



APCOMS 2009

The 2nd Asia-Pacific Conference on Manufacturing System

Reconfigurable Manufacturing System for Facing
Turbulent Manufacturing Environment

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PROCEEDING BOOK

NOVEMBER 4th-5th, 2009

YOGYAKARTA, INDONESIA



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FOREWORD FROM ORGANIZING COMMITTEE

Distinguished Rector of Universitas Islam Yogyakarta, Dean of Faculty of Industrial Technology, ITB, keynote speakers, participants of Asia Pacific Conference on Manufacturing Systems and National Seminar on Production Systems, Ladies and Gentleman,

Welcome !

This is the second conference for Asia Pacific Conference on Manufacturing Systems, known as APCOMS 2009 and the ninth conference for the National Seminar on Production Systems, known as SNSP. These joint conference is held biannually. At the beginning we start the conference for the national scope and strated from two years ago we extend this national seminar regionally to Asia and Pacific regions.

The conference main objectives are firstly to make a forum for exchanging research results on manufacturing systems; secondly to facilitate discussions among researchers and academicians for better understanding of current challenging issues on manufacturing system research as well as manufacturing practices; and lastly to strengthen the research network around Asia-Pacific.

Today and tomorrow, we will have 58 papers to be presented at APCOMS and 22 papers to be presented at SNSP. I' m expecting that all papers will stimulates critical discussion and provides interesting time for all of you during your stay in this joint conference.

Moreover, Yogyakarta is also an interesting historical city. As one of the main tourist destination in Indonesia, I do hope that besides of spending your time for discussion, you can spend your time to enjoy the Javanese food, traditional, and culture in Yogyakarta.

I would like to thanks to all of conference participants for your paper contribution. To both keynote speakers, I would also like to convey my gratitude for your interesting speech. Lastly, I think, we would not be able to make this conference happened without all hard works and extra efforts contribute by the reviewers and others member of organizing committee. May I take this opportunity to thanks you all for the efforts you shown.

Thank you and pleased do enjoy this conference. ●

Dr. Ir. TMA Ari Samadhi

Prof. Dr. Ir. Chairul Saleh

Organizing Committee Chairs

2nd Asia Pacific Conference on Manufacturing Systems

9th National Seminar for Production Systems

FOREWORD FROM DEAN OF FACULTY OF INDUSTRIAL BANDUNG INSTITUTE OF TECHNOLOGY

First of all, allow me to extend our warmest welcome to all distinguished delegates to the 2nd Asia Pacific Conference on Manufacturing Systems (APCOMS 2009) organized in conjunction with the 9th National Seminar on Production Systems. Welcome to Yogyakarta, a historic city and one of the popular tourist destinations in Indonesia. It is our utmost pleasure to be given the honor to host a regional conference and a national seminar, referred to as a joint conference, simultaneously.

The development of manufacturing sector in one country is believed to be one critical factor in the growth of nation's prosperity as has been shown by developed countries like USA, Japan, Korea, Australia and many European countries. Therefore, all initiatives on research and development of methods, tools, and practices for design and operation of manufacturing system are expected to contribute significantly to the development of manufacturing system. This, in turn, would assist the advancement of manufacturing sector.

Moreover, the development of manufacturing system indicates the trend toward a wide network information system, a robust process and intelligent control system, and the globalization of production as well as the development of virtual manufacturing network. This challenges academicians and practitioners to cope with current and future competitive environments.

I have learned from the Organizing Committee that more than 70 papers will be discussed in this joint conference, in which APCOMS 2009 will discuss more than 50 papers submitted by authors from several countries. I do believe that this conference will provide you a stimulating environment to share experiences and discuss your research findings in addressing the current issues on manufacturing system. This joint conference also functions as a means for strengthening research network across Asia Pacific region.

