10.20378/irb-58352

Sustainable Design Process to achieve Sustainable Logistics: Opportunities offered by Business Analytics

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Abstract:

Logistics is a rapidly expanding industry, and mobility is critical to our way of life. At the same time, there are several environmental, societal, and economic implications associated with logistics transportation, including pollution, noise, and the use of urban space for transportation infrastructure. Business analytics solutions may help firms with logistics operations achieve these targets, while keeping costs down and positively impacting the society. However, many corporations haven't ventured into business analytics to achieve sustainability. The main reasons are the need to customize analytics solutions for each business problem as well as the lack of a viable, coherent process model closing the loop between sustainability objectives and analytical questions, metrics, and tools. This paper introduces a functional framework for sustainability analytics, which can be implemented in any corporation, making the planning, controlling, and measuring of sustainable development easier. The resulting business analytics blueprint, called as "Sustainability Design Process", is suitable to effectively implement sustainable logistics using business analytics approaches such that there is a balance between economic, environmental, and societal factors.

JEL Classification: L21, L91, M11, M14, O31, Q56. Keywords: Corporate sustainability, Sustainable logistics, Triple Bottom Line, Business analytics

1 Corporate Sustainability & Business Analytics

Sustainability is a broad topic that is one of the most highly used catchwords of the past two decades (Scoones, 2007, p. 589; Reis, 2021). The United Nations General Assembly developed the Sustainable Development Goals (SDGs) as a framework for achieving a sustainable future.

According to this set of goals, sustainability should be implemented by every corporation, as it is beneficial for both the businesses as well as society. Earlier, a few businesses pursued sustainability since it was beneficial for their brand image and seemed like the "right thing to do". However, eventually, companies discovered that sustainability was a perfect way to cut down operating costs and protect themselves from resource shortages and price shocks (Deloitte, 2012, p. 3).

According to some researchers (e.g., Hart & Dowell, 2011; Hart & Milstein, 2003), the concept of corporate sustainability is hard to comprehend. This is mainly because there is an ambiguity regarding the scope of the concept. By reviewing various pieces of literature (e.g., Marshall & Brown, 2005; Hall & Vredenburg, 2003; Bansal, 2005), it can be observed that some consider only environmental issues of corporate sustainability, some examine social and economic factors while others consider all three aspects (planet, people, profit). Therefore, Montiel et al. (2014) suggested to best consider the Triple Bottom Line (TBL; environmental, social, and economic aspects) for achieving corporate sustainability as shown in figure 1.

Figure 1: The triple bottom line framework of Sustainability, adapted from Kisacik (2017)

In our digital era, data-driven processes based on big data and data analytics foster the growth of businesses. On the path towards the achievement of corporate sustainability, business management concepts such as business intelligence (BI) and business analytics (BA) can play an important role. Companies will gain the deep insights

they need to direct their sustainability-related initiatives and increase their overall resource efficiency by gathering and analyzing data on a broad variety of sustainability-related factors, such as energy and resource usage, greenhouse gas emissions, and supply chain efficiency.

1.1 Sustainability and Logistics

Over the last few years, the logistics industry has become much more environmentally conscious. Due to the multiple environmental implications touching practically every individual, logistics – particularly freight transport – has gained a lot of attention in the sustainability debate in recent years. As a result, players in logistics processes have been pushed to address the issue of sustainability (Macharis et al., 2014). Without appropriate intervention, rising demand for e-commerce delivery alone would result in 36 percent more delivery vehicles in inner cities by 2030, leading to an increase in both emissions and traffic congestion (World Economic Forum, 2020).

Some strategies provided by Ilgar (2021) to increase sustainability within logistics operations include:

- **Creating a data-driven end-to-end process**: Using the most recent technological breakthroughs, this aids firms in route optimization, supply chain management, and energy-efficient operations.
- **Pop-up warehouses**: As ecommerce's last-mile delivery emissions rise, logistics companies are under pressure to discover ways to minimize their carbon footprints, which is one of the main indicators of sustainable supply chain logistics. Setting up a pop-up warehouse brings businesses closer to their consumers, lowering last-mile emissions. It aids firms in reducing delivery times and costs, as well as providing greater flexibility in addressing supply chain crises.
- **Advanced fuel technologies**: Using lower carbon fuels such as biofuel instead of fossil fuels and replacing ageing trucks with environmentally friendly vehicles are examples of actions done to achieve ecological and social sustainability goals. On the market, there is a diverse choice of environmentally friendly products that challenge old practices. Green alternatives include sea shipping, environmentally efficient train solutions, and hybrid or electric automobiles.

Whereas these strategies are convincing, one question remains, namely, how to systematically develop them and how to evaluate their impact on sustainability.

1.2 Sustainability Balanced Scorecard

One of the most relevant strategic systems that has recently been considered by researchers (e.g., Hristov & Chirico, 2019; Dočekalová & Kocmanová, 2016) is the Sustainability Balanced Scorecard (SBSC). This tool helps to transform strategies

into business goals and provides specific Key Performance Indicators (KPIs). SBSC has been known to help corporations regarding implementing sustainability initiatives effectively. In the balanced scorecard (BSC) approach, four key perspectives are considered, namely 1) the financial perspective, 2) the customer perspective, 3) the internal process perspective, and 4) the learning and growth perspective. The purpose of a BSC is to assign the strategic objectives within these four perspectives such that the financial aspect of a corporation is no longer the sole determinant for competitive advantage (Figge et al., 2002, pp. 270–271). According to Möller & Schaltegger (2005), the term *balanced* in the BSC is considered as the balance between external measures (shareholders and customers) and internal measures (business processes and innovation), and the same ideology has been adapted in SBSC with the inclusion of sustainability initiatives. According to Figge et al. (2002), three major steps must be followed to formulate a SBSC as illustrated in figure 2. The implementation of SBSC brings structure to the sustainability strategy, makes communication easier and facilitates better alignment of sustainability goals with the different levels of the company.

