

# **A Framework for Managerial Accounting of Disposal Systems**

by

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## **ABSTRACT**

Whereas the management accounting of aggregation and segregation systems has been developed well over time, comparable approaches to account for disposal processes and systems are at best limited in nature, scope, and sophistication. This paper discusses the differences between aggregation, segregation, and disposal systems, and articulates key attributes of disposal systems. A case for the development of a framework for management accounting of disposal systems is presented, and several propositions relating to such a framework are outlined.

## **I. INTRODUCTION**

Management accounting provides accounting and related information to support the management of an organization in its internal decision-making. Examples include product costing, relevant costing, cost-volume-profit analysis, capital budgeting, and operational, tactical, and strategic planning. A major activity included in the management accounting is the measurement of costs of processes that create value. For example, in a manufacturing environment, management accounting focuses on a clear separation of product costs from period costs, so that the product costs can be assigned to the output of the firm's primary value chain. The costs thus assigned are then used for valuation of work in process and finished goods inventory and for decision-making (e.g., product pricing).

Before the 19<sup>th</sup> century, firms acted more like contemporary retailers in which manufacturing activities were outsourced, thus removing the need for extensive capital infrastructure and for detailed costs of operations [see Kaplan and Atkinson (1998)]. As the industrial revolution emerged, management accounting tools were developed to support internal decision-making. Comprehensive manufacturing processes, such as those found in textile mills and later, steel mills, drove the demand for detailed recordkeeping for the determination of the

cost of materials, labor, and overhead. The service industry, notably the railroads, followed the emergence of manufacturing firms, and extended the scope of internal accounting to areas outside of manufacturing.

The early literature on industrial accounting, later termed cost/managerial accounting, is comprised primarily of descriptive works, with little theoretical foundation. The departure from this line of research to more empirical and multidisciplinary investigations took place around early 1960s [see Klemstine and Maher (1984)]. And the historical development of managerial accounting is written mostly in the context of manufacturing activities and to some degree, service activities. Over time, the manufacturing environment grew in size and complexity, and this led to further sophistication in the management accounting processes. The discipline of management accounting further developed with the emergence of the service industry. As the economy moved into the knowledge age and the netcentric environment, greater sophistication in management accounting practices became necessary. Today, the management accounting embraces a variety of sophisticated systems, tools, and techniques, such as activity-based costing, enterprise value analysis, value-chain analysis, and the balanced scorecard.

Throughout the historical development of the field, the context remained initially the tangible product manufactured, and later, included services. This can be justified on the ground that in the beginning the manufacturing sector dominated the economy; later, the service industry gained its significant share in the economy and thus required attention from the management accountant. Over the past few decades, a new player in the economy has emerged, which can be called the disposal sector. This sector addresses not the creation of a product or rendering of a service, but rather disposal of imposed inputs.

The issue of disposal is multidisciplinary. Politics, health and human welfare, economics, technology, and sociology – all are involved in defining the problem of disposal and in finding solutions for effective disposal. Certain issues in this area, such as radioactive waste, have transcended national boundaries. As the needs for disposal become significant, more sophisticated management accounting and control will be necessary. Consequently, management accounting for disposal systems can be expected to gain prominence. For example, EPA (Environmental Protection Agency) maintains an excellent resource site to educate its constituency on the need for better information and how to generate it ([www.epa.org](http://www.epa.org)).

Mankind has always generated waste. But it has not been until recently that waste containment has become a business process. For example, although city and county governments disposed of domestic trash for many years, huge companies have arisen to meet the demands of a growing problem of waste disposal. And as more restrictions are placed on what can and cannot be placed in community landfills, other such enterprises arise to meet the demand. For example, many communities have very recently restricted the disposal of cathode-ray tubes and other computer hardware. Accordingly, firms have arisen to disassemble, reclaim (in some cases), and dispose of what are considered to be harmful after-products of computer hardware. Such disposal is a thing of value, not in the contemporary sense of creating product, but in a new sense disposing of harmful or disagreeable elements. Management accounting for such systems is as crucial for decision-making purposes in firms that dispose of such elements as it is in firms that created the elements in the first place.

A primary purpose of this paper is to demonstrate the managerial accounting needs of disposal systems, and encourage further research in this area. In this paper, we examine the nature and characteristics of disposal as an activity compared to manufacturing. Based on the

differences between the two types of activities, we develop a set of propositions for management accounting of disposal systems.

