Green Activity Based Management (ABM) for organisations

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Abstract

Green Activity Based Management (ABM) is a bottom-up approach for environmentally sustainable business process management. This approach extends Activity Based Costing (ABC) and Critical Path Method (CPM) principles for the purpose of capturing, measuring, modelling and reporting Greenhouse Gas (GHG) emissions. The Green ABM not only looks at GHG emissions but also considers cost and time as well. Thus, this provides a holistic picture of these inter-dependent dimensions to the organizational manager for decision making. Furthermore, this research shows that Green ABM can be used to minimise the costs associated with the timing of activities while keeping other business objectives in consideration.

Keywords

Greenhouse Gas (GHG) Emissions, Business Process Management, Activity Based Management, Activity Based Costing, Critical Path Method

INTRODUCTION

Environmental sustainability is an important objective in organizational business process management context (Seidel et al. 2012). Managers make decisions to accomplish business objectives at business process level. Business decisions cannot be made by taking only environmental aspects like mitigating GHG emissions into consideration. They need to take other business objectives like time and cost of production along with GHGs as these are related to each other. For an example, in some organizations timing of business process activities can have an impact on both cost and associated GHGs (e.g. the time a truck takes to deliver goods between two locations during daytime high traffic hours as opposed to the same delivery during the night).

For the organizations to remain sustainable, managers need a holistic approach to manage GHG emissions together with other business objectives like time and cost of production to assist decision making. In order to manage GHGs, organizations have to capture, measure, model and report GHG emissions at a business process level (Wesumperuma et al. 2011). The information gained through such means is very insightful in decision making. In addition, managers can use simulation to vary the timing of business process activities to minimise the cost of production and GHGs.

The research objectives of this paper are twofold. First is to investigate suitable tools and techniques that would facilitate the construction of a methodology to support managing GHGs at a business process level. Such a methodology should assist in capturing, measuring, modelling and reporting GHG emissions along with other business objectives. The second objective is to vary the timing of business process activities to minimise the associated costs and GHGs while keeping other business objectives in consideration. This paper considers business processes in manufacturing and logistics sectors where the business processes are stable and less dynamic. The other business objectives considered in this paper are minimising the cost and time of production.

To achieve the research objectives, we propose Green Activity Based Management (ABM) methodology. The proposed Green ABM is a bottom-up approach for environmentally sustainable business process management. Green ABM extends the Activity Based Costing (ABC) and Critical Path Management (CPM) principles and considers GHG emissions, along with time and cost of production. The results show that by using the Green ABM, organizational managers can easily capture, model and measure emissions at various process levels (i.e. activity, sub-process, process and shared). Then, by using simulation, it shows the effect of varying the activity timings on important business objectives like cost and GHGs.

The holistic approach taken by the Green IS reported here is distinct from previous studies as it contributes to the existing body of research. First, the approach considers important business aspects like cost and time together with GHGs. It clearly shows how to capture, measure, model and report GHGs together with cost and time. Thereafter, it shows the variations in cost and GHGs depending on the timing of activities. Thus, this research provides valuable insights for the organizational managers to optimize their business processes.

The paper is organised as follows. This Introduction section provides the motivation, the problem being solved, a brief summary of what was done to solve the problem, the answer and the implications the answer provides. Next, the theoretical background looks at ABC and CPM methods. The following section explains the proposed Green ABM methodology. Next, the implementation section applies the Green ABM methodology to a case study of a manufacturing process. Then it presents the results and finally, the paper discusses the results and concludes with future directions.

THEORETICAL BACKGROUND

Sustainability requires sustainable business practices. Today Information Systems (IS) are becoming an integral part of doing business (Esty 2006). Moreover, Green IS are designed and implemented to contribute to sustainable business processes (Boudreau et al. 2008). In the emerging Green IS literature, the bottom-up approaches look at the application of IS and the usefulness of IS to reduce the carbon footprint in a cost effective and socially acceptable way. These bottom-up approaches either create theory based-frameworks or come up with Information Technology (IT) based practical and localised activities which may influence an individual or a group behaviours (Hasan et al. 2010). In this regard, this research is a bottom-up Green IS as it creates a theory-based framework, which is the Green ABM methodology. Thus, Green ABM enables environmentally sustainable business process management practices. Green ABM methodology extends Activity Based Costing (ABC) and Critical Path Method (CPM), two well-known business process management techniques. Currently, these are applied in isolation mostly to manage cost with ABC and to manage time with CPM. Therefore, next sub-section looks at CPM followed by ABC.

