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Microworlds of the Dynamic Balanced Scorecard for University (DBSC-UNI)

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Abstract. This research focuses on the development of a Microworlds of the dynamic balanced scorecard for university in order to enhance the university strategic planning process. To develop the model, we integrated both the balanced scorecard method and the system dynamics modelling method. Contrasting the traditional university planning tools, the developed model addresses university management problems holistically and dynamically. It is found that using system dynamics modelling method, the cause-and-effect relationships among variables related to the four conventional balanced scorecard perspectives are better understand. The dynamic processes that give rise to performance differences between targeted and actual performances also could be better understood. So, it is expected that the quality of the decisions taken are improved because of being better informed. The developed Microworlds can be exploited by university management to design policies that can positively influence the future in the direction of desired goals, and will have minimal side effects. This paper integrates balanced scorecard and system dynamics modelling methods in analyzing university performance. Therefore, this paper demonstrates the effectiveness and strength of system dynamics modelling method in solving problem in strategic planning area particularly in higher education sector.

INTRODUCTION

Microworlds so called interactive learning environment (ILE) enables managers and management teams to begin "learning through doing" about their most important systemic issues. Barlas [1] reported that no matter how scientific and exact the policy design phase is, the ultimate success depends on implementation. This research focuses on the development of a Microworlds of the dynamic balanced scorecard for university in order to enhance the university strategic planning process. Universities worldwide are striving for quality. In doing so, to meet the targeted university performances, university management committee needs to understand the parameters which contributed to performances in order to assess its effects. Unbalanced growth in student population in universities, infrastructures that cannot keep up with the enrolment growth, increased student to faculty ratios, concerns about quality of teaching, heavy competition for limited funding for research, and heavy competition among private universities for limited student demand are the problems of which are interconnected and closely interacted simultaneously, which further creating the complex dynamic nature of the university performance system [1]. These parameters are interacted simultaneously, and dynamics in nature, which cause difficulty in assessing performances. Also, [2] reported that unlike business systems, the higher education institutions have peculiar dynamic nature that calls for effective strategic management for sustainable and competitive delivery of quality education. Thus, a proper understanding the behaviour of its interaction is required for more effective university planning process.

However, many universities do not meet their goals because their planning processes use tools that are particularly inadequate for present-day environments of complexity and rapid change [3]. The complex dynamics underpinning funding and quality relationship of university performance cannot be addressed by linear methods.

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However, existing university planning has been based on certain behavioural rules such as simple arguments of direct cause and effect of one variable to another. Furthermore, traditional problem solving looking at individual parts, but problems may only come to light when we investigate the interactions between parts. As mentioned, university performance system is a complex social system that must be addresses holistically. Unfortunately, traditional planning tools utilise static and linear approach, as well as breaking problems into sub problems to be analysed partly due to the problem complexity. Thus, these traditional approaches are no longer suitable to address such dynamic, complex, and non-linear feedback system of university performance.

For instance, balanced scorecard (BSC) is a performance measurement tool which enables managers to translate strategy into a correlated set of performance indicators from several business perspectives [4]. In spite of its widely recognised advantages, this approach is inadequate in addressing such complexities in managing university performance system in order to track and steer performance through time. Also, it is found that BSC are static and inadequate to support the university under study in university planning problem [5,6].

To track and steer performance through time efficiently and effectively, a holistic systemic approach is required in analysing the peculiar dynamic nature of university performance system for university planning. Therefore, this study adopts system dynamics methodology, as it is a holistic and systemic approach to problem solving. It is not a regular approach using system dynamics in analysing university performance system. System dynamics method has been a new trend of analysis in many different areas. Management struggles in monitoring the achievement and the performance of its organisation. A singular approach like using balanced scorecard may not be able to provide a holistic answer to management problem. An effort may be required to enhance this approach of using a singular technique of analysis. Thus, this study integrates both the balanced scorecard method and system dynamics method for university planning.

