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Goal programming model for management accounting and auditing: a new typology

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Abstract In practice, generally the accountants are facing complex decision-making situations where they aggregate simultaneously several conflicting and incommensurable factors (dimensions). They look for the decision of the best compromise. The goal programming (GP) is one of the multi-criteria decision aid models that have been applied to the field of accounting. The aim of this paper is to provide an exhaustive literature review of the GP application within the field of accounting and to propose a new typology which serves as a guideline for the accountants to identify the most appropriate variant of GP to deal with specific accounting related decision making situation.

Keywords Management accounting · Auditing · Goal programming · Multi-criteria decision aid · Typology

1 Introduction

The goal programming (GP) is a multi-criteria decision aid model that allows decision makers to consider simultaneously several conflicting and incommensurable objectives. This model is based on the satisfactory and sufficient philosophy (Martel and Aouni 1990, 1998; Romero 2004). With the aid of GP, the decision-maker (DM) searches for the solution that represents the best compromise rather than one that is deemed to be optimal. The standard version

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of GP was introduced by Charnes and Cooper (1961). This version is a special case of the 'distance function model' (DFM) where the formulation of GP seeks to minimize the unwanted deviations between the achievement and aspiration levels of the DM's aspiration levels (goals). This multi-criteria decision aid has been applied to a wide variety of decision-making situations within different fields, including accounting.

In fact, early seventies, the GP model has been applied to the field of accounting and particularly to management accounting and auditing. Our literature review reveals an increase interest in theoretical developments and applications in different fields. One field of these applications is Management Accounting that focusses on collecting financial information and establishing some measures required for analysis and decision-making related to the organization's objectives and mission. These objectives are aligned the priorities of the company's shareholders and creditors. The DMs' objectives can be conflicting and incommensurable. Their simultaneously aggregation requires some compromises from the DM.

The aim of this paper is to provide a literature review of the application of GP in the context of accounting decision-making, in order to construct a typology, which will serve as a guideline to identify the most appropriate variant of GP to deal with specific accounting decision-making situations. In fact, this typology provides useful insights and it will demystify the use of GP model within the field of accounting. The structure of the manuscript is as follows. Section 2 provides an overview of GP model and describes the two main variants, namely weighted and lexicographic goal programming. Section 3 is devoted to an overview of the literature involving the decision-making context of the accounting decisions where different GP variants are suggested as decision-making tools. Section 4 outlines a proposed typology based on the type of GP variant used for different types of accounting decisions. The final section of this paper provides summary and some concluding remarks.

2 Weighted and lexicographic goal programming variants

This section reviews the GP highlighting the two main variants of this model, namely weighted goal programming (WGP) and lexicographic goal programming (LGP) which are the prominent variants applied to accounting decision-making contexts. Indeed, the GP model is one of the most popular and powerful multi-criteria decision aid tool (Aouni and Kettani 2001). This model is designed to aggregate simultaneously several conflicting and incommensurable dimensions (criteria, objectives or attributes). Based on a satisficing philosophy, the decision-making process results in the search for the alternative of the best compromise where the unwanted deviations from the aspiration levels are minimized. The GP model is easy to understand, easy to apply and facilitates consideration of trade-off in the decision making process (Aouni et al. 2014).

Tamiz et al. (1998) highlighted that the most popular and applied variants of GP are the WGP and the LGP. Since the literature tying GP to accounting decision making focuses mainly on these two variants, this section draws on the work of Aouni et al. (2009) where the authors present the formulation for these two variants of the GP model and discuss how these variants are used to handle explicitly the DM's preferences.

In the first variant, WGP, the weights are assigned to the unwanted deviation variables representing the relative importance given to the deviations associated with different objectives represented as per provided by the DM according to his/her preferences.

