Development of a performance measurement tool for an agricultural enterprise using BSC and QFD models

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Abstract. The business eco system of contemporary market is witnessing quick and hastening transformation, resulting in growing ambiguity and complication. Therefore, the need of a comprehensive performance measurement technique that can provide management oriented information and act as a supporting tool in developing and analyzing organizational strategies with a view to achieve competitive advantage is ardently felt. So, this paper proposes the application of balanced scorecard (BSC) model in an Indian seed manufacturing organisation to place the organizations expediently against the competitors by aligning its corporate vision and strategy with organisational performance through the interconnectedness of different layers of perspectives. Next, a framework to integrate both BSC and quality function deployment (QFD) models is provided for the first time in a seed manufacturing industry in order to evaluate its performance over the two time period periods. The integrated BSC-QFD technique can help managers to understand competitive strength of the said organization and in turn facilitate in efficient and effective decision making. Even though, these models are adopted for an explicit business, there is also adequate future scope of their implementation to diverse industries.

1. Introduction

Food is the main and the primary requirement of the human race for their sustained survival. It has an extremely broad implication, and can be summarized as any plant or animal material, which is consumed for nourishment and victuals. The basic foundation of human civilization, culture and home comprises of cultivation, preparation and distribution of food. Agriculture plays a critical role in India's economy. Over 58% of the rural households depend on agriculture as their principal means of livelihood on the basis of a research report of India Brand Equity Foundation published in 2017. Agriculture, along with fisheries and forestry, is one of the principal contributors to the gross domestic product. Moreover, based on 2nd advised estimates by the Central Statistics Office, the share of agriculture and allied sectors (including agriculture, livestock, forestry and fishery) is expected to be 17.3% of the gross value added during 2016-17 at 2011-12 prices. Besides, according to the Ministry of Agriculture, total food grain production in India in May 2017, stood at around 273.38 million tonnes. Despite that, India imported 2.7 million tonnes of wheat in Financial Year 2016-17 (till January 16, 2017). The significance of quality seeds has been documented from the time antediluvian. Seeds are the storehouse of the genetic potential of crop varieties and their assortment resulting from

the unremitting development and selection over time. Crop upgrading and the delivery of high quality seeds and planting materials of selected diversities to farmers is essential for ensuring improved crop production and meeting emergent environmental challenges. Food security consequently is reliant on the seed aegis of farming populace. As per a report published by SeedNet India Portal in 2017, it is calculated that the straight contribution of quality seed only to the total production is about 15% to 20% depending upon the crop and it can be further augmented up to 45% with proficient management of other ingredients. Hence, a superior quality seed is critical for improved production of crops. Therefore, it is imperative to analyse the performance of seed organisations in a comprehensive way which can in turn help in providing high standard and cost effective food to the people of this country.

The balanced scorecard (BSC) model is developed to be employed as a performance management tool for identifying the need of an inclusive management system that would include both traditional quantitative and more subjective qualitative performance measures. It is a contemporary performance measurement technique designed to overcome the limitations of traditional performance measurement systems. Quality function deployment (QFD) technique is the visual representation of a well planned engineering process, and an array of interrelated engineering and management tools, which can establish precedence of the customers by means of their voice, and transform them to design characteristics during development of a product. Thus, this paper intends to first develop BSC model in an Indian seed organization to help its management in monitoring its performance and administer the execution of assorted strategies. Next, an integrated BSC-QFD framework is also designed to evaluate the progress of the said enterprise over a period of time with respect to key performance measures of BSC model in order to demonstrate the efficiency of strategies applied. The results derived from the implementation of the above models would not only facilitate performance measurement of the enterprise during a time period in quantitative terms, but assists the policy makers to recognize what should be carried out and measured in an organization with a view to enhance the productivity and progress.

