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A FRAMEWORK FOR SOUTH AFRICAN COMPANIES TO OPERATIONALISE THE SUSTAINABLE DEVELOPMENT GOALS

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A research project submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration.

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Abstract

The current operating environment requires of companies to account for their social impact and contribute towards national and global sustainability targets. With the adoption of the Sustainable Development Goals in 2015 by the United Nations members, the Corporate Social Responsibility expectations on corporates are enormous.

This research study provides South African corporates with a framework to operationalise the new Sustainable Development Goals and to measure and compare their social value, i.e. the impact, created within the context of Corporate Social Responsibility. The framework enables companies to incorporate their Sustainable Development Goals strategy into their performance management system and business review cycle.

Three research problems were identified as the key challenges to the implementation of this framework: the identification and prioritisation of social need, the measurement of the social impact of the intervention and finally the comparison between different social interventions, nationally and internationally. To overcome these challenges, a composite index was constructed for Sustainable Development Goal 1, as an example. The index was developed from a structural equation model and the South African General Household Survey was used as the research instrument. The Kroeger & Weber (2015) methodology was finally applied to the composite index to demonstrate the measurement and comparison of social value.

This study extends upon the research of Smulowitz (2015) and Kroeger & Weber (2015) and proposes a Sustainable Development Goal operationalisation framework, in which performance is measured relative to the social need. There has been a positive trend observed in monitoring and evaluation research in Africa, fueled by the social need of the continent. This research study aims to contribute towards the further theoretical development of this field.

Keywords: Corporate Social Responsibility, Sustainable Development Goals, South African General Household Survey, Structural Equation Model, Composite Index

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Student Name: Rilet Davison

Student Signature: ______________________

Date: 07 November 2016

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A FRAMEWORK FOR SOUTH AFRICAN COMPANIES TO OPERATIONALISE THE SUSTAINABLE DEVELOPMENT GOALS

Chapter 1. Introduction to Research Problem

Corporate Social Responsibility (CSR) discussions have, in recent years, moved away from defining or contextualising CSR in reference to the organisation's mission and shareholder value (Wang, Tong, Takeuchi, & George, 2016). Scholars and practitioners now emphasise the importance of formulating methodologies to measure and compare the social value, i.e. the impact, of specific social interventions (Gautier & Pache, 2015; Kroeger & Weber, 2015; Liket & Simaens, 2015).

The United Nations (UN) members, including South Africa, adopted the Sustainable Development Goals (SDGs) in 2015. In 2016, at the 47th session of the UN Statistical Commission, general agreement was reached on 230 indicators that can measure the SDGs and their targets (United Nations Department of Economic and Social Affairs Statistics Division, 2016). The SDGs and targets are part of a 15-year global action plan for "people, planet and prosperity" (General Assembly resolution 70/1, 2015). With the recent adoption of the SDGs, "the expectations on business in the new SDG era are immense, but at the same time the opportunities are enormous", Lise Kingo, Executive Director of the UN Global Compact (United Nations News Centre, 2016).

The objective of this research study is to provide South African corporates with a framework to operationalise the new SDGs and to measure and compare their social value, i.e. the impact, created within the context of CSR and the SDG targets. Strategy implementation and performance management theories are applied to conceptualise the SDG operationalisation framework within a corporate environment. These theories require assumptions regarding the supposed links between operations and strategic level indicators. The South African General Household Survey (GHS) is used to develop structural equation models (SEMs) for the first three SDGs. These three SDGs were chosen, as examples, to demonstrate the feasibility of modeling the relationships between the UN approved indicators and the latent factor SDG. An composite index is then developed from the significant relationships in the SEM. The Kroeger & Weber (2015) framework is finally tested with the SDG1 composite index. The Kroeger & Weber (2015) framework is a theoretical approach to measuring and comparing social value created.

1.1. Background

The ambitious SDGs set by the UN will not be achievable without the support of corporations and without freely accessible, reliable, high quality data and measurement frameworks (Eccles, 2015; Economist, 2015). The concept of CSR has branched into multiple theoretical debates, including more recent research on creating shared value (CSV) and creating integrated value (CIV) (Crane, Palazzo, Spence, & Matten, 2014; Visser, 2015). Rather than debate the definition of corporate social involvement, this study is concerned with the SDGs and the identification, quantification and comparison of "social need", as defined through the deconstruction of the SDGs. The term CSR, in this research study, defines the role companies play in achieving the SDGs.

The South African government has prioritised job creation and the alleviation of poverty and inequality in the National Development Plan (NDP) (Kosciulek, 2015). The King III code encourages South African companies to emphasise sustainability and requires the Chief Executive Officer and board to take accountability for the conduct of the company in society (IoDSA, 2016). South African companies have acknowledged government pressures towards social responsibility as a key driver for their Corporate Social Investment (CSI) and CSR (Henry & Rifer, 2013). Companies will need to incorporate CSR into their short-, medium- and long-term strategies if they are to meet their commitment towards CSR and to respond to the pressures from the governance structures. This research study therefore leverages strategy implementation and performance management theories in the development of the SDG operationalisation framework.