The mathematical formulation of the WGP variant is as follows:

$$\begin{aligned}
&\text{Min Z} = \sum_{i=1}^{p} (w_i^+ \delta_i^+ + w_i^- \delta_i^-) \\
&\text{Subject to : } f_i(x) + \delta_i^- - \delta_i^+ = g_i, \quad (i = 1, 2, \ldots, p) \\
&x \in F, \\
&\delta_i^- \text{ and } \delta_i^+ \geq 0, \quad (i = 1, 2, \ldots, p).
\end{aligned}$$

where w_i^+ and w_i^- represent the relative importance (weights) of the positive (δ_i^+) and the negative (δ_i^-) deviations respectively; $f_i(x)$ and g_i are the achievement and the aspiration levels for each objective respectively. The decision-making situation constraints are designed by the set F. The weights allow the DM to express explicitly his/her preferences and also to perform some trade-offs among the objectives (Jones and Tamiz 2010). In practice, the DM may face difficulties in providing accurate values of the weights (Aouni et al. 2009). In their paper Kettani et al. (2004) argued that the weights in GP model play double roles as follows: (a) for normalizing the scale measurement of the objectives and, (b) for preferences elucidation.

The LGP variant is as follows:

$$\begin{aligned}
&\text{Lex. Min Z} = L = \left[l_1(\delta^-, \delta^+), l_2(\delta^-, \delta^+), \ldots, l_q(\delta^-, \delta^+)\right] \\
&\text{Subject to : } f_i(x) + \delta_i^- - \delta_i^+ = g_i, \quad (i = 1, 2, \ldots, p) \\
&x \in F, \\
&\delta_i^- \text{ and } \delta_i^+ \geq 0, \quad (i = 1, 2, \ldots, p).
\end{aligned}$$

where L represents an ordered vector of unwanted deviations; q indicates the different priority levels (Aouni et al. 2009).

LGP, also known as pre-emptive goal programming, allows the DM to rank the objectives in a lexicographic order according to their relative importance as per expressed by the DM. As the decision-making progresses, the DM will be adding the obtained solution to the next level of priority, and the process will evolve to the recommendation of the best compromise until reaching the last level of priority q.

These two variants are the most popular variants of the GP model and this is found to be the case in the applications related to accounting decision making. In the next section we will discuss and highlight the application of the GP model within the area of accounting.

3 Goal programming model for accounting

The environment within which accountants practice is increasingly becoming more complex which is reflected in the nature of the decisions faced by accountants. More often than not, these decisions involve consideration of multiple conflicting and incommensurable dimensions. Given the nature of accounting decisions, GP has been proposed as a decision aid tool within this field, specifically in the areas of auditing and management accounting. This section provides an overview of auditing and management accounting and highlights the use of GP in these areas of accounting.

For instance, in accounting context there is a need in aggregating simultaneously several choices to take decisions where accounting objectives are conflicting. Thus deciding based

on a single criterion might obscure the overall effect obtained through a collection of choices (Fields et al. 2001; Dechow et al. 2010).

This section is divided in two sub-sections, as follows: (a) an overview of the literature related to the application of GP model in auditing, and (b) review of the applications in the area of management accounting.

3.1 Auditing

While directors and officers of the corporation must ensure that the preparation of financial statements is compliant with the accounting standards, public confidence in the financial statements is enhanced through independent verification of this compliance. One of the critical mechanisms used to ensure independent verification is the statutory audit (Hodgdon et al. 2009). Compliance is evidenced in the audited financial statements where the auditor report indicates what standards were used by management to prepare the financial statements. The objective of the audit is to allow auditors expressing their opinion as to whether the financial statements are prepared in all material respects in accordance with a financial reporting framework such as International Financial Reporting Standards (IFRS).

The audit function has come under increased scrutiny over the last few years as a result of concerns that accountants and auditors failed to discharge their responsibilities in highly publicized frauds (Walker 2005) and more recently the market meltdown (Deuchars 2010). These concerns were further raised with the failure of one of the world's largest and most reputable auditing firms, Arthur Andersen LLP. In the past, public accounting and auditing was self-regulated. This has since changed in some jurisdictions such as the United States. In this jurisdiction there is a new system of independent oversight with the establishment of the Public Company Accounting Oversight Board (PCAOB) with the mandate to audit the auditors to ensure effective regulation and promote quality audits.