The analysis and observations presented in this paper are based largely on an exploratory investigation of disposal systems in a Midwestern city in the USA. To gain insights into the nature and attributes of disposal systems, three such systems were observed over an extended period of time: solid waste management, wastewater treatment, and snow removal. As a part of the study of operations of these systems, unstructured interviews of supervisors of these systems were conducted. In each case, follow up visits were made and further discussions with the supervisors were held to seek clarification or request additional information. Observations and insights of these managers are reflected in our analysis throughout this paper.

## **II. A CLASSIFICATION OF PROCESSES**

Over the past two centuries, the industrial revolution and the associated advances in production systems drove the demand for management accounting information. Indeed, management accounting was, by default, tailored for decision information needs of production processes. Thus, costing approaches concentrated on the basic need to measure costs in relation to units of product. The output in terms of costs served many purposes, including pricing, inventory valuation, and budgeting. Product cost measured in this manner also served as a floor for determining value of the product manufactured.

It is important to recognize at the outset that accounting requires customization according to the nature of the process underlying the activity. There are two broad categories of processes, production and disposal. In turn, production processes are to two types, aggregative and disaggregative. The underlying value chain in a manufacturing environment represents an aggregation process. The cost of raw materials is added to the conversion costs, direct labor

costs and manufacturing overhead, to determine the total costs incurred in creating value in the form of the final product. This model has been applied to an almost infinite number of production situations, each of which differs from the others, but all of which have had the fundamental goal of converting raw materials to a finished product (i.e., a thing of value). In contrast to production processes, there are processes that by their nature segregate (or dis-aggregate) rather than aggregate. A refinery, for example, segregates crude oil into gasoline and other end products that are consumed and expended in other markets. In stark contrast to the aggregation and segregation of inputs, both of which result in some form of final products, certain other processes create value by disposal. That is, by societal reforms, and by market demand inducements, removal and disposal of certain substances are valued by markets and hence can be considered to create value. The value comes in discarding, removing, and disposing of substances that are deemed, for example, to be adverse to the environment, such as nuclear waste, or to the safety in transportation, such as snow on the snow-covered streets. Table 1 presents examples of various situations needing a disposal treatment.

**TABLE 1**  
**Examples of systems**

Aggregation (or assembly) systems:
Auto manufacturing
Electrical appliances manufacturing
Software development
Pharmaceuticals
Disaggregation (or disassembly) systems:
Meat packing
Crude oil refining
Disposal systems:
Nuclear waste containment
Solid waste (garbage) disposal and containment
Wastewater treatment
Chemical disposal and containment
Pollution control
Treatment of prisoners
Treatment of bodies upon death
Snow removal

For management accounting processes and methods to be relevant, they must reflect the underlying model of processes that add value. The typical management accounting model was designed to reflect the production process using cost as a surrogate for value. The model quite

logically ‘tracks’ the production process. In a disposal system, a comparable managerial accounting model should parallel disposal processes. Interestingly, the underlying activities in a disposal system seem opposite to those of aggregation systems. In a disposal system, the “stuff” we start with is gone (at least most of it) at the end of the process; there is nothing tangible left to attach costs, and consequently, assign value. However, processes supporting disposal activities must be designed and their activities measured. We begin our analysis with a comparison of the three types of systems: aggregation, segregation, and disposal.

### **III. ATTRIBUTES OF SYSTEMS**

The three types of value creation processes -- aggregation, segregation, and disposal -- are systems. Consequently, their attributes can be classified in terms of inputs, processes, outputs, and environment of the system. Table 2 presents a comparative view of attributes of the three types of value creation systems.

Whereas the aggregation and segregation systems produce something, the disposal system is designed to get rid of something. The output of manufacturing systems is tangible, appearing at the end of the manufacturing processes. There is a visible evidence of value. In contrast, a disposal system’s goal is to eliminate or minimize the imposed input. The value here is in terms of opportunity costs, what would happen if we were not to take care of the imposed inputs. While aggregation and segregation rely on the demand for what they produce, disposal is dependent upon when and how much of imposed input is required to be treated. Thus, the processes involved in disposal are different in nature compared to the production processes.

Conceptually, the three types of systems can be treated as mutually exclusive. However, these systems may exist together in the same organization. In a manufacturing plant the production system may have subsystems that work as disposal systems. For example, a power

plant may have air and water pollution control and treatment systems. In such cases, costs of disposal systems are somehow folded into the overhead and assigned to the product manufactured. This is much like the treatment of an economically inconsequential output as a byproduct, treating its effect as a residual item.