Kroeger & Weber (2015) and Wang et al. (2016) highlight three key challenges that have emerged from the recent literature on CSR. The first challenge is how the company should balance and prioritise CSR activities, navigating multiple stakeholder groups' requirements. The second challenge is the measurement of the effectiveness of the intervention. The measurement is complicated by elements such as the time-frame, available resources and the attribution versus contribution discussion. The third challenge is more pertinent to multi-national companies: how do multinational companies measure and compare the effectiveness of their social interventions in a global landscape, with different socioeconomic and institutional contexts?

The World Economic Forum (WEF) lists three key challenges associated with the implementation of the SDGs (Patterson, 2015). The first challenge is to assemble the right stakeholders. The second challenge is to make difficult trade-offs, given competing interests. A third challenge is in managing the accountability for action.

1.2. Research problems

Given the important role corporates are expected to play in achieving the SDGs, it is perhaps not surprising that the challenges related to the implementation of the SDGs (Patterson, 2015), echoed the challenges that have emerged from recent literature on CSR (Kroeger & Weber, 2015; Wang et al., 2016). The identified challenges were distilled into three key research problems.

Research problem 1: Identification of the social need. The definition of social welfare or "social need" is, in itself, a topic of extensive ongoing debate (Jones & Felps, 2013; Kroeger & Weber, 2015; Marti & Scherer, 2016). A single-value objective allows management to make informed choices among multiple alternatives (Jones & Felps, 2013)**.** However, Mitchell, Weaver, Agle, Bailey, & Carlson (2016) argue that a single objective or definition of social welfare could impede the effectiveness of additional social welfare improvements, given the multidimensional nature of the construct.

Research problem 2: Measurement of the social impact. The business-society relationship has predominantly measured the value of the investment in terms of firm profitability and employee or customer satisfaction. There has been limited research conducted on the outcomes on the firm's strategic economic performance and even less on the impact on the end beneficiaries and the intermediary organisations serving end beneficiaries (Gautier & Pache, 2015; Kroeger & Weber, 2015; Liket & Simaens, 2015).

Research problem 3: Comparison between social interventions. Given the multidimensional nature of social welfare, the effectiveness of social interventions should not only be measured through the cumulative economic wealth created (Marti & Scherer, 2016; Mitchell et al., 2016). This complicates the comparison of effectiveness between unrelated interventions. National differences in socioeconomic and institutional contexts also create dissimilar environments (Kroeger & Weber, 2015), further complicating the exercise of comparing the effectiveness of different interventions with one another.

1.3. Research objectives

As stated earlier, the objective of this research study is to provide South African corporates with a framework to operationalise the new SDGs and to measure and compare the social value, i.e. the impact, created within the context of CSR and the SDG targets.

The specific objectives related to the research problems are as follows:

- The SDG operationalisation framework should enable corporates to identify and prioritise social interventions based on a shared definition of social need, as defined within the context of the SDGs.
- The SDG operationalisation framework should enable corporates to measure the social impact of their social intervention.
- The SDG operationalisation framework should enable corporates to compare the effectiveness of different social interventions, locally and internationally.

1.4. Relevance of the research

To achieve the SDGs a coordinated and collaborative approach between private and public sector and civil society is necessary so that resources can be invested wisely. In this way they can make a sustainable impact and make genuine progress towards social upliftment.

Business relevance. Trialogue estimates that corporates spent R8.1 billion on CSI in South Africa during the 2014/2015 financial year (Trialogue Publishing SA, 2016). The effectiveness of current corporate social interventions in South Africa is however questionable. For example, Besharati (2014) found that the almost R100 million invested by Anglo American Platinum in education in Limpopo and North West, during the period 2009 to 2012, resulted in a relatively small education and development impact. The study identified the company's fragmented investment approach (i.e. too many, too small projects) as one of the major reasons for not creating a significant and lasting impact. This research study develops an SEM and composite index for an SDG, that is weighted, based on the strength of the relationship between the indicator and the SDG. The SDG composite index allows business to focus investment where it will have the greatest impact.

The need for a cost-effective method of evaluation is identified as one of the five key challenges facing evaluation capacity building in Africa (Basheka & Byamugisha, 2015). This research study uses free data from the GHS and the free SAS Studio software package. Targeted surveys and experiments will still be required for more robust analysis, but the SDG operationalisation framework, with the SEM model and composite index, will allow companies to analyse and track the trends with regard to the social need and social value created for their focus area or group. This allows corporates to actively measure impact and only apply the more costly and rigorous monitoring and evaluation (M&E) techniques at key strategic milestones.

Institutional relevance. The National Education Collaboration Trust (NECT) was established in 2013 and is an example of an institutional body established to facilitate cross-sector collaboration to improve education outcomes. Even though South African CSI spend is primarily focussed on education, Trialogue estimated that only 8% of the surveyed corporates contributed to NECT(Trialogue Publishing SA, 2016). Corporates were willing to direct CSI spend through Non Profit Organisations (NPOs), but not collaborate with NECT. To be effective in the long run all the SDGs require some level of institutional involvement (i.e. policy changes, governance, cross-sector dialogue). This research hopes to contribute to the development of a shared SDG framework that will create transparency. This, in turn, should increase trust, collaboration and joint prioritisation which should lead to the identification of social need and the achievement of the SDGs.

