Firm-level outsourcing decision making: A balanced scorecard-based analytic network process model

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1. Introduction

Beginning with Kodak’s 1989 contract with IBM (Applegate and Montaalegre, 1991), IT outsourcing has grown steadily as a strategic IT management option. During this period, the pressure of globalization, rapid technological evolution, and the necessity for cost reduction have motivated if not compelled companies to turn to outsourcing. In the early 1990s, the two primary objectives for IT outsourcing were cost savings and technical efficiency. Today, the number of outsourcing objectives has increased along with their significance to the firm and, as a result, outsourcing has become a strategic option for firms seeking to improve their overall business performance (Lee et al., 2003). Dahilberg and Nyrhinen (2006) pointed out that in the current environment, outsourcing objectives are not only economic, but also strategic (e.g., aligning IT with corporate objectives and focusing on the core business), technological (e.g., ensuring the availability of technology and technology skills, and standardizing hardware, software and business processes), and social (e.g., improving the quality and availability of services, as well as user satisfaction). In a broader sense, outsourcing allows firms to develop alliances, to keep pace with technology advancement, to expand their IT infrastructure, and to extend the reach of their operations.

A strategic focus is also required in order to manage the inherent risks associated with outsourcing (Osei-Bryson and Ngwenyama, 2006). Strategic factors that can put the client at risk include specialization of the product and/or vendor, uncertainty of the business environment, interdependence between client and vendor business processes, and the level of client and vendor expertise with both the IT operation and outsourcing in general (Bahlia and Rivard, 2005). In light of these risk elements, a successful firm should understand and prioritize its objectives, set specific and obtainable goals, select the right vendor(s), and negotiate an enforceable contract with vendor(s). In daily operations, the firm should engage in effective communications and monitoring in pursuit of successful vendor relationships management.

Toward this end, management requires a structured approach that considers the elements of decision making involved in the outsourcing process: i.e., the objectives sought through outsourcing, the associated benefits and costs, and the set of financial and non-financial concerns for making outsourcing decisions in specific situations. The Balanced Scorecard (BSC) method provides such elements within a framework that assesses strategic performance. The Analytic Network Process (ANP), in turn, provides a structure and process that guide the decision maker in weighing the various criteria and choosing actions intended to achieve the
stated objectives. In this paper, we focus on outsourcing issue and employ the combined BSC and ANP model. We show how a BSC-based ANP model is useful in identifying the optimal strategy, and how important managerial insights may be derived by exploiting sensitivity analyses of the model.

1.1. The balanced scorecard (BSC)

As organizations endeavor for value creation and future growth, conventional unidimensional financial measures increasingly become inadequate and irrelevant (Francis and Shipper, 1999). To provide a more comprehensive measurement, Kaplan and Norton (1992) developed the multidimensional Balanced Scorecard (BSC). It has been widely adopted as a performance evaluation framework (Cobbold and Lawrie, 2002a; Rigby, 2001). Marr and Neely (2003) reported that the BSC was employed by more than 60% of the fortune 1000 companies.

The BSC reflects a balance between short- and long-term objectives, financial and non-financial measures, lagging and leading indicators, and external and internal measures. It emphasizes linking and aligning multiple measures to strategic objectives, and conceptualizing the strategic alignment between business goals and specific tactics. The BSC evaluates an organization from four perspectives: financial measures, customer satisfaction, internal operations, and company learning and growth. The BSC permits organizing indicators within the four perspectives and also indicates the interactions among them. To implement a BSC framework, a manager must establish the strengths of all relationships and determine their relative importance.

1.2. The analytic network process (ANP)

As a multicriteria decision making (MCDM) tool, the Analytic Hierarchy Process (AHP) allows subjective judgments in addition to quantitative information to enter into the evaluation process. Its framework is straightforward and comprehensive, and adaptable to both group and individual decision making, thus allowing better communication among decision-makers. The AHP uses 9-point scale for comparison, namely unimportant=1; somewhat important=3; important=5; very important=7; and extremely important=9.