Critical Path Method (CPM)

Today, there are many applications of CPM in projects of different sectors such as construction, manufacturing and aerospace (Santiago et al. 2009). This is extremely useful in planning, scheduling and controlling of projects for on time delivery and keeping within budget. Very often, projects encounter events like scarcity of resources such as labour and material that adversely affect the execution of the original plan. CPM has proved its worth on small, medium and large projects by highlighting the organization, activities, processes, procedures, inter-relationships and inter-dependencies. (Galloway 2006; Santiago et al. 2009)

CPM constructs a model of the project that includes: a list of activities needed to complete that particular project, the time (duration) each activity will take to complete and the dependencies between the activities. This leads towards the development of a network / model of activities that enables the identification of the critical path. Critical path is the longest activity path in the project from the start to the finish. If an activity is not on the critical path it will have a *float / slack*. A float/slack is the amount of time an activity can be delayed. If an activity on the critical path experiences a delay, that will delay the project completion date (Galloway 2006). There are two ways to identify the critical path i.e. the forward-pass and the backward-pass. The forward pass calculates the earliest start time and the earliest finish time for each activity in the model. The backward pass calculates the latest start time and the latest finish time for each activity in the model. (Wei et al. 2002).

The CPM constructs a visual process model with a formal under-pinning. Formal parameters capture activity related data that can be used to form a mathematical model of the business process. CPM can also take activity costs into consideration. This allows it to build a time-cost relationship and to provide time-cost estimates (Stelth et al. 2009). In this study this relationship is used to bridge the gap between CPM and the ABC models.

Activity Based Costing (ABC)

Traditional costing systems assume that a cost object (e.g. a product or a service) will directly consume resources (Emblemsvåg et al. 2001) and they do not pay attention to the activities which consume these resources. As they are relatively simple to use, traditional costing systems are the most widely used cost accounting systems. Traditional costing systems use volume/ unit-level allocation bases like direct labour (Kaplan et al. 1992). A major problem with this type of costing is they rely on direct labour as the allocation base for overhead / indirect cost allocation. However, today overhead/indirect costs are much higher and production costs are not directly proportional to direct labour (Emblemsvåg et al. 2001). Thus, the product costs generated by the traditional systems were inaccurate and as they do not give the managers the correct information, resulted in hindered decision making.

On the other hand, ABC solves the problems in traditional cost accounting systems. ABC gives accurate and reliable cost information in representing financial data and allows more realistic view in profitability analysis

(SAP 2001). ABC view is critical when it comes down to understanding what resources are consumed and how to reduce costs. Currently it is popular in manufacturing sector. ABC assumes, a cost object will consume activities and in turn activities will consume resources. In ABC, resources and activity drivers are used to trace costs from resources to activities and then from activities to cost objects in a causal directly proportional manner(Emblemsvåg et al. 2001; Kaplan et al. 1992; Sedgley et al. 2001; Turney 2008).

Raffish et al. (1991) defines an activity driver as a "Measure of frequency and intensity of demands placed on activities by cost objects." and this is can be used to assign costs to cost objects. According to Raffish et al. (1991), a resource driver is defined as "A measure of the quantity of resources consumed by an activity." Thus, it is a multi-stage costing system as cost tracing is done in three ways:

- Direct attribution: resources directly match activities and cost objects. E.g. The fuel (i.e. cost object) consumed by a car while driving (i.e. activity) to a particular destination.
- Allocation: costs are traced in an arbitrary manner. E.g. Production planning costs are allocated using the number of units of a product that was produced.
- Causal assignment using resource and activity drivers: A driver is an attribute of the cost object which is a *measure* or amount of consumption.

ABC provides a systematic approach to cost accounting. First, ABC identifies activities within an organization. Then, it assigns resource costs of each activity to products or services according to their resource consumption (Turney 2008).