Theoretical relevance. The SDG indicators that have been proposed by global measurement organisations such as Sustainable Development Solutions Network & Bertelsmann Stiftung (2016) and the United Nations Department of Economic and Social Affairs Statistics Division (2016) are typically measured at a national level. Different indicators are obtained from different sources and an average score is then generated that enables countries to assess their current performance against each of the goals. This study aims to construct a composite index for an individual SDG. The composite index is weighted with the SEM path coefficients and only one data source is used, enabling more detailed analysis at a geographic, socioeconomic and demographic level.

The SDG operationalisation framework developed in this research study builds and expands on strategy implementation and performance management theory (Smulowitz,

2015) and implements the theoretical approach to measuring and comparing social value created by Kroeger & Weber (2015). Given the social need of the continent, there has been a positive trend observed in M&E research in Africa (Basheka & Byamugisha, 2015) and this study further contributes towards the theoretical development of this field.

1.5. Outline of the study

The research is structured along the following layout.

Chapter 2: Literature review. The literature review provides a theoretical foundation for the development of a framework to operationalise the SDGs. Figure 1 illustrates a consolidated view of the business review and performance management system design and implementation theory. The literature review in chapter 2 will be structured according to this framework. The chapter 2 section numbers are indicated on the graphic.

Chapter 3: Research questions. Chapter 3 outlines the five research questions that this research study will address.

Chapter 4: Research methodology. The research methodology describes and defends the research design, the research scope, the research instrument and the data analysis process. The chapter also explains the key research assumptions and limitations.

Chapter 5: Results. This chapter presents the results from the analysis outlined in Chapter 4. The chapter first describes the descriptive statistics of the sample. The chapter then presents results of the reliability and validity tests from the three structural equation models and concludes with the results from the composite index for SDG1.

Chapter 6: Discussion of results. In chapter 6 the results presented in chapter 5 are reviewed in the context of the study and the literature review.

Chapter 7: Conclusion. This chapter concludes the research study and synthesises the key findings and research limitations. Managerial, institutional and academic considerations are discussed and avenues for future research are recommended.

1.6. Conclusion

The current operating environment requires of companies to account for their social impact and contribute towards national and global sustainability targets. With the adoption of the SDGs in 2015 by the UN members, the CSR expectations on corporates are enormous.

This research study provides South African corporates with a framework to operationalise the new SDGs and to measure and compare their social value, i.e. the impact, created within the context of CSR. The framework enables companies to incorporate their Sustainable Development Goals strategy into their performance management system and business review cycle.

Chapter 2 will provide a critical review of the significant literature and theories relevant to the development and implementation of the performance management system, as well as the business review cycle.

Chapter 2. Literature Review

Poverty, wellbeing and happiness are complex notions, with multiple, often dependent, dimensions. Social theories are continuously being developed to study and quantify these concepts. These social theories can impact institutional designs and social norms as well as shape the lens that determines how individuals view their reality (Marti & Scherer, 2016). This chapter contextualises the research by providing a critical review of the significant literature and theories relevant to the research objective. The objective of this research study is to provide South African corporates with a framework to operationalise the new SDGs and to measure and compare the social value created within the context of CSR and the SDG targets.

2.1. Operationalising Strategy

CSR and the SDGs should be incorporated into the short-, medium- and long-term strategies of the company. Strategy implementation often receives less attention than strategy formulation, both in literature and in practice (Hu, Leopold-Wildburger, & Strohhecker, in press). Strategy implementation is the alignment of the operational decisions developed and taken to close the gap between the actual and the target performance (Strohhecker, 2016). Performance measurement is thus essential to strategic management research (Chen, Delmas, & Lieberman, 2015; Luoma, 2015).

The performance management system. The performance management system (PMS) is a management control system applied by organisations to measure organisational effectiveness, defined through value creation for stakeholders. Traditional financial measures had the potential to incentivise short-term profit maximisation behaviours which were in conflict with strategic effectiveness. PMS requires that individual measures and sets of measures be developed at the operational and strategic performance levels and that they are periodically reviewed and aligned to the organisation's strategic objectives. The frequency of review depends on the type of organisation and the individual measurements (Smulowitz, 2015; Upadhaya, Munir, & Blount, 2014). This research study expanded the research by Smulowitz (2015) to construct the SDGs operationalisation framework. The remainder of this chapter will be structured according to the business review cycle and the performance management system, as illustrated in Figure 1.

Smulowitz (2015) proposed a two-part framework; one part focussed on business performance and outlined how to review the performance of companies that used the performance prism. This consisted of four phases; planning (section 2.2), measuring (section 2.3), reporting and analysis (section 2.4). The second part focussed on the performance of the performance management system itself. In other words it focussed on framework design (section 2.5), implementation and use (section 2.6).