**TABLE 2****A Comparison of Attributes of Value Creation Systems**

Value creation system	Aggregation: Assembling something of value	Segregation: Dissecting, chemically or physically, something to generate valuable outputs	Disposal: Recovering from an undesired state
Value parameters	Levels of production/sales	Levels of production/sales	Services
Inputs	Direct material, direct labor, and manufacturing overhead	Direct material, direct labor, and manufacturing overhead	Resources consumed to achieve non-existence (or limited/modified existence) of certain conditions or states
Process	Assimilation and alteration of inputs, conversion	Breaking down or disassembly of joint- or by-products. May include refinement of such products	Extinction, transportation, conversion, or treatment of inputs in a selective manner
Output	Assembled product	Joint products	Non-existence or removal of the input or certain traits of input (e.g., removal sediments to make water potable)
Economic environment	Demand driven. High degree of structure. Aggregation activities correlate well with the process of accumulation of costs. Cost pools assigned to outputs can be refined using activity-based costing.	Demand driven. Processes are structured. However, the segregation process results in segregation of common or joint resources, leading to substantial arbitrariness in product cost measurement.	Supply driven. Processes may or may not be structured. Community as a consumer; community's view of value, not the individual's. Uncertainty in planning the need for disposal.

#### **IV. DISPOSAL SYSTEMS**

For the purpose of this paper, disposal systems are defined as systems that deal with *imposed* inputs, inputs that are harmful, disagreeable, and an appropriate treatment or disposal of which is the thing of value. Such inputs can be considered exogenous to, and not controlled by, the system designed to take care of its disposition. In contrast to the general sense of imposition as an arbitrary demand on others, the term as used here conveys that disposal system inputs are not demand driven, are not “ordered,” but rather are generated by others and imposed by other processes and activities. Disposal systems collect, treat, and contain such inputs for the long-term safety, welfare, and comfort of the affected citizens.

##### **Imposed Inputs**

Imposed inputs can be a one-time event (e.g., flash floods, forest fires, mud slides, a massive attack by insects, for example), or they can be expected to arise on an ongoing basis (e.g., wastewater, solid waste, environmental pollutants). The former requires containment of the disaster and rebuilding of the affected parts; the latter requires ongoing systems in place to regularly dispose of received inputs. Imposed inputs are considered undesirable, perhaps even unhealthy or unsafe, and their proper disposition is a necessity for the survival and health of those affected by such inputs; hence, there is value (i.e., value creation) in disposing of such inputs.

Sources of imposed inputs can be classified using two dimensions. The first has to do with the origin of the input. Two major origins of such inputs are human beings or the forces of nature itself. The second dimension is the activity causing imposed inputs. This can be either human beings or the forces of nature. The two dimensions result in a 2X2 matrix for the classification of illustrative imposed inputs, as shown in Table 3.

**TABLE 3**

A Classification of Imposed Inputs by Origin and Activity

		Proximate activity causing imposed inputs	
		Forces of nature	Humans
Proximate origin of imposed inputs	Forces of nature	(Cell 1) Mosquitoes Fruit flies Floods Volcano eruptions Mud slides Forest fires (caused by electric storms)	(Cell 3) Yard waste (e.g., lawn clippings, other organic elements) Forest fires (caused by humans) Nutshells and fruit pits Snow (Street clearing)
	Humans	(Cell 2) Wastewater	(Cell 4) Oil spills Solid waste (garbage) Slag Hazardous chemicals Nuclear waste Air pollutants/émissions

Cell 1 inputs have existed forever. Cell 2 inputs are biological in nature, for human beings are a part of the nature and have natural needs. Cell 3 inputs arise from nature, but only with interaction from human processes. Grass clippings will not be necessary to dispose off if we decide not to have neatly cropped lawns. Cell 4 inputs can be attributed to industrialization. Generally, the controllability of inputs increases progressively from Cell 1 through Cell 4. By choice, communities accept imposed inputs generated by human activity (Cells 2 and 4). Where humans are biological origins of imposed inputs (Cell 3), the degree of sophistication in the disposal system evolves with the development of the society. For example, in a highly

developed society, a network of pipelines drains the wastewater into a treatment plant, which treats the inputs and releases the treated results into a river stream.

Broadly, there are three alternative methods to dispose of imposed inputs. For some, there may not be any need to take an action, as in the case of minor volcano eruptions. In some cases, where event-based disposal is required, a project-orientation may be appropriate, as in the case of oil spills, snow removal, or solid waste disposal. Oil spills in oceans are dealt with when and where they occur. The need for snow removal from the streets is seasonal and even during the season, only when there is a snowfall. Solid waste occurs continuously and its periodical collection and disposal is necessary. In most other cases, a systems-orientation is appropriate, as in dealing with wastewater transportation and treatment.