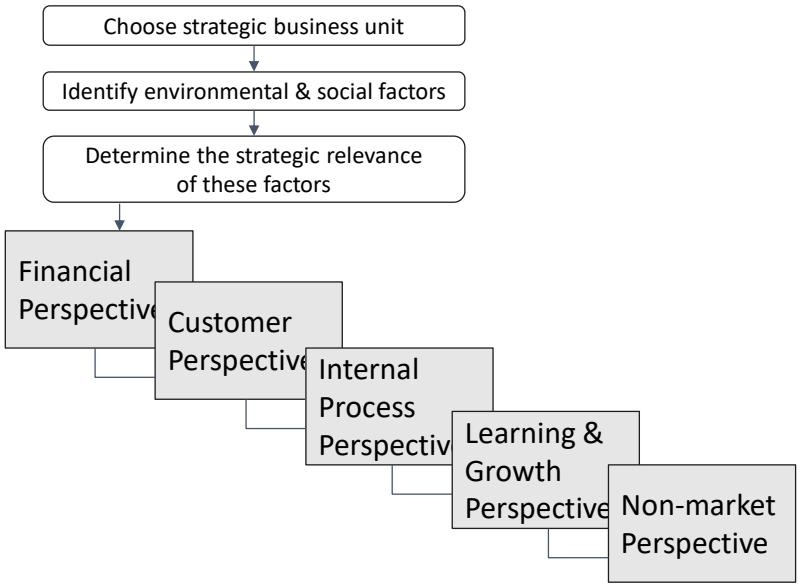

Figure 2: The process of formulating an SBSC, adapted from Figge et al. (2002)

1.3 Business Analytics to improve Corporate Sustainability

A strong business intelligence system gives decision-makers the right information at the right time and in the right place, allowing them to make better business decisions. Data warehousing optimization, reporting, dashboards, customer analysis, and predictive maintenance are the top 5 strategic initiatives carried out with business intelligence and business analytics (BI/BA) tools (Columbus, 2017). However, most corporations haven't ventured into sustainability in business analytics, since only 25% of the firms have integrated sustainability in their business model according to the BCG/MIT survey (Haanaes, 2016). Out of this 25% of corporations, many find it

time-consuming and overly complicated to utilize analytics because it needs to be customized for each business problem. To leverage business analytics for corporate sustainability, a business analytics framework is necessary to be developed which can be effortlessly incorporated in any organization.

The basic Design Science Research (DSR) process, which is an approach to develop research, can be integrated with BI/BA framework, as illustrated in figure 3, which can be used to provide a process for achieving business-specific research (Muntean et al., 2021, pp. 8–9).

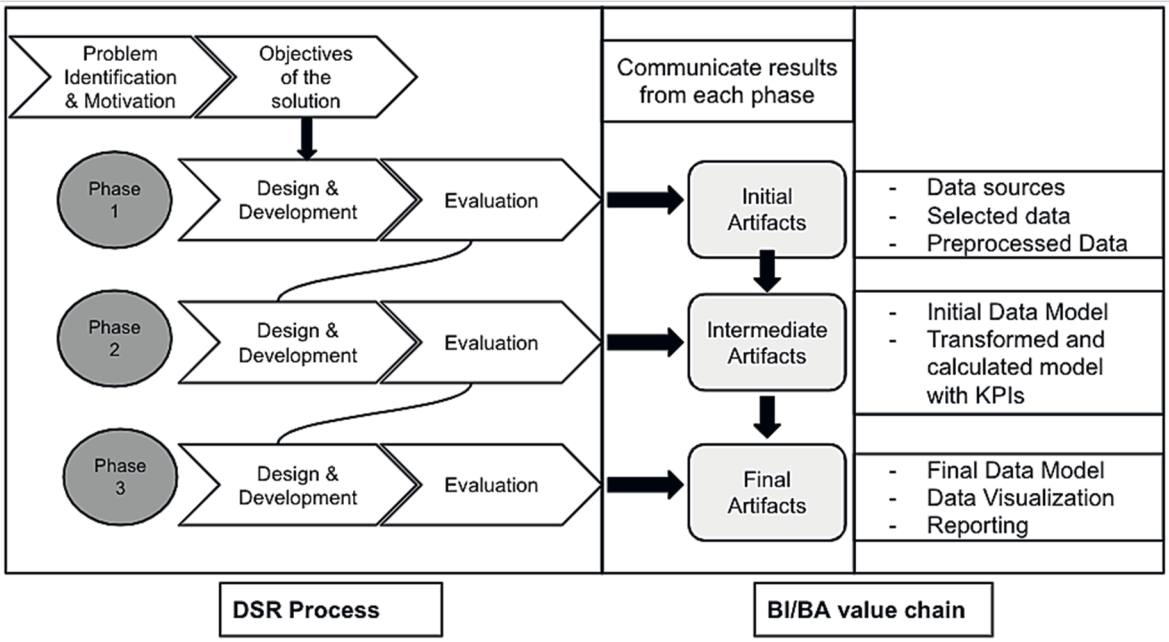

Figure 3: Developing BI/BA framework through DSR process, adapted from Muntean et al. (2021)

This process can also be integrated with BA framework and tools, which is known to be less time consuming with the provision of descriptive and prescriptive research analysis. But the process usage in BA remains unclear (cf. Knobloch, 2018, pp. 3f.) since there is no explicit case study or use-cases based on this theory in BA, which could be a scope for future research. There has been no use-cases defining the implementation of DSR framework for sustainability analysis. Moreover, this approach starts with data sources instead of business problems or business questions, leaving a lot of uncertainty with the business analysts to handle.

1.4 Corporate Sustainability Measurement Network

To successfully synchronize SBSC and sustainability strategy concerns, Oliveira et al. (2012) proposed the Matrix of Sustainability Strategic Alignment, which allows for true integration between sustainability strategy spread through the sustainability pillars/TBL and SBSC perspectives. Furthermore, for making business decisions, the weightage of sustainability concerns can be carried out using the Analytic Hierarchy Process (AHP) by the decision-makers, developed by Prof. Thomas L. Saaty. This

method, generally used for project prioritization and selection by organizations, is also an effective selection criterion for establishing sustainability initiatives (Medel-González et al., 2016, p. 532). The AHP model, used for multi-criteria decision analysis, is structured in a hierarchy with Goals, Criteria and Alternatives as illustrated in figure 4 (Karami, 2006, p. 103).

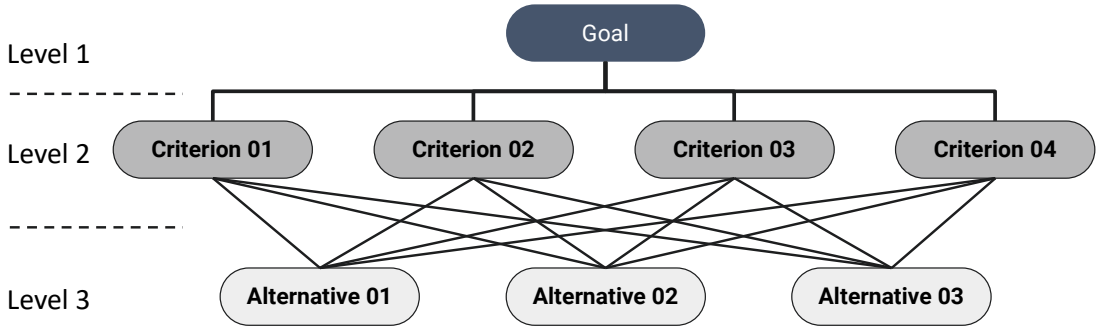

Figure 4: Analytic Hierarchy Process Model for project prioritization, adapted from Karami (2006)

This model is transformed into a network, called the Analytic Network Process (ANP), to model complex decision problems in a more generalized form. The combination of all these tools and techniques helps build the Corporate Sustainability Measurement Network (CSMN) which consists of four key levels as illustrated in figure 5 (Medel-González et al., 2016, p. 532).