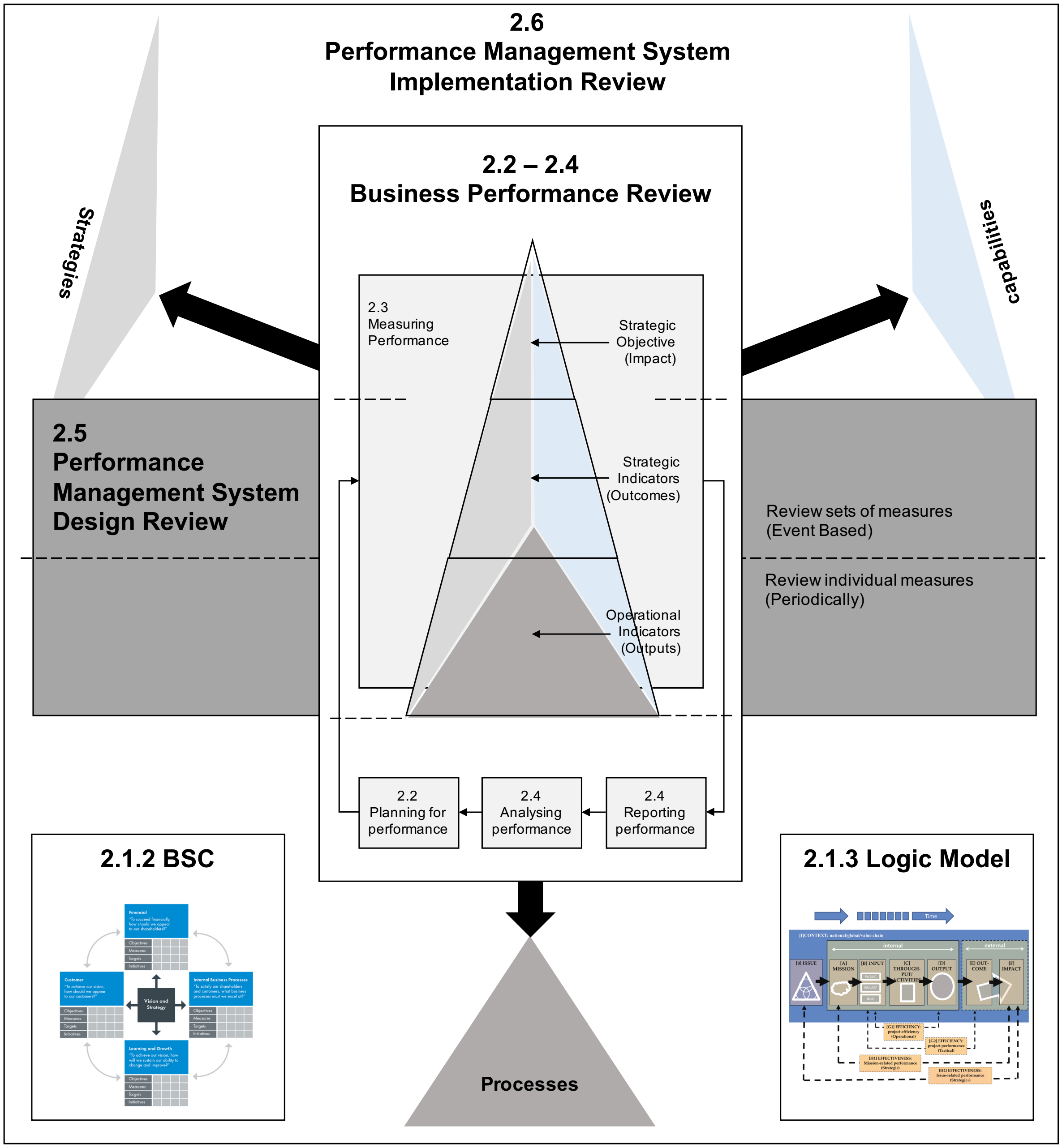

Figure 1: Literature review structure

Balanced scorecard and strategy map. The Balanced Scorecard (BSC) is a mature strategy tool used for strategic planning, execution and management (Hoque, 2014; Radomska, 2015; Wu, 2012). The strategy map is used to enable the BSC (Radomska, 2015) and it visualises the causal interactions that connect the four parts of the BSC (i.e. finance, customer, internal business processes and learning and growth) with the company strategy (Wu, 2012). Amado, Santos, & Marques (2012) highlight two limitations of these methods; the methods do not explain compromises that might result from interlinked relationships between the measurements and do not propose a data-driven weighting scheme for the performance measures. The SEM and composite index have the potential to address the limitations of these tools.

The logic model. The Kellogg Foundation's programme logic model is commonly used when developing monitoring and evaluation (M&E) frameworks (Miller, 2013; Rogers, 2008; Trialogue, 2014). It links the outcomes with the activities, processes and assumptions of the program. Outcomes are specific changes relating to the programme's participants and can be both short-term (one to three years) and longer-term (four to six years). Impacts are the fundamental changes caused by the project (intended or unintended) within seven to ten years (W.K. Kellogg Foundation, 2004).

Van Tulder, Seitanidi, Crane, & Brammer (2015) expanded on the logic model framework and constructed a partnership monitoring and evaluation framework that could be applied in cross-sector collaborations. There was a noticeable methodological alignment between the PMS and the expanded version of the logic model, as developed by van Tulder et al. (2015). The PMS operational performance indicators can be seen to be aligned to the internal efficiency measurements in the partnership monitoring and evaluation framework. The same is true for the PSM strategic performance indicators and the external effectiveness measurements in the partnership monitoring and evaluation framework. Both models require assumptions to be formulated regarding the supposed links between the operations/efficiency level and the strategic/effectiveness objectives and indicators.

The theory of change (ToC) methodology requires the company to critically hypothesise the causal relational and underlying assumptions of the social intervention. The goal is to develop a theory to explain why the intended change could potentially be achieved through the intervention (Mayne & Johnson, 2015; van Tulder et al., 2015). Van Tulder et al.

