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Abstract

Anthropogenic climate change is shaping up to be a major global challenge in its potential impacts to humanity. A major contributor to this is Greenhouse Gas (GHG) emissions from various sources, including industrial or organizational sector. Some organizational managers realizing the inevitability of government legislations or taxes want to take proactive measures to manage their own GHG emissions. The current emission measuring tools and guidelines are not aimed at measuring emissions of organisational processes. Hence these guidelines and tools do not allow emissions to be handled in a pragmatic manner alongside other business objectives such as cost, turnaround time and quality of production. Therefore, we propose a framework for multi-dimensional business process optimisation that would facilitate modelling, measuring, analysing and reporting GHG emissions. This framework, derived from the GHG Protocol, enables organizational management to optimize their business processes for GHG emission mitigation, alongside other vital business objectives.

Keywords

Greenhouse Gas Emissions, Business Process Modelling, Business Process Optimization

INTRODUCTION

Human activity induced Greenhouse Gases (GHG), of which Carbon Emissions (CE) is a major pollutant, are rapidly changing the earth's climate. Around the globe governments, economists and business leaders agree the best way to reduce pollution is by putting a price tag on pollution (ACF 2011). As a result, now some governments have implemented various carbon taxes or trading schemes. One of the main aims is to encourage people and organizations to actively seek out cleaner energy sources. Alternative cleaner energy sources (e.g. solar, wind) help in mitigating GHG emissions. Accurate measurement of GHG emissions is the key for mitigation. Therefore the need for measuring GHG emissions accurately, effectively and meaningfully is emerging.

Much research has been carried out globally as well as nationally on methods of identifying, quantifying, calculating and mitigating GHG emissions. Currently, emission calculations are mainly estimated at national, economic sector, organizational and individual levels. These GHG or carbon emissions calculators are too broad-brushed (Padgett et al. 2007). They fail to give a detailed account as to where emissions came from, how much and for how long. While these calculators provide important information about the GHG emissions, from an organisational management perspective these reporting mechanisms are insufficient or not detailed enough to turn into concrete mitigation action.

Management and accountability in an organization happens at business process level. Therefore it makes sense to manage GHG emissions alongside other process performance objectives like cost and time reduction and quality improvement. Thus, to manage GHG emissions, managers need to know how much GHGs were produced by each business process. Presently, cumulated GHG emissions calculated at various levels are not traced back to their origins in business processes. This makes management of GHG emissions a difficult task. The need is there for GHG emissions to be modelled, measured, calculated and reported at the business process level (Recker et al. 2011).

Visual business process modelling is very popular and preferred by organizational management as they can depict a process through observational analysis even without any technical expertise. A purely visual business process model will only allow observational analysis through inspection of diagrams or qualitative analysis of static diagrams. It can lead to redesigning a process, simplifying activities, eliminating non-value adding activities, etc. However, a visual process model with a formal/mathematical underpinning will enable quantitative analysis as well (Aguilar-Savén 2004; Vergidis et al. 2008). Therefore it is important to model GHG emissions with other business objectives like cost reduction, time reduction and quality improvement at business process level as a visual formal model. This can pave the way to multi-dimensional business process optimization which is the key to gaining competitive advantage in current business environment (Castellanos 2008). From the organizational management's perspective, an organizations function as a set of business processes under the supervision of middle management. Performing multi-dimensional optimization for the whole organization incur a great deal of effort for any organization. It involves the top level managements' time consuming meticulous planning and decision making. However if an empowered middle management can look at processes within their purview and take the most appropriate action to optimize them, the effort required would be considerably less and thus much more practical.

Therefore, this paper addresses the question of "How to perform multi-dimensional business process optimization for GHG emission mitigation?" We propose a framework in accordance with the GHG protocol to model and measure at business process level and report GHG emissions at corporate/ organizational level. It opens up many new avenues with regard to business process management. One such important avenue is the ability for multi-dimensional process optimization leading to GHG emission mitigation.