Thus, Cell 1 inputs may not need any treatment; if they do the response to the disposal need takes a project orientation, like in fighting a forest fire or, in the case of a volcanic eruption, evacuating a town. Cell 2 inputs typically require project planning and control methods and procedures. Cell 3 inputs are generally addressed by setting up systems consisting of transportation networks and processing plants. Cell 4 inputs almost invariably are mandated for proper disposal, and require either a project management methodology (e.g., oil spills) or a system comprised of processes (e.g., air pollution control systems).

Sometimes people tend to erroneously equate imposed inputs with waste. Imposed inputs are not necessarily waste; for example, snow removal from streets is essential but snow that is removed is not a waste. “Waste” as a generic term includes, for example, waste of time, effort, and resources [see Winthrop (1980)]. However, such waste is not subject to any kind of *post hoc* disposal, although its prevention may be possible. In sum, non-waste may require disposal and certain types of waste cannot be subjected to disposal.

Finally, it is necessary to differentiate between imposed inputs and treatment inputs. Treatment inputs are those parts or materials that are intentionally used in the disposal process, for example, salt in a snow removal process and chemicals in wastewater treatment. Treatment inputs are acquired and used by choice and play an important role in appropriate disposal of imposed inputs. Interestingly, treatment inputs may create a second wave of disposal problem. For example, the sand used in a snow removal activity needs to be swept later in the season, when temperatures rise, to maintain clean streets.

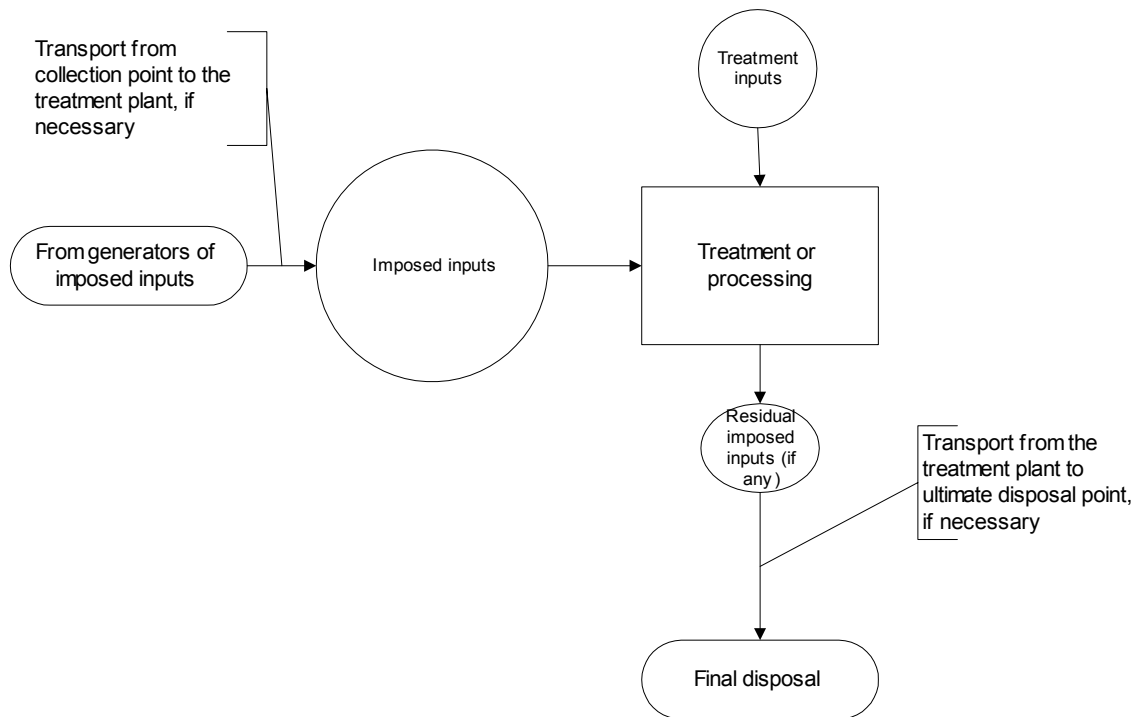
### **Processing Steps**

Disposal systems vary in terms of processing but typically contain the following stages: collect imposed inputs, store (if necessary), transport (if necessary), process or treat, and dispose of or contain the remainder. These steps are essential to the success of disposal systems. As noted earlier, the fundamental goal of a disposal system is starkly contrasted with the goal of bringing a product to market in an aggregation system. Consequently, the revenue model of the aggregation systems does not fit the disposal systems. For example, when a wastewater system returns clean water to an aquifer there is no direct revenue. The value created lies in the opportunity costs of not treating the wastewater!