(2015) emphasised the importance of evaluating the evidence-based insights associated with the social impacts. The difficulty in determining the evidence is often associated with the ability to account for the "counterfactual", the "what would have happened anyway" element and its associated contribution to the impact. Delahais & Toulemonde (2012) propose that contribution analysis (CA) has the potential to measure effectiveness, where a counterfactual-based method is not possible. CA applies a principled, theory-based approach, but in order to be acknowledged as rigorous, the method requires quality criteria and recognised benchmarks. CA follows a six step approach; defining the causal issue (the logic model), developing the TOC, gathering evidence, drafting the contribution story, strengthening the contribution story and finalising the contribution story.

2.2. Planning for performance

Two of the most important components of planning for performance are determining targets and time-frames for the three levels of measurement which are: strategic objectives, strategic performance indicators and operational performance indicators (Smulowitz, 2015). The United Nations has set specific targets against the SDGs within the 2030 time frame (General Assembly resolution 70/1, 2015). With regard to the organisation, the firm should review company level targets periodically against its available resources and performance and then assess if their targets are realistic or if the targets and/or resource strategy should be adjusted (Smulowitz, 2015). Practically, once the targets are set or updated, the operational plan is created, including the resource allocations and the performance measurement scorecard.

2.3. Measuring performance

Following the target-setting and performance planning stage, performance is measured. The frequency of the measurement is related to the strategic level of the indicator and the measure's rate of change (Smulowitz, 2015). There are three levels of measurement; strategic objectives, strategic performance indicators and operational performance indicators.

Strategic objectives. Smulowitz (2015) described the vision and mission as the indicator against which to measure the firm's overall success in meeting stakeholder requirements. Performance against the vision and mission can be complicated and costly and is usually measured with the lowest frequency. However, analysis should not be limited to the review periods.

This definition of welfare / happiness / social need is still widely debated in literature today. Mitchell et al. (2016) argues against the Jones & Felps (2013) recommendation for a single all-encompassing corporate objective (i.e. stakeholder happiness), with regards to social welfare and stakeholder agency. The advantage of a single-objective approach is stated to improve efficiencies through increased focus and better decision-making (Jones & Felps, 2013). Mitchell et al. (2016) critique the unitary view of social welfare by debating the value of monism.

Well-being is typically used to describe “what is good for a person” and is analysed either through hedonist theories or desire theories or objective list theories (Crisp, 2008). Subjective well-being (SWB) is frequently used in social evaluations to study macroeconomic indicators of life quality and social policy. It has also proved its validity and reliability (Benjamin, Heffetz, Kimball, & Rees-Jones, 2012; Helliwell & Huang, 2014; Kroll & Delhey, 2013). Life Satisfaction (LS) has proven to be a key indicator of SWB. This applies more specifically to the cognitive component (Erdogan, Bauer, Truxillo, & Mansfield, 2012; Kroeger & Weber, 2015). In recent years, however, there has been increasing debate between economists, governments and psychologists alike, regarding the indicators and measurement of well-being, both within and between countries (Adler & Seligman, 2016; Deaton & Stone, 2013; Heffetz & Rabin, 2013).

The SDGs can provide a comprehensive, multidimensional evaluation framework for “people, planet and prosperity” (General Assembly resolution 70/1, 2015). This research study proposes the use of the SDGs as the framework against which to measure progress towards the concepts of improved welfare / happiness / social need / sustainability. Given the complexity of measuring performance against strategic objectives, Smulowitz (2015) stresses that the type of analysis for this level is trend based and should be reviewed over a period sufficiently long to allow for a trend to be observed.

Strategic performance indicators. Progress towards the strategic objectives is monitored through the strategic indicators (Smulowitz, 2015). Measures, metrics and indicators are terms that are often used interchangeably in social measuring and evaluation.

Using indicators can produce comparable and robust data. A set of related indicators is referred to as an index (Better Evaluation, 2016). Strategic indicators are heavily reliant on the operational indicators and are typically measured over shorter periods (Smulowitz, 2015).

Each of the 17 SDGs measure the consolidated performance towards a specific sustainability strategy, i.e. poverty reduction, improved education, reduced inequality, etc. This research study consequently recommends the use of the individual SDGs as the specific strategic indicators in the performance framework.

Operational performance indicators. To successfully implement strategies the organisation is required to understand and execute processes effectively and efficiently (Smulowitz, 2015). With the agreement on the 17 SDGs, there has been a call to operationalise the goals into measurable, comparable, reliable and relevant indicators. A number of organisations and researchers have in the past year proposed draft indicators for the measurement of the SDGs (Hák, Janoušková, & Moldan, 2016; Sustainable Development Solutions Network & Bertelsmann Stiftung, 2016). In March 2016, at the 47th session of the United National Statistical Commission, general agreement was reached on 230 indicators (United Nations Department of Economic and Social Affairs Statistics Division, 2016). It should be noted that not all SDGs can be measured at an individual and household level. The researcher conducted a high-level analysis of the 230 indicators, grouped per SDG and per "unit of measure".