The remainder of the paper is organized as follows. First, it analyses the study back ground by discussing relevant literature. Next it introduces a novel approach to measure and model GHG emissions at the business process level. This is followed by a detailed discussion on the proposed framework for *Multi-dimensional business process optimization for GHG emission mitigation*. Next section validates the proposed framework. Finally, the paper concludes with study findings and future directions.

STUDY BACKGROUND

As indentified above, this research mainly draws knowledge from three areas; 1) current ways to perform GHG emissions measurements, calculation and reporting at corporate level; 2) business process modelling techniques; and 3) optimization (as shown in Figure 1).

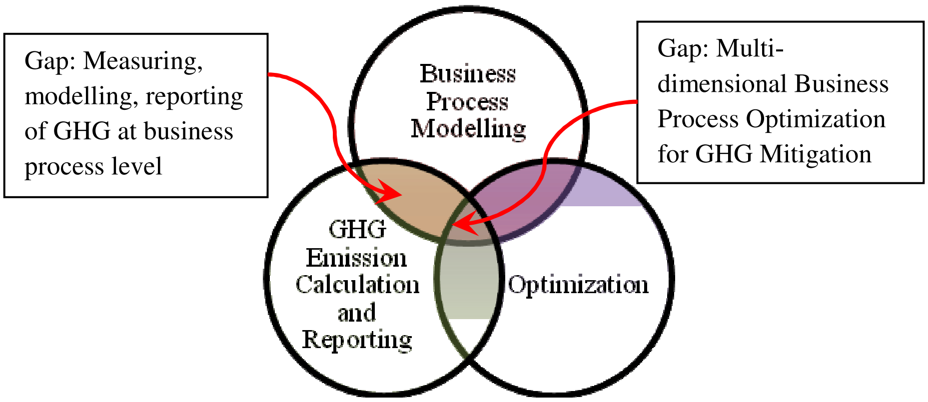


Figure 1: Venn diagram for research gaps in literature

Accounting of GHG emissions needs to be analysed with a globally agreed set of standards. Currently, GHG Protocol is the most widely accepted guide for accounting and reporting of GHG emissions from organizations (Ranganathan et al. 2004). According to this, emissions are broadly categorised as *Direct Emissions* and *Indirect Emissions*. Emissions from sources, which are owned or controlled by the reporting company, are termed *Direct Emissions*. When emissions are due to activities of the reporting company, but occur at sources controlled or owned by another company, they are said to be *Indirect Emissions* (Daviet 2006). Furthermore, GHG Protocol defines *Scopes* for reporting purposes as Scope 1, 2 and 3. Direct emissions except from combustion of biomass are considered as Scope 1. Scope 2 is mainly for GHG from generation of purchased electricity. Scope 3 emissions are said to be all other indirect emissions (Ranganathan et al. 2004).

It is important to be able to measure *Direct* as well as *Indirect* emissions. For this purpose, GHG emissions calculation tools or carbon emission calculation tools are vital. Presently, there are a plethora of emission calculators online. There are many issues associated with these tools. Lack of standards, being too broad brushed, usage of different conversion factors are some of these (Gavin 2010; Padgett et al. 2007). However, to date all most all of the calculators measure GHG emissions at either national level, economic sector level, corporate level or at individual level. Interestingly, GHG emissions at business process level are not handled by any calculation tool.

In an organization, it is the business processes that are within the control of managers. A business process is composed of a series of tasks and activities known as process elements. These specify how the actual work happens within an organization (Davenport 1993; Harmon 2007). If process level emissions are known, managers can take steps towards GHG mitigation. Thus the need prevails for measuring of all GHG emissions at process level. Prior to this, GHG emission modelling has to happen similar to other objectives modelled at business process level.e.g. Activity Based Costing (ABC). As shown in Figure 1, we have identified that there is a lack of literature related to the modelling and measuring of GHG emissions at the business process level.