The ANP is a generalization of the AHP (Saaty, 2001, 2005). While AHP uses a unidirectional hierarchical relationship to model decision levels, ANP allows for complex interactions and influences among the various components of the decision problem, thus making it a better choice for studying more complex decision problems. ANP brings all of the decision objectives, criteria, alternatives and actors (such as decision makers, stakeholder, and influencers) into a single unified framework, and it facilitates interaction and feedback of elements (alternatives, criteria and actors) within groups (inner dependence) and between groups (outer dependence) (Saaty, 2001). ANP has been applied to a number of complex real-world decision such as transportation project selection (Shang et al., 2004; Tjader et al., 2010), policy decisions (Saaty, 2005), and supply chain management analysis (Meade and Sarkis, 1998; Nakagawa and Sekitani, 2004). See Saaty and Vargas (2006) for details.

The organization of the paper is as follows. In Section 2 we reviewed the outsourcing theories and multicriteria outsourcing decision models. We discuss the literature that utilizes the BSC/ANP approach in other application. Section 3 describes the case firm by whom our research was motivated, and discusses the performance metrics the firm helped build from the four BSC perspectives. Based on the indicators developed and validated by the management team, we build a combined BSC-ANP model and report the model results in Section 4. Section 5 shows the robustness of the proposed model and provides managerial insights through sensitivity analyses. The limitations of our model as well as the summary of our findings are given in Section 6.

2. Literature review

2.1. The outsourcing decision

The outsourcing decision has been the object of a number of studies. Loebbecke and Huyskens (2009) use a logistic regression model to identify criteria for netsourcing decision. Osei-Bryson and Ngwenyama (2006) present a mathematical model to show firms the value of outsourcing, identify outsourcing risks, and construct mutually satisfactory vendor incentive schemes. Amarel and Tsay (2009) describe the cognitive influences and biases that impact decision making among vendors and clients in a distributed outsourcing (supply chain) environment. A comprehensive review of 191 articles on IT outsourcing can be found in Lacity et al. (2009).

Lacity and Willcocks (2000) classify the outsourcing strategies into three categories: Insourcing, Outsourcing, and Selective Outsourcing. In Insourcing, companies retain the management and provision of more than 80% of the IT budget internally. In Outsourcing, firms transfers IT assets, leases, staff, and management responsibility to an external IT provider which correspond to more than 80% of its IT budget. Finally, the Selective Outsourcing (Select-Out) strategy selects IT function from external provider(s) while still providing between 20% and 80% of the IT budget internally.

2.1.1. Outsourcing theories

Several researchers have studied the theoretical basis of outsourcing. Since cost saving is a primary objective of businesses, the transaction cost theory (TCT) dominates the sourcing studies (Ang and Straub, 1998; Lyons, 1995; Osei-Bryson and Ngwenyama, 2006; Walker and Weber, 1984, 1987; Nam et al., 1996; Hui and Beath, 2002). The theory was pioneered by Coase (1937) and developed by Williamson (1985). It deemed that firms are rational and opportunistic in their profit pursuit, and the classic question is: should a firm produce in-house or buy from market? Firms weigh between the production costs (P) and transactions cost (T), and if savings (P–T > 0) exists, outsourcing occurs. The cost elements of the transaction involve (i) operational costs: information searching, and (ii) contractual costs: bargaining and writing the agreement, and monitoring and enforcing the contract.

Recently, TCT has been criticized for its singular focus on cost minimization. Douma and Schreuder (2002) contend that a resource-based view (RBV) should be used to understand outsourcing decisions and outcomes. The knowledge-based theory (KBT), which evolved from resource-based theory (RBT), views a firm as bundles of resources or sets of knowledge (Nickerson and Zenger, 2004; Wernerfelt, 1984) Firms using KBT seek to best allocate existing resource and obtain new resources in order to achieve economic efficiency. Likewise, property rights theory (PRT) (Alchian and Demsetz, 1973; Demsetz, 1967; Grossman and Hart, 1986), agency theory (Holmstrom, 1979), and power theory (Rajan and Zingales, 1998) have all been used to either complement or substitute for TCT. However, no existing theories can provide a comprehensive view to address the outsourcing policy strategy. In this paper, we combine various perspectives of outsourcing concerns into one unified framework, and enable it by the BSC-based ANP model.