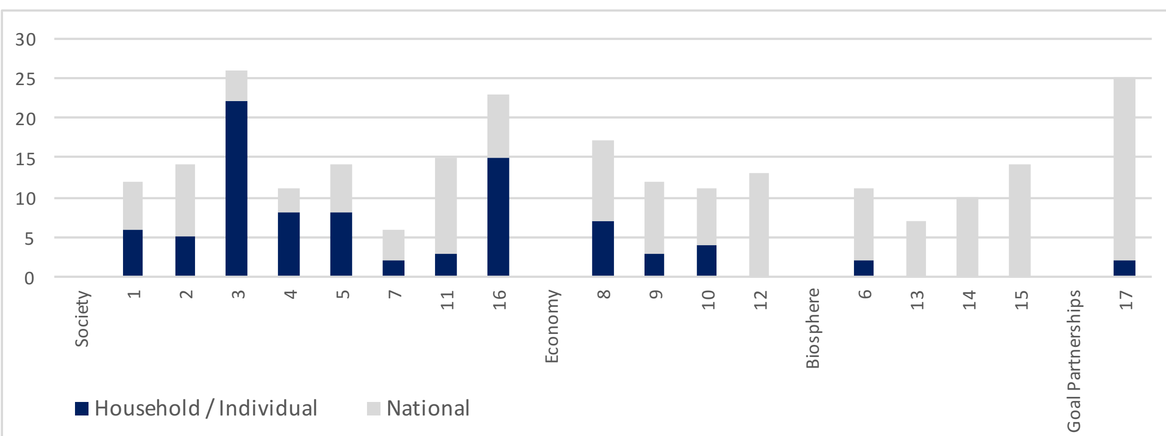

Figure 2: Breakdown of the 230 indicators per SDG and per unit of measure

Note: the x-axis captures the SDGs, while the y-axis quantifies the number of indicators

It is evident from Figure 2 that the societal and economical type SDGs can be measured at an individual and household level. With regard to the biosphere and the strategic goal orientated partnerships, these goals can only be measured at a national level. It should also be noted that not all individual and household level indicators are captured in the South African General Household Survey (GHS), the research instrument that was used in this research study. Appendix 3 summarizes the number of indicators identified per SDG and identifies the number of indicators that can be measured with the current GHS dataset.

2.4. Analysis and reporting of performance

Smulowitz (2015) recommends that reports should include the analysis of individual measures and sets of measures in order to represent inter-related performance. As previously stated, an index is a set of related indicators. Masset (2011) stated the following as the key technical properties to develop a good index: the index should be based on reliable data, reflect an accurate summary of the information and be able to represent short term and longer term effects; it should be sensitive to time and the distribution of outcomes in the population, and robust to different specifications.

Reliable data. As emphasised in chapter 1, reliable and timely statistics and indicators are key to successfully achieving the SDGs. This research study used data from the GHS. The motivation for choosing the GHS as well as an assessment of its reliability and validity was included in the methodology chapter of this study.

Accurate reflection of information over time. Numerous statistical techniques have been used in the analysis of social measurements and the construction of relevant indices. These techniques can be grouped into descriptive and model-based methods (Bartholomew, Steele, Galbraith, & Moustaki, 2008). Descriptive techniques include cluster analysis, principle component analysis (PCA) and multiple correspondence analysis (MCA) (Alkire et al., 2015). PCA and MCA are commonly used in well-being assessments and are favoured for their computational simplicity. PCA is primarily a data reduction method and is descriptive in nature. It aims to reproduce the observed variance using linear combinations (Tarakci et al., 2014; Yu, Umashankar, & Rao, 2015; Zhu, 2013; Zupic & Čater, 2015). PCA is used with variables of cardinal scale while MCA is used with variables of a categorical or binary nature (Di Ciaccio, Coli, & Ibanez, 2012; Vandemoortele, 2014; Vicari, Okada, Ragozini, & Weihs, 2014).

The methods that require model constructs are latent variable models and include latent class analysis (LCA), factor analysis (FA) and structural equation models (SEM) (Alkire et al., 2015). Factor analysis is a frequently used technique in poverty measurements (Batana, 2013; Friis-Hansen & Duveskog, 2012; Whelan, Nolan, & Maitre, 2014). It usually entails additional mathematical manipulation (rotation). Brown (2015) states that rotation does not alter the fit of the solution, but it maximises larger factor loadings closer to one and minimises smaller factor loadings closer to zero. This aspect could potentially limit the method's capability for direct analysis of the original measurements, especially between different periods and subsequently impacts how the tool could be used for assessing the long-term impacts of policy changes and social interventions.

Gerbing & Hamilton (1996) demonstrated that exploratory factor analysis (EFA) can be a good technique for model specification before confirmatory factor analysis (CFA) is used for cross-validation. However, Green, Tonidandel, & Cortina (2016) critiqued the use of EFA and CFA on the same sample, noting that it could not provide evidence of confirmation. Such an exercise on the same dataset could only indicate that the two modelling approaches converged.