This joint conference would not have been possible without a strong collaboration between Manufacturing System Research Group, Faculty of Industrial Technology, Institut Teknologi Bandung and Industrial Engineering Department, Universitas Islam Indonesia and generous supports from the Association of Institutions of Industrial Engineering Higher Education in Indonesia (BKSTI) and Ikatan Sarjana Teknik dan Manajemen Industri (ISTMI). I would like to take this opportunity to express my sincere gratitude to all of them. My special thanks go to keynote speakers, reviewers, authors and all delegates to this joint conference. I should also be grateful to all sponsors for financial supports and, of course, to the Steering Committee and Organizing Committee for working very hard in preparing and organizing this joint conference.

I wish you a fruitful and productive conference. Have a pleasant stay in and explore the fascination of Yogyakarta.

Dwiwahju Sasongko

Dean, Faculty of Industrial Technology, Institut Teknologi Bandung

FOREWORD FROM RECTOR OF ISLAMIC UNIVERSITY OF INDONESIA,

Distinguished Professors, Participants of 2nd Asia Pacific Conference on Manufacturing Systems and 9th National Seminar on Production System, Ladies and Gentleman,

Assalamu'alaikum warahmatullah wabarakatuh,

It is a great pleasure for me to welcome you to this conference and to Yogyakarta, one of the main tourist destination in Indonesia that rich with Javanese Culture, the city that is part of our nation development history, and also the education city. I do hope that your two days stay here in Yogyakarta will bring you an enjoyable and memorable experience since you are not only sharing knowledge, experience and building network of research on manufacturing system, but you are also stay in a warm and friendly atmosphere.

I'm also want to express my sincere joyful, that Universitas Islam Indonesia be able to cooperate with Institut Teknologi Bandung, along with the Coordinating Body of the Industrial Engineering Education in Indonesia (BKSTI) and Ikatan Sarjana Teknik dan Manajemen Industri (ISTMI), to host this 2nd Asia Pacific Conference on Manufacturing Systems in conjunction with the 9th National Seminar on Production System. I will sincerely hope that this cooperation will continue in the future.

This conference is a good opportunity for all of you to share your research results, to communicate with other researcher across Asia Pacific, to build network of researchers and academicians which then will provides you with capabilities to create new knowledge. I do hope the seminar will be stimulating, interesting, beneficial and give you enjoyment.

The conference would not have been possible without your contribution as well as the support from steering committee, organizing committee, key note speakers, and others parties. I would like to express my sincere appreciation to all of them. Again, please enjoy your stay in Yogyakarta.

Wassalamu'alaikum Wr. Wb.

Yogyakarta, November 4, 2009

Prof. Dr. Drs. Edy Suandi Hamid, M.Ec.
Rector, Islamic University of Indonesia

Group 1: Ergonomic, Quality Culture

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FOREWORD FROM HEAD OF MANUFACTURING RESEARCH GROUP ITB

The current condition of the global economy has made many manufacturing companies struggling to cut their costs or improve their value by any means necessary. During these difficult times, it is obvious that there is less money available for new or additional development, market is harder to predict and thus income is harder to maintain, and there is increasing pressure from global customers to lower prices. What manufacturing companies need to keep in mind, however, is that while the impact of a recession may be significant from a business perspective, in reality the application of sound manufacturing improvement principles has a much more significant effect on companies' success than the state of the economy.

There are many companies that have prospered in recessionary times, and they have done so by focusing their efforts to meet the demands of the market. There are issues that can affect the prosperity, and the application of these principles can help make hard times a lot easier. The theme for this conference is "*Reconfigurable Manufacturing System (RMS) for Facing Turbulent Manufacturing Environment*". It is widely accepted that turbulent manufacturing environment forces manufacturing enterprises to build capability to reconfigure its system in line with the environment change. The manufacturing enterprises must be able to adapt to the environment changes and transforming its system effectively and efficiently for gaining competitiveness.