2.1.2. Multicriteria decision models

A number of researchers have applied multicriteria model for outsourcing decisions, but none have considered a full, comprehensive
range of indicators from the BSC perspective. Chen et al. (2007) and Lokachari and Moharanagan (2001) did not include strategic-level consideration. Udo (2000) and Yang and Huang (2000) only focus on a very small number of evaluation criteria. Yang et al. (2007) presented a simple AHP model for business process outsourcing decision. In general, these models were rudimentary with incomplete criteria, and lacked sophistication for real-world application. In particular, none of these models prioritized these indicators.

Kaplan and Norton (1992), Campbell et al. (2002) and Cobbold and Lawrie (2002a, 2002b) have demonstrated that including interrelationships among indicators in BSC is essential, since interactions can change the strength of an indicator and not including the interrelationships may compromise the power and accuracy of the BSC framework. To address the interactions issue, Lee and Kim (2000) proposed an ANP-Goal Programming (GP) model for IS project selection. A small hypothetical example given by Marc and Wilson (1991) was used to illustrate the advantages of AHP-GP. Both articles do not apply the BSC as.

Formulating a GP model to tackle a large number of outsourcing criteria and interactions would place an unreasonable burden on decision makers. Likewise, using the ANP alone without BSC, would possibly miss important decisive factors, as seen in Udo (2000), Yang and Huang (2000), and Yang et al. (2007). Both articles do not apply the BSC as formulating a GP model to tackle a large number of outsourcing criteria are brought in and examined. The ANP provides a well-suited means of incorporating the interactions among all the BSC indicators and helps to accurately prioritize these indicators.

2.2. Applications of BSC and ANP models

Our research is a novel application of BSC/ANP to the strategic level IT outsourcing decision. Our work is characterized by across-the-board indicators, extensive sensitivity analysis and a robustness check. In order to place the contribution of this paper into a proper context, it is necessary to understand and to briefly discuss previous research that has utilized the BSC/ANP approach in other areas.

Viglas et al. (2011) combine BSC and ANP to select a Quality Management Information System for a large Greek retailer. Yöksel and Dagdeviren (2010) integrate BSC with fuzzy ANP to determine the performance of a manufacturing firm in Ankara, Turkey. To solve the dependence and feedback issue, Chen et al. (2011) developed a DANP hybrid MCDM model to evaluate the performance of hot spring hotels in Taiwan. Alternatively, Leung et al. (2006) show that the AHP and the ANP can be tailor-made for different situations and can overcome traditional problems of BSC implementation, such as the dependency relationship between measures and the use of subjective versus objective measures. Finally, Ravi et al. (2005) use ANP to structure options in reverse logistics for end-of-life (EOL) computers in a hierarchy and links the determinants, dimensions and enablers of the reverse logistics with alternatives available to the decision maker. The dimensions of reverse logistics for the EOL computers are derived from the BSC. Previous work combining the ANP and the BSC has resulted in interesting and important applications, but none of the previous papers analyzed the sensitivity of the combined model or studied its robustness as we did.