A key component of the audit is the exercise of the auditors' professional judgment to identify risks and subsequently to tailor the engagement to those risks resulting in better quality audit (Arens et al. 2011). The quality of the audit is assessed in terms of the auditor's documentation and demonstration of a process that conforms to professional standards (Wedemeyer 2010). In assessing risk, the auditor must outline how the audit will deal with the identified risks in order to confirm that financial statements are not materially misstated (Allen et al. 2006). In conducting the audit, the auditor must ensure that sufficient appropriate audit evidences are gathered to support the audit findings. In gathering these evidences, the auditor uses sampling in testing risk assessment procedures, procedures to obtain an understanding of internal control, tests of controls and tests of detailed balances. With audit quality coming under greater regulatory scrutiny, there is a need to ensure that the auditor can substantiate the basis for the claims outlined in the final auditor's report.

One of the earliest applications of GP model in accounting was in the area of auditing. Ijiri and Kaplan (1971) suggest that the audit sampling objectives are much broader and should include not only representative sampling but also corrective sampling, protective sampling and preventative sampling. The authors propose the use of the WGP model to combine the audit sampling objectives of representative, corrective and protective where the auditor will assign to each objective an acceptable aspiration level or goal. The authors suggest that when the sample size is predetermined, the GP model can be utilized to try to meet each of the goals to the extent possible.

Building on the work of Ijiri and Kaplan (1971), Tayi and Gangolly (1985) introduce a goal programming approach that they assert is more flexible than the former one. The authors

highlight that the proposed formulations by Ijiri and Kaplan (1971) do not explicitly consider that cost may differ in sampling across strata. Additionally, the authors are critical of pre-emptive weights in GP that can result in compensation giving rise to infinite marginal rate of substitution of a high-priority objective for a lower one, which they state is inconsistent auditing standards. The authors suggest the use of an adaptation of polynomial functions of the pertinent deviation variables to model intra and inter-objective compromises by integrating the DM's preferences. They proposed a GP model that incorporates the auditor's preferences in establishing priorities for the corrective, protective and representative sampling objectives along with the auditor's objective with respect to cost.

In additions to audit sampling, GP has been applied to audit staff planning. Killough and Souders (1973) address the need for formal model for managing human resource in public auditing firms. Audit staff planning is a critical component in the auditing process that requires the matching of skills and ability to the specific audit. Killough and Souders (1973) acknowledge that this function is an extremely complex task that requires quantitative tools for a better management of their limited resources. To develop a planning model for a public accounting firm, LGP model was utilized to reflect the DM's priority levels of the objectives, including increasing revenues, chargeable hours, billing rates, distribution of clients, management staff ratio and net income. The authors illustrated how modifying the priority structure can be done to reflect better the DM's preferences. Welling (1977) also applies GP to the complex problem of a public accounting firm's human resource management. The author developed a non-monetary approach for human resource valuation through the LGP model. The model was applied for planning human resources by incorporating job productivity, human resource development and individual satisfaction.

The GP model has also been applied in the context of the internal audit function within organizations. Corporate management is responsible for the financial statements. It is management's responsibility to prepare and present financial statements using an applicable financial reporting framework, to design, implement and maintain internal control over financial reporting and to provide auditors with information relevant to the financial statements (Rittenberg et al. 2011). As a result of recent corporate scandals, management is becoming more accountable for ensuring that the financial statements are truthful representations of the economic events affecting the firm. With the adoption of corporate acts, such as Sarbanes–Oxley in the US, corporate managers are increasingly more responsible to ensure proper controls and compliance, which can be enhanced through the internal audit function within these corporations (Bargeron et al. 2010). A key consideration of an internal audit department management is therefore, to determine the most effective allocation of internal audit time by selecting those audit projects that will provide the greatest benefit to the organization. Given the complexity and incommensurability of the factors affecting such planning, GP model is suggested as a decision aid tool to enhance the planning decisions of internal audit departments. Krüger and Hattingh (2006) suggest a combined Analytic Hierarchy Process (AHP) GP approach to facilitate the selection of IA projects for internal audit departments. Risk assessment of the available projects under consideration is first established using AHP. The authors then build a WGP model that combines AHP risk assessment with other factors that form part of the IA planning decision. The model is then tested in an IA department of an international gold mine located in South Africa.