Business process modelling enables a comprehensive understanding and perception of a business process (Aguilar-Savén 2004). When modelling a business process , it is essential to identify the various characteristics (parameters) of each process element (Wang et al. 2009). Integrated Computer Aided Manufacturing Definition (IDEF), petri-nets approach, hyper-graph approach, entity relationship modelling, the role activity diagrams approach, Business Process Modelling Notation (BPMN) and state-driven approach are some of the leading business process modelling approaches (Lam et al. 2009). Most of these popular approaches have a visual modelling aspect with some having a formal flavour to them (e.g. petri-nets). Mostly a business process is analysed to improve the process performance. 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).

Literature reveals several attempts in business process optimization for a single objective and multiple dimensions like cost, time and quality (Fitzgerald et al. 2008; Tiwari et al. 2006; Wang et al. 2009). However, none of these proposed single or multi-dimensional optimization techniques consider GHG emission mitigation as one of the dimensions. Therefore we believe addressing this gap found in literature (as shown in Figure 1) of “multi-dimensional business process optimization for GHG emission mitigation” to be very important from an organizational management’s perspective. While we were building this framework, in parallel to our work, studies addressing one aspect of the identified gap has emerged (Hoesch-Klohe et al. 2010; Recker et al. 2011).

Especially calculating carbon footprint of a process, like ours’ is inspired by the concept of ABC (Recker et al. 2011). Application of the ABC concept from environmental perspective was identified by several earlier studies (Hoesch-Klohe et al. 2010; Renison 2009; Turney 2008). The Recker, Rosemann et al’s (2011) study does not talk about: how they can trace all the emissions to their emission sources; nor consider other emissions other than carbon emissions; how to calculate shared emissions e.g. lighting and heating. Therefore, following sections discusses how we address the same issues by introducing a framework.

THE FRAMEWORK

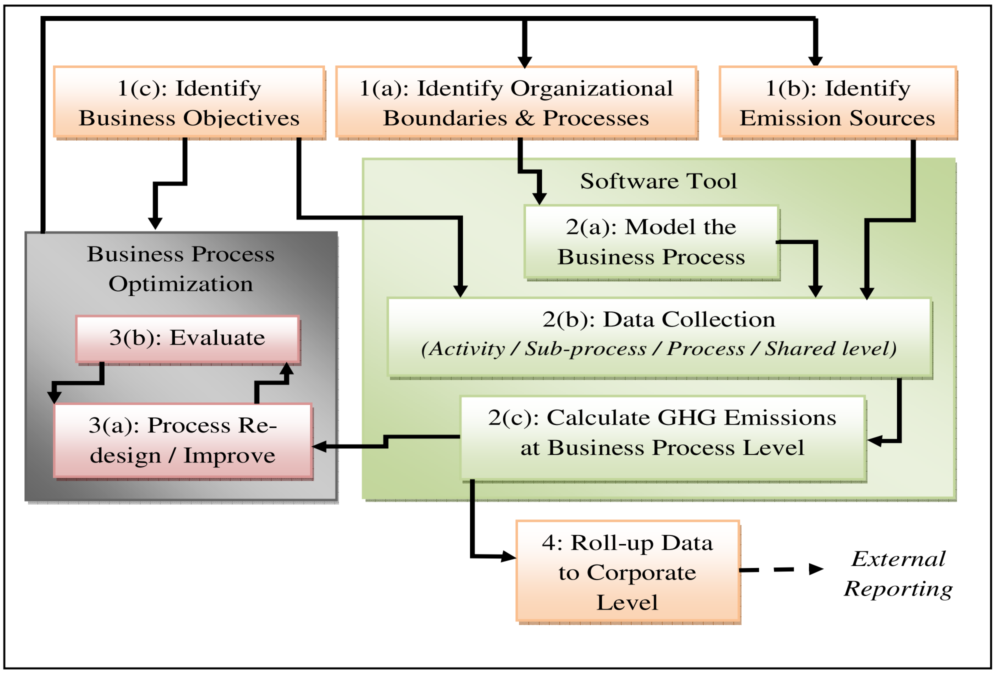


Figure 2: A framework for multi-dimensional business process optimization including GHG emission mitigation

We propose a framework to systematically optimize a business process with multiple-dimensions and consider GHG emission mitigation as one. This framework is presented in Figure 2. The framework contains four distinctive areas. First area is the identification stage i.e. identification of organizational boundaries, processes, emission sources and business objectives. Second area is the business process modelling, data collection and GHG emission calculation. Third area is concerned with the business process optimization and in the fourth area data is rolled up to the corporate level for reporting. Due to the cyclic nature of the framework, this can be used to adapt to dynamic business environments. Below we have presented each step in detail.