2. Review of past literature

Amado et al. [1] presented a framework integrating BSC model with data envelopment analysis technique while using an assortment of interrelated models for examining the organizational progress. Garengo and Biazzo [2] proposed a circular method to employ a strategically aligned performance measurement system in small and medium enterprises based on BSC model. Houck et al. [3] applied the concept of BSC model in a forensic laboratory management environment. Rajesh et al. [4] designed a framework to formulate strategies for the entire four BSC perspectives of various functions of third party logistics service providers, and evaluated the weights for different strategies using Delphi analysis. Nikolaou and Tsalis [5] introduced a new sustainable BSC scoring structure employing global reporting initiative indicators and scoring-benchmarking techniques to estimate the corporate sustainability performance. Ekmekci [6] implemented BSC technique to the Ministry of Youth and Sport of Turkey as a strategic management tool. Tjader et al. [7] integrated analytic network process and BSC methods to construct a consistent decision model for establishing organization level outsourcing policy.

Shrivastava and Verma [8] proposed a QFD model to improve service quality of a 5-star hotel while evaluating customer needs priorities. Prasad and Chakraborty [9] developed an expert system based on QFD technique in Visual BASIC 6.0 to automate the CNC turning centre selection procedure for different production plans. Prasad et al. [10] designed an expert system for selection of materials for various engineering applications while integrating it with the QFD technique. Camgöz-Akdağ et al. [11] employed QFD method for translating internal customer needs and expectations into appropriate service specifications to perform existing process assessments in relation to quality characteristics for increasing internal customer satisfaction. Dehe and Bamford [12] demonstrated how QFD can enhance a healthcare organisation's strategic operational alignment, through synchronising the infrastructure design with the service intention. Dwivedi and Chakraborty [13]

developed a combined ABC-BSC-QFD model to demonstrate how it could enhance the accuracy of BSC and assign strategic values to different activity groups of ABC model.

It follows from the foregoing literature review that both BSC and QFD models have been implemented separately to establish and evaluate effective organizational strategies. But, there is limited published research papers associated with implementation of combined BSC and QFD techniques for providing the management with realistic and tactical outlook of key performance indicators of the enterprise that are critical in efficient planning, controlling and decision making. Therefore, this paper proposes the development of a BSC model for a seed organization of India in a simple cost effective manner to demonstrate its exactness as strategic management decision-making tool. Furthermore, a combined BSC-QFD model is designed to comprehend the progress of the considered organisation and identify its potential leverage points for enhancing the performance.
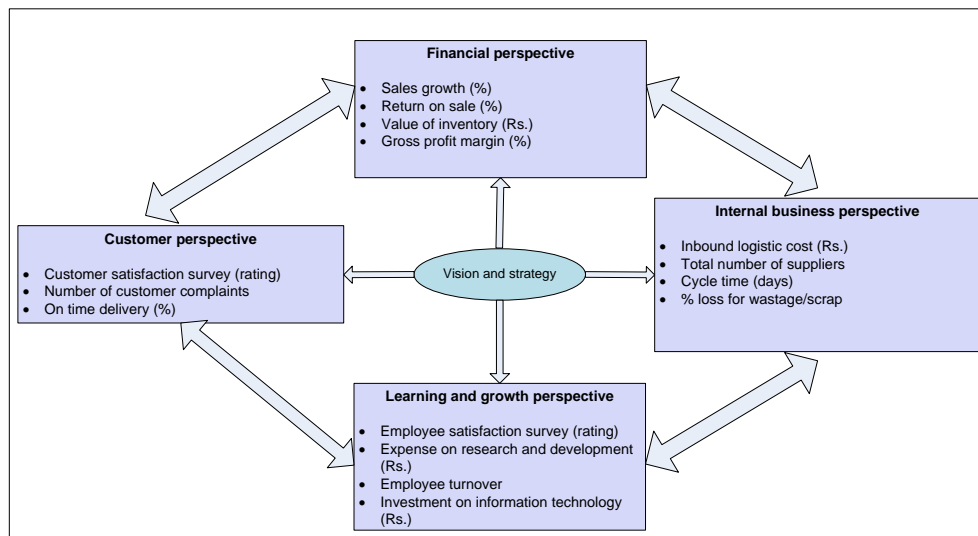
3. BSC Model