Figure 1 presents typical processing steps involved in a disposal system. Since there is considerable diversity among disposal systems, some of the steps may be minor or absent in a particular disposal system, although shown here.

**FIGURE 1**

**Processing Steps in a Disposal System**



**Need for a Framework**

A great deal of literature exists about disposal systems in fields of engineering and environmental science. Although some attempts have been made to develop a rudimentary model of accounting for solid waste management [see, for example, [www.epa.gov](http://www.epa.gov) (1997)], there is a paucity of works in this area in the field of accounting. Several reasons may account for this. First, the share of economic activity claimed by the domain of disposal systems is fairly limited. Consequently, any emphasis on developing economic, financial and accounting measures is also

limited. Most disposal systems in the past were owned by public administrations, such as a city, county, or state. The community served was assessed a tax to cover the costs of owning, maintaining, and running the system. The cost-price relationship was not stressed in seeking revenues to support such systems, as they were seen as necessary public services that the government must support. Initially, disposal systems were monopolistic in nature. Issues of efficiency and effectiveness of such systems were not as paramount as they are today, in part due to today's growing public opinion and information communication regarding accountability. Budget crises, although not new or recent in pseudo-government and government organizations, add to this visibility. Over time, some of these systems have been privatized or outsourced. In the process, the need for detailed cost accounting was eliminated, or at least transferred to the firm that took over the charge.

Disposal systems are now an increasingly visible segment of total economic activity. There has been considerable growth in the need for disposal systems in the past decade. Given the increasing population and the growth in the amount and varying types of imposed inputs, these systems are playing more important roles within society. According to the EPA, the growth in solid waste has been problematic since the 1960s. In 2002, Americans generated about 222 million pounds of solid waste compared to the 88 million pounds in the 1960 (see [www.epa.gov/epaoswer/non-hw/muncpl/factbook/internet/mswf/disp.htm](http://www.epa.gov/epaoswer/non-hw/muncpl/factbook/internet/mswf/disp.htm)).

A systematic analysis of the nature and characteristics of disposal systems accounting has been missing. What kind of management accounting models are appropriate for disposal systems? Does the management accounting model used in aggregation and segregation systems fit disposal systems? To address these questions, we began with a discussion of the attributes of the three types of value creation system. In the remaining portion of the article, these attributes

are explored to determine key differences that should be considered in the design of management accounting models and processes for disposal systems. Finally, we present a case for the development of a framework for management accounting of disposal systems and outline several propositions relating to such a framework.

## **V. DRIVERS OF DISPOSAL SYSTEMS**

### **Activity Levels**

The activity levels of disposal systems depend on the supply of imposed inputs. If the supply function is volatile (i.e., uncertain), predicting the disposal system activity levels may be difficult. Moreover, the circumstances surrounding a particular activity may warrant different actions. The snow removal systems are a good example to illustrate this point. First, the decision to clear streets of snow depends upon the quantity of snowfall. The greater the quantity of snowfall, harder it gets to clear the snow, and often, it is done in stages, incrementally improving the street conditions. Depending on the traffic patterns and importance of streets in the overall transportation network, each street is assigned a priority code for snow clearance. Second, the temperature and wind velocity before, during, and after the snowfall complicates the snow removal process; winds may blow the snow right back on the streets, or in the case of falling temperatures, a layer of ice may develop on the streets prior to the snowfall. The mix of ingredients in the treatment input, such as salt and sand, would vary depending on temperature conditions. Third, timing of the snowfall is a significant factor as well. A substantial amount of snowfall right before the rush hour would make it difficult to clear the snow efficiently. As more people drive to or return from the work, traffic on the road limits the freedom to the snow-clearing crew. A freezing rain just prior to a snowfall is an entirely different challenge than a snowfall on previously dry streets. Finally, if you are expecting more snow within the next 48

hours following a snowfall, a more complicated decision is on hand. Certain conditions, such as a minimum snowfall combined with expected high temperatures immediately following the snowfall, may eliminate the need for disposal altogether. In sum, most disposal systems suffer from unpredictability of the type and level of activity, as well as conditions surrounding the activity. A challenge posed by this phenomenon lies in the design and operation of the system to manage variety of conditions and activity levels.