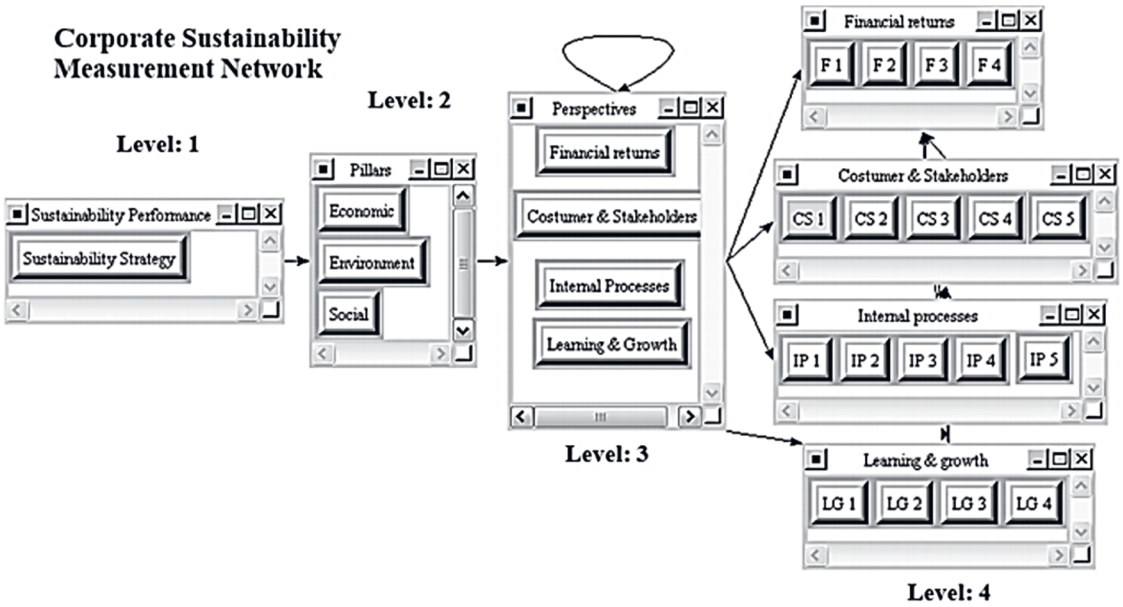

Figure 5: CSMN (Medel-González et al., 2016)

Overall, the CSMN is a valuable approach used to measure indicators and identify impediments in the business approach for a corporation to become more sustainable. Though it is an effective approach, it has not been implemented in BA/BI solutions or models. As a consequence, many organizations aiming to achieve corporate sustainability find it hard to implement data analytics approaches for this purpose. The

difficulties encountered are mainly related with the handling of large volumes of data, the challenges of analytics tools, and the implementation of ambiguous architectures and frameworks (Yaglewad, 2020).

It can hence be observed that a sustainability-oriented analytics blueprint is required describing how to support corporate sustainability initiatives by systematic business analytics. This motivates research on the topic **"Sustainability Design Process"**. The aim is to provide a business-specific, functional analytics framework which can be effectively implemented in any corporation, making sustainable development easier by acquiring accurate insights regarding sustainability-related factors.

2 Sustainability Design Process

A BI/BA blueprint called as "Sustainability Design Process" (SDP) has been developed which provides a process for achieving business-specific analysis (Narasimhamoorthy, 2021). This process rests upon the Design Science Research (DSR) approach, the Plan-do-check-act (PDCA) cycle, which is a design and management method for continuous improvement of business processes, and the Define-Measure-Analyze-Improve-Control (DMAIC) strategy, which is a data-driven quality strategy to improve business processes. The Sustainability Design Process has been laid out in figure 6.

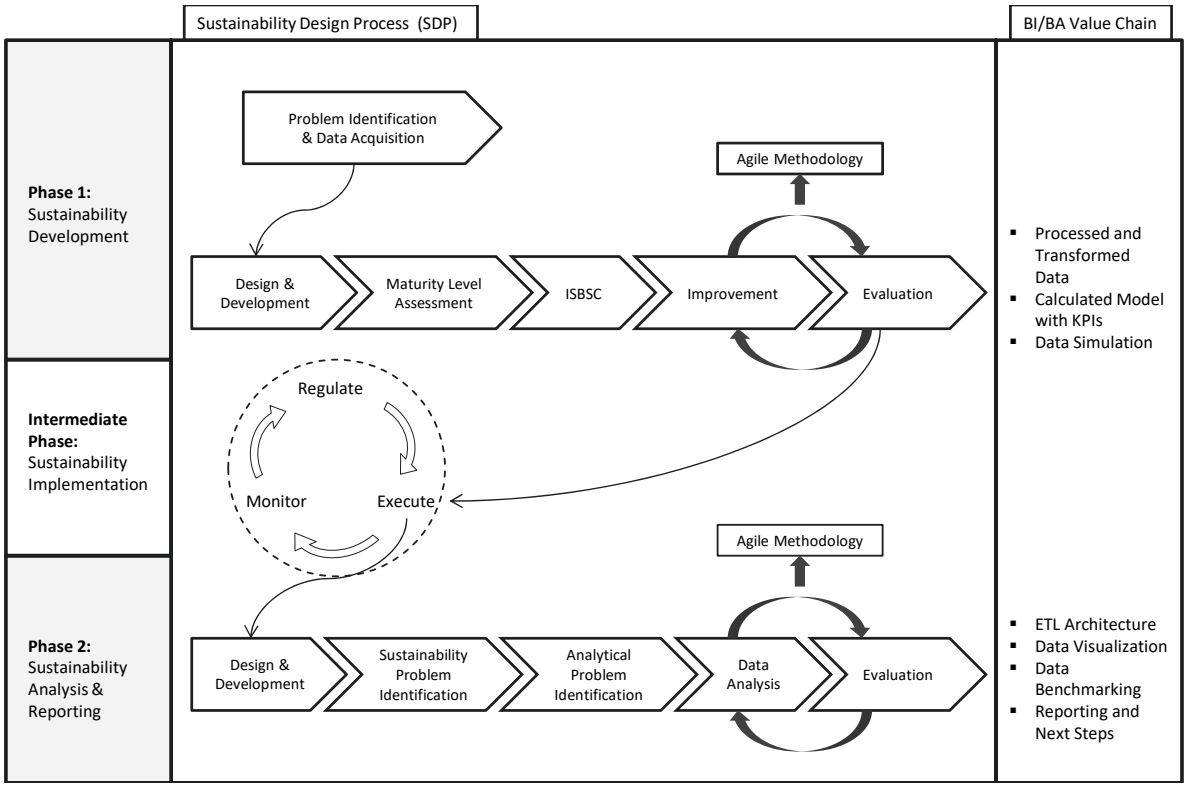

Figure 6: Sustainability Design Process for achieving Corporate Sustainability, adapted from Narasimhamoorthy (2021, p. 50)

This process has been separated into three phases: 1) Phase 1: Sustainability Development, 2) Intermediate phase: Sustainability Implementation, and 3) Phase 2: Sustainability Analysis and Reporting. The two main phases are data- or analytics-oriented, whereas the intermediate phase is about effectively implementing changes.