The objective of this paper is to develop an interactive Microworlds of dynamic balanced scorecard for university to help university to assess the impact of different strategies towards university targeted performances. The structure of the paper is as follows. First, in Section II, the research works regarding university planning tools, balanced scorecard and system dynamics in literatures are reviewed to put this research into perspective. In Section III, we present the proposed method. Section IV discusses the dynamic balanced scorecard for university planning model development and the model validation. Section V presents the DBSC-UNI Microworlds and Section VI discusses the analysis and findings. Finally, some further research directions are given in the conclusions.

LITERATURE REVIEW

In literature, strategic planning research in university has started as early 1970s [7]. The future that appears to hold many threats for most universities should become less imposing with the well thought out use of strategic planning [8]. Existing in literature, among most popular tools for strategic planning in university setting is SWOT (Strength, Weakness, Opportunity, and Threat) analysis [9], balanced scorecard [10,11], benchmarking [12], statistical linear models [13] and system dynamics models [1]. The statistical linear models and spreadsheets, performance indicators approach, and system dynamics models are of use planning tools. Each method has its merits and potential usefulness as an aid to specific aspects of the planning process, but they are distinctively different in terms of the input requirements, the type of data used, how the results are used, and most of all, the modelling purpose. Performance indicators are statistics, ratios, and other quantitative information, which indicate the way in which an institution is operating. It can be powerful tools, at both the university and the college or department levels, for internal evaluation and strategic assessment. Performance indicators can provide substantive information for strategic decision making [11]. Balanced scorecard, benchmarking, total quality management, and key performance indicator are the apparent examples in planning tools which utilising performance indicators approach.

However, the performance indicators used should relate to the mission statement of the institution and, over a period of time, may confirm or otherwise, whether the institution making progress in meeting the objectives set out in the mission statement. They should not be used not as an end in themselves to draw definitive conclusions, but to trigger areas of concern and provide catalyst for further investigation. If performance indicators are not used to facilitate decision making and day-to-day management, they are likely to fall into disrepute and be disregarded. One of the fundamental problems with performance indicators as a management tool is that they are normally measuring inputs or outputs to the organisation, and ignore the actual things that management can directly influence. In other words, these performance indicators approaches do not directly consider the policies that the management can adopt. Besides, system dynamics models are an excellent way of exploring the links between ‘levers’ and ‘outcomes.’

System dynamics discipline is an attempt to address such dynamic, long-term policy problems. It can address the fundamental structural causes of the long term dynamic contemporary socio-economic problems. System dynamics is a way of thinking about the future which focuses on 'stocks' and 'flows' within processes and the relationships between them. It can facilitate ideas for both specific solutions and generic 'new world' rules. It is a risk-free way of refining plans before implementation, and of testing idea using computer simulation. This study integrates both system dynamics modelling method and balanced scorecard approach to develop a Microworlds of strategic university planning model for university performance analysis.

A large number of case studies and surveys are now present in balanced scorecard literature. However, there is a lack of more theoretical and analytical modelling of the balanced scorecard. The idea of dynamic approach towards traditional balanced scorecard has emerged around late 1990s. Wolstenholme [14] suggests that system dynamic modelling has much to offer the growing field of balanced scorecard. Experience to date has indicated the types of contribution likely to be most important, which revolve around the ability of system dynamics to move balanced scorecard activities from a first step in systemic thinking to comprehensive systemic methods. It also suggested that the process will provide a platform for system dynamics methods to gain greater acceptability in mainstream in management thinking. The initial studies in dynamic balanced scorecard stressed the idea of dynamic approach towards traditional balanced scorecard which lack of systemic perspective. Balanced scorecard is found essentially a static representation of a complex dynamic system, and performance measurement is only one element of based feedback control cycle [6,14].

Many university have adopts balanced scorecard approach as managerial technique in measuring performance towards objectives. However, this approach lack of systemic perspective and static to represent the complex dynamic system of university management. University planning involve the management various complex dynamic problem such as infrastructure that cannot keep up with the enrolment growth, growing student to faculty ratios, concerns about quality of teaching, efforts to contain debt by staff attrition, competition between institutions for students, setting of goals for enrolment levels, and distribution of scarce resources on the basis or research activity provide contexts for the manifestation of delayed feedback loops, escalation, sliding goals, and tragedy scenarios.