1(a): Identify Organizational Boundaries and Processes

Today's businesses have different legal and organizational structures. Ownership of an organization can differ from wholly owned, incorporated and non-incorporated joint ventures, subsidiaries, and others. Setting up of organizational boundaries is important for accounting and reporting. It defines facilities or entities that will be included in the final GHG inventory of the entire organization. It links data with relevant operations, sites, geographic locations, business processes, and owners (Fransen et al. 2007; Ranganathan et al. 2004). Once the organizational boundaries are known, the next is to identify the business processes. An organization will have several sub-divisions as processes and similarly these processes too will have their own sub divisions (Harmon 2007). Therefore, this study will attempt to identify the business processes with its own sub-divisions. Next step categorises GHG emission sources within the organizational boundary.

1(b): Identify Emission Sources

Emission sources are identified according to accounting and reporting scopes. Following list describes emission source categories according to GHG protocol.

- **Scope 1 emissions:** Stationary Fuel Combustion, Mobile and Transportation Source Emissions, Process Emissions (Ex. Oil and Gas Energy Sector) and Fugitive emissions
- **Scope 2 emissions**: Stationary Fuel Combustion (consumption of purchased electricity, heat or steam) and Electricity and/or steam imports
- **Scope 3 emissions**: Stationary combustion (Ex. raw material processing), Process emissions (Ex . during production of purchased materials), Mobile combustion (Ex. transportation of fuels/waste, employee business travel, employee commuting) and Fugitive emissions (CH4 and CO2 from waste landfills, pipelines, SF6 emissions)

There are four major *Emission measurement and estimation techniques*. In this study, *Emission factors based approach* estimation technique would be used as it is the most accurate estimate for carbon emissions (Ranganathan et al. 2004).

1(c): Identify Business Objectives

Every business will have business objectives, such as cost reduction, time reduction and quality improvement (Tiwari et al. 2006). Businesses strive to meet these objectives and they are the driving force behind an organization. Generally these objectives are defined as business dimensions, goals or targets. These are defined in quantifiable terms. We introduce GHG emission mitigation as another objective into the above set of objectives (e.g. mitigating emissions by 10% by 2015).

2(a): Model the Business Process

This step refers to visualisation of the business processes identified in the previous step 1(a). Business process modelling enables a comprehensive understanding and perception of a business process (Aguilar-Savén 2004). It captures the ordered sequence of activities and supporting information. In this regard the selection of a tool to model business process is important. Business Process Modelling Notation (BPMN) is an intuitive flow chart based modelling notation (White 2006) and in this study it is used to model business processes.

2(b): Data Collection

We developed a web-based tool to collect organizational data from various organizations. This tool allows higher, middle and lower management, and individuals to submit data within their power. Study identifies GHG emission frequency patterns and these are also taken in to consideration. We name these two major emission frequencies as: ad-hoc emissions and routine emissions. Ad-hoc emissions do not fall in to a specific time frame. Therefore, they are non-generalizable. Routine emissions fall into four categories: daily, weekly, monthly and yearly. Daily activities include, employees' commute to work, computer usage. Weekly activities are things like garbage disposal. A monthly activity can be a goods receiving and a yearly activity can be stock taking. The business process modelled earlier was used to collect data. In order to model GHG emissions, visual modelling needs to capture GHG emissions aspects as well. However BPMN does not possess this ability. Therefore we extended the BPMN notation to capture GHG emissions at the business process level as shown later on (Figure 8). These extensions allow GHG emissions modelling at a business process level. Once the GHG emissions are modelled with relation to their emission sources, next step is to calculate GHG emissions at various business process levels.