The following use-case on logistics industry has been considered to elaborate on the Sustainability Design Process and its phases:

"How can a data-driven logistics company that follows basic sustainability practices effectively implement sustainable logistics?"

2.1 Initial Considerations

Before proceeding with sustainability development and analysis, the following must be developed as a prerequisite for systematic development of sustainability initiatives:

Corporate Sustainability Measurement Databank

A databank of Corporate Sustainability (CS) measurements is created with appropriate indicators and indices based on the type of industry and organizational growth. This is developed to directly get data on government regulations on sustainable operations. These indicators can be taken from sources such as GRI, DJSI, Global Compact etc., and can be stored in a data warehouse as depicted in figure 7. Alternatively, the measurements databank might also be provided by public authorities, NGOs, or consultancy companies.

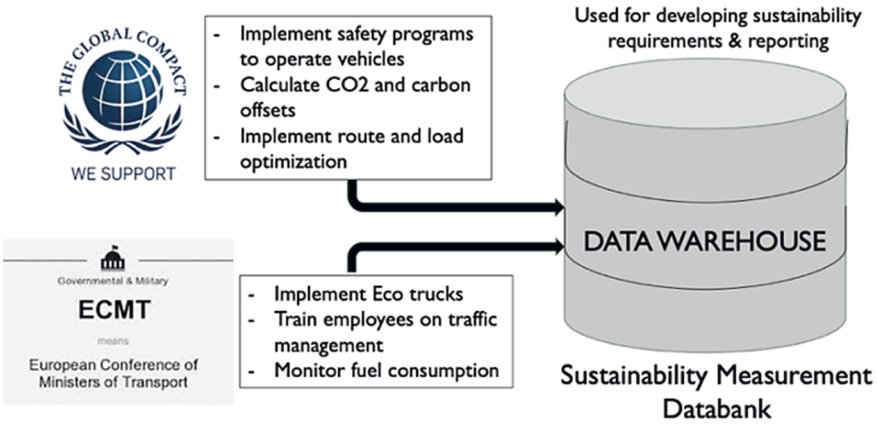

Figure 7: Creating a Sustainability Measurements Databank

5-Level Maturity Model

A 5-level maturity model has been developed as shown in table 1, to calculate the current level of maturity, based on sustainability integration in the organization. Maturity level analyses are carried out to identify the imbalances between steps to achieve in each maturity level (parameters) and to avoid these imbalances, it must all be brought to a single level. When all parameters are equal, a strategy is developed

to advance to the next maturity level. The evaluation to understand the current organization's degree of implementing sustainability based on KPIs is carried out through sustainability assessment using the developed databank of sustainability measurement index described above.

Maturity Levels	Description
Level 1: Novice	Classifies companies that are not aware of sustainability implementation but are planning on following sustainability practices.
Level 2: Advanced Beginner	Classifies companies that know the advantages of Corporate Sustainability, have worked on projects and are aiming to achieve Corporate Sustainability.
Level 3: Competent	Classifies sustainability-certified companies that are going beyond compliance. However, they still have some organizational issues in monitoring Sustainability KPIs and restructuring value creation.
Level 4: Proficient	Classifies companies that have obtained recognition for Corporate Sustainability initiatives and have integrated sustainability in business models.
Level 5: Expert	Classifies data-driven companies that have obtained recognition in competing against other organizations on Corporate Sustainability, creating significant impact to the Triple Bottom-Line and promoting sustainability sincerely.

Table 1: Five Improved Levels of Maturity in Corporate Sustainability

2.2 Sustainability Development (Phase 1)

In this phase, corporate sustainability problems are identified and steps to implement sustainability goals by assessing the current level of maturity, formulating KPIs, and developing a strategy map are defined using BI/BA.

Problem Identification and Data Acquisition

As a first step, the sustainability problem is identified, and data about the problem identified are collected and loaded into an analytics tool. A sustainability problem is an undesirable state of the business related to sustainability concerns which the corporation wants to improve on (cf. Knobloch, 2018, pp. 131f.). Business problems like this can best be communicated by utilizing the Entity-Attribute-Modifier schema (Knobloch 2018, pp. 141f.). An entity is considered as the class of objects that is being mastered, for example, a group of people, a group of vehicles, or a type of products. But in this case, it is majorly on an instance level such as business process or business unit. An attribute describes an entity and is considered as a characteristic of an entity type (IBM Corporation, 2021), such as employees' health status, the fleet's CO2 emissions, or a product's carbon footprint. Modifiers are specific keywords that describe how the attributes should be modified. This includes keywords such as increase, improve, reduce, decrease, generate, establish, eliminate, cancel.

In this phase of SDP, the Entity-Attribute-Modifier schema can be utilized to describe sustainability goals with respect to the maturity model, as illustrated in figure 8. If

Logistics company would want to establish a competent level in corporate sustainability in the production department, then "production logistics" will be taken as the entity, "competent" would be the attribute, and "establish" would be the modifier.

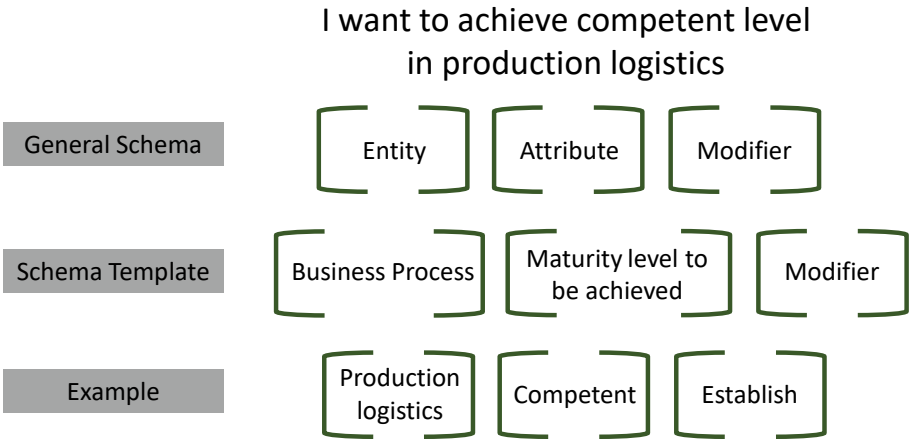

Figure 8: Entity-Attribute-Modifier schema with examples

Design and Development

In the second step, the existing data available on the chosen entity must be loaded into the analytics tool to design and develop the current maturity level assessment of the entity. For establishing corporate sustainability, the existing/available data that are to be analyzed are:

- **Government regulations:** The existing government regulations relevant for the chosen entity (i.e., production logistics) must be considered as a dataset. The existing government regulation taken under consideration for the production department will be added to the production department's BI system which can be further cleansed or filtered according to the organization's needs. Precisely, the existing regulations stated and considered for the production department are a) to maintain the equivalent of carbon dioxide (CO2e) < 10kg, b) the labors have the right to equal remunerations, and c) to provide regular training programs to support the staffers. These are to be considered as the dataset for maturity level assessment.
- **IoT Sensor data:** The existing IoT sensor data (e.g., carbon emissions data that are collected via sensors in the production department) based on the chosen entity must be considered as a dataset and fed into the analytics database. For example, the existing sensor data collected in the production department are CO2 emissions and fuel consumption rate data which must be taken into consideration and fed into a data warehouse/data mart. In other contexts, instead of sensor data, transaction data from business process execution might be helpful here.