METHODOLOGY

This paper integrates the balanced scorecard (BSC) perspectives for university planning using system dynamics (SD) methodology. By integrating BSC and SD approach, Figure 1 shows the process flow of the proposed research methodology. Hawari [15] discusses this methodology meticulously. This study is conducted at one of the public universities in Malaysia. Data and information were gathered from university cooperate planning unit through interviews and document content analysis. Five years worth of historical annual data dated from 2008 to 2012 consist of data concerning academic staffs, students, teaching activities, research and publications activities, and financial information.

To model the dynamic balanced scorecard, first, interviews with the university management about university performance system and strategy is conducted. Founder of system dynamics, Jay W. Forrester stated that a personal interview with the experts in the problem under study should be the starting point for any system dynamics modelling implementation [16,17]. These interviews aimed to synthesise the causal relationships between the key elements for strategy formulations, and consequently, design performance measurement system. Based on the series of interviews conducted, and document content analysis, a balanced scorecard is developed.

The balanced scorecard was very supportive to university management committee in order to articulate their views about strategies to undertake. However, as already discussed, the traditional balanced scorecard approach is not sufficient to figure out either the strategic resources to build, or the processes through which they will interact to affect university performance. Therefore, we integrated the four traditional perspectives of balanced scorecard using in order to identify the relationships among performances variables towards university performance.

Based on the performance variables which were framed in the balanced scorecard, the historical behaviour of these selected variables is illustrated in order to formulate the dynamic hypothesis of the problem. Little later, a causal loop diagram is utilized in formulating the dynamic hypothesis (refer Figure 2).

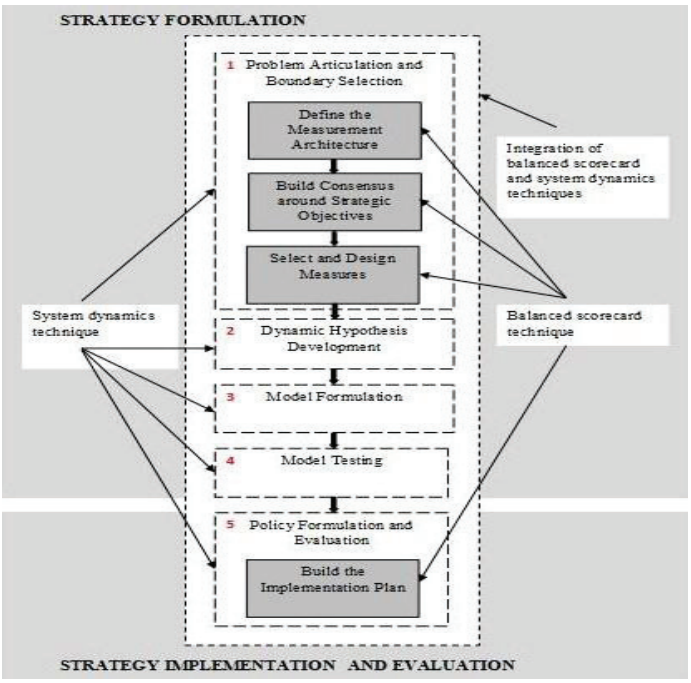

FIGURE 1. Integration of balanced scorecard and system dynamics techniques in strategic planning process

To test the dynamic hypothesis, a formal simulation model is constructed. The model is constructed on five sector basis which interact with each other according to the feedback structure described in the causal loop diagram analysis:

1. Students sector: to analyze the dynamic interactions between performance variables which affect the quality of students.
2. Academic staff sector: to analyze the dynamic interactions between performance variables which affect the quality of staff.
3. Teaching sector: to analyze the dynamic interactions between performance variables which affect the quality of teaching.
4. Research and publications sector: to analyze the dynamic interactions between performance variables which affect the quality of research.
5. Financial sector: to analyse the dynamic interactions between performance variables which affect the funding and strategic planning.