Ignoring measurement error can lead to biased estimates pertaining to the paths between variables. Structural Equation Modelling (SEM) accounts for measurement error (Sardeshmukh & Vandenberg, in press). SEM also enables the integration and understanding of numerous interactions within a complicated environment. Covariance-based SEM focusses on common factor variances in comparison to partial least squares (PLS) SEM that considers unique variances. PLS SEM is considered statistically inferior to covariance-based SEM (McIntosh, Edwards, & Antonakis, 2014; Peng & Lai, 2012; Rönkkö, McIntosh, Antonakis, & Edwards, in press). SEM requires a strong theoretical foundation, as the model construct is predetermined. This aspect of SEM avoids problems of instability and rotated solutions that is prevalent in factor analysis (Walford, Tucker, & Viswanathan, 2010).

Sensitivity to time and the distribution of outcomes in the population. Masset (2011) argues that a good index should be both time sensitive (i.e. the analysis for one year only will overlook seasonal changes) and distribution sensitive (i.e. an increase in the suffering of those living in poverty should be weighted higher than a change in the living conditions of the population not living in poverty). The composite index that was developed in this research study can identify and focus on the “socially disadvantaged” in the population and measures and compares impact over time.

Robustness to the technical difficulties of data availability. Masset (2011) specifies that the index should be usable for a large number of countries, using reliable data in all instances and it should be sensitive to the underlying assumptions that were made during construction. To address these requirements, this research study will use the globally agreed United Nations indicators and use GHS data. National household surveys are commonly used in literature to compare social studies between countries (Adams Jr, 2011).

2.5. Performance Management System design

The framework design and review focusses on the review of individual measures and sets of measures (Smulowitz, 2015). The following section provides a theoretical basis for three of the 17 SDGs. The first three SDGs were chosen as illustrative examples of applying the framework design. The measurement indicators that have been approved by the United Nations are analysed for each SDG to assess which of the indicators can be measured at an individual and household level and, of those indicators, what can be measured using the data available from the GHS. SEM path diagrams are then hypothesised for SDG1, SDG2 and SDG3, as examples, to demonstrate how an SEM model can be developed for an individual SDG.

SDG 1: End poverty in all its forms everywhere. Poverty measures the contrast between resources and needs and is conceptualised in either absolute, relative or subjective terms (Dhongde & Minoiu, 2013). Historically, poverty has been measured either directly (i.e. if the individual satisfies a set of specified basic needs) or indirectly (i.e. if the individual’s income falls below the poverty line) (Alkire & Santos, 2014). Davids & Gouws (2013) investigated the theory that poverty is typically perceived to be caused by either the individuals themselves, external economic, political and/or cultural factors or unforeseen circumstances (i.e. illness). Their study found that the South African sample predominantly perceived external economic, political and/or cultural factors as the cause of poverty. However they also found strong support for individualistic perceptions.

The Progress out of Poverty Index (PPI) is an internationally adopted poverty measurement. Indicators were selected to be simple and quick to collect and verify. Indicators were also strongly correlated with poverty and were liable to change over time as the poverty status changed (IPA, 2016). The last PPI for South Africa was done in 2009, and used the 2005/2006 South African Income and Expenditure Survey to develop the scorecard (Chen, Schreiner, & Woller, 2009).

The multidimensional poverty index (MPI) is internationally comparable. It measures ten indicators related to the Millennium Development Goals (MDGs) across health, education and standard of living (Alkire & Santos, 2014; Mushongera, Zikhali, & Ngwenya, 2015). The South African Multidimensional Poverty Index (SAMPI), is calculated by Statistics South Africa. It is based on census data from 2010, and differs from the global MPI in the following ways (Statistics South Africa, 2014):

1. With regard to the health dimension, nutrition has been excluded due to the (lack of) availability of information
2. The type of flooring indicator in the global MPI was not measured in South Africa and the dwelling type was used instead
3. SAMPI includes unemployment under the economic activity dimension, which was deemed critical in the South African country context.

Appendix 2 summarises the dimensions and indicators used in the PPI, MPI and SAMPI and where applicable lists the expected SDGs linked to each of the indicators.

There were 12 indicators approved by the United Nations to measure SDG1. Six indicators can be measured at an individual and household level and can be measured from the data in the GHS. The six remaining indicators are measured at a national level only and measure the impact of extreme environmental events and economic shocks on the poor (indicators 1.5.1, 1.5.2, 1.5.3) and government spending with regards to poverty reduction programmes, policies and essential services (indicators 1.a.1, 1.a.2, 1.b.1). Table 1 summarises the key indicators that are used in the SEM for SDG1.

The hypothisised SEM path diagram for the SDG1 SEM model is illustrated in Figure 3. Unobserved latent factors or variables are illustrated as circles, while observed variables are illustrated as rectangles. The single headed arrow represents the impact of one variable on another while the double headed arrows represent co-variances between variables.

When the curved double headed arrow relates to only one unobserved factor, it represents the residual error in predicting that factor. When the curved double headed arrow relates to only one observed variable, it represents the measurement error for that variable.