2(c): GHG Emission Calculation at Business Process Level

ABC, a related process level modelling approach categorizes activities into different levels. According to ABC, each activity has various resource consumption levels (Walther 2010): 1. Unit level activities; 2. Batch level activities; 3. Product line activities; 4. Facility / customer support activities. These levels allow cost modelling at activity level and this leads the way to process costing. Similarly, GHG emissions result at various business process levels. In-depth study reveals four levels in GHG emissions: activity level, sub-process level, business process level and shared level described below with an example. The GHG emission frequency patterns are also taken into consideration in summing up the total emissions per annum. With regard to the emission calculations, special emphasis is given to electricity consumption related emissions at various process levels. This is to aid the process managers to get a clear understanding of the breakdown of the total electricity consumed within their processes. In the figure 5 shown below, the sample warehouse management process has three sub processes ("receiving", "put away" and "pick, pack dispatch") and an activity (inventory management). We mostly consider CO2 emissions in this example.

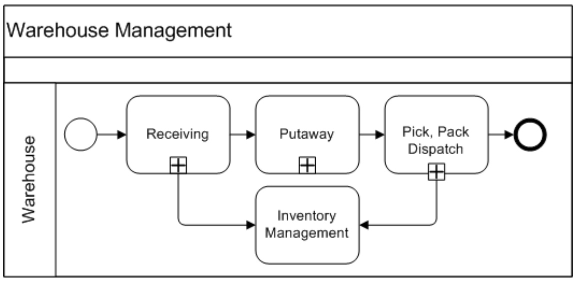


Figure 5: Sample warehouse management process modelled using BPMN

Activity Level Emissions:

GHG emissions result from various tasks and activities are calculated here. The following formula quantifies emissions for an activity (Pino and Bhatia 2002). 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

As an example in the process shown in figure 5 above for the inventory management activity a computer is used. Therefore, emissions from inventory management activity per annum would be: CO_2 emissions = 4.32 kWh * 0.90 (emission factor)/ 1000000 * 252 (working days per year) = 0.0038 metric tonnes. Similarly all GHG emissions can be calculated for other activities and for other emissions (e.g. CH_4, N_2O). Total emissions from GHG emissions that can be captured at activity level can be calculated using the following formula.

A_{tot} = Total emissions captured at task and activity level
T_i = Non electricity consuming task level emissions
T_j = Electricity consuming task level emissions
n = 1,2,3,4, .., m = 1,2,3, 4, .., i = 1,2,3,4, ..., j = 1,2,3,4, ...

$$\boxed{\sum_{i=1}^{n} T_i + \sum_{j=1}^{m} T_j = A_{tot}}$$

Sub-process Level Emissions:

Sub process level emissions are from emissions that can be quantified at this level. In the above example, a team of 9 members are assigned only to the "receiving" sub process. Their daily commuting can be captured at this level. GHG Protocol provides the formulas for this type of calculation. For an employee travelling daily with 2 other passengers, the emission figures per annum are:

Emissions due to commute = distance travelled /fuel economy of employee's car / number of people in car *emissions factor *number of working days

(40km / 6 / 2 * .19/1000) * 252 = 0.1596 metric tonnes

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_{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
SP_{tot} = Total emissions due to emissions captured at sub process level

$$\boxed{SP_{elec} + SP_{non} = SP_{tot}}$$

Process Level Emissions:

Emissions which can be quantified at process level belong to this group. In the same example, warehouse disposes of waste at process level. Waste mostly consists of cardboard, shrink wrap and paper. According to NGER (2011), following equation can be used to calculate emissions associated with the disposal of waste.

Waste disposal emissions = quantity of waste * emission factor

(3000kg * .05(Cardboard)) + (40kg* 0(Shrink Wrap)) + (500kg * 2.5(Paper))

= 1.5 metric tonnes

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.

