validity is that a company might use company-specific quality attributes in the model so that the results are only applicable to the context where they are designed. To ensure external validity, the metrology should be used as the foundation and then extend the evaluation for other contexts by using international standards.

Table 1. Categories of KPI validity evaluation criteria.

Validity	Threat	Resolution
Construct validity	Different type of companies have different interpretation in the KPI context.	Evaluate the model under different industries and suitable evaluation theory.
Internal validity	The evaluation of the model is in the same context where it was designed (within the company).	Work with domain experts. They could evaluate the model objectively within the industry domain.
Conclusion validity	Lack of inferential statistics for evaluation.	Quantify and visualize the results with in-depth analyses and verified the results with the stakeholder
External validity	Using company-specific quality attributes which are only applicable to the context where they are designed.	Use the metrology as the foundation and extend the evaluation for other contexts using international standards.

4. Questionnaire design and survey implementation

This study designs a questionnaire for evaluating several case company's key performance. The questionnaire contains KPI self-evaluation performance measures and KPI quantitative data. Each questionnaire is designed according to the KPI framework proposed in this study. The self-evaluation performance questionnaire includes seven subclasses in three categories, i.e., manufacturing (as OEM centric indexes), R&D (as ODM centric indexes), and marketing (as OBM centric indexes). By measuring the KPIs for the case companies, the questionnaire results are used as an incentive for improvement and enhancement with respect to OEM, ODM, and/or OBM-centric development.

4.1. Weight of the KPI indicators

In order to highlight the OEM/ODM/OBM focuses of case company types, the questionnaire performance analysis must establish standard attribute weights (Table 2). The table indicates that successful Taiwan companies generally believe their research and marketing performance attributes carry higher weights (needs more emphasis) than manufacturing attributes, which are already held in high regard. Moreover, for the OBM-centric companies, the marketing aspect is much more significant regarded than both research and manufacturing. The above relationships are reflected in the KPI weight settings for this research. Further, innovation and brand equity attributes are valued the highest among the case companies.

Table 2. Categories of KPI validity evaluation criteria.

Classification	Attribute	Weight
Manufacturing	Productivity	0.1
	Sustainability	0.1
Research	Innovation	0.2
	Academic collaboration	0.15
Marketing	Brand equity	0.17
	Promotion	0.14
	Distribution	0.14

4.2. Analysis of the Questionnaire results

Referring to the questionnaire results for KPI self-evaluation performance, this study collected ten questionnaires from companies which have successfully implemented government projects funded by Industrial Development Bureau (IDB). These companies' self-evaluated performances for the 7 KPIs are shown in Figure 1. The surveyed companies relied largely on their R&D innovations which has been a major focus of IDB funded projects. In the marketing category, most of the companies have self-assessed lower scores, indicating that incentives and KPIs should be designed into the funded programs to improve performances in this category. Generally speaking, companies gave low scores to their performances in academic collaboration and brand equity which showed major gaps between academic research and industrial adoption. Both are essential for OBM-centric expansion and development. On the other hand, the survey also found that the self-assessed performance of service-oriented companies (D, G, I, J) are low on their expectations for brand equity and market promotion while electronic and mechanical manufacturers (B, C) want their productivity to improve. In summary, service-oriented industries hope to enhance their brand strength and their marketing promotion efforts while manufacturing companies focus on improving their production efficiency. These outcomes indicate that majority of Taiwan companies still belong to the OEM and ODM types. These companies act as bellwethers yielding data that is not ideal for the IDB's OBM promotion to other manufacturing industries.

We have interviewed three companies for their detailed KPI quantitative data. Company A is dedicated to IC design and manufacturing. Company B design, manufacturing, and distributes information and communication hardware products. Company C is in the precision machinery manufacturing. By analyzing the questionnaire results, some suggestions are made. Although Company A currently focuses on ODM / OEM as its main business model, the high number of patents granted and the number of international trademark registrations indicates that it has good R&D capabilities, actively commercializes its technologies, and enhances its brand equity. Compared with Company A, Company B has licensed several foreign technologies. It also has a low number of international trademarks. Company B's advertising campaigns indicate that the company's marketing category indicators (brand equity and market expansion) need to be further strengthened. Company C is a typical OEM company but it is active in marketing efforts, owning a large number of international trademarks and expanding its product offerings into 52 countries. Based on the above KPI quantitative data, Company A should continue to strengthen their

technology, global R&D cooperation, and commercialization. Company A also needs to enhance its performance in the marketing categories. Company B proposes to actively expand its product awareness for international market expansion. Company C should strengthen its R&D capabilities to facilitate the establishment of its own brand.

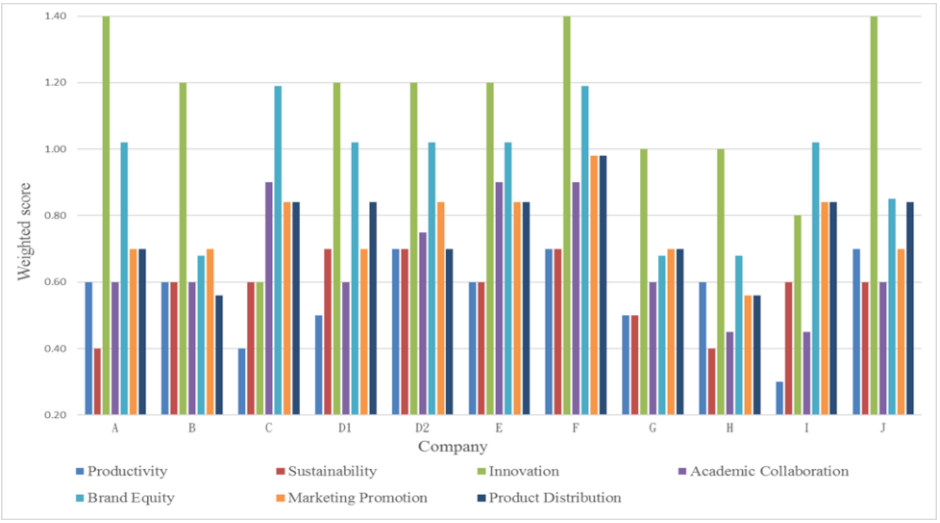

Figure 1. The weighted self-evaluation performance indexes

5. Conclusion

In the process of this study, key performance indicators and previous IDB reports were aggregated. Then, based on an extensive analysis of the relevant literature, a new evaluation model has been developed and reengineered considering aspects of OEM, ODM, and OBM. The new KPI framework proposed in this study has defined three major categories and seven attribute sub-classes. In addition, weights can be assigned with respect to the attributes' importance. In summary, the proposed model provides OBM-centric (in addition to the as-is OEB- and ODM-centric KPIs) and transition-relevant, thematically cohesive, actionable evaluations. The model is useful for tracking post-program performance while allowing enterprises to identify categories in need of attention. Component scores for individual functions allow to quickly identify under-performing attributes, while the aggregate score gives a final and total performance evaluation of the funded project and company. This research conducted a questionnaire survey for ten companies including manufacturing and service industries. By using the OBM-centric KPI indexes and weights, this research discovers the different strengths of three case companies and their needs for enhancement. Although this research only has 10 company samples in demonstrating their performance in specific aspects, the results do demonstrate the re-engineered KPIs can accurately show highlights of OEM, ODM, or OBM features and capabilities. This research will continue to improve the performance evaluation system allowing industry specific ready-to-use evaluation models.

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