If we take an example from the manufacturing sector, first manufacturing costs of the organization is analysed and evaluated by converting them in to three major pools: direct material; direct labour and factory overhead. Each activity has got various resource consumption levels. Therefore, these activities are divided into categories according to their levels of resource consumption as: Unit level activities, Batch level activities, Product line activities, Facility / customer support activities (Walther 2010).

Successful ABC implementation involves several steps: 1. Study of processes and costs; 2. Identification of activities at different levels; 3. Identification of traceable costs; 4. Assignment of remaining costs to activities; 5. Determination of per activity allocation rates; 6. Application of costs to cost objects (Walther 2010); In this study ABC is analysed in depth to understand the cost modelling at activity levels leading to process costing. The following section describes how we extended the ABC to achieve the first research question and extended CPM to achieve the second research objective.

By extending the ABC method to include GHGs, managers can easily trace GHGs to the resources and activities. Thereafter, further extend this to include CPM. In literature we found some similar approaches to the proposed architecture (Emblemsvåg et al. 2001; Recker et al. 2011). These approaches address GHG emission measurement from the business process aspect of our research objective. However, with the proposed methodology, we have gone beyond these approaches by introducing a formal and visual model to capture GHGs, cost and time simultaneously; measure and aggregate at different process levels; provide external reporting according to national and international standards. Hence, the following section gives an overview of the research design and explains the proposed research methodology.

RESEARCH METHODOLOGY

In this research, the research approach can be described as both inductive and deductive. Inductive approach collects the data first and theory or hypothesis is built as a result of the data analysis. Deductive approach will develop a theory or a hypothesis and the designed strategy will test the hypothesis. The solution (Green ABM) is deduced from existing theoretical body of knowledge i.e. ABC and CPM. The research also develops a new activity-based business process modelling, analysing and reporting methodology for sustainable business process management. The case study was selected as the research strategy and the strategy selection was guided by the research objectives. As this is dependent on a particular time, this is a cross-sectional study (Saunders et al. 2009). Data collection is carried out through questionnaires, observations, interviews and documentation.

Extension of the ABC method to include GHG emissions management

The following Figure 1 illustrates the Extended Activity Based Costing method to include GHG emissions management. In ABC, the underlying concept is that activities (e.g. maintenance) consume resources (e.g. material, labour) and cost objects consume activities (Kaplan et al. 1992). As shown in Figure 1, costs are traced in three ways: direct attribution, allocation, causal assignment using resource and activity drivers. In causal assignment ABC uses drivers.

The driver cost is calculated by multiplying *Driver Value* by *Driver Intensity*. The driver value is the amount of the resource or the activity in units (e.g. 5 direct labour hours) and the driver intensity is the corresponding consumption rate (e.g. direct labour charges are $20/hour). We sub-divide the drivers into two categories as *costs* and *emissions*. Therefore, the resource driver will have two components. The *Resource Driver Costs* corresponding to the cost accounting aspect and the *Resource Driver Emissions* corresponding to the emissions accounting aspect of management. Similar to *Resource Driver Costs*, *Resource Driver Emissions* will contain a driver value (e.g. 5 liters of fuel) and a driver intensity (e.g. energy consumption rate is 50 MJ/liter) and by multiplying the driver value by the corresponding driver intensity, it will give the resource driver emissions (e.g. energy consumption 250MJ).