P_{elec} = Process level total electricity consuming emissions
P_{non} = Process level total non-electricity consuming emissions
P_{tot} = Process level total shared emissions

$$\boxed{P_{elec} + P_{non} = P_{tot}}$$

Shared Level Emissions

Emissions belonging to this level are due to activities that do not directly add value to a business process or the organization e.g. lighting, heating. 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:

$$\text{Approximate kWh used} = \text{Total building use of electricity} * \frac{\text{Area of process's space}}{\text{Total building area}}$$

If in the above example the organization's electricity bill per annum is 1129608 kWh and the floor occupancy by "warehouse management" process is 40000 m^2 out of 200000 m^2. The warehouse is not shared by any other process. However, if the warehouse was shared equally with another process, then the floor area occupied by both processes would be divided in half.

Approximate kWh used = 1129608kWh * 40000/200000 = 225921.6kWh

Emissions from process = 225921.6kWh * 0.9/1000000 = = 0. 2033 tonnes

Sum of Emissions at Process Level

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

E_{proc} = Total business process related emissions
SH_{proc} = Total shared level emissions
P_{tot} = Process level total shared emissions
SP_{tot} = Total sub process level emissions
A_{tot} = Total activity level emissions

$$\boxed{SH_{proc} + P_{tot} + SP_{tot} + A_{tot} = E_{proc}}$$

3. Multi-dimensional Business Process Optimization

This step can be sub-divided into two lower level steps 1) Re-design / improve the business process and 2) Evaluate the resulting business process.

3(a): Process Redesign / Improve

In the redesign / improve stage many different actions are possible to optimize a business process. For an example these actions may include some unnecessary tasks elimination, combination of small tasks in to a one large task or decomposition of large tasks in to workable tasks, execution of several tasks in parallel if possible, empowering the employees to make decisions to reduce middle management, task automating (Reijers and Mansar 2005), identification and removal of process performance bottlenecks (Vergidis et al. 2008). In relation to GHG emissions instead of burning fossil fuel to generate power, organizations can switch to green energy sources. In this section we analyse GHG emissions against other objectives to arrive at an optimal solution in emission mitigation.

Other business objectives can be cost reduction, time reduction and quality improvement identified in the “Identify the business objectives” step. In literature there are many attempts at optimizing for a single objective (Dewan et al. 1998; Kock 2003; Fitzgerald et al. 2008). According to Chong and Zak (2008, p. 541), business objectives usually are competitive against one another or conflicting. Therefore no single or unique solution can be found. When, an optimization problem involves more than one objective function, the task of finding one or more optimum solutions is called multi-objective optimization (Deb 2001).Therefore, higher level information in terms of in-depth business objectives (e.g. reduction of 10 % of CO_2 emissions out of all process emissions) will guide in selecting one solution. So organizational management will be empowered to make timely decisions and consider several optimization solutions before selecting the most suitable one.

Classical optimization methods most of the time find one solution in a single simulation run. On the other hand Evolutionary Algorithms (EA) can result in multiple optimal solutions in a single simulation run as they use the population approach (Deb 2001). Non-dominated Sorting Genetic Algorithm II (NSGA2) is a popular multi-objective evolutionary algorithm among genetic algorithms due to its robustness and performance (Vergidis et al. 2006). Vergidis, Tiwari et al. (2006) have successfully applied NSGA2 for two objectives: cost and time. For the specified optimization critieria, a number of different optimization solutions were found. They argued that having alternatives enabled organizational management to evaluate several different options before selecting the most suitable one, according to decision making priorities. Genetic algorithms need to consider several paramters related to each dimension. Therefore a formal/ mathematical model should support modelling of all these parameters. For an example GHG emissions calculated at various process levels form a part of the parametric formal model. This then can be used to perform optimization. Therefore we propose to apply a genetic algorithm to multi-dimensional business process optimization for GHG emissons mitigation and address the knowledge gap found in literature. As this is a research in progress paper, the final formal mathematical model is not complete yet.

3(b): Evaluate

Next, step is to evaluate the optimized solution. A manager needs to take into consideration the dynamic environment and the multiple objectives in decision making. Therefore simulation is a very useful tool for evaluation. With the use of a visual tool, dynamic simulation will allow vadiation of the business process. Simulation is performed for several hypothetical scenarios to see if they perform well (Figure 6). So final optimized solution will again be analysed against the business objectives and justification of the reasons behind selection of that particular optimization solution from the resulting suitable set of optimized solutions. If the evaluation suggests further changes, we can take the feed back from this instance and apply it back to the previous step of *process re-design / improve*.