Solid waste disposal systems face similar issues in levels of activity. Garbage put out is usually more and heavier during the warm weather seasons, while less and lighter waste is experienced during cold winters. The quantity of waste is somewhat affected by the community's attitude to reduce, reuse, and recycle the consumables.

For funeral homes, deadly viruses can result in a disproportionately high number of deaths, taxing funeral homes' capacity to handle the deceased. Choices of cremation versus burial and their preference within a community also make the planning and operation of a funeral home more complicated.

Activity levels play a crucial role in the cost measurement process. For example, an estimated overhead rate is determined using an estimated activity level as a denominator to divide the expected total overhead cost. The larger the proportion of fixed overhead in the total overhead costs, the greater the variability in predicting the rate at which overhead is applied to the outcomes. Since activity levels are difficult to predict and manage in disposal systems, the unit cost measurement presents a significant challenge. The reliability of information is compromised and therefore the use of cost data may be lower than in aggregation systems. Even if variable overhead is traced and assigned separately from the fixed overhead, some expectation of activity levels is required to determine total unit costs. Although disposal systems are not

concerned with inventory valuation using unit costs, they have alternative uses of similar data, for example, in developing a fee structure for the citizens of the community it serves. Target and actual activity levels are also essential to plan capacity, monitor capacity utilization, determine cost variances, and control fixed costs.

A disposal system may require a significant capital base, as in the case of a wastewater treatment plant. Where infrastructure is elaborate and has a long lifespan, fixed overhead due to capacity costs is likely to be a major cost item. This combined with the volatility in activity levels causes special problems in the accounting for overhead for managerial decision-making in disposal systems.

### **Measuring Performance**

The measurement of performance of disposal systems can be problematic for various reasons. Since the activity levels in terms of inputs to the system are not predictable, the output (e.g., how much garbage is collected and taken to a landfill) may be neither relevant nor a comprehensive measure of the system's performance. The solid waste produced during winters is dry, light, and less in volume, but the collection route is the same as in summer or fall. Consequently, the amount of solid waste collected and processed is only one of the factors in determining and evaluating performance of a solid waste disposal system. The utilization of assets, which gives an indication of a volume variance, is also a difficult measure to use. For example, to what extent would you hold a manager responsible for non-utilization of snowplows? The degree of utilization of snow clearing equipment is closely related to the amount, type (e.g., snow versus ice) and frequency of snowfall and conditions surrounding the snowfall (e.g., temperature, rush traffic hour), which are beyond the control of the manager responsible for clearing the snow from the streets.

## **Determining Value**

Disposal systems have outcomes, but very few, if any, outputs. So, the typical value addition proposition (system output has greater value than its inputs) does not apply in a strict quantitative sense. How do you attach value to the output when a concrete, visible output does not exist? What is the value of clean streets, or contaminant-free drinking water? Clearing the snow off the streets would mean safer driving conditions, which may result in fewer auto accidents and a lower consequent damage to vehicles and human casualties. But the benefit of a saved traffic accident belongs to the driver and his or her insurance company – entities that fall outside the boundaries of the disposal system. Moreover, some of these values are not measurable, nor clearly traceable to the disposal system. In the case of a pollution control system or a water treatment system, the benefit may be evident more in the long term (healthier citizens, fewer medical bills, lower health insurance premiums, etc.) while the disposal costs are incurred in the short run. Consequently, determining the value of the system is much more challenging in disposal systems than in aggregation or segregation systems.

## **Cost-Benefit Considerations**

Most often, accountants are faced with cases where benefits are not as easily measurable as the costs. Likewise, the value of a disposal system is difficult to measure. In aggregation and segregation systems, we compute and apply production costs to finished goods and work in process inventory. We presume that the cost of production has a relationship with the value of what is produced, and that the cost is a conservative measure of value. This rationale does not hold in measuring value, or benefit, of disposal systems, for such systems are designed to minimize the negative impact of imposed inputs, an opportunity cost. Although costs of disposal, both long-term and short-term, are measurable, such costs are not “attachable” to any

inventories, for such inventory may not exist, except for some byproducts as a result of the disposal activity (e.g., sludge). A water treatment plant may be able to measure gallons of water treated as an output, but the snow removal system's output is at best in terms of the number of street-miles opened – it is a state of an existing system of a network of roads. The benefit of snow-cleared streets is difficult to measure. More importantly, extending the cost per street-mile cleaned into a value measure is nearly impossible. How do you price a snow-cleared street-mile to the citizens of a community?