3. The case firm and its outsourcing decision factors

Our research was motivated by the IT needs of a Pittsburgh-based commercial building company. For the sake of confidentiality, we name it BC Inc. BC is a general contractor founded in 1991. It is a member of the top 10 general contractors in the Pittsburgh area. The Company by and large pursues projects from the industry groups, such as hospital/healthcare, institutional/educational, corporate/commercial, industrial, and interior. BC generates approximately $90 million in annual revenue. It constantly strives for excellence in value and quality. The executive team chooses to keep the company big enough to provide customers with the resources and critical mass necessary to develop and complete projects efficiently, i.e. to reach economy of scale. On the other hand, it wants to stay small enough to ensure that each project is treated with highest degree of care and attention. Management in the company clearly recognizes that customer's satisfaction is the building block of BC's reputation. Recently, it has won the Tilt-Up Achievement Award, the Award from Master Builders' Association, the Excellence Award in Craftsmanship and the Award of Merit Building Excellence. In addition to attract, develop and deploy the most experienced, professional and committed managers to assure the firm's premiere performance, the firm also wants to make use of the most advanced and effective IT technology available to manage the diverse aspects of the business operations.

A recent system problem nearly caused a serious delay to the bid submission of an important project. Missing the request for proposal deadline would have resulted in the loss of a $20 million contract potential. To ensure quality and on-time document preparation and submission for potential projects, management of the company was compelled to re-consider streamlining their IT functions, where IT outsourcing was one of the options. Management is eager to know if they should focus on improving their internal IT capability, outsourcing the entire IT function to some reputable firms, or contracting out certain IT activities and if so what activities should be outsourced.

Our research team was provided with the access to key personnel of the company, and was readily accepted for an across-the-board examination. Top executives of the firm, including the owner and CEO of the company, were interviewed to establish alternatives and criteria, to determine the BSC-ANP network connections, and to provide the numerical value to the comparison matrix. Management was introduced to the BSC model and got familiar with the four perspectives of the BSC: Customer, Financial, Internal Operations, and Company Learning and Growth. The executive team employs the nominal group technique (NGT) to collect different views. NGT involves four steps (Delbecq et al. 1975). They are idea generation, idea recording, idea discussion, and voting on ideas. Each participant privately rates each item from no importance “0” to top priority “10”. The procedure limits the urge to oppose and gives the advocate a chance to make his case and not to be brushed off without discussion. The committee identified 35 factors and to finally narrow it down to a list of 17 performance indicators that are most relevant to their outsourcing decisions. These indicators are listed in Table 1 and are discussed from the four BSC perspectives below, where the words in italics match the indicator names in Table 1.

3.1. From the customer perspective

The technological specialization of IT vendors may directly provide for, or indirectly facilitate, better quality products or services than an in-house team can. Superior IT vendors can also support a firm's efforts in improving its credibility and image towards its customers, and in gaining the trust of its customers. Furthermore, IT outsourcing could present the possibility for firms to increase business activity and gain market access and business opportunities. Those considerations are particularly meaningful during the periods when funding, internal or external, is not available to support an expansion opportunity.
Successful outsourcing has the potential to bring significant value to customers, employees and shareholders. But outsourcing often opens up a firm's customer database to its service provider. This increases the risk of the firm's business information being exposed to competitors. Furthermore, if a company's IT vendor is inexperienced, outsourcing could compromise customer satisfaction. Therefore, it is important to select the vendor prudently, negotiate the contract carefully, and monitor the daily operations vigilantly in order to minimize these risks.

At a more detailed level, typically indicators adopted to measure a firm's outsourcing performance with regard to the customers' perspective include: quality, flexibility, reliability of response, timeliness of delivery, service attitude, customer satisfaction index, number of complaints, delivery index, frequency of order backlog, service level percentage, and monthly backlog orders. The customer perspective also measures the extent to which the outsourcing activity improves price quotations, quotations acceptance, call ratios, orders quantity and value, repeat business, and specification compliance.