Traditional performance measurement systems examine the progress of an enterprise principally on the basis of short-term financial goals. Those are no longer apposite to overcome the challenges faced by the organisations in recent times. Moreover, with changing business environment organisations have to make sure that their strategy is transformed into consequent actions through a more scrupulous consideration of the objectives of pertinent stakeholders. BSC model is often recommended as an inclusive management tool connecting strategic and short-term action planning. BSC technique is developed in such a way that it eliminates the most common mistake of the existing traditional systems of performance management, i.e. reporting only on the basis of financial data. In today's cut throat competitive market, it is immensely critical to achieve a balance between financial and non-financial data in management reporting. Therefore, BSC is developed as a modern performance appraisal technique to overcome the shortcoming of the previously adopted performance measurement systems through introducing four perspectives financial perspective, customer perspective, internal perspective, and learning and growth perspective on which progress of an enterprise would be evaluated. All the key performance indicators that is identified for the scorecard under each perspective has to fit the sequence of cause and effect relationship within them.

3.1 Designing of a BSC model for the seed organization

Developing an appropriate BSC model for an enterprise employing an profound evaluation of the organization's foundations, core beliefs, values, opportunities, financial position, short and long term goals, and operating business environment is of enormous significance for enduring sustainability. The confidentiality of the considered organisation is maintained and hence the name of the seed manufacturing enterprise is not being disclosed and hereafter, we refer to it as ABC Limited. It is an organisation with a strong presence in the domestic market. It has unique, superior and proprietary germplasm that helps them to compete in the market through its innovative products in seed category, like rice, pulses, wheat, cotton, mustard, vegetables etc. All the data required for the calculation of BSC will be pertaining to the financial year 2016 and 2017. Here, a focus group is established comprising of managers and subject experts to develop a distinctive BSC model for ABC Limited, while keeping balanced representation of key indicators from each perspective. The developed BSC model in ABC Limited is shown in Figure 1.

It can be noticed that the designed BSC model recognises 15 performance indicators that provide the management with a concise summary of the key performance parameters of ABC Limited. These performance measures also assist in suitably aligning the business processes of ABC Limited with its overall policy. For instance, the performance measure of sales growth signals about organisation's survival and profitability, whereas, the value of inventory explains the operating performance and the financial position of the enterprise. Gross profit margin suggests the managers of the organization about enterprise's financial health and business model through revealing the proportion of money left over from revenues after accounting for the cost of goods sold. On the other

hand, return on sale is useful for estimating the ability of policy makers to efficiently generate a profit from a given level of sales. In a similar manner customer satisfaction survey, number of customer complaints and on time delivery divulge about the acuity of ABC Limited among its customers, which acts as a stimulator for potential expansion. Employee satisfaction survey, expense on research and development, employee turnover and investment on information technology are the apt performance indicators expounding the learning and growth aspect of the employees in the considered enterprise. In addition, inbound logistic cost, total number of suppliers, cycle time and % loss for wastage/scrap are the most critical performance measures for gratifying customers and stakeholders of the organisation. Hence, the developed BSC model can assist the management of ABC Limited in examining its overall growth and consequently acts as a catalyst at diverse echelons of decision making process of the said enterprise.

Figure 1 Developed BSC model for seed organization

4. Development of the seed organization's performance measurement tool employing BSC and QFD tools

4.1 QFD methodology

The essence of an extensively used proverb, 'If you fail to plan, then you are planning to fail', is certainly echoed in the fundamental philosophy of QFD methodology. QFD was invented in Japan in late 1960s as a form of cause and effect analysis by Akao [14]. It provides a process to allocate relative priorities to different requirements or criteria for product development. The house of quality (HOQ) matrix, which is the principal tool in QFD method, summarizes the understanding of the customers' requirements. It consists of six major building blocks, i.e. customers' requirements, technical requirements, interrelationship matrix, technical correlation matrix, planning matrix and prioritized technical requirement.