- **Stakeholder data:** The existing data on stakeholder (customers, employees, society etc.) satisfaction due to sustainability initiatives and the support provided by them for implementing corporate sustainability based on production logistics must be considered as a dataset and fed into the database. An example is the rate of customer satisfaction due to Corporate Sustainability (CS) initiatives.
- **Formulated KPIs:** The existing set of KPIs formulated specifically for production department must be considered as a dataset and fed into the data warehouse/data mart.

Maturity Level Assessment

In the third step, the current maturity level is measured by utilizing the data collected or stored in the chosen entity's DWH/data mart (e.g., in the production data mart). Based on the assessment, a recommendation is notified in BA software as illustrated in figure 9. Here, two examples have been provided regarding how the recommendation could look like based on the maturity level assessment.

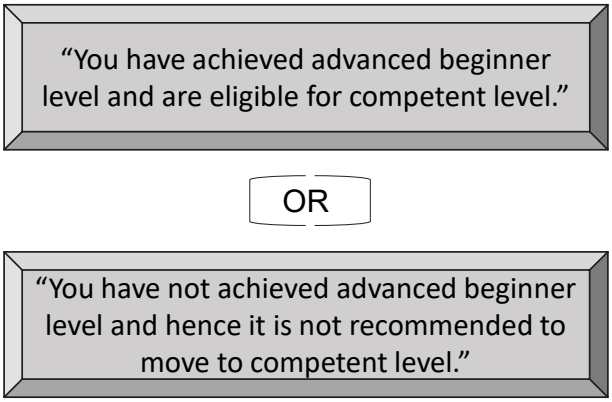

Figure 9: Notification in BA software based on maturity level assessment

Overall, this process helps the organization to measure their current maturity level on sustainability initiatives, based on which the KPIs for the implementation of corporate sustainability could be formulated.

Improved Sustainability Balanced Scorecard (ISBSC)

After the maturity level assessment for establishing corporate sustainability, a set of KPIs are to be formulated, selected, and segmented with equal weightage criteria. The list for selecting KPIs will be provided by the software, as illustrated in figure 10 with an example of logistics industry, based on the sustainability problem, current maturity level on corporate sustainable development and CS measurement databank.

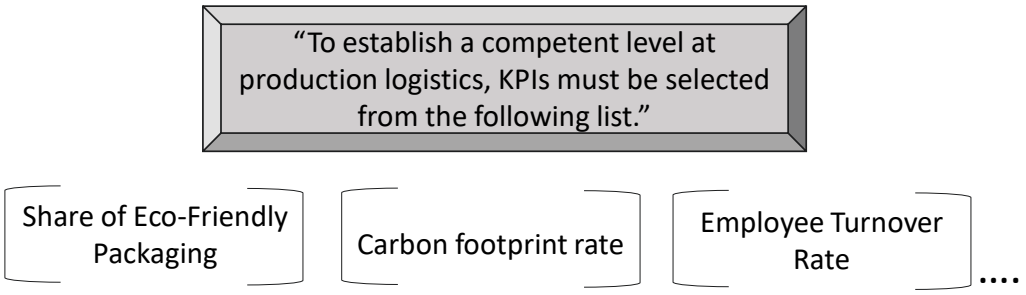

Figure 10: Example of a KPI generation list according to maturity level assessment and problem specification

After the selection of KPIs, they are segmented based on the perspectives defined for each sustainability pillar to develop an improved sustainability balanced scorecard (ISBSC). Considering all the defined KPIs are on the same level of granularity, each perspective will contain an equal number of KPIs (to provide a balanced scorecard with equal weightage). If they do not provide equal number of KPIs, a weightage criteria method can be utilized to consider high priority KPIs based on some factors such as resource availability, cost of implementation, impact to the environment etc.

In our example, the perspectives considered are "Employee retention and satisfaction perspective", "Financial perspective", "Management Perspective", "Competitive perspective", "Internal Process perspective", "Stakeholder perspective" and "Learning and Growth perspective". The sustainability pillars considered are "Environmental", "Economic", "Social", "Socio-environmental", "Eco-Social" and "Eco-Environmental" aspects (called sustainability attributes). In the example provided in figure 11, for the ease of understanding, the perspectives have not been considered, only the sustainability pillars are shown.

Attributes/ KPIs	Environment	Economic	Social
List of all selected KPIs	Share of Eco-Friendly Packaging	Operating expense ratio	Employee absence rate
	Renewable energy rate	Social return on investment	Rate of stakeholder engagement
	Carbon footprint rate	Job offer acceptance rate	Training and education rate
	% of environmental reporting		Employee Turnover Rate
			Diversity & Opportunity rate

Figure 11: Example of segmenting KPIs based on sustainability pillars

It can be observed that after the selected KPIs have been segmented, they have not been equally weighted (i.e., from the environmental attribute, there is an additional KPI and from social attribute there are two additional KPIs). To eliminate this inequality, a pair-wise comparison matrix can be employed using a scale of relative importance as depicted in figures 12 and 13. This is executed according to Analytic Hierarchy Process (AHP).

Figure 12 depicts the pair-wise comparison matrix for the criteria such as "impact on the environment", "resources required", "cost of implementation" etc. From this, the most important and least important criteria can be ranked based on the developed criteria weights.

Goal	Impact on the environment (Criterion 1)	Resources Required (Criterion 2)	Cost of Implementation (Criterion 3)	Criteria Weights
Criterion 1	1	3	5	0.6038
Criterion 2	1/3	1	2	0.1365
Criterion 3	1/5	1/2	1	0.1958

IMPORTANCE

1 – Equal
3 – Moderate
5 – Strong
7 – Very strong
9 – Extreme
2,4,6,8 – Intermediate values
1/3,1/5,1/7,1/9 – Values for inverse comparison

Figure 12: Pair-wise comparison matrix of defined sustainability criteria according to AHP

In figure 13, a pair-wise comparison matrix for the environmental KPIs have been depicted. From this, the importance level is ranked based on the developed criteria weights.