There are different causal linkages between the five sectors. As related to the BSC chart (refer Figure 2), the student sector and academic staff sector generally represent the Customer perspective. The teaching sector and research and publication sector generally represent the Internal Process perspective. Whereas the financial sector represent the Financial perspective. The university objective which to increase human capital competencies in the Learning and Growth perspective is measures by the expenses on the emolument and staff training.

In this study, the model credibility is established by two types of test; structural validity and behaviour validity [18,19,20]. To test the model structure, the dimensional consistency test and the extreme conditions test were conducted. Next, the behaviour reproduction test was conducted to test the model behaviour. For dimensional consistency test, the built-in unit consistency checking feature of the iThink environment, which checks the equivalence of units on both sides of the equations, was used to eliminate errors that might be in the equations in the developed model. All the sectors were individually verified, followed by the unit equivalence check was repeated for the model as a whole. From the iThink dimensional consistency analysis, no dimensional errors were detected in the simulation model. Next, extreme condition test were applied to test the robustness of model equations. Numerous extreme-condition simulation runs were done on the model, including: No new registration, No new postgraduate

registration, No new FT staff recruitment rate, No research funding. Results of these tests reveal evidence of high structural validity.

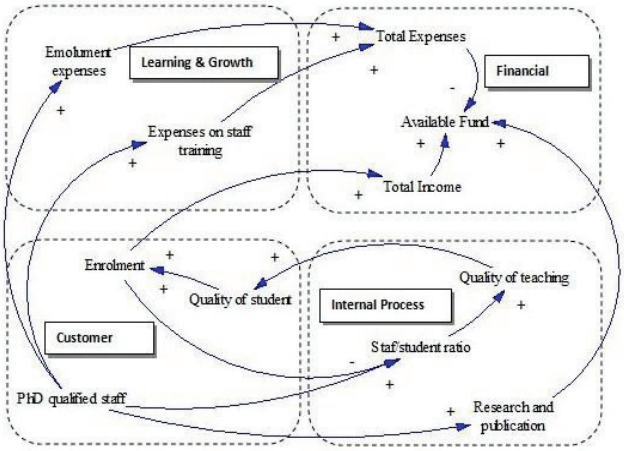

FIGURE 2. Causal loop diagram of the dynamic balanced scorecard

The purpose of behaviour validation tests is to determine whether the behaviour of the model resembles the behaviour exhibited by the real system that was modeled. After the structural validity tests were completed, the behaviour of the model was compared with the data from university under study. Based from analysis, a broad resemblance between the model behaviour and the behaviour of the real system was obtained. Thus, it is concluded that the model is behaviorally acceptable.

MICROWORLDS OF DYNAMIC BALANCED SCORECARD FOR UNIVERSITY (DBSC-UNI)

In the dynamic balanced scorecard for university planning (DBSC-UNI), the objective of the user is to make seven decisions that will improve the performance indicators in the balanced scorecard chart of the university, within the limitation imposed by outside factors. The selection of these seven parameters are based on sensitivity analysis that has been conducted using the developed simulation model. Figure 3 shows the front page of *Dynamic BSC for University Planning*. The front page displays the short description of DBSC-UNI model background information. On the left hand side of the front page are the five main buttons; *Tour Model, Decision, Dynamic BSC, University BSC Chart,* and *Performance of Sectors*. The *Tour Model* button navigates users to the *Tour Model* page where the five sectors of university performance system are discussed. The *Decision* button navigates users to the *Decision Parameters* page where users may define the values of parameters of decision. The *Dynamic BSC* button navigates users to *Dynamic BSC* page which consists of four balanced scorecard perspectives; Financial, Customer, Learning and Growth, and Internal Process, through which users have access to other sections of the simulator to appreciate the effects of their policies over a thirteen year period. The *University BSC Chart* button navigate users to *University BSC Chart* page which consists of university BSC chart where users may view the targeted and simulated values of selected university performance variables in the four traditional BSC perspectives. The *Performance of Sectors* button navigates user to *Performance of Sectors* page where at this page, there are five buttons which functions to navigate user to the pages of performances by named sectors.