3.2. From the financial perspective

A primary objective of outsourcing is to free up internal manpower and resources, and to reduce the need for management oversight, thus improving cash flows and reducing costs. Firms seeking a cash infusion may indirectly increase capital by cutting down investments in fixed assets, and by turning fixed costs into variable costs, which in turn affect the cash flow of the company. By taking advantage of external suppliers' lower costs, a firm can reduce its own fixed, variable and human costs. Due to reduced capital expenditures, firms may free up funds, make capital available for other purposes, and achieve greater financial flexibility. As a consequence of the provider's economies of scale, an IT outsourcing firm can often achieve cost reduction, which in turn allows the firm to market more aggressively to increase market share, and eventually becomes an industry leader. Even though cost savings could lead to greater profitability, there is a potential risk of incurring transition costs, and project and vendor management costs, which can more than offset the savings from outsourcing, resulting in a net loss.

In a general business environment, financial measures of outsourcing performance also include: inventory/fixed assets turnover, liquidity (e.g., quick/current ratio and inventory to net working capital), and leverage (debt to assets/equity, long term debt to equity). Using these indicators allows a firm to better understand the financial impacts of outsourcing, and provides feedback for investment decisions and necessary changes.

3.3. From the internal operations perspective

A firm may consider outsourcing non-core activities, in order to excel at core business processes, improve company focus, and increase operating efficiency. By minimizing routine maintenance and nonessential infrastructure in IT, a firm can apply its internal resources to meet changing business conditions, accelerate reengineering, and improve response time. Experienced and competent vendors make client firms agile, responsive to market needs, and technology smart. Client firms become more flexible, because they can obtain extra capacity and new technologies whenever they are in need. High flexibility enables a firm to react quickly to changing business environment and market situations. However, a company may lose internal control over those activities that are outsourced. Therefore, prudent vendor(s) selection, careful coordination, integration, and supervision are necessary. Finally, partnering with outsourcing vendors helps a firm to obtain technologies, to develop world-class capabilities, and to share operational risks, resulting in an improved infrastructure and broadened operational reach.

Under the concern of internal operations, 'quality' is often associated with certifications and professional licenses, which many companies pursue to ensure proper processes for efficient and effective production of goods and services. The range of outsourcing-related measures that a company can monitor in order to satisfy its operational requirements include: resource availability, quality, new product success rate, production lead time, information flows, R&D productivity, vendor on-time delivery, material efficiencies (waste, yield, scrap), and equipment efficiencies (customer demand, set-up costs, uptime, downtime).

3.4. From the company learning and growth perspective

Management expertise, employee competency, employee satisfaction, and the organization's effectiveness are parts of the intangible assets that are critical for the success of a company, as well as being an integral part of the company's learning and growth. Management expertise and know-how facilitate innovation and learning. For socially responsible employers, outsourcing frees up human resources and provides them with the opportunity to...
re-train their employees in new skills and technologies. Learning cutting-edge technologies and investment in R&D brings employees closer to formulating new concepts and to generating novel ideas. However, outsourcing may also make employees anxious and insecure, which may deplete a firm’s skill-base and reduce learning and growth potential. The pressure of creating greater immediate profit can also push the management to lower re-training budgets, which contributes to additional IT workers being laid off and the dissatisfaction of those in need of re-training.

By tapping into providers’ world-class IT capabilities, firms can reallocate more resources to focus on organizational effectiveness, management expertise, and technology research and development. Therefore, well planned resource allocation post-outsourcing could make a company more capable in terms of innovation and R&D, while inferior resource allocation will do the opposite. As a result, the choice of outsourcing and subsequent strategy may either enhance or weaken the technology research and development for new products and/or services.

The growth and development perspective includes measures such as product/process innovation, partnership management, and employee health and safety. It also measures availability of training, absenteeism, staff turnover, project success rates, injury rates, lost workdays, and medical treatment cases. The dependency of the four perspectives of BSC and the interactions of their corresponding indicators will be discussed in the framework discussed next.