The GP model has been utilized by Gardner et al. (1990) to study the audit human resource planning problem. They developed a multi-period audit staff planning application and evaluate the model using a test application involving actual decision makers (partners in public accounting firms). According to Gardner et al. (1990), their proposed model can be easily applied to auditing human resources.

Fuzzy set approach employed to study staff allocation problems and the firm's overall strategic resource management by Kwak et al. (2003). They suggest that the fuzzy solution can help the firm to make a realistic decision regarding its staff allocation problems and the firm's overall strategic resource management when environmental factors are uncertain. They proposed a solution procedure to identify a satisfying selection of possible staffing solutions.

The GP model has been applied as a multi-criteria decision aid tool in the auditing function in the field of accounting, specifically as it pertains to the audit sampling, human resource planning and project planning.

3.2 Management accounting

Management accounting and control (MAC) is the process of identification, measurement, accumulation, analysis, preparation, interpretation, and communication of information that assists managers in making decisions (Horngren et al. 2012). The focus of MAC is to provide users within organizations with relevant financial and non-financial information for complex decision making for planning and control purposes. Managers have become more accountable out of necessity in the hopes to compete in the more hostile, resource constrained business environment. With the current trend toward increased accountability and demands for management effectiveness, the field of management accounting has adapted to this environment by developing new management accounting techniques, such as activity based costing and activity based management and new performance measurement systems, such as the balanced scorecard. The decision environment for organizations has become more complex involving multiple objectives that management must consider simultaneous and influenced by the consideration of multiple stakeholders. The role of management accounting within organizations has become more strategic (Shank and Govindarajan 1992). The result is that management accountants within organizations act as strategists and internal consultants by contributing strategies and recommendations for managers' decisions (Hülle et al. 2011).

Given the complexity of the decision making in this environment, there is a need to have more sophisticated systems that will support more complex, multi-criteria problem solving. It appears that this need is even greater with the increasing complexity in the business environment. The GP model has been used in management accounting applications to provide a decision aid in making business decisions. The remainder of this part will provide an overview of the GP applications in management accounting, specifically in the areas of budgeting, pricing, costing, capital, budgeting and performance evaluation. The type of GP variant used in these applications will be highlighted.

Charnes et al. (1963) were the first to apply GP in a management accounting context and they addressed the management accounting problem of determining breakeven. The authors suggested the use of the standard GP model for modeling a breakeven analysis decision involving a product mix of two products, a constant level of fixed costs and two machines capacity constraints.

Sheshai et al. (1977) extend the GP by proposing an Integer GP model to eliminate the two simplifying assumptions adopted in Charnes et al. (1963) regarding cost volume profit analysis in product mix decisions. These assumptions were the linear contribution function of the products and the constant fixed cost. Using the general WGP variant, Sheshai et al. (1977) have applied the WGP model to Cost Volume Profit Analysis where they considered the contribution functions as curvilinear and the separable product costs as semi-fixed with incremental steps. The authors believe that this cost modeling is more representative of how costs actually behave.

In budgeting, Lin (1978) illustrates the application of LGP in a budgeting decision for a company with two products and a labour resource constraint. The model has three priorities relating to overtime, contribution and sales.