Historically, three factors are responsible in relegating most disposal systems to the public sector, such as the city, county, or state. First, it is difficult to measure the value of a disposal system's output. Second, the value goes to the community, not any individual customer, thus making it a community-focused value system rather than something ordered by an individual consumer. Third, benefit in the long term is as critical in disposal decisions as the benefit in the short term. All these are issues with which the private sector is not typically prepared to deal. Where a public utility attends the disposal needs of a community, the pricing of disposal services is also community-based, regulated by a group of elected or appointed representatives. However, during the last two decades, there has been a great deal of movement toward privatization of such services, where prices may be regulated, but a for-profit organization is selected to maintain the infrastructure and run the operations. When disposal systems are privatized, some measure of return on investment drives the bidding for the job, thus resulting in a market-driven pricing of the disposal service.

### **Regulatory Requirements**

Since most disposal systems affect neighborhoods, communities, and even states and nations, it is not surprising that regulations dominate the disposal systems environment. Public

safety (e.g., nuclear waste), health (e.g., solid waste, waste water), and other needs (e.g., funeral homes, snow removal) are addressed by disposal systems. In certain disposal systems (e.g., solid waste), use or non-use of services is not as important as the availability of the service to the community. Even when privatized, disposal systems retain their basic characteristics, which point to the need for regulation.

## **VI. PROPOSITIONS**

Based on the discussion of disposal systems in this paper, we present in this section six propositions relating to management accounting of disposal systems. Again, the systems approach applied to disposal systems helps us develop these propositions through analysis and synthesis of our understanding of such systems.

**Proposition 1:** *Planning and control of disposal systems is driven by the nature, characteristics, timing, and flow of imposed inputs.*

Production systems have the advantage of controlling the arrival or inputs, where as disposal systems may not be aware of the arrival of inputs until they have already been imposed on the system. For example, funeral homes do not have the ability to predict or control the arrival of deceased humans just as snow removal services are sometimes surprised by changing and unpredictable weather patterns. The thawing of ground covering snow during the first few warm days of spring stresses the capacity of the wastewater system to its limits.

The ability of a disposal system to control its operations depends on the generator of the imposed inputs. Imposed inputs generated by Mother Nature such as snow and ice are uncontrollable and to some degree unpredictable and thus impose these characteristics on the system responsible for the disposal or removal. On the other hand, solid waste generated by industry and households can be predicted and are controllable with programs such as the EPA's

Pay-As-You-Throw program. Furthermore, waste materials can be predicted based on their cyclical natures as well as regulations governing the types and amounts of waste that can be disposed of in the environment. Yet, the ability of these systems to predict the inputs to be received and handled is considerably less accurate than the ability of assembly systems to account for inputs.

Thus, the uncertainty surrounding disposal systems largely stem from the nature, characteristics, and timing of imposed inputs. Accordingly, disposal systems' inputs are exogenous and non-controllable at least in the short run.

**Proposition 2: *Process costing combined with activity-based costing appears to be widely applicable to most disposal systems.***

Few, if any, disposal systems resemble job shops and consequently will not use job order costing. Rather, they are mostly a collection of processes. Inputs to the system are similar, if not identical, over time and the nature of treatment almost uniform. Activities within each process are identified and the manner of their achievement is determined. Thus, the process costing model applies to disposal systems logically. Since processes comprise a collection of related activities, applying activity-based costing within the process costing model would improve the effectiveness of disposal systems in their planning and control.

**Proposition 3: *Feedforward controls can be expected to be more prominently used in disposal systems management.***

Controls can be classified in terms of stages of a system that feed information about variances. This classification provides three categories of controls: feedback at the output stage, feedforward at the input and environment stage, and feedwithin at processing stage [see Bogart (1980)].

Thus, feedforward is information about the system environment or inputs that is fed forward into the system. Examples of feedforward controls include planning and replanning, goal setting, and budgeting. In disposal systems in which uncertainty surrounding the disposition of imposed inputs is significant, planning and control for disposal processes should focus more on feedforward controls. The use of such proactive measures is likely to streamline expectations regarding preparations for processing over a short horizon. For example, cities located in the northern part of the USA are likely to monitor weather forecasts frequently during the winter months to anticipate snowfall and accompanying weather conditions. This in turn allows them to prepare to respond more appropriately to a developing need for snow clearing.