To cope with this situation, Manufacturing Systems Research Group (MSRG) of ITB needs to contribute in promoting concerns for the importance of RMS by initiating action to promote the development of knowledge and application of RMS. To achieve this, MSRG of ITB need to share and cooperate with other contributors worldwide. This is the main motivation of MSRG of ITB to endorse the RMS as the theme at the 2nd Asia Pacific Conference on Manufacturing Systems 2009. This is a biannual conference which is aimed at providing a forum for presenting new ideas on the current issues of manufacturing system among international researchers and the industry professional. At the same time, the 9th National Conference on Production System is held to accommodate local participants presenting related topics in Bahasa Indonesia.

Finally, I hope that all of these efforts in making these events will benefit to us, as I am certain that it is your hope as well.

Bandung, November 2009

Dr. Dradjad Irianto
Head of Manufacturing System Research Group ITB

Integrating Balanced Scorecard and Malcolm Baldrige National Quality Award: A Case Study in a Distribution Company

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Abstract. *In this paper Balanced Scorecard (BSC) and Malcolm Baldrige National Quality Award (MBNQA) are integrated to create a better performance measurement system. The nature of each system is briefly explained and the strengths and weaknesses are discussed. The integration is exercised by firstly mapping the perspectives of each system. MBNQA's perspectives are then overlaid into a typical BSC's strategy map. Using this approach, advantages of both systems can be exploited while at the same limitations are reduced. The new model is then implemented in a distribution company in Indonesia and the results are reported.*

Keywords: *Balanced Scorecard, Malcolm Baldrige National Quality Award, performance measurement system.*

1. INTRODUCTION

To date, performance management has risen as one subject that attracts attention of scholars and business practitioners worldwide. Many researchers devote their study on its development with the aid of businesses that lend their hand in providing ground for implementation. Its necessity has its root from today's information era, where changes and exchanges of information flow rapidly thus demand a new approach for monitoring and evaluating company's performance. Such approach must be able to gauge company's performance in a timely manner. This is to complement the traditional financial measures that are still used but naturally lagging, hence its sole use will not be able to describe company's performance as a whole.

Hand in hand with the advancement of this subject are its success/fail stories. While the fail stories outnumber the success ones, the main reason why it still keeps evolving is the absent of a system that can be proven superior to others. Problems lie both in the body of knowledge (concept,

philosophy, and structure of each system) and in the implementation area (perception, skills, and determination of parties involved). In this regard, the search continues for a model that can be widely applied. It is understood that there will never be a one-fits-for-all model, but a generally accepted one is nonetheless worth to seek.

Among many models developed, Balanced Scorecard (BSC) stands out and is considered as a groundbreaking innovation in performance measurement theories over the decades (Bourne *et al.*, 2003). It has, however, evolved from one generation to another in its effort to adapt with the latest business environmental changes. This evolution is partly driven by reported failures of its application in various organizations that enforces the search for a better BSC (Schneiderman, 1999; Neely & Bourne, 2000).

One approach for the search that has been adopted lately is through integration of two different systems. This is to overcome weaknesses of one system with strengths of the other. Using this approach, advantages of both systems

can be exploited while at the same limitations are reduced.

This paper discusses the integration of two different performance measurement systems: Balanced Scorecard and Malcolm Baldrige National Quality Award (MBNQA). Each is firstly reviewed independently, and the process of integration is then discussed. The new integrated model is then implemented in a distribution company and the results are reported.

2. LITERATURE REVIEW

Pioneered by Kaplan and Norton through various publications (Kaplan & Norton, 1992, 1993, 1996, 2001, 2004), BSC has gained interest in the subject of performance management. It has also evolved in several generations. Brown (2007) divided this evolution into three stages: (1) early 1990s when the concept of scorecard emerged as alternative to sole financial measurement in performance management; (2) 1995-2005 when the term BSC was first coined and the concept began taking off; and (3) 2006 and beyond that marked the introduction of scorecard deployment technique and analytics metrics.