In the same vein, Lee and Shim (1984) applies LGP model in the context of Zero-Based Budgeting (ZZB). The ZBB is an approach to budgeting, commonly used in the public sector, where the management starts budgeting from zero and each expense item must be evaluated and justified for inclusion in the next year's budget. The budgeting decisions involve multiple conflicting objectives that can be addressed in the GP model which Lee and Shim (1984) state the flexibility of the budgeting process by incorporating various aspiration levels in the form of objectives and priorities established by the organization for the coming year. The author proposes the use of LGP to account for organization's budget priorities. Hemaida and Hupfer (1995) also apply GP in the public sector specifically addressing financial constraints facing higher education. The authors propose the use of LGP as a decision aid in the management of faculty resources. The authors propose the development of planning models which allow for prioritizing specific departmental goals while recognizing the need to address the goal of minimizing costs.

More recently, in public sector, Zamfirescu and Zamfirescu (2013) employs GP in performance based budgeting; they argued that the optimization of public funds allocation is carried out using GP which eliminates shortcoming of the linear programming methods. In the based budgeting problem of optimizing the allocation of public funds is the optimal identification amounts allocated to each program, from set of N programs in time horizon consisting of T periods. The authors stressed that their approach enable users to make changes in funds for each program.

A very important pricing decision facing decentralized organizations is the establishing transfer price between divisions. This pricing decision involves greater complexity when the divisions are operating internationally. Merville and Petty (1978) outline the use of GP model in transfer pricing decisions of decentralized international business entities. Establishing global transfer prices involve the consideration of multiple conflicting objectives including consideration of differing tax rates, profit requirements, risk avoidance along with the behavioral implications of such prices. The authors illustrate the consideration of these conflicting objectives through LGP. The use of LGP allows the flexibility to integrate simultaneously financial, legal, behavioral and social-political requirements within a single setting.

Pricing decisions in contractor bidding has become more complex than simply providing the lowest cost alternative. Tan et al. (2008) assert that customers are more sophisticated and will evaluate potential contractors on other objectives in addition to cost such as quality, time to complete, safety performance and environmental performance. The authors use LGP to model the contractor's bidding strategy with consideration of the project client's multiple objectives and contractor's resource constraints. The use of LGP allows the contractor to determine a bidding strategy while considering the client's priorities for the objectives of a specific project.

Costing decisions are integral part of management accounting and, in particular, understanding how costs behave is critical in determining the relevance of cost for management decisions. Traditional costing for explaining or predicting cost behavior relied on simple cost systems usually constructed based on single cost drivers, such as production volume. These traditional systems were used for various purposes, one of which was to determine full costing of cost objects. Another application is in the evaluation of departmental performance. Badran (1984) explores cost allocation decisions using GP for departmental overhead allocation. The author presents the management accounting problem of determining a cost allocation base (driver) to ensure that the allocation of costs to departments is objective,

uniform, logically defensible and recognize that the allocation must be made to reflect the fact that the departments "are evaluated on the basis of their contribution to the achievement of the organization's goals (p. 332)." The author proposes the use of a standard GP model to address the conflicting objectives of the organizational desire to have full costing of departments and the departmental objectives to minimize the amount of indirect costs allocated to the department.

By using activity-based costing, Khataie et al. (2010), develop a multi-objective mixed-integer programming model which considers performance to effectively manage order acceptance decisions in supply chains, subject to capacity constraints. They expand the previous models with a more customer-oriented approach. The model expands the previous related studies through the application of WGP. The proposed model fulfills a desirable amount of orders completely and accepts selective number of orders partially with an objective of minimizing the amount of residual capacity and increasing the profitability