4.2 *Estimation of significance of BSC performance parameters using QFD*

The weight for all recognised performance measure of BSC model in ABC Limited is estimated through employing the QFD technique. A simplified house of quality is considered here while not including technical correlation and planning matrices. Development of world class product, promotion of hybrid technology, providing reliability, empower solution innovation and augment profitability are the five identified strategic objectives of ABC Limited that replaces the customer's requirements. In a similar manner, the technical requirements are symbolized by 15 performance parameters for the four perspectives of BSC model developed for ABC Limited. Thus, the rows of

house of quality matrix contain diverse organizational objectives (Whats), while the BSC performance parameters (Hows) are arranged along its columns. The interrelationship matrix indicating the relationship between the organization's requirements and performance parameters ('Whats' and 'Hows') is now designed using an apt scale which is set by allocating the relative importance as 1 - very weak, 3 - weak, 5 - moderate, 7 - strong and 9 - very strong. Additionally, the relative significance of the organization's requirements is also evaluated in accordance with a priority scale as 1 - not important, 2 - important, 3 - much more important, 4 - very important and 5 - most important. The enterprise's requirements can be either beneficial (higher values are preferred) or non-beneficial (lower values are desired) and are stated by the value of the corresponding improvement driver (+1 for beneficial attribute and -1 for non-beneficial attribute).

After the house of quality matrix is filled up with every essential data, the weight for each identified performance measure of BSC model is calculated utilizing the following equation:

$$w_j = \sum_{i=1}^{n} P_i \times ID_i \times \text{correlation index} \qquad (1)$$

where w_j is the weight for j^{th} performance measure, n is the number of organization's requirements, ID_i is the value of improvement driver for i^{th} organization requirement, P_i is the priority assigned to i^{th} organization requirement and correlation index is the relative importance of jth performance measure with respect to i^{th} organization requirement. The calculated normalized weights of assorted BSC performance parameter as calculated employing QFD technique is shown in Table 1.

Table 1 Normalized weights of BSC performance measures

Performance measure	Normalized Weight
Sales growth	7.06
Value of inventory	4.95
Return on sale	8.71
Gross profit margin %	7.36
Customer satisfaction survey	7.81
Number of customer complaints	7.51
On time delivery %	6.31
Employee satisfaction survey	6.16
Expense on research and development	8.56
Employee turnover	4.80
Investment on information technology	7.36
% loss for wastage/scrap	7.21
Total number of suppliers	4.35
Cycle time	6.61
Inbound logistic cost	5.26
Performance index	**100.0**

4.3 Designing of a performance index to examine the overall progress of the organization

After the comparative importance of all performance measures is determined, an index is developed to evaluate the enterprise's overall performance [15]. With an intention to compute the index and examine the progress of ABC Limited with respect to the performance parameters of BSC model, the related data for all the 15 recognised BSC performance measures for two unique time periods are required. The first set of data related to the 15 performance indicators for the initial period is set as the baseline value, which in this case is derived from ABC Limited's record books for the financial year 2015-16. Then again, current period value indicates the second data set for those parameters and is compiled from the record books of ABC Limited for the financial year 2016-17. An

opening point of 100 is allocated to all performance measures and afterward, their weighted points are calculated using the following equation:

$$\text{Weighted point} = \text{Normalized performance measure weight (NPMW)} \times \text{Initial point} \qquad (2)$$

Subsequently, the performance index for the initial period is estimated by summing up all the weighted points computed for each individual performance parameter. Table 2 shows a detailed calculation of performance index of ABC Limited for the initial period.