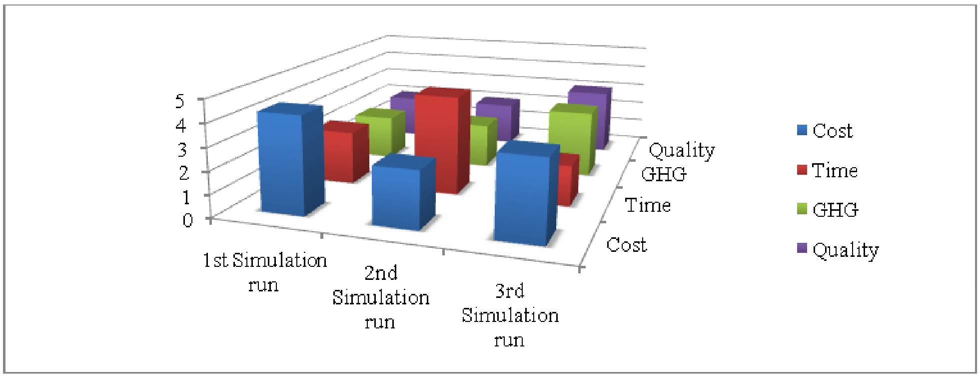


Figure 6: Relationship among time, cost, quality and GHG

4. Roll-up Data to Corporate Level

GHG Emissions calculated at various business process levels will give a cumulative figure. The Step 1(b) identifies the emission sources. "GHG emissions frequency patterns" explained by the Step 2(b) aid in calculating total emissions. The Step 2(c) tells what they are and how much. It helps to roll-up to the corporate level to arrive at a consolidated GHG emissions inventory based on scopes 1, 2 and 3. Thus the management gets a bird's eye view of what is happening within the organization. Moreover, according to GHG Protocol for accounting and reporting purposes, reporting according to scopes 1, 2 and 3 is what is required.

Next, section discusses the validation of the framework.

VALIDATION OF THE FRAMEWORK

The validation of the framework is important. Therefore we have conducted a baseline study with a medium sized company in the Western Sydney region. Baseline study involved face-to-face interviews and surveys. Following is a summary of the study with relation to the proposed framework.

Table 1. Validation of the study with relation to the *Stage 1* of the proposed framework

Stage 1	Description
1(a): Identify organizational boundaries and processes	The study identified the organization's ownership and the structure including geographic locations and the sites. Organization's "Supply Chain" stream of processes was studied, starting from the demand forecasting, customer ordering and ultimate goods delivery. Especially the warehouse management process was analysed in great detail.
1(b): Identify emission sources	All GHG emission sources were identified according to various scopes and emission categories.
1(c): Identify business objectives	Organizations' business objectives were recorded in terms of cost reduction, time reduction and GHG emission mitigation

Table 2. Validation of the study with relation to the *Stage 2* of the proposed framework

Stage 2	Description
2(a): Model the business process	All the business processes along the supply chain were modelled by using BPMN as the modelling tool (Figure 7).
2(b): Data Collection	With help of the web site, data collection at various business process levels was conducted. Data collection at activity level, sub-process level, process level and shared level were meticulously performed. For the warehouse management process, the newly introduced BPMN visual and formal extensions were used as shown in Figure 8.
2(c): GHG emission calculation at business process level	GHG emissions at various process levels were calculated with the use of a set of spreadsheets. Formulated process level equations were used to calculate the sum of emissions at process levels.