Understanding why costs exist and what causes changes in cost, particularly overhead costs, lead to the development of activity based costing (ABC) which makes use of multiple activity drivers and cost drivers (Cooper and Kaplan 1988, 1992; Johnson 1995). A major problem in applying ABC is the proper determination of cost drivers to help explain why costs change. Schniederjans and Garvin (1997) propose the use of Analytic Hierarchy Process (AHP) and zero–one GP (ZOGP) to enhance the quality of decisions concerning cost driver selection in ABC systems. The authors illustrate how, through the prioritizing of possible cost drivers using AHP, the ZOGP model can be developed to allow the DM to consider some incommensurable and conflicting objectives related to budgeted costs, analyst hours, auditing hours and the AHP weighting. This model gives to the accounting analyst the opportunity to in select more than one cost driver. The authors' proposed model is an application of LGP, which "permits accounting analysts the flexibility to prioritize resources in the cost driver selection progress (p. 77)." The authors do caution that AHP weightings may be compromised as a result of arbitrary rankings when multiple alternatives are selected at one time which they suggest can be overcome by using an interactive two-stage selection process.

Costing is also the subject of the MAC GP application proposed by Dowlatshahi (2001). The author presents a case study to establish priorities for Life Cycle Costing and Time Based Competition in the context of concurrent engineering. This model allows "manufacturing firms to base their crucial product design decisions on tangible and important criteria without subjecting them to the rigidities of pre-determined models or frameworks unsuitable to their unique requirements (p. 1208)." When making these decisions, the author highlights the importance of the consideration of strategic, intermediate and tactical planning horizons that impact on cost and delivery when making product design decisions in a concurrent engineering environment. LGP is suggested to recognize the priority structure of planning horizons, specifically ordered as strategic, intermediate and then tactical.

Iranmanesh and Thomson (2008) propose a three-stage model for product design based on quality function deployment (QFD) employing target costing. The model represents a cost-design parameter method that optimizes cost and design characteristics during product development. The model works at three levels-strategic, operational and tactical. WGP is employed at the operational level to facilitate the decision as to the degree of improvement of each design characteristic relative to the customer attributes given the desired cost targets budget constraints and the allowed limits of design characteristic optimization. The weights in the model represent the DM perceived importance of each customer attribute recognized in the QFD matrix.

Capital budgeting is another area of MAC that utilizes GP as a decision-making aid tool. In his overview of different applications of GP in management accounting, Lin (1979) outlines

the use of LGP for project selection in capital budgeting decisions. The two priority levels in the model relate to the DM's concern in selecting the project that meets the minimum net present value of cash flows and meeting the minimum acceptable accounting earnings.

In his paper, Kalu (1999) presents an extended GP model to address uncertainty in capital budgeting decision-making. Through the introduction of an efficiency index, the author addresses one of the major defects of the GP which is "the difficulty of selecting alternative options (or solutions) when the level of achievement of the preferred priority structure remains unchanged for all possible solution alternatives" (p. 237). Kalu (1999) develops a model involving a multi-objective mathematical programing that was applied by oil executives in the Nigerian oil industry. The author utilizes LGP model in which the objectives, prioritized by Oil executives, included achievement of net profit after tax NPAT, minimization of worker dissatisfaction, ensuring adequate supply of labor, maximize contribution to society's welfare in relationship to environmental protection and community services and ensuring compliance with the Petroleum Decree of maintaining ratios of expatriates to nationals in management and supervisory/professional categories.

Tsai and Hung (2009) propose the development of a comprehensive and systematic GP model that integrates activity based costing (ABC) and performance evaluation in a value-chain structure for optimal green supply chain (GSC) supplier selection and flow allocation using a fuzzy goal programming (FGP) model. The authors recognize that the costs associated to suppliers are not simply the cost of the purchased product or service, but have a value-chain structure where the costs and performance measures are identifiable and measurable. The authors use LGP in the development of the FGP model. The model is then illustrated through mobile phone brand manufacturer. The authors use LGP to allow the DM to establish priorities for the objectives outlined in the model. The authors demonstrate the flexibility of their model through sensitivity analysis, where the results vary according to changes to priority levels assigned to the objectives.