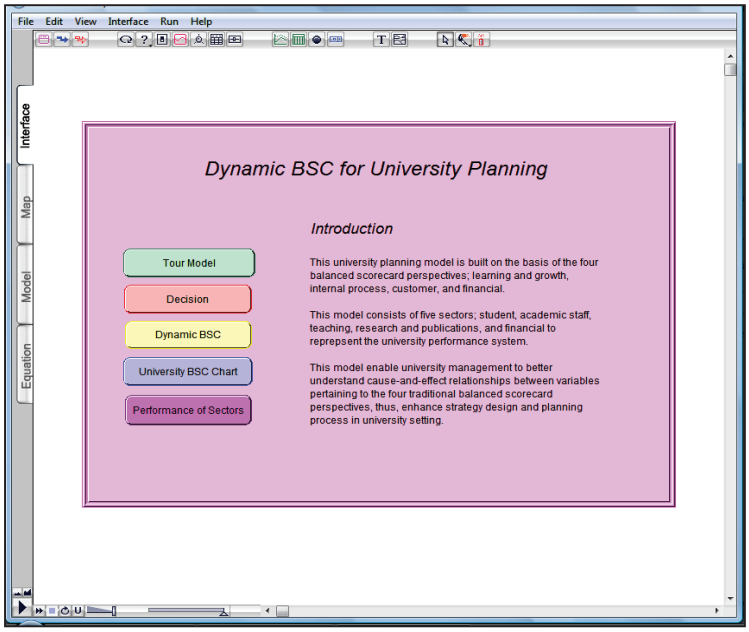

FIGURE 3. The *Dynamic BSC for University Planning* front page

Figure 4 depicts the page screen when users click the *Academic Staff sector* button at *Tour Model* page. This button navigates users to the academic staff sector of the developed DBSC-UNI simulation model, where users may observe the dynamic relationships between variables in this sector which determine quality of staff.

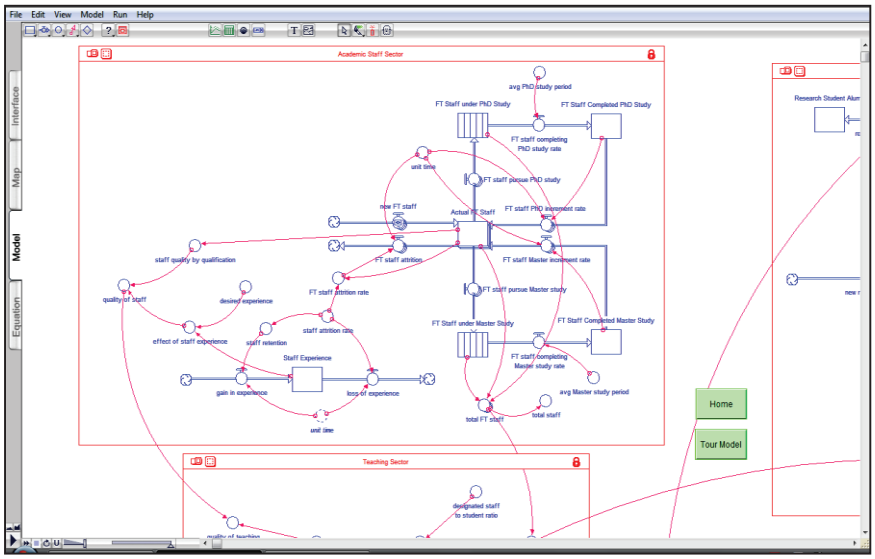

FIGURE 4. The Academic Staff sector of DBSC-UNI simulation model

Figure 5 illustrates the *Decision Parameters* page. There are three main decision parameters; new FT staff, new registration, and research funding rate. This research focuses on analysing the recruitment, enrolment, and funding policies on university performance. The control panel were designed to only contain influential parameters. In this DBSC-UNI, policy makers may test their policies by changing the values of these parameters, and observe the impact of these policies towards the university performance.