The main selling point of BSC is that in today's information era, financial measures are lagging and thus incapable to anticipate future challenges of a company. Other perspectives than financial were then introduced, namely: customer, internal business process, and learning and growth. However, a number of critiques have been addressed as BSC limitations. McAdam and O'Neill (1999) stated that BSC remains a means of effectively measuring strategy rather than a means of deciding strategy, therefore requires other tools as support such as SWOT analysis. Rillo (2003) criticized that cause-and-effect relationships or strategy maps in BSC are built up in a subjective way that does not necessarily refer to time factor. In other words, they are not time-wise connected. Further argument that is also mentioned is whether the causal interrelations between the perspectives exist in all circumstances. Wibisono and Surjani (2005) analyzed four common problems in BSC applications: (1) being used merely as metrics rather than strategy-based initiative; (2) lacking of commitment during implementation; (3) company-wide communication issues; and (4) needing better techniques for measuring intangible indicators. The latter was also cited by De Waal (2003).

Other types of performance measurement systems are award-driven systems. The most notable in this classification is Malcolm Baldrige National Quality Award (MBNQA), initiated since 1987 and originated in the USA (<http://www.baldrige.nist.gov>). It is awarded once a year to the best company from several categories (manufacturing,

service, small business, education, health care, and non-profit organizations). Its major aim is to promote quality awareness towards performance excellence. As a national initiative, competition for the award is for USA companies only. However, being a model for excellence, many firms outside USA try to adopt the concept for self improvement. Today, other continents now have their own model similar to MBNQA. In Europe, European Foundation for Quality Management (EFQM) was launched in 1991 and set forth as an excellence framework that helps organizations learn better of their business process in order to achieve better performance (<http://www.efqm.org>). In Singapore, adapted from MBNQA, the Singapore Quality Award (SQA) was established in 1994 and has been used by industries both for self-improvement initiative and performance excellence recognition. The difference with MBNQA, apart from the weights of the categories, is that SQA focuses heavily on customer satisfaction in determining performance (Chow & Goh, 2002).

Both types of performance measurement systems (vision-led system such as BSC and excellence model such as MBNQA) have their own advantages and disadvantages. While typical BSC is constructed based on its classical four perspectives, flexibility is given in this aspect. Companies can add/modify their own perspectives to create a scorecard that can better explain their strategy. The strategy map that is inherent in all BSC models, when designed properly, has a great advantage to detail the alignment of a company's strategy toward its vision and mission. This flexibility, however, can also translate to the absent of guidance and could produce difficulties during the process in generating key performance indicators (KPIs). In this regard MBNQA has the upper hand for being a system that is intentionally designed to measure the entire aspects of an organization. However this is where the debate starts: should we measure everything and gain total information but at the expense of focus, or should we focus by measuring only the important issues? BSC users always argue that measurement must be aligned to organization's vision and therefore it needs to be directed on the important and relevant strategies only. Indeed, a good BSC is often associated with having small number of KPIs. On the other hand, MBNQA practitioners often argue that the model might lack focus on strategy, but still put emphasis on operational results.

3. INTEGRATED MODEL BSC & MBNQA

Different characteristics of each performance model lead to the need of a combined model with better traits. We show first the original framework of MBNQA, followed by brief explanation of BSC. Lastly, the integrated model of BSC-MBNQA is presented with discussion on its rationale.

The framework of MBNQA consists of seven categories: (1) leadership; (2) strategic planning; (3) customer and market focus; (4) measurement, analysis, and knowledge management; (5) workforce focus; (6) process management; and (7) results (Figure 1). These categories are grouped into three perspectives: driver, system, and results.