### 4. The proposed BSC-ANP model

The BSC-ANP model is a network consisting of nodes representing decision criteria and alternatives, and arcs depicting relationships among criteria and alternatives. Fig. 1 provides an overview of the framework. The clustering of the criteria is based on the four perspectives of BSC. The four clusters in Fig. 1 give the 17 BSC performance indicators established by the case firm’s executive team. The one-way arrows indicate the impact from one node to the other. For example, under the Customer Perspective a one-way arrow is placed between node “Availability Product/Service” and node “Customer Satisfaction”, indicating the former influences the latter. One-way arrows can also represent subordinate relationship between nodes.

A two-way arrow denotes an interaction between two nodes. For example, under the Financial Perspective a two-way arrow is placed between node “Profitability” and node “Industry Leadership” since changes in Profitability affect Industry Leadership, and similarly, changes in Industry Leadership affect Profitability. In our model, we use both one- and two-way arrows to show the relationships, and the interdependencies (interactions) of criteria within clusters and between clusters.

#### 4.1. Pairwise comparison

In the ANP model, the criteria are pairwise-compared, both within and between clusters (Saaty, 1980). For example, in Fig. 1 when comparing the criteria within the Internal Operations cluster with respect to the Profitability criterion in the Financial cluster, we capture the relative importance of the five Internal Operations criteria when Profitability is concerned. The criteria used for evaluating the alternatives are the 17 performance metrics (indicators) under the four BSC perspectives.

The ANP assists in deriving the global priorities of the indicators by first pairwise comparing them with regard to their BSC perspective and then to all other indicators which they interact with (or have influence on). Next, each normalized comparison matrix is taken to the limit to calculate the local priority of every
criteria. In the last step, a super-matrix consisting of all the local-limiting matrices is formed for overall criteria prioritization and alternative ranking. The weighted supermatrix is eventually taken to the limit to form the final results. Table 2 shows a basic pairwise comparison of the four indicators with respect to the Financial Perspective and the derived local priorities of those criteria within the Financial Perspective cluster. When multiple decision makers are involved, it is necessary to aggregate individual judgments into a single representative judgment for the entire group. In such aggregation, one needs to ascertain that the reciprocal of the synthesized judgment equals the synthesis of the reciprocals of individual judgments. In fact, the geometric mean has been proved to be the only correct way to perform such aggregation (Aczel and Saaty, 1983). When decision makers do not wish to combine their judgments, a combined value may be determined by taking the geometric mean of their final result rather than the geometric mean of their judgments. The values contributed by individual decision makers can be weighted so as to give them differential weights. Each decision maker’s final composite score may be raised to the power of the importance of the decision makers before calculating the geometric mean (Saaty, 2008).

The connections representing relationships and interactions among these indicators are given in Fig. 2. As an example, Profitability interacts with other indicators under the Financial perspective, and also with indicators under other perspectives. Table 3 gives example pairwise comparisons of indicators under the Customers perspective with respect to the indicator Profitability under Financial Perspective. The local priorities at the bottom row show the importance of these indicators with respect to Profitability.

4.2. Deriving the global weights for BSC indicators

After pairwise comparison, the principal right eigenvector of each comparison matrix is computed (Saaty, 2001). A super-matrix consisting of all the local-limiting matrices is weighted and taken to the limit to determine the global criteria weights. See the third column of Table 4 for the global priorities of all 17 criteria derived.

4.3. Determining the scores of the outsourcing alternatives

Finally, the alternatives are pairwise compared under each of the criteria. For example: ‘With respect to a specific criterion, is Alternative X better than Alternative Y? If so, by how much?’ An inverse value is chosen if, under the specified criterion, alternative Y is better than alternative X. Similar to criteria rankings, each set of comparison matrices is used to calculate the local rankings of the alternatives. The local rankings of the alternatives are then included in the supermatrix for final synthesis. The composite scores of the alternatives are finally synthesized and summarized in Table 5. Note that the raw scores in Table 5 are the limiting values of the weighted supermatrix for the alternatives. The ideals are the raw values divided by their largest member, whereas the Normals are the normalized values (each raw score divided by the total) of the raw scores. The results clearly indicate that selective outsourcing is the best strategy.