In management accounting performance measurement, the Balanced Scorecard (BSC) is an effective management tool that includes measures on four perspectives, financial, customer, internal business processes and learning and growth, and represents a balance between long term and short term objectives using financial and non -financial measures, (Kaplan and Norton 1992; 2007). Bhagwat and Sharma (2009) suggest that using the BSC enhances supply chain performance measurement. The authors propose the integration of AHP Preemptive GP (PGP) model to assist supply chain (SC) industries in their day-to-day performance measurement decisions utilizing the Balanced Scorecard (BSC) to allow for a balanced picture of performance evaluation. The performance indicators identified in the BSC and prioritized through AHP are the decision variables in the PGP model. The authors highlight that the use of PGP additional managerial preferences can be reflected by adding criteria related to the three performance levels: strategic, tactical and operational.

In his paper, Hung (2011) suggests that global supply chain (GSC) management represents a control challenge to initiating companies to ensure that global suppliers integrate a customer focus and quality management due to conflicting factors of moral hazard, different legal and cultural environments and loose links in the supply chain system. The author suggests that there is a link between GSC incentive systems and ensuring a certain desired level of quality. Hung (2011) proposes the integration of an economic incentive scheme with activity based costing to solve the global supply chain quality management incentive problem. Through zero–one GP, the author suggests that the GSC designer can determine the optimal quality to be used to determine the optimal incentive amounts of suppliers and the initiating company gains for each economic incentive scheme. The DM chooses from three quality levels to find the optimal one.

Table 1 A typology for auditing and management accounting through GP model

Auditing decisions	WGP	LGP
Sampling-external audit	Ijiri and Kaplan (1971)	Tayi and Gangolly (1985)
HR planning-external and internal audit		Killough and Souders (1973)
		Welling (1977)
Audit planning-internal audit	Krüger and Hattingh (2006)	
Management accounting decisions		
Budgeting	Charnes et al. (1963)	Sheshai et al. (1977)
		Lin (1978)
		Lee and Shim (1984)
		Hemaida and Hupfer (1995)
		Zamfirescu and Zamfirescu (2013)
Pricing	Brown and Norgaard (1992)	Merville and Petty (1978)
		Tan et al. (2008)
Costing	Badran (1984)	Schniederjans and Garvin (1997)
	Iranmanesh and Thomson (2008)	Dowlatshahi (2001)
Capital budgeting		Lin (1979)
		Kalu (1999)
Performance evaluation		Tsai and Hung (2009)
		Bhagwat and Sharma (2009)
		Hung (2011)

4 New typology

The preceding section discusses the application of GP for accounting decision-making in the areas of auditing and management accounting. The discussion identifies the type of GP variant that was used in the different decision-making contexts. From the literature review, it is possible to propose a typology based on GP variant that will be helpful for practitioners and academics interested in applying GP to the field of accounting and auditing. The typology provides a summary of the nature of the GP variant and the type of accounting decisions considered using the variant. The following table presents the new typology.

Table 1 identifies the types of auditing and management accounting decisions and highlights the GP variants (WGP or LGP) proposed for such decision context. It is clear that LGP is by far the most popular variant applied to Accounting decision making with 74 % of the articles proposing the use of LGP versus only 26 % of the articles proposing the use of WGP.

It is also clear from the typology that the application of GP in general is more prevalent in the area of Management Accounting as opposed to Auditing, 78 versus 22 % respectively. On the other hand GP is absent in the area of financial reporting. The GP is applied to auditing decision that relate to audit sampling, audit staff planning and internal audit project planning. Approximately 60 % of the GP applications in Auditing involved LGP while 40 % of the applications involved WGP. The dominance of LGP is also evident in the MAC area of accounting decision making, where over 78 % of the MAC applications use LGP. In management accounting, GP is used in decisions involving budgeting, pricing, costing, cap-

ital budgeting and performance evaluation. In particular, GP appears to be most evident in management accounting decisions involving budgeting and costing with more current MAC applications in the area of performance evaluation.