Goal	% of environmental reporting	Carbon footprint rate	Operating expense ratio	Share of Eco-Friendly Packaging	Criteria Weights
% of environmental reporting	1	2	5	6	0.597
Carbon footprint rate	1/2	1	2	1/5	0.276
Operating expense ratio	1/5	1/2	1	2	0.195
Share of Eco-Friendly Packaging	1/2	1/7	2	1	0.128

IMPORTANCE

1 – Equal
3 – Moderate
5 – Strong
7 – Very strong
9 – Extreme
2,4,6,8 – Intermediate values
1/3,1/5,1/7,1/9 – Values for inverse comparison

Figure 13: Pair-wise comparison matrix of defined environmental KPIs according to AHP

Overall, a decision matrix is developed which depicts each KPI against all the defined criteria. Using AHP method, the priority values are calculated and the KPIs are ranked. Based on this, the high priority KPIs are included to segment these KPIs against sustainability pillars.

Improvement

Based on the maturity level assessment and KPI formulation, government regulation, IoT sensors and stakeholder data must be selected to improve the corporate sustainability initiatives. This appears as a drag and drop selection in the analytics tool as illustrated in figure 14 to select IoT sensor requirements.

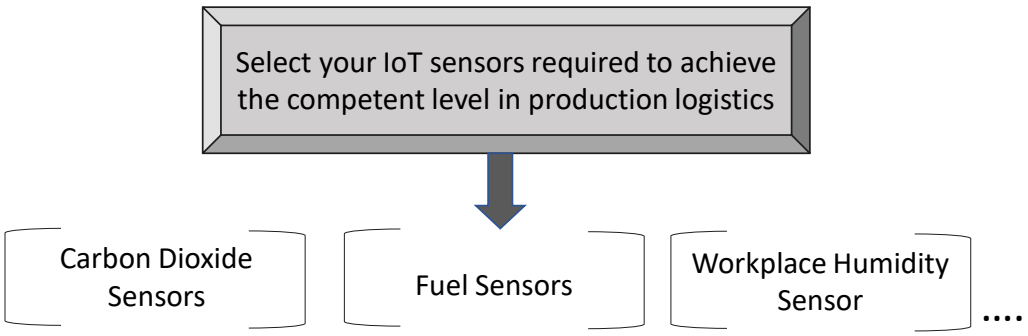

Figure 14: Example of a drag and drop selection of IoT sensors

Evaluation

After the selection of required data to execute and monitor corporate sustainability, they must be simulated to mirror real-world production site conditions based on the formulated KPIs and the selected improvisation methods. This is executed to validate the model and to determine potential actions that could cause challenges during the real execution process.

For example, if the goal is to send notifications when fuel consumption > planned consumption, on simulation, we validate and test this case to ensure potential risks are analyzed.

2.3 Sustainability Implementation (Intermediate Phase)

During the implementation phase, the designed goals and improvisations are executed in the production department by incorporating IoT sensors, labor practices, government regulations, and methods to reduce costs. These are regularly monitored, and if errors occur such as increase in machine temperature in the production department, or any modifications are to be made, they are regulated and modified accordingly. This cycle continues till the organization/the members of the production department move(s) to phase 2 for the purpose of analysis and final evaluation.

2.4 Sustainability Analysis and Reporting (Phase 2)

In the second phase, the data generated through IoT sensors, stakeholder surveys, social media, defined regulations followed and other KPIs will be extracted, transformed, and loaded. Under this segment, a Sustainability Multidimensional Data Model (SMDM) is developed to understand the level of detail considered to analyze corporate sustainability. In addition to which, sustainability problem and analytical problem are identified to define the goals easily and clearly for the purpose of analysis. Furthermore, the structure of a potential dashboard to visualize corporate sustainability is developed and the analytics components used for determining the organization's success level or their performance for elucidated. Finally, the informed data on sustainability initiatives, data benchmarking and success rate are reported and visualized.

Design and Development

As a first step, the relevant data as described above will be extracted, transformed, and loaded into an analytical database or BI system.

For example, considering CO2 sensor dataset from the production department, these data are selected and retrieved from the source system (i.e., IoT sensor database). The retrieved data are cleansed (by removing syntactical and semantical defects, and the overall data quality is assessed – removing rows with null values for "carbon index" considering it as a mandatory column), harmonized (by determining appropriate level of granularity and aligning the data according to business figures – having a common measurement value for carbon emission by using kg instead of ppm or metric tons) and aggregated (by consolidating the harmonized data on different levels). These are finally loaded into the production data mart.

In the next step, a Multidimensional Data Model is designed to enable data to be viewed and analyzed in multiple dimensions. An example of possible "Drill-down" & "Roll-up" operation used to determine detailed information about the environmental KPI "Carbon Index" has been illustrated in figure 15. This is used to navigate through hierarchical dimensions of sustainability data.

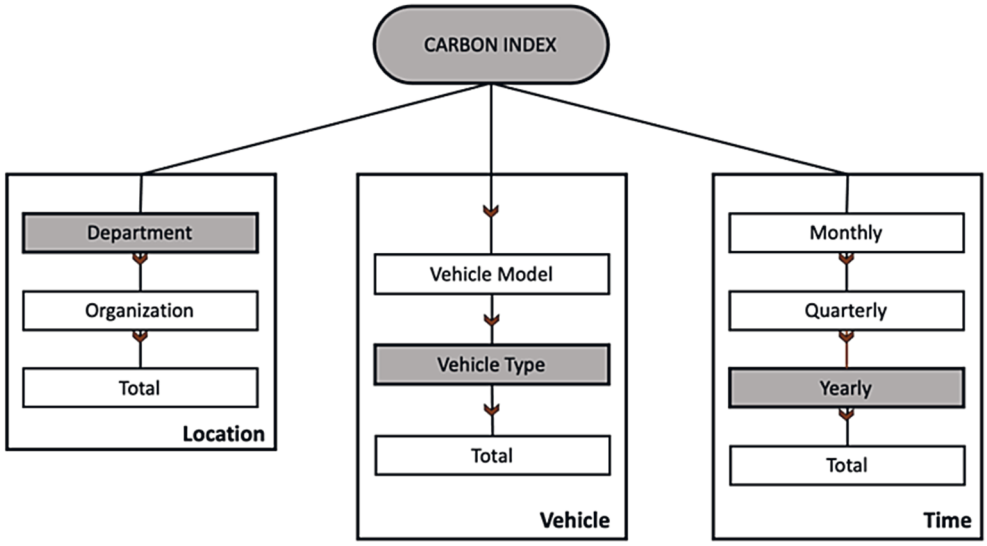

Figure 15: "Drill-down" & "Roll-up" options in a multidimensional model to investigate "Carbon Index" dependencies, following SDWM notation according to Böhnlein (2001, pp. 257ff.)