Table 2 Performance index for initial period

Performance measure	Baseline value	Initial point	Weighted point
Sales growth	15.00	100	7.06
Value of inventory	1800.00	100	4.95
Return on sale	12.48	100	8.71
Gross profit margin %	7.85	100	7.36
Customer satisfaction survey	74.00	100	7.81
Number of customer complaints	477.00	100	7.51
On time delivery %	96.00	100	6.31
Employee satisfaction survey	87.00	100	6.16
Expense on research and development	1.81	100	8.56
Employee turnover	2.00	100	4.80
Investment on information technology	0.75	100	7.36
% loss for wastage/scrap	0.33	100	7.20
Total number of suppliers	147.00	100	4.34
Cycle time	65.00	100	6.61
Inbound logistic cost	6.50	100	5.26
Performance index	-	-	100

In order to analyze and scrutinize the advancement of the enterprise over the considered time period, the performance index for the subsequent period is also needed. So, the first step in computing the performance index for the current quarter is to calculate the current period points, employing either Eqn. (3) (for beneficial performance parameters) or Eqn. (4) (for non-beneficial performance parameters).

$$\text{Current period point} = (\text{Current quarter value/Baseline value}) \times 100 \qquad (3)$$

$$\text{Current period point} = 200 - [(\text{Current quarter value/Baseline value}) \times 100] \qquad (4)$$

Applying Eqn. (5), the value of the current period weighted point for the individual performance parameter is now similarly estimated.

$$\text{Current period weighted point} = \text{NPMW} \times \text{current period point} \qquad (5)$$

Next, the performance index for the current period is calculated by adding up all the current period weighted points for all the individual performance measure. A comprehensive estimation of performance index of ABC Limited for the current period as computed utilizing integrated QFD and BSC models is given in Table 3.

An assessment of the performance index values for the current period with those for the initial period, derived from Table 3 and Table 2 respectively, helps in evaluating the comprehensive performance of the enterprise over the two time periods, and thus allowing the policy makers to comprehend the efficacy of assorted applied policies. It can be observed that ABC Limited has improved performance index of 116.94 for the current period in comparison to 100 for the initial period. This implies that the said enterprise is progressing in appropriate direction with respect to its organizational objectives. Moreover, when the weighted point of an individual performance measure for the initial period is compared with the current period weighted point, it quantifies enterprise's development with respect to that particular parameter. For example, it is estimated that ABC Limited's weighted point for cycle time is 6.61 for the initial period, whereas, its current period weighted point is

6.71. An evaluation between these two points signifies that ABC Limited has performed positively with respect to its cycle time. Hence, it can be comprehended that a combined BSC-QFD technique can be successfully applied to design a quantitative tool to measure the performance of an organization and monitor the efficiency of the implemented strategies, which may overlay the pathway for future policy making.

Table 3 Current period performance index

Performance measure	Current year value	Current period point	Current period weighted point
Sales growth	20.00	133.33	9.41
Value of inventory	2100.00	83.33	4.13
Return on sale	16.66	133.49	11.63
Gross profit margin %	10.24	130.45	9.60
Customer satisfaction survey	82.00	110.81	8.65
Number of customer complaints	412.00	113.63	8.53
On time delivery %	98.00	102.08	6.44
Employee satisfaction survey	89.50	102.87	6.34
Expense on research and development	2.04	112.71	9.65
Employee turnover	1.00	150.00	7.20
Investment on information technology	1.20	160.00	11.78
% loss for wastage/scrap	0.28	115.15	8.30
Total number of suppliers	153.00	104.08	4.53
Cycle time	64.00	101.54	6.71
Inbound logistic cost	8.00	76.92	4.05
Performance index			116.94

5. Conclusions

India is witnessing an immense agricultural progress lately, and high quality seeds have key role in that development. Technology has rationalized much of farming's routine processes, but devoid of a sturdy supply of premium seeds, yields and crop quality would be significantly reduced. Indian farmers therefore, duly recognize the importance of high-quality cost efficient seed. Hence, there is immense competition among the domestic seed organisation to optimise profit while minimising operating expense and developing products that are tasty to eat, nutritious and healthy. In this paper, a BSC model is first developed for a seed manufacturing industry in India to identify a relevant range of financial and non-financial parameters that supports effective business management. Next, a performance measurement tool combining BSC and QFD techniques is developed and applied in the said organisation to demonstrate how it can be employed to monitor the performance of the enterprise, which can be subsequently utilized as a driver for the organisation's future growth. Even though, the integrated BSC-QFD model is designed and developed for a specific seed organisation, it can also be employed to other organizations with minor adjustments.

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