4.4. Prioritizing the IT functions to outsource through the AHP ratings model

Following the recommendation made to our case company, i.e. to pursue SelectOut, management further requests us to help prioritize the firm’s assorted IT functions, so as to determine the most appropriate function(s) for outsourcing. We employed the AHP ratings model (Saaty, 1980) based on the criteria provided by executives and the criteria suggested by Cullen and Willcocks (2003). In the model, we evaluate each IT function feasible for outsourcing under four sets of relevant criteria: Benefits (B), Opportunities (O), Costs (C), and Risks (R). The subcriteria under B

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**Table 2**

Pairwise comparisons of criteria within the financial perspective.

<table>
<thead>
<tr>
<th></th>
<th>CashFlow</th>
<th>CostSavings</th>
<th>IndLeader</th>
<th>Profitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>CashFlow</td>
<td>1</td>
<td>1/5</td>
<td>1/2</td>
<td>1/7</td>
</tr>
<tr>
<td>CostSavings</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>1/2</td>
</tr>
<tr>
<td>IndLeader</td>
<td>2</td>
<td>1/2</td>
<td>1</td>
<td>1/3</td>
</tr>
<tr>
<td>Profitability</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Local priorities</td>
<td>0.0671</td>
<td>0.2908</td>
<td>0.1473</td>
<td>0.4948</td>
</tr>
</tbody>
</table>

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**Fig. 2.** Detailed network.
include: access skills, cost saving, quality IT, response time; Under O: IT architecture, industry application, simplifying management; under C: process cost, loss control, unpredicted cost; and under R: unrealizable cost savings, lower IT quality, and slow response. The alternative ratings obtained from each set of BOCR criteria can be synthesized using the Additive-Negative formula (Saaty, 2005), which equals $p_2 \cdot (1 + p_3 - p_4)$, and is generally best for long term results. The values of $p_1$, $p_2$, $p_3$, and $p_4$ for the priorities of BOCR which are derived through pairwise comparison pertaining to the overall goal. Another synthesization method is to apply the multiplicative formula, using $(B \cdot O)/(C \cdot R)$, which is conceptually equivalent to marginal cost/benefit analysis and is more suitable for short term results (Saaty, 2005).

The proposed AHP ratings model generated the IT functions in the descending order of priorities: Documentation; DSS; Account-...
Software (2009) conducts a total of 81 BSC-ANP experiments. Each experiment corresponds to a unique weights combination of the four criteria set at 0.0001 (as explained on the footnote of Table 6, 1 stands for 0.0001, 2 for 0.5, and 3 for 0.9999). Out of the 81 experiments, Insourcing is found to be the top choice at experiments #36 and #73. The SelectOut strategy is the best alternative in 79 out of the 81 experiments (97.53%). SelectOut consistently dominates other outsourcing strategies. Thus we conclude the model is robust.

Of the two points (#36 and #73) where Insourcing is the top choice, we found in Table 6 that both Satisfaction and AvailablePS are at their lowest level (1), while Database is at its highest level (3). In experiment #73, InternalControl is also at its highest (3), but in #36, InternalControl is at its medium level (2). Managerially, this suggests that when database security becomes a dominating concern, while customer satisfaction and the availability of product/service are of less concern, Insourcing becomes the better choice if internal control is at least of moderate concern. See Fig. 6 for graphical results.

To understand the effect of the opposing factors, we next conduct a two-variable three-level sensitivity analysis using CoreFocus and Database. The results are shown in Table 7, each row shows the criteria weight level and the corresponding scores for alternatives. Of the nine experiments conducted, only in experiment #3, has the Insourcing ranked top. In other words, SelectOut is the top choice eight out of nine experiments (88.88%). Insourcing becomes the top choice because Database is at its highest and CoreFocus at its lowest. Namely, Insourcing becomes the best choice when database security is the most critical concern, and focusing on core business is not a concern. The sensitivity analysis results show that our model is robust and the SelectOut strategy is a reliable and trustable choice for the studied firm. The result coincides with the survey outcome conducted by Lacity and Willcocks (2000): We therefore feel confident in recommending selective outsourcing as the best strategy for the firm.