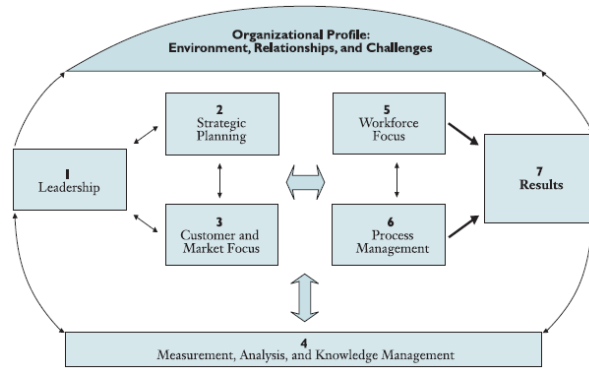


Figure 1: Framework of MBNQA.

For BSC, the original perspectives are learning and growth, internal business process, customer, and financial. These four perspectives are linked in a causal manner from first to last, i.e., good performance in learning and growth will result to good performance in internal business process and so on. Nowadays there are varieties in perspective formulation and organizations adjust them to better suit their operations. For example, service industry such as logistics has its own scorecard with perspectives such as warehousing, transportation, marketing, and customer service. The idea is that service-oriented companies should have different key issues from manufacturing companies, putting more emphasis on their relationship with customers. Likewise, non-profit organizations normally have different structure for their performance system. Perspectives in such organizations can also vary, but the most important part is on the causal relationship, where financial is not normally put at the top as an ultimate goal.

Given this development, a new model can also be reasonably constructed. The approach used is by combining already sound frameworks of BSC and MBNQA. It is realized that each system has its own high and low points. Being a vision-driven system, BSC helps organizations to achieve its future goals by aligning their strategies toward its vision. However, as McAdam and O'Neill (1999) mentioned, the system itself does not dwell on the discussion as to how to develop strategies. This lack of guidance is a potential problem whereby if strategies are not properly designed then the causal relationships among perspectives will also come to questions. By firstly

mapping and finding similarities of functions between BSC's and MBNQA's perspectives, associations are made between them. The strength of BSC with its strategy map and cause-and-effect relationships is used as main structure of the combined model. Its weakness of being too flexible in strategy formulation is then offset by imposing MBNQA's structure into the strategy map. The combined model is illustrated in the right block of Figure 2.

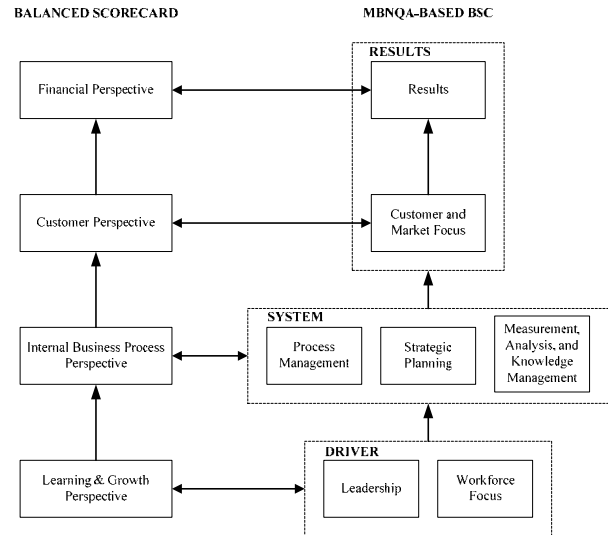


Figure 2: Integrated model of BSC-MBNQA.

As seen in Figure 2, the interrelationship between perspectives in BSC is maintained, but the structure is replaced with those of MBNQA's. In this combined model, learning and growth perspective of BSC is substituted with MBNQA's driver perspective, consisting of two categories: leadership and workforce focus. Internal business process perspective is viewed equivalent with system perspective of MBNQA that consists of the following categories: process management; strategic planning; and measurement, analysis, and knowledge management. Two categories in MBNQA's results perspective (results, and customer and market focus) are broken down and connected to the last two of BSC's perspectives.