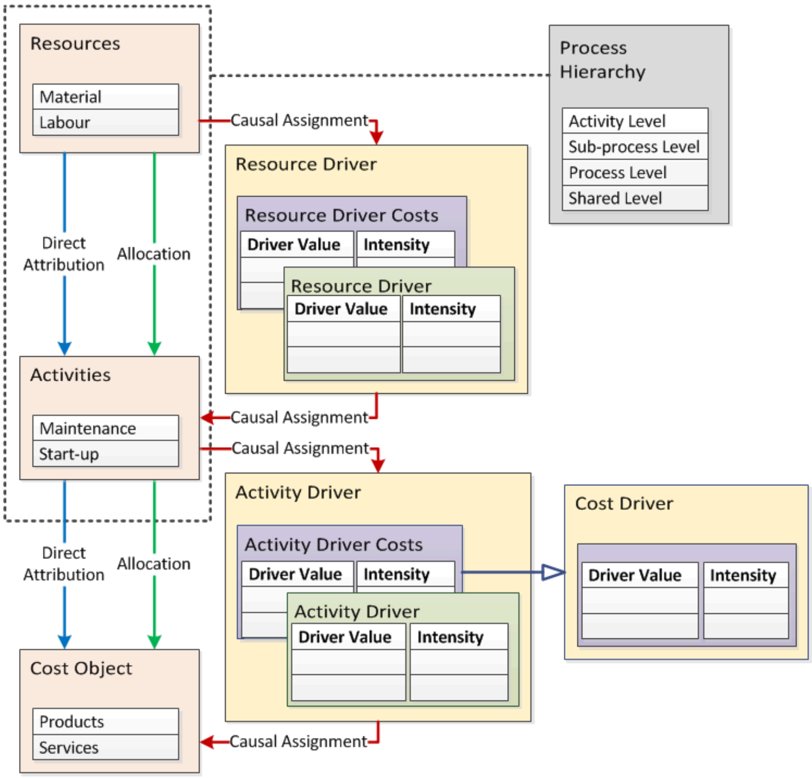

Figure 1: Extended ABC method to include GHG emission management.

As can be depicted by Figure 1, the *Cost Driver* has a broader measure than activity or resource drivers as it will indicate the root cause of a change in the activity's cost (e.g. a factory worker spends 20 mins painting a particular toy and spends 30 mins painting a different type of a toy). A cost driver (e.g. product design complexity) is not easily measurable like a resource cost drive. However, these provide insights (Emblemsvåg et al. 2001) to the manager if they identify them correctly.

This method links the activities and resources to the business process model. Similar to ABC's, various resource consumption levels, emissions happen and can measure at various process levels as Activity level, Sub-process level, Process level and Shared level(Wesumperuma et al. 2011):. This extended ABC model for GHG emissions management will help to measure, calculate, model and report emissions from an organizational process point of view. At the same time, as this model is activity based it has the potential to capture time related data as well. For any activity, duration is an important characteristic. Many manufacturing processes have activities of which the cost depends on timing. In some activities the timing of activities will have an impact on both cost and emissions. CPM is widely used in project management for scheduling and estimating costs. Therefore, we further extend the extended ABC model by incorporating the CPM.

Extension of the CPM to include the extended ABC

In CPM all the nodes are networked according the dependencies between the nodes with respect to time. As explained earlier, time, cost and emissions are correlated. In CPM, a node represents an activity with its time duration. The duration of an activity is just one of its characteristics. There are other characteristics like cost and related emissions of an activity. On this premise, the boundaries of a CPM node can be broadened to include cost and GHG emissions of an activity. A business process is a collection of activities (Hammer 1993), a node can represent an activity, a sub-process or a process. As explained in the previous section, this will depend on where the GHG emissions happen and where it is practical to measure it. A node as shown in Figure 2 contains four tabs: Time, Energy, Cost, and Emissions. Related parameters are grouped into these four different tabs:

- Time Tab: This orange tab contains all the parameters required for applying the CPM. Parameters include: Earliest start, Earliest finish, Latest start, Latest finish, Duration, Slack.
- Energy Tab: This purple tab contains parameters required to calculate the energy consumption of a particular action. Energy related parameters include: kW (Wattage of a machine used to perform a certain action / Useful power), KVA (total apparent power), Power Factor (the ratio between the useful (true) power (kW) to the total (apparent) power (KVA) consumed by a machine to perform a certain action.), and Different time periods (Peak, Shoulder, Off-peak).
- Cost Tab: This blue tab consists of parameters required to do costing. These are: Labour rate and Labour hours to calculate Labour costs, Equipment and sub-contractor costs to perform this action, Material costs incurred during this action, and Electricity rates (Peak rates, Shoulder rates, Off-peak rates, Network rates).
- Emission tab: This green tab comprises of GHG emission related parameters. Some of the parameters are: Fuel type, Fuel amount, Consumption rate (Km/L), Travel distance, Amount of paper waste, Amount of Wood waste, and Amount of other waste.