### 5.3. Empirical validation of the importance of the interaction effects

A key contention of this research is whether modeling the interactions is essential to the use of a BSC for strategic IT decision making. No formal mechanism is available to validate our assertion, but we can empirically investigate how the exclusion of indicator interactions would change the BSC model for our example firm when the rest of the model structure is retained, thus isolating the effect of the interactions alone. Removing interactions converts the structure into a BSC-AHP model, with all 17 criteria organized into one single hierarchy. We applied the same procedure as before to derive the global weights for the 17 criteria; the results are shown in Table 7. Each row consists of the global weights for the 17 criteria; the results are shown in Table 7. Each row consists of the global weights for the 17 criteria.

Note that there is a substantial difference in criterion rankings between the model with- and without-interactions. For example, the Profitability criterion is ranked 10th in the model with interactions (column 4), while it is ranked 2nd in the model without interactions.

The inclusion of interactions appears to increase the importance of the criteria under the Customer Perspective and decreases the weights of the criteria under the Financial Perspective. Undoubtedly, a financial indicator such as Profitability is important to a firm, but it is largely driven by the customer indicators such as Satisfaction and AvailablePS. Thus, from this comparison we can conclude that the priority shift is sensible. We can explain the weight shift, and justify the use of the more complex BSC-ANP interaction model than a simpler no-interaction model.

### 6. Summary and conclusions

It is important to note that there exist some limitations to the proposed BSC-ANP model, due the inherent limitation of ANP and...
BSC. First, because the BSC approach does not guarantee the inclusion of every measure in all of the dimensions, the final selection of measures that are included is left to the decision maker, and therefore the model’s structure might not be complete in a mathematical sense. Second, while the results produced by the model should be validated, validation in this context is a mixture of replication, satisfaction, and non-falsity of the conditions, as opposed to a mathematical proof of optimality as is typical of an OR model. In the absence of a gold-standard basis for comparison, the decision maker cannot be presented with a guarantee that the strategy identified by the model is superior to all of the available alternatives.

Notwithstanding these limitations, our combination of ANP and BSC offers a number of distinct advantages over other methods and models. The BSC complements the ANP by providing a framework to ensure that all important criteria are examined, and all relevant criteria are included in the outsourcing decision model. The ANP provides a convenient means of including BSC indicator interactions and prioritizing the BSC indicators. As a result, the combined BSC-ANP approach supports the decision maker in a number of ways, including:

- Establishing relationships between and within different dimensions,
- Measuring the strengths of those relationships and interactions,
- Determining the overall impact of different dimensions and individual elements of a dimension on the strategies studied,
- Deriving priorities for the dimensions, the components of the dimensions, and the strategies considered,
- Allocating resources according to those priorities, and
- Assessing the sensitivity of strategy priorities to changes in the priorities of the dimensions and their components.

In this paper, we showed how the Balanced Scorecard can be operationalized to serve as a basis for a firm’s strategic IT outsourcing policy decisions. The framework of the balanced scorecard captures and interrelates different perspectives and indicator measures, providing a comprehensive view of the firm for strategic analysis. The Analytical Network Process provides a proven way of eliciting and quantifying the relationships necessary to actually use the BSC. The ANP is particularly important for estimating the values for the interactions in the BSC model. Using the actual problems faced by the case firm, we demonstrated the feasibility and usefulness of the combined BSC–ANP approach, as well as the importance and consequence of incorporating the interaction terms in the decision making process.

### Table 6

<table>
<thead>
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<th>Experiment #</th>
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For columns 2–5, when level=1, it means low weight and, corresponding weight = 0.0001; when level=2, it means medium weight, corresponding weight = 0.5000; when level=3, it means high weight, corresponding weight = 0.9999.

### Table 7

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