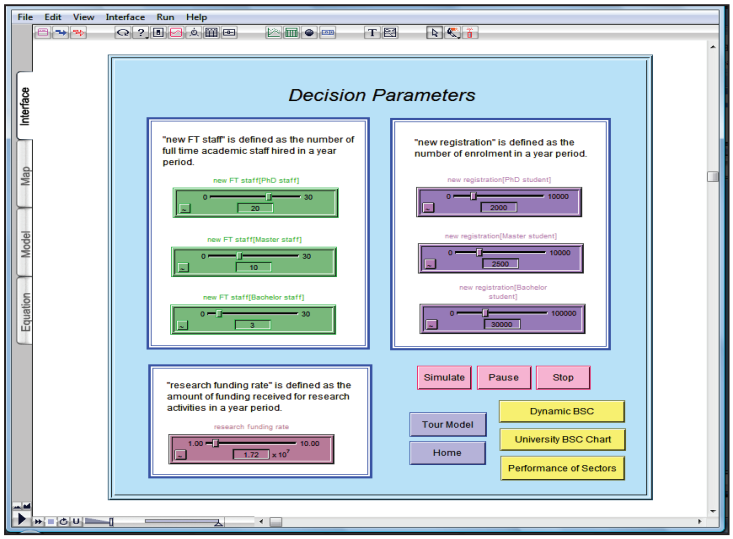

FIGURE 5. The *Decision Parameters* page

Figure 6 shows the Dynamic BSC of university. As displays, there are four traditional perspectives of BSC; Financial, Customer, Internal Process, and Learning and Growth. In the Financial perspective, users may observe the impact of policies towards targeted financial objectives; available fund, and research fund. In the Customer perspective, users may asses the impact of policies towards university quality; quality of staff, quality of teaching, and perceived quality of research. In the Internal Process perspective, the graph shows the current staff to student ratio and the staff commitment to student supervision which both in related to staff capacity indicator. In the Learning and Growth perspective, the graph shows the number of total staff. At this page, users may observe that altogether; the performance variables in the four different perspectives of BSC are interrelated and are affecting among each others towards improved university performances.

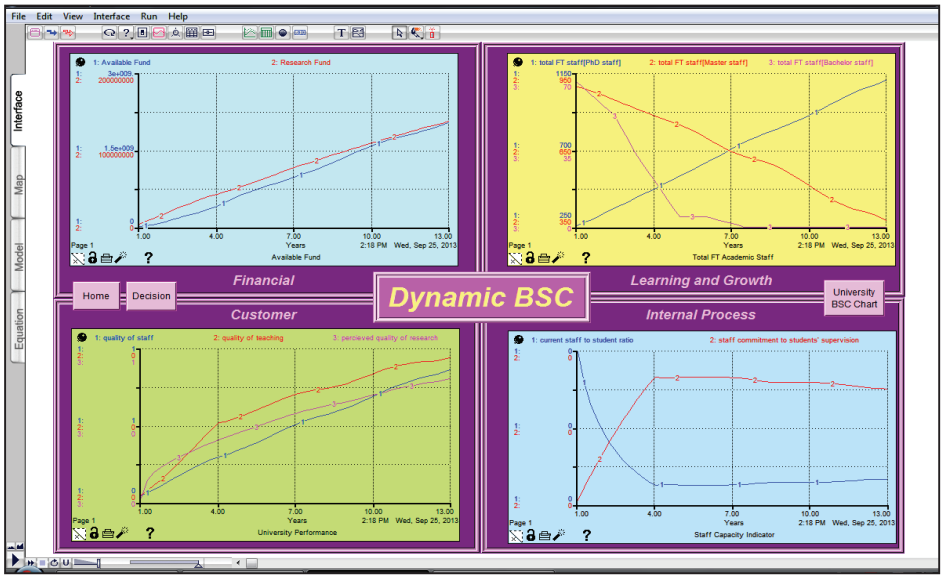

FIGURE 6. The Dynamic BSC page

Figure 7 exhibits the University BSC Chart page, from which users may view the university BSC chart which consisting the strategic objectives of different perspectives. From Figure 6, there is no input at the 'Target' column besides the units. Here, universities may input their own target values for documentation and analysis.