What follows in the next step is strategy formulation. In this stage, strategies are formulated from MBNQA items by focusing on organization's vision. To maintain clarity of the strategy map, only relevant items should be taken out and elaborated as strategies. The principle "measuring what are important, not what can be measured" is upheld in this process in order to avoid creating a cluttered strategy map. A performance measurement system is after all different from an award-based or excellence model. Such a system

must be concise and easily understood by the stakeholders with regard to its vision and how it can be achieved via proper strategic planning.

Based on the formulated strategies, KPIs are then generated. The effectiveness of a particular strategy can be tracked down by more than one KPI. This whole process is exercised using a distribution company in Indonesia for case study. The next section details the application of the integrated model for performance measurement.

4. CASE STUDY IMPLEMENTATION

In this section we report the implementation of the integrated model in one company. We start by describing the company's background followed by the performance measurement process.

4.1 Background of the Company

The company chosen for the case study is located in Denpasar, Bali. It operates in the fields of trade and distribution and was formed in 2007 from a merger of two companies: a paint distribution company (established in 1998) and a motorcycle parts and accessories dealer (established in 2004). Its areas of operation include Bali and West Nusa Tenggara.

Implementing a new model poses a certain degree of risk to the benefactor. To reduce it so to ensure that the process will be manageable, we therefore chose a company that is fairly small in size with just 20 workers and led by two senior managers and a CEO. However, given the recent organizational restructuring resulting from the merger, the process remained challenging. The recent merger also creates complexity in the company's daily operations and as such it can be considered in a growth stage.

4.2 Implementing the Integrated Model

The company envisioned itself to become the largest distributor of paint and motorcycle parts/accessories in Bali and West Nusa Tenggara. To achieve this vision, the company formulated the following missions: (1) establish a variety of marketing channels to reach out more customers; (2) improve human resources skills to support growth by providing quality products and excellent services to customers; (3) build close work relationship with partner companies.

To construct the strategy map, MBNQA items from its seven categories were mapped. SWOT analysis was also carried out at this stage and used to assist in filtering

MBNQA items that will be formulated into strategies. This is where the integration rationale plays its role. Without MBNQA items, there is less direction as to what strategies are to be built. However, an important principle that a good scorecard must be compact is maintained by the use of SWOT analysis as filter. It prevents explosion of MBNQA items from swamping the strategy map with strategies irrelevant to the achievement of the company's vision.

From this process, nine strategies have been formulated and grouped under the seven MBNQA categories. Both the categories and strategies are aligned to particular mission. Causal relationships were then made, linking one strategy to another in the most logical manner. How "logical" the relationships are depends on the assumptions underlying them. There is no way at this stage to ascertain the strength of the connections. Such must be evaluated in the long run, adjusted and readjusted as necessary responding to the changing/present condition. It is suffice for early construction of the strategy map to rely on logic supported by intensive discussion among key persons in the company. The resulting strategy map is depicted in Figure 3. Each of the five categories of MBNQA has one strategy, whereas the other two have two strategies each.

To measure the effectiveness of the strategies, KPIs were generated. There are 27 KPIs involved, 7 belong to driver perspective, 9 system, and 11 results. Classified in the MBNQA categories: 2 leadership, 5 workforce focus, 3 strategic planning, 3 measurement, 3 process management, 8 customer and market focus, and 3 results. These KPIs were then weighed. Firstly, we assigned weights to the perspectives and categories based on MBNQA original points for those elements (Table 1). It should be noted here that the MBNQA framework puts emphasis on results where this perspective is given more than half of the overall weight. This spirit is in line with all performance measurement systems, including BSC, where it is common for financial perspective to be given the most weight. These weights were then distributed to the KPIs using pairwise comparison based on Saaty's analytical hierarchy process (Saaty, 1980). The final distribution of KPIs' weights is listed in Table 2.

Table 1: MBNQA points.