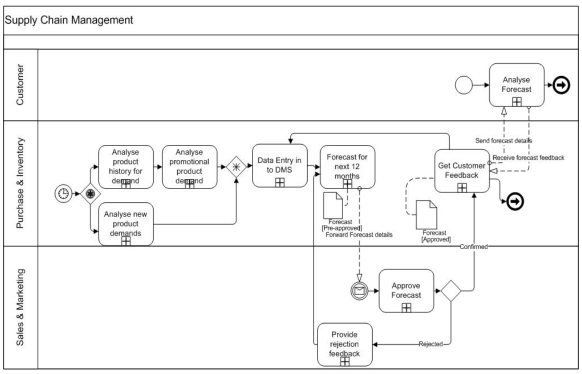


Figure 7: A sample BPMN process modelling

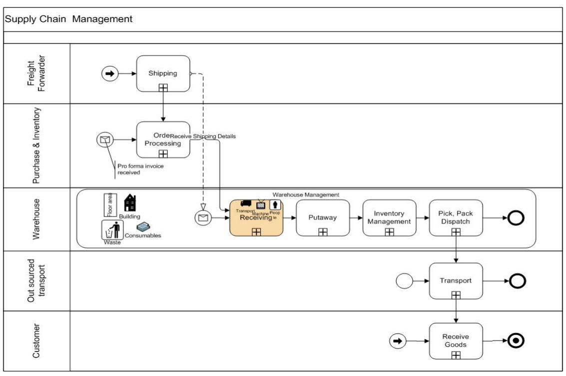
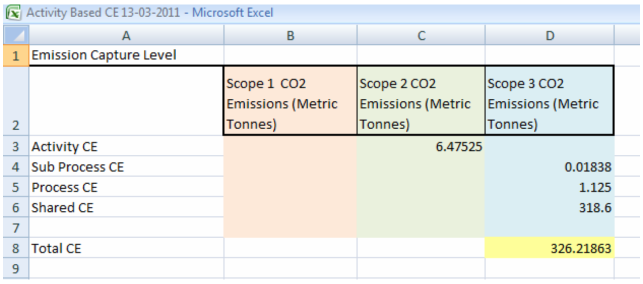


Figure 8: BPMN extensions for modelling GHG emissions at various business process levels.

Table 3. Validation of the study with relation to the *Stages 3 & 4* of the proposed framework

Stage 3 & 4	Description
3: Multi-dimensional Business process optimization	The study identifies NSGA-II as the approach to perform multi-dimensional business process optimization and has been used in the past for optimization of time and cost of a business process.
4: Roll-up data to corporate level	Cumulate GHG emission figure was obtained according to scope 1, scope 2 and scope 3. Even though scope 3 emission reporting is optional, this study considered that as well to give a holistic picture of all of the emissions (Figure 9).


Activity Based CE 13-03-2011 - Microsoft Excel

	A	B	C	D
1	Emission Capture Level			
2		Scope 1 CO2 Emissions (Metric Tonnes)	Scope 2 CO2 Emissions (Metric Tonnes)	Scope 3 CO2 Emissions (Metric Tonnes)
3	Activity CE		6.47525	
4	Sub Process CE			0.01838
5	Process CE			1.125
6	Shared CE			318.6
7				
8	Total CE			326.21863
9				

Figure 9: GHG emission reporting from business process level up to corporate level

CONCLUSION AND FUTURE WORKS

The main contribution from this study is the framework for multi-dimensional business process optimization for the mitigation of GHG emissions. The framework provides systematic business process optimization for several quantitative dimensions. To date, quantitative dimensions like cost reduction, turnaround time and quality of product have materialized as business objectives for business process optimization. However, GHG emission mitigation has never been considered as one objective. Therefore, another important contribution is the new knowledge on how to optimize a business process based on multiple dimensions including GHG emission mitigation.

In this study, the multi-dimensional business process optimization step is not fully implemented. As this is an ongoing research project, the optimization step is still to be developed. The framework was validated against an organization in the manufacturing sector. Thus, we realise that this framework needs to be implemented against organizations from different sectors. The framework can be extended to test for other business objectives that we have not mentioned in this section. As long as organizational management is able to quantify the new objective the incorporation of it into this framework could be achievable. The same concept would be applicable to project based work scenarios as well. The whole framework can become an entire software solution which the organizational management can use to optimize their business processes for several objectives including GHG emissions.

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