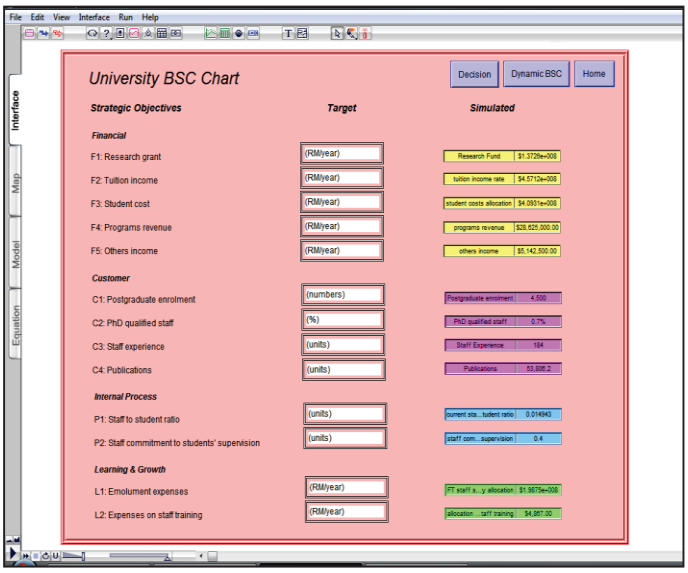

FIGURE 7. The University BSC Chart page

ANALYSIS AND FINDINGS

The aim of particular university is to target key performance variables of university system to improve strategic performance. There are many underlying factors that directly influence performances and which therefore underpin the excellence of the institution. The developed Microworld was used to improve the understanding of the relationships between key factors and how these factors influence the strategic university performance. This knowledge would enable university management policies to be improved. For this particular study, two fundamental policy experimentations are discussed in this section. Policies regarding recruitment rate and enrolment rate are assessed and its sensitivity towards university quality is evaluated. University's strategy is embedded in the simulation run from 2013 to 2020. The first scenario analyse the impact of targeted recruitment rate and its sensitivity towards university quality. Meanwhile, the second scenario analyse the impact of achieving targeted postgraduates enrolments and assessed its sensitivity towards university quality. Both these two policy experiments are conducted to find best policy in achieving university aim to become a research university by 2020.

Below are the summaries of important findings from the analysis carried out in the model. The findings are as follows:

1. Scenario 1: Impact of the recruitment policy implementation did improve the university performances.
2. Scenario 2: Impact of the combined recruitment and enrolment policies implementation did improve the quality of staff and the perceived quality of research, but not to the quality of teaching.

In conclusion, looking separately at quality of staff, quality of teaching, quality of student, and perceived quality of research, strategic university planning may involve modifying recruitment rate, enrolment rate, and research funding rate, but the biggest impact on university performances will come from modifying recruitment rate. The findings suggest that an increment in Ph.D qualified staff may have increases the overall university performances. A comparison made among two different scenarios discovered that modifying recruitment rate is the most effective strategy for improved university performances.

CONCLUSION

A Microworlds of dynamic balanced scorecard is developed to support the university strategic planning. Traditional balanced scorecard provides performance measurement tool as communication tool. However, as discussed earlier, balanced scorecard do not support decision makers in assessing the impact of policies towards

performances through time dynamically. By integrating the two, the impact of different policies towards university performances through time could be better understood and may support in decision making processes. Based on analysis and results from the Microworlds, the recruitment policy could be the best policy in achieving university's strategic objectives. The current university planning model fits the purpose of the model. However, the model still can be improved through testing its utilisation in different application context. In the future, it is expected that other decision tools such as data envelopment analysis (DEA), analytical hierarchy process (AHP), and benchmarking will be complemented by system dynamics modelling method to enhance the process of strategy design and planning.

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