Perspectives	Categories	Points	Total points	Weights
Driver	Leadership	120	205	20,5%
	Workforce focus	85		
System	Strategic planning	85	260	26,0%
	Measurement, analysis, and knowledge management	90		
	Process	85		

	management			
Results	Customer and market focus	85	535	53,5%
	Results	450		
Total		1000	1000	100,0%

The integrated model has now been fully developed and is set for application in measuring the company's performance.

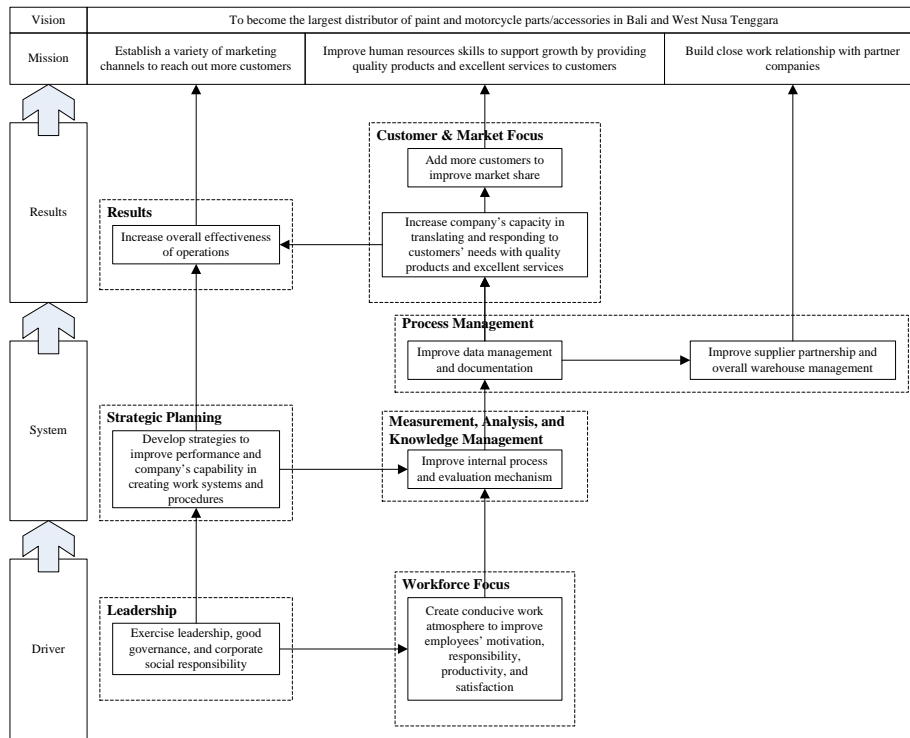


Figure 3: Modified Strategy Map for the case study's company.

Table 2: Strategies, KPIs, and KPIs' weights.

Strategies	KPIs	Weights (%)
Increase overall effectiveness of operations	Process effectiveness level	4,12%
	Workforce focused outcomes level	5,56%
	Leadership outcomes level	2,84%
Add more customers to improve market share	Market share improvement capacity	6,21%
	Product sales	6,15%
	Customer acquisition	5,14%
	Customer complaints	3,32%
Increase company's capacity in translating and responding to customers' needs with quality products and excellent services	Customer focused outcomes level	4,98%
	Product & service outcomes	4,98%
	Customer satisfaction	5,19%
	Market knowledge	4,98%
Improve supplier partnership and overall warehouse management	Supplier stockout level	1,69%
	Supplier turnover	1,46%
	Supplier performance	1,40%
Improve data management and documentation	Evaluation & analysis capacity	4,45%
Improve internal process and evaluation	Information & knowledge management	3,87%
	Process management capacity	2,99%
Develop strategies to improve performance and company's capability in creating work systems and procedures	Work system design	3,35%
	Strategy deployment	3,41%
	Strategy development	3,38%
Create conducive work atmosphere to improve employees' motivation, responsibility, productivity, and satisfaction	Employee turnover	1,52%
	Abseenteism	1,70%
	Employee complaints	1,29%
	Workforce environment	3,92%
	Workforce engagement	2,21%
Exercise leadership, good governance, and corporate social responsibility	Governance and social responsibility	3,71%
	Senior leadership involvement	6,13%