The Green ABM Methodology

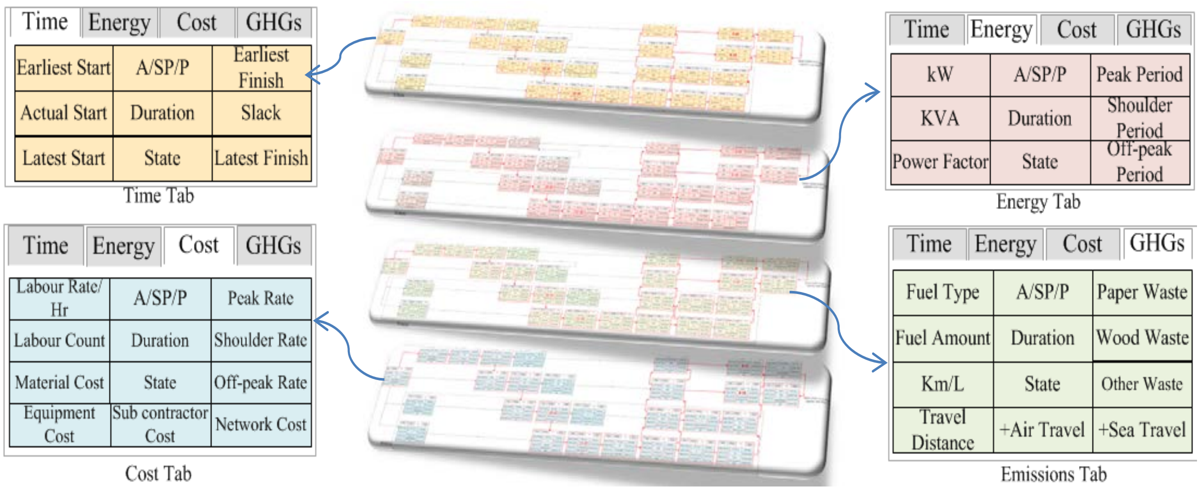

Figure 2: The Green ABM to model time, energy, cost and GHG profiles of a business process and Time, Energy, Cost and Emissions tabs of a node

All the tabs share a set of common parameters: A/SP/P (Activity Sub Process/ Process), Duration (Time to perform the action), and State (Describe different states a particular machine would go through during production. This is briefly explained in the *Implementation* section of this paper). Even though, energy consumption results GHGs, we separately capture energy related parameters. This is mainly because the energy management alone is a very important area that directly contributes to GHG. Managers spend a great deal of time and effort in improving energy efficiency, reducing energy bills, correcting the power factor, and load management. Thus, energy is considered in a separate tab. The parameters captured in this visual model are used to build the formal model described in the *Implementation* section.

In this extended model, if we select the time tabs of all nodes, they would show the CPM network of the process. As time, energy, cost and GHG tabs are interconnected, similar to the CPM model, if we select the energy tabs of all the nodes in this process this will show the underlying energy model or the energy profile of the process. Similarly, all the cost tabs would model the associated cost parameters and the GHGs tabs would model the associated emission parameters. As can be depicted from the Figure 2, for a particular process, the same tabs collectively model different dimensions i.e. time, energy, cost, GHGs of this activity based model.

This Green ABM will help organizational managers to look at several dimensions like time, cost, GHGs and as well as energy. Though separated, it is easy to consolidate cost and GHG accounts at different process levels (e.g. activity, sub-process, process, shared) in a meaningful manner as emission sources are linked with the activities in the business process. This is very valuable in reporting and decision making. In the next section, we apply the proposed Green ABM to a case study from the manufacturing sector.

IMPLEMENTATION

This research implements the Green ABM approach with a Polyethylene terephthalate (PET) bottle manufacturing process of an Australian plastic packaging company. Several machines run simultaneously during this process. If several machines are switched on at the same time, KVA values will add up and result in high network costs. Due to this reason and heavy energy consumption costs, each machine switch-on is staggered based on the activity they perform. This needs careful decision making and managers need time, cost, energy consumption and GHG related information to support the process. Presently this kind of detailed information is not available for the managers. In this case study four separate machines (i.e. PET Heat, PET Drive, Water Chiller, and Dryer) are staggered. A digital power meter is used to collect energy related data for a production cycle.