Sustainability Problem Specification

After defining a multidimensional model and implementing it in the analytics tool, for the users to access and analyze the required data according to their problem specification, a sustainability problem must be identified and operationalized. To attain this, the Entity-Attribute-Modifier schema introduced above can be utilized. In this phase, the sustainability problem does not refer to the maturity level, but describes a more specific undesired sustainability condition, and how this situation should be changed. If for instance the manager of production department wants to check the increment in the utilization of eco-friendly packaging, then "Entity" = "Production", "Attribute" = "Eco-friendly packaging", and "Modifier" = "Increase", as illustrated in figure 16.

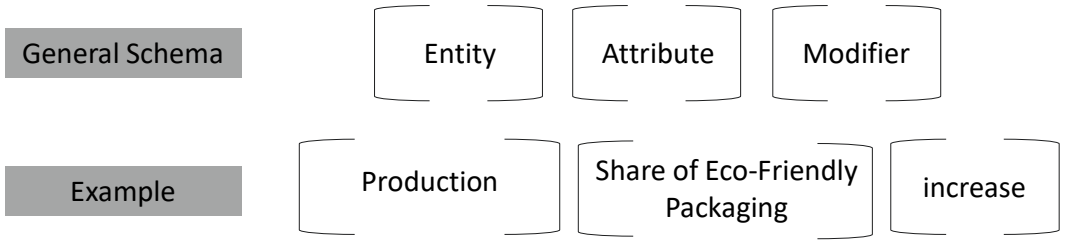

Figure 16: Entity-Attribute-Modifier schema to define specific sustainability conditions

Analytical Problem Specification

Once the basic sustainability problem has been defined, one or more analytical problems must be specified to understand and analyze the sustainability problem and to derive solution options. This can be supported by formulating questions following the SMART (Specific, Measurable, Achievable, Realistic and Timely) goals ap-

proach. This helps to easily define information requirements and attain what the analyst is looking for. For example, if the manager of "ABC chain" organization wants to view the performance related to eco-friendly packaging that provide less carbon index with high sales rate, then the following might be formulated as analytical question as illustrated in figure 17. The analytical problem is basically an operationalization (translation) of the sustainability problem into empirical variables, metrics, and filters (Knobloch, 2018, pp. 145ff).

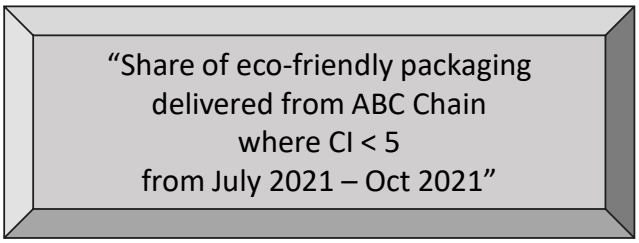

Figure 17: An analytical question following SMART goals to specify information requirements

Data Analysis and Evaluation

In the previous steps, sustainability problems and analytical problems were specified, for which the analytics tool can now provide access to appropriate data. Furthermore, deeper analysis can be executed on the specified data by utilizing descriptive, diagnostic, predictive, and prescriptive analysis methods. Likewise, through scenario planning analytics, considering all the uncertainties, questions, trigger events, and historical data, the best-case scenario, worst-case scenario, and average case scenario can be developed. Using this information, a scenario strategy plan may be determined. Additionally, this can be integrated with predictive analytics to find the likelihood of each outcome that occurs according to the designed scenario.

As a final step, a sustainability report is to be generated. This report includes the following major segments:

1) Sustainability problem and description.
2) Methods or tools utilized for attaining sustainability success in the organization along with alternative methods used that did not provide appropriate information according to the user's needs.
3) Detailed view on types of data collected and visualizations that are necessary for the future determination of sustainability success.
4) Competitor's sustainability analysis (data benchmarking): Through automated competitor research, specific data on their sustainability objectives, annual report, and their current sustainability progress are updated in the analytics tool which is used to position the corporations' sustainability strategy against their competitors' strategy.
5) Stakeholders need analysis: Employee satisfaction, customer needs and complaints, shareholder needs, and government regulations are fed to the business

analytics tool. Based on this information, the possible future needs of the stakeholders could be determined through predictive analytics and scenario planning, to stay one step ahead of other corporations.

6) Next Steps related to improvements in the BI architecture or new sustainability initiatives must be reported that will help the organization's growth. In addition to individual brainstorming methods followed by managers, executives or analysts, such steps may also be determined by employing prescriptive analytics methods.

The data analysis and evaluation steps (automated reporting process) follow an agile methodology, where analysts gain the possibility to go back to the analysis phase if they have missed any details or if new potential uncertainties have occurred, leading to proceed with predictive analytics/scenario planning.

3 Conclusion and Recommendations

This research is aimed to identify an effective framework to implement corporate sustainability on a long-term basis with a focus on utilizing business analytics for faster, business-specific, and data-driven sustainability incorporation. Major research studies have reported that organizations find it challenging to follow up with numerous available sustainability frameworks and theories which are not applicable for all industries or business-specific cases. Multiple limitations to utilize sustainability practices in corporations exist, and as a result, they are rarely integrated into the business models. Furthermore, previous research studies did not cover the systematic usage of business analytics to gather sustainability insights.

A business analytics framework called as "Sustainability Design Process" (SDP) was introduced to assist organizations identify sustainability problems, utilize the improved sustainability balanced scorecard, and to efficiently execute corporate sustainability. These frameworks provide an effective and systematic step-by-step methodology with guidelines to support the analysts, executives, and managers of any organization or industry dealing with business specific use-cases. Logistics industry has been considered to focus on a specific business use-case.

There exist some limitations in this research paper which are considered as a scope for future research works, which are listed below.

- *Designing a business-specific corporate sustainability measurement databank with indicators and indices*: This research paper has elucidated an approach towards designing a business-specific corporate sustainability measurement databank. This may prove useful for implementing corporate sustainability. With the use of this databank, a list of KPIs can be determined according to the sustainability business problem. Therefore, future research on developing such a databank for particular industries including a detailed explanation of

the attributes in the databank, as well as methods for automated data extraction and storage, is recommended. The data extraction can be performed by linking sustainability indicator websites such as GRI, DJSI and others to data collection and integration processes.

- *Formulating a weightage criterion for developing an improved sustainability balanced scorecard and integrating this factor in business analytics*: This paper has made use of an approach towards formulating a weightage criterion using AHP. This can be further expanded, and suitable weightage criteria can be determined. Additionally, the formulated weightage criteria must be integrated in the analytics tool for corporations to implement the improved sustainability balanced scorecard.
- *Developing a business analytics tool to incorporate the sustainability design process for implementing corporate sustainability*: In this research paper, a systematic framework has been proposed to implement corporate sustainability using business analytics. This approach should be transformed into an analytics tool for the effective usage of sustainability analytics in organizations. Besides, it is also crucial to investigate appropriate data warehouse and data mart structures in detail.