**Proposition 4: *Capacity costs and capacity utilization are two major decision contexts for disposal systems.***

Developing the appropriate type and level of capacity is an important dimension of disposal systems. An intriguing question that several states in the USA are currently addressing is this: How much capacity should they build to accommodate future needs? Currently, prisons are overcrowded, and this results in putting some of them on an early parole and shortening the duration of sentences. Wastewater systems are capital intensive, last several decades, and must be built considering present and future needs of the community. Long-term storage of nuclear waste in remote areas requires planning for the appropriate type and level of capacity. Forward contracts for salt and sand are issued to create capacity to deal with snow clearing needs for the entire season, and solid waste systems concern themselves with landfill capacity.

For seasonal disposal systems such as snow and ice removal, capacity is created somewhat uniquely. The snow removal typically uses street maintenance vehicles, to be fitted with front-end “shovels.” Since street maintenance is undertaken only to a limited degree during

winter, this overlapping use of vehicles tends to optimize the investment. A second approach cities and counties typically take to boost their seasonal capacity is by using local contractors who agree under a contract for services to clear snow from designated secondary streets and communities.

Where capacity costs are dominant in disposal systems, it is logical to consider such systems as investment centers. The creation of capacity requires long term planning and high levels of capital expenditure. However, this is not commonly done. Instead, they are treated as expense centers. In part, this may be due to a weak link between costs of services and how the charging for such services is regulated. If there is a shortfall, the operations are typically subsidized by the public administration responsible for the system. However, as more disposal systems are privatized, some degree of emphasis on comparing present value of cash receipts for services with the present value of all future cash outflows is inevitable, for a return on the investment will be expected by the outsourcer.

Thus, it seems that capacity planning and capacity utilization are important considerations for disposal systems. Since capacity requires up-front investment and a long-term horizon, capacity-related decisions are prone to serious debates about financing considerations, including public bond issues and assessment of additional property tax levy to generate cash flow to payoff capital costs.

***Proposition 5: Throughput measures can be expected to dominate operations control of most disposal systems.***

For disposal systems, generally, outcomes have to meet a certain quality requirements. Such requirement may be objective (e.g., parts per million of residue in treated wastewater) or subjective (e.g., how well is the snow cleared off the streets). The quality of output generally has

no direct value, and in some cases, limited or no visible outcomes exists (e.g., following the cremation of a body). Hence, the value of the activity chain lies in doing the right thing with imposed inputs, and this points to the processing stage of disposal. The processing stage is dominant, for it is the only stage that is most controllable. Throughput quantity, quality, and efficiency are important. Throughput measures are critical to success of disposal systems.

**Proposition 6: *Non-financial measures dominate planning and control of disposal systems.***

Quantification of value produced by a disposal system and an identification of its beneficiary remain a challenge. For example, what is the value of a snow-cleared street on a wintry day to someone who drives on the street that day? Who should pay for the cost of snow clearing services? As a rule, the community, however defined, as a whole is the beneficiary and there is no individual pricing of the services, although exceptions to this rule exist (e.g., funeral homes). If you live in a community, but produced very little or no garbage, you still will be assessed for the services by the city, unless these services are outsourced and you never contracted with the outsourcer.

Since disposal systems involve communities, they invariably involve learning and behavior of the community. “Reduce, reuse, recycle” is a popular example in the case of solid waste. Molding the behavior of a community is no easy task; however, it should be attempted for the long run benefit of the communities.

Finally, because of community level consequences of disposal systems, politics and regulation are ever present. Elections have been fought on issues of disposal [see Savas (1973)] and detailed requirements have been in place for the design and operation of disposal systems, and for the discharge of the residue.

All this leads to a very high probability that non-financial measures play an equal, and perhaps more important, role than financial measures in the planning and control of disposal systems. As a result, an appropriate measurement and management system should consider a combination of financial and non-financial measures. Perhaps disposal systems can benefit a great deal from implementing a Balanced Scorecard [see Kaplan and Norton (1996)], a strategic performance management system that integrates financial and non-financial measures into a single framework.

## **VII. CONCLUDING REMARKS**

The landscape of disposal systems is diverse. It cannot be treated uniformly. At the same time viewing disposal systems as possessing similar characteristics allows a focus on broad attributes for managerial accounting analysis. These characteristics are substantively different from those found in aggregation and segregation systems. Consequently, there is a need to examine the area of disposal systems with a view to develop a framework for managerial accounting. The need for accounting research in this area is increasing in light of growing significance of disposal systems and the necessity of tracking their costs and revenues, and to support managerial decision-making. To advance this goal, this paper presents six propositions, each of which is potentially an area of research in disposal systems accounting. Hopefully, this paper will generate additional interest in the area and consequently promote greater understanding of the nature of accounting and control as related to disposal.

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