Power consumption states of PET manufacturing machines

After analysing the machine power consumption, this research identified seven distinct states in power consumption during a single production cycle (Figure 3). The seven states include:
1-Pre-Activity: This time is used for the machine maintenance activity.
2- Start-Up: This has the highest rate of electricity consumption before it goes into its running mode.
3- Pre-Production Fixed: Machine is in the running mode for a fixed time to perform a certain activity. This activity completion will trigger another machine to start working.
4- Pre-Production Variable: Machine is in the idle running mode until the production state. This happens when several machines are also required for production or operators may need to inspect before starting the machines.
5- Production: Final products are manufactured during this time.
6-Shutdown Variable: Machine is in the idle running mode until the shutdown or until the operator is ready for the shut-down procedure.
7-Shutdown Fixed: Machine is in the running the mode for a fixed time to perform a certain activity prior to shutting down

Consolidating GHG emissions at various process levels

In order to consolidate GHG emissions at different process levels a set of formulas are needed. This set includes formulas to: calculate emissions at an activity level; consolidate GHGs at activity level; consolidate emissions at sub-process and process levels and to allocate GHGs at shared level (Wesumperuma et al. 2011).

GHG emissions at task and activity levels:

According to Ranganathan, Corbier et al.(2004), two kinds of data will give the associated GHG emission figure. They are the *activity data* and *emission factor* to help in calculating GHG emissions by using the formula given below. Activity data quantifies an activity in units.

GHG emissions from an activity = activity data * emission factor ……………… (1)

Consolidated GHG emissions at activity level:

Process level emission calculation formulas proposed by the authors in the previous study were used to calculate the sum of emissions at process levels. According to our previous study, total emissions from GHG emissions that can be captured at activity level can be calculated using the following formula.

$$\sum_{i=1}^{n} T_i + \sum_{j=1}^{m} T_j = A_{tot} \quad \text{……….................} \ (2)$$

A_{tot} = Total emissions captured at task level; T_i = Non electricity consuming task level emissions; T_i = Non electricity consuming task level emissions; n = 1,2,3,.., m= 1,2,3,.., i = 1,2,3...., j = 1,2,3...

Consolidated GHG emissions at sub-process level:

Sub process level emissions are from emissions that can be quantified at this level. Similarly, total emissions due to electricity consuming and non-electricity consuming values are calculated here. The sum of both emissions will give the total emissions that can be quantified at sub process level.

$SP_{tot} = SP_{elec} + SP_{non}$ ……………………… (3)

SP_{tot} = Total emissions due to emissions captured at sub process level; SP_{elec} = Electricity consuming emissions due to emissions captured at sub process level; SP_{non} = Non-electricity consuming emissions due to emissions captured at sub-process level.

Consolidated GHG emissions at process level:

As described in the sub process level, at process level some emissions can be quantified for both electricity consuming processes and for non-electricity consuming processes.

$Ptot = Pelec + Pnon$ ……………………… (4)

$Ptot$ = Total emissions due to emissions captured at process level; $SPelec$ = Electricity consuming emissions due to emissions captured at process level; $SPnon$ = Non-electricity consuming emissions due to emissions captured at process level.

Consolidated shared level emissions:

According to a formula shown by Pino, Levinson et al. (2006), approximate kWh consumed by an organization sharing the same building with other organizations can be estimated. Similarly a derived formula from the above approximation formula is used to calculate emissions from a business process (which does not share the organization space). Thus the derived formula would be:

Approximate kWh used = Total building use of electricity * Area of process's space / Total building area ……..(5)

Total business process level emissions can be summed up using the following formula.

$E_{proc} = SH_{proc} + P_{tot} + SP_{tot} + A_{tot}$ ………………………… (6)

E_{proc} = Total business process related emissions; SH_{proc}= Total shared level emissions; SP_{tot} = Total sub process level emissions; A_{tot} = Total activity level emissions.

RESULTS

Figure 3 shows the time profile of the Green ABM architecture for the PET manufacturing process along with the seven states each machine will go through during a production cycle. CPM is employed to identify the critical activities and is shown with a red outline. However, for this test scenario, as machines start-up and automatically go into running mode, slack times are not considered. Yet, there may be activities where the task duration can be a variable value. As shown in the Figure 3, there are underlying energy, cost and GHG profiles. Due to the limitations in the length of the paper these are not shown in this paper. In here PET Heat machine's Start-up Activity is considered to show the results. We describe how activity related time, cost, energy and GHG figures can be calculated at the activity level. As shown in Figure 1, *Resource Driver Costs* can be obtained by multiplying the *Driver value* with the *Consumption Intensity*.