The use of LGP appears to be most popular primarily due to ease of the decision maker to establish priorities for the objectives as opposed to determining weights. This method is seen as lending itself well to modeling decisions where the DM has a pre-defined ordering of the objectives in mind and there is no need to make direct trade-off comparisons between these objectives (Jones and Tamiz 2010). As can been seen from the types of accounting decisions previously discussed and represented in the typology in Table 1, the majority of these accounting decisions lend themselves to the DM ability to establishing priorities for the objectives.

The use of the WGP is not as prevalent in accounting decision-making as LGP. In WGP, the DM's preferences are captured in the weights assigned to the objectives reflecting the relative importance of each objective compared to the others (Aouni et al. 2009). As a multi-criteria decision-making aid tool, the GP variant allows for significantly more trade-off analysis through sensitivity where the DM assigns different weights for the objectives. Through this sensitivity analysis, the DM learns better about his/her preferences with respect to the objectives affecting the decision. The method does, however, cause the DM some consternation since he/she may have some difficulty in determining precisely the weight of each objective resulting in difficulty in obtaining usable information about these preferences.

5 Concluding remarks

This paper introduces a new typology based on the GP model and how it is employed in accounting and auditing areas. It is an interdisciplinary paper that reviews literature in accounting and auditing which employed GP. This paper advances prior studies by showing the most commonly used GP variants. The emphasis on the role of GP in multi-criteria decision-making aid in accounting and auditing as it provides a useful way of striving toward various managerial objectives simultaneously while giving higher priority to the more important objectives.

This typology is based on the type of GP variant that is used in accounting decision making. Through a review of the literature, studies were classified according to the types of auditing and management accounting decisions and by the type of GP variant proposed for the decision. In many cases the problems faced by accountants are complex and involve multiple conflicting and incommensurable factors that must be considered when arriving at a decision.

In an environment where there is increasing complexity and uncertainty, and decisions involve or affect multiple stakeholders, there are greater demands for accountability and transparency in the decisions made by accountants. Also accountant needs to investigate mangers incentives/motives in taking multiple accounting choices to accomplish a specific objective. Decision theory provides a variety of multi-criteria decision aid tools that can assist the accountant or team of accountants in the systematic preparation and evaluation of the alternatives relating to these complex problems. The GP model is one of these powerful approaches that can help in dealing with complex accounting problems.

The distinction feature of this paper is that, while GP is evidenced in literature users do not agree on one type. It is found that LGP widely accepted in both areas, thus the users commonly used LGP compared with WGP which in turn lead to recommend LGP as variant

technique in accounting. The popularity of the LGP and reasons for adopting was discussed in the paper.

The typology represents a guideline for practitioners and accountants to gain an appreciation of how GP can be an effective decision aid for accounting decisions and to highlight the most appropriate variant to use for those decisions. This typology can serve as a catalyst for researchers and practitioners to explore how to use goal programming in the accounting contexts they are interested.

The paper opens new ways for new areas for research into other accounting decision applications. In fact it might be useful to think about accounting decision areas where there is a void in the usage of GP such as financial reporting where there is a need for accountants to exercise professional judgment, particularly in preparation of estimates. Judgment may relate to expected collection of the amount of accounts receivable or how long the company will hold a marketable security. Over the last decade, more and more countries are adopting International Financial Reporting Standards, which involve the use estimates, such as fair value. At the same time, there has been increasing scrutiny and calls for greater accountability of management in preparing financial statements. As such, preparers of financial information must illustrate due care in establishing the estimates. The GP model could be used as a decision aid tool to ensure proper consideration of the factors affecting financial accounting decisions, such as accounting estimates of fair values. Other two suggested areas are accounting choice and earning management. In their reviewing paper, Fields et al. (2001) and Dechow et al. (2010) argued that there have been few attempts to take an integrated perspective with multiple objectives on accounting choices. They highlighted also that the existing literature has focused on a particular objective, rather than considering trade-offs among multiple objectives (Fields et al. 2001; Dechow et al. 2010). Thus, the GP can be applied in this area.

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