4 Appendix

This part of the Appendix belongs to Chapter 2. Improved Sustainability Balanced Scorecard is developed after defining the organization's maturity level. In this process, the KPI selection process and development of ISBSC has not been elaborated in Chapter 2.

KPI Selection Process and ISBSC

The KPI selection must be business unit specific or business process specific and it must correlate with the organization's strategic objectives and its current growth. The KPIs must be effective, significant, reliable, and consistent with the value creation process. To select the KPIs, it is essential to focus on a few key metrics rather than a slew of data, and it is appropriate to aim for 3 or 4 KPIs per goal for each business unit/business process per TBL segment. Additionally, the sustainability measurement indicators can be used as is, or can also be modified with respect to the industry and organizational size.

After the KPIs are selected, an ISBSC must be developed wherein equal weightage to each sector in the TBL must be provided. Though SBSC is a balanced and well-rounded approach to measure a business's sustainability performance, the factor to develop equal weightage is not implemented, and the original SBSC considers the TBL segments in pillar form representation rather than as intersection of 3 segments. Therefore, ISBSC consists of two segments namely, 1) the intersection of TBL in

SBSC with the implementation of equal weightage for each segment, and 2) the utilization of Scrum framework for agile determination and segmentation of strategic KPIs. An ISBSC model has been illustrated in figure 18, with a KPI selection flowchart and figure 19, with KPI segmentation and seven ISBSC perspectives (more aspects could be included according to the organizational needs, but the current model consists of crucial factors to be included). The number in the illustration has the following connotations: 1 – depicts the selection process of KPIs, 2 – depicts the segmentation of the selected KPIs through the Scrum framework, 3 – depicts the aspects considered for KPI clustering and classification.

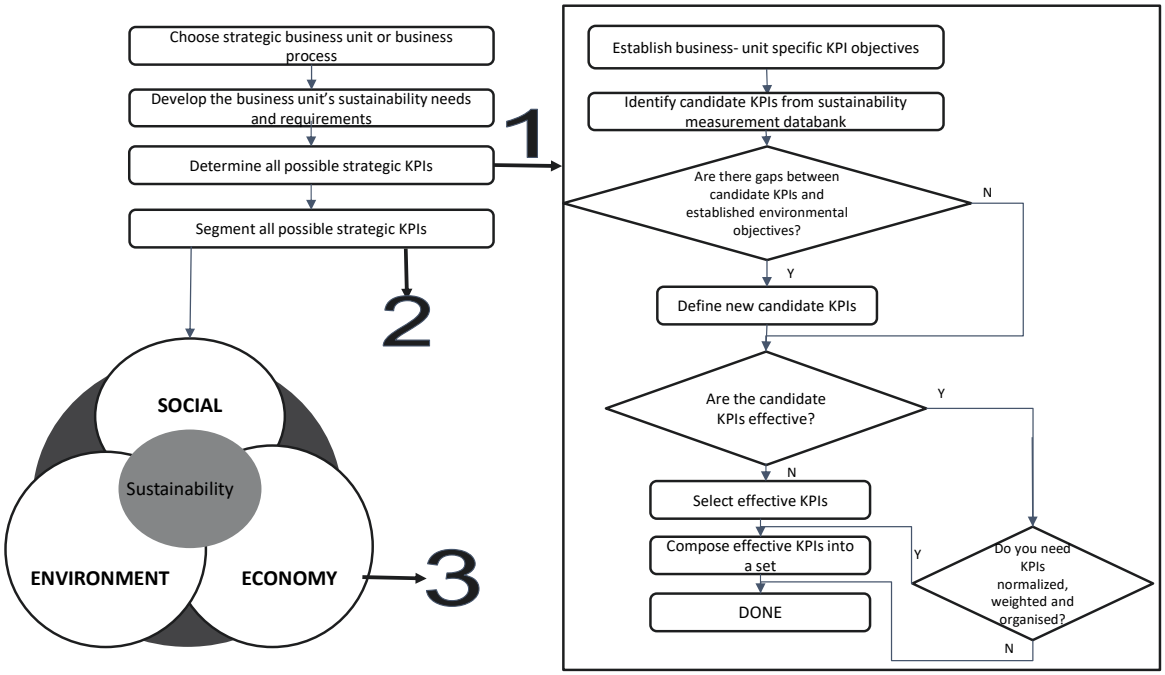

Figure 18: An Improved Sustainability Balanced Scorecard Model with KPI selection flow chart

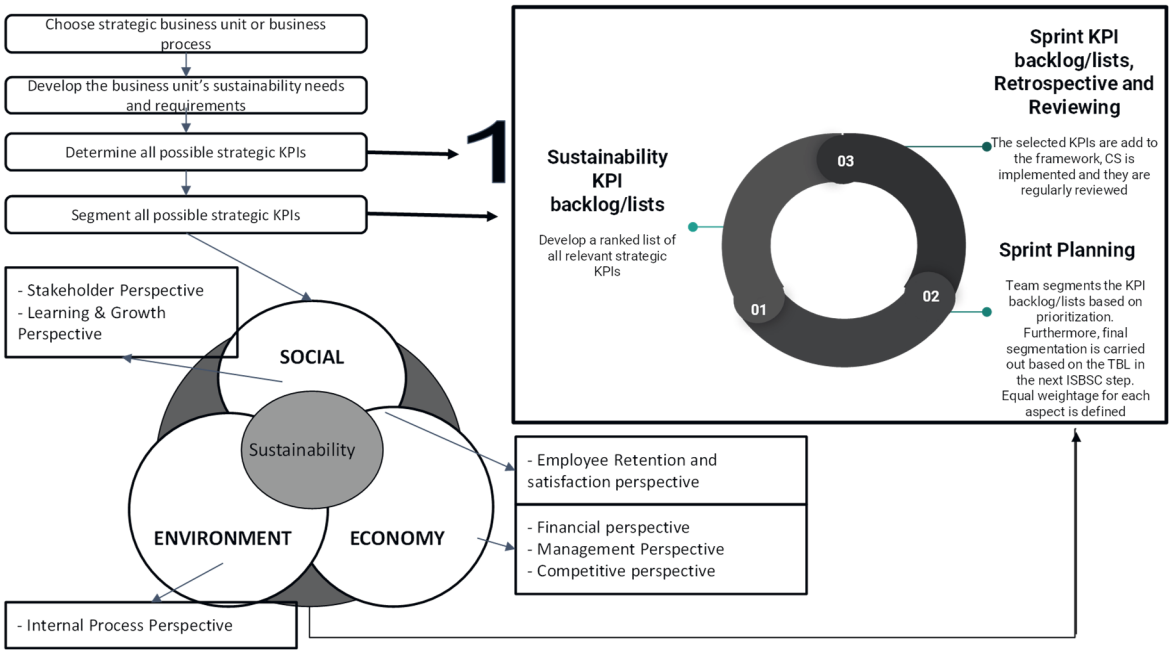

Figure 19: An Improved Sustainability Balanced Scorecard Model with KPI segmentation

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