Table 1. PET Heat Machine Start-up activity's Activity Based Cost

Driver Value	**Consumption Intensity**	**Driver Cost**
Labour hours (25 minutes)	Labour rate/hr ($25)	Labour cost ($10.42)
Peak energy consumption (44.58 kWh)	Peak rate (11.776 c/kWh)	Energy cost ($ 4.91)

The *Resource Driver Emissions* were calculated similar to *Resource Driver Costs*.

Table 2. PET Heat Machine Start-up activity's Activity Based GHG Emissions

Driver Value	**Consumption Intensity**	**Resource Driver Emissions**
Total electricity consumption (44.56kWh)	Emission Factor (0.9)	GHG emissions (0.040122 tonnes)

The consolidated sub-process level GHG emissions for the activity level are calculated using the Formulas 1& 2, as shown in the Table 3.
According to the Formula (5), the total allocated emissions per process were calculated as follows.

Monthly allocated process electricity consumption= 253335* 200/1400 = 36190.71429 kWh.

In this manufacturing plant, in any given month they run 6 production cycles. Thus, by dividing the monthly allocated process electricity consumption by the number of production cycles gave the allocated production consumption per process (36190.71429 /6 = 6031.786kWh). The total shared emissions per process were found out by reducing the total traced activity or sub-process consumption from the total allocated consumptions (6031.786-5074.202 = 957.584 kWh.) Therefore, total shared emissions per process = 957.584 * 0.9 /1000= 0.862 tonnes. Similarly other process level emissions figures too were calculated. ABC was used to calculate the associated cost figures at different process levels and the costs were cumulated per process.

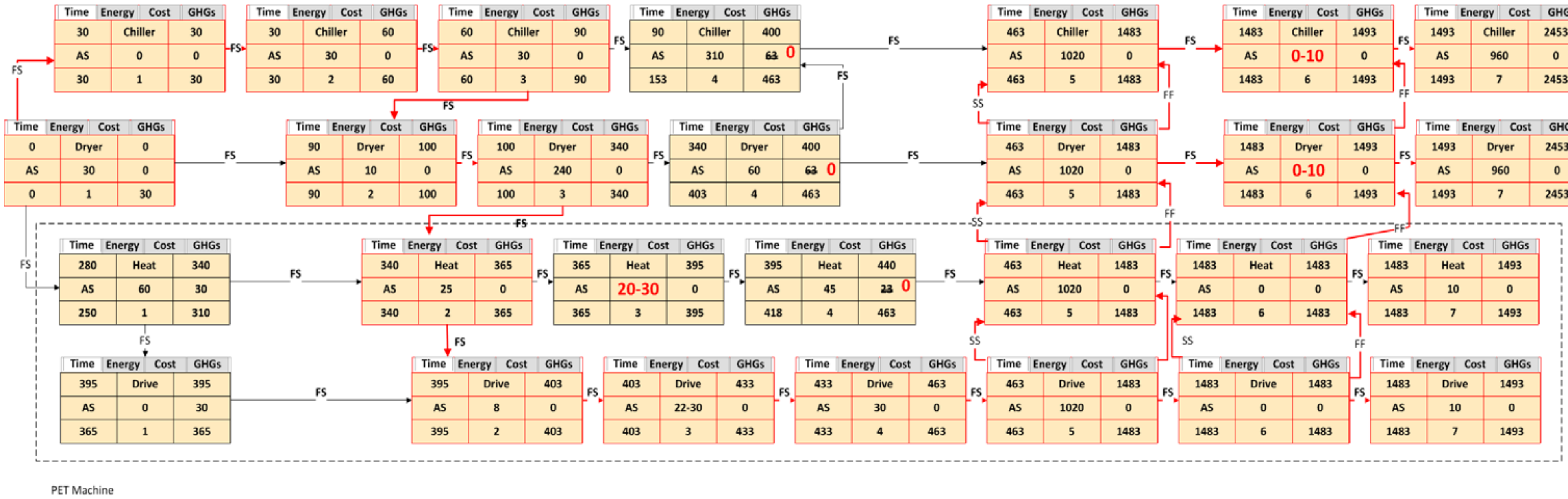

Figure 3: The time profile of the Green ABM architecture.