Data were collected quarterly from January 2008 to March 2009, i.e., period 1 equals to January to March 2008, period 2 equals to April to June 2008 and so on. Thus there are five data points. Some data were measured qualitatively using interview and questionnaire, for example employees' perception on company's leadership, strategic planning and execution, etc., and some were obtained from secondary resources (company's data) such as employee turnover, supplier performance, etc. Other data such as customer satisfaction rating were gathered externally from a survey to customers.

To be able to aggregate the measurements into a total performance index, all KPI measures are scaled from 1 to 5, with 1 being the farthest from expectation and 5 being the most desired performance. After a series of calculation, we arrived at the following charts describing the company's performance viewed in perspectives and as a whole (Figure 4 and 5). The chart shows that the company is progressing well overall, except in period 4 where it suffered the impact of global economy crisis as were also experienced by most companies worldwide.

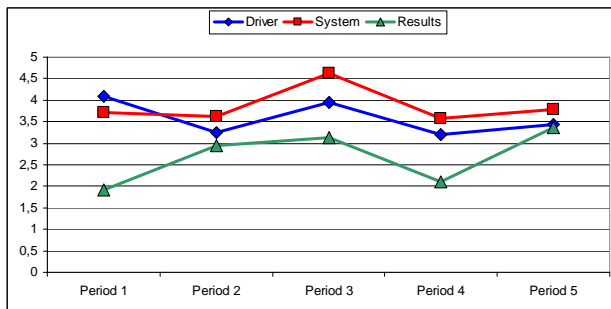


Figure 4: Performance of perspectives.

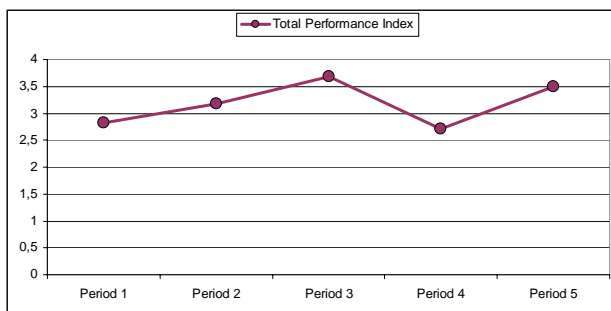


Figure 5: Total Performance Index.

5. CONCLUDING REMARKS

This research shows the integration process of two different performance models into a combined model that is believed able to utilize the good principles and limit the drawbacks of each model. The structure used is BSC and its principles such as vision alignment and compact scorecard are maintained. This approach is chosen since we intend to develop a performance measurement system rather than an excellence model. The framework, however, follows MBNQA to capitalize its nature as an excellence model that evaluates an organization in wide ranging aspects. The common lack-of-guidance problem in BSC during the strategy development stage is lessened with this approach. Furthermore, our case study also shows that the integrated model did not meet any major obstacle and could be applied smoothly. An issue that should be anticipated is regarding the number of KPIs with qualitative data that tends to dominate the quantitative measures. This should be controlled so that the performance index remains objective.

Future research in this area is wide open given a number of today's existing performance/excellence models. EFQM, SQA, Oregon Productivity Matrix, Supply Chain Operations Reference (logistics-based scorecard), are just to name a few. The quest in finding a robust model or other supporting techniques shall always continue. Such a mixed model must be able to elevate the benefits of each and more importantly, adapt to the current condition or organizational environment.

One must always remember, however, that a good model is but a start to a good practice. Other issues at the implementation ground such as leadership support, overall commitment, and determination to run the system in the long run before being able to reap the promised benefits, are important factors to attend. A good model thus should also be easily understood and implementation-friendly to help in this area.

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