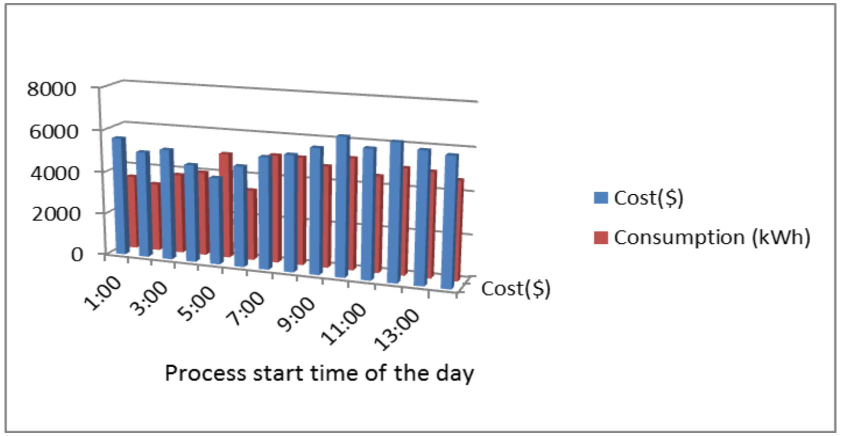

Figure 4: Impact of process activity timing and green energy

Table 3: Sub-process level total emissions

Sub process level	Total electricity consumed (kWh)	Emissions (t)
Water Chilling	2828.233	2.54541
Drying	850.052	0.7650465
PET Heat	689.167	0.62025
PET Drive	706.750	0.636075
Total traced process level consumption (kWh)	5074.202	4.5667815

As can be seen from the Figure 4, when we changed the start time of the process (i.e. timing of process activities) differences in the process costs were observed. *Green Energy* supports the production of electricity from government accredited renewable sources (such as solar, wind, hydro and biomass). As green energy is relatively expensive, by choosing the amount (25%, 50% or 100%) of accredited green energy we simulated the changes in both GHG emissions and start time of the process using Matlab.

DISCUSSION AND CONCLUSION

The Green ABM, a bottom-up Green IS presented here demonstrates the use of ABC and CPM in capturing, measuring, modelling and reporting of GHG emissions along with the two business objectives time and costs of production. The study showed that detailed analysis of GHG emissions along with other process level objectives like time and costs gives more comprehensive information for the organizational managers. Based on this information, organizational managers can take necessary action to mitigate their GHG emissions and achieving economic, social and ecological sustainability. In particular, the following were identified as some of the benefits of this Green IS:

- The simulation results provided a set of solutions with respect to activity start time of the day, cost of production and energy consumption (i.e. GHG emissions are proportional to this value). This provided the management the information needed to decide on the amount of green energy (25%, 50% or 100%). If a particular activity can be performed in a different way (e.g. energy from renewable energy source vs. non-renewable energy sources), both options would be available for the comparison.
- As there are many variables involved, it is difficult to manually calculate all these variations. With the use of a simulation package it is very easy to visualise the impact of changes.
- The critical path method helped in identifying the activities which did not have a slack time. Thus, management can make sure that these activities are performed on time and plan for it.
- Higher KVA values result in higher network costs for the PET organization. Results showed clearly what the impact of time plays, particularly in achieving a lower network cost.
- In Australia, electricity rates vary depending on the time of the day as peak rates, shoulder rates and off-peak rates. The company was able to simulate the impact on cost if the machine start-up times changed. This helped them to look at several aspects like overtime labour costs, off-peak start-up opportunities.
- Another important aspect was the ability to manage the power factor. This gives them the ability to control the power factor as each machine activity modelling using the critical path method can consider this at the same time. Visualization of the impact on KVA value helped to reduce the network costs.

This process level analysis can lead to business process level optimization. The automated improvement of business processes using pre-defined quantitative measures of performance or objectives is known as business process optimization (Vergidis et al. 2008). Multi-dimensional business process optimization including Greenhouse Gas (GHG) emission management is an important contemporary need faced by many organizations to survive in the present business environment. Hence, it is important to look at the many facets involved in this issue, analyse them and come up with criteria to select an optimization technique. For future work we plan to evaluate the current optimization techniques and will select the best-suited optimization technique to implement.

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