Table 1: Indicators to measure SDG1

Indicator	Measurement
1.1.1	% of the group living below the international poverty line[1]. This equates to R24.24[2] per day, R732 per month[3]. GHS Variables: q42msal_hh
1.2.1	% of the group living below the three main South African poverty lines[4]. GHS Variables: q42msal_hh
1.2.2	% of people of all ages living in multidimensional poverty[5] GHS Variables: Appendix 2
1.3.1	% of the group receiving social grants or social relief from the Government. GHS Variables: soc_grant_hh
1.4.1	% of the group with access to basic services. GHS Variables: Q512Drin, Q522Toil, Q527Access, Q532Rub
1.4.2	% of total adult group with secure tenure rights to land GHS Variables: Q88cTenu

Notes*:*

[1] *The new $1.90 per person a day international poverty line was constructed by inflating 15 national poverty lines and converting them to US Dollars using 2011 purchasing power parity (PPP) (Ferreira et al., 2016).*

[2] *The 2015 PPP conversion factor (local currency unit per international US Dollar) for South Africa is 12.76 (International Monetary Fund International Financial Statistics, 2016).*

[3] *The daily poverty line is multiplied by (365/12) to get to a monthly figure.*

[4] *Statistics South Africa rebased the three national poverty lines (2011) for South Africa by applying the cost-of-basic-needs approach* (Statistics South Africa, 2015)*. Food and lower and upper bound poverty lines were also calculated at a provincial level (Appendix 1).*

[5] *The methodology for the calculation of the South African Multidimensional Poverty Index (SAMPI)will be used to measure this indicator. Refer to Appendix 2 for its composition.*

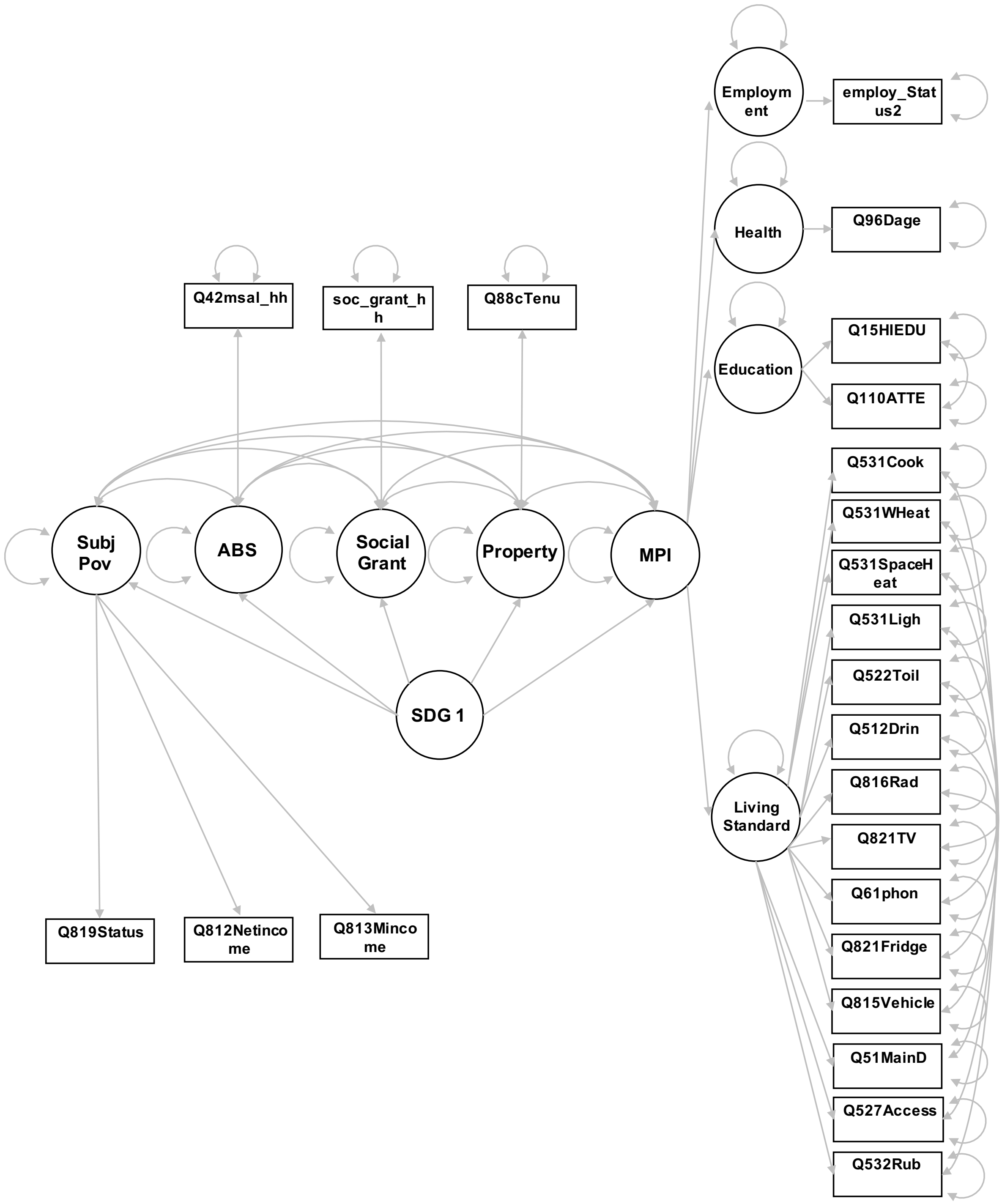

Figure 3: Hypothesized path diagram for the SDG1 SEM model

It should be noted that the observed variables in Figure 3 (and Figure 4 and Figure 5) indicate the “raw variables” as observed directly in the GHS and still require data preparation. The latent variable “ABS” addresses indicator 1.1.1 and 1.2.1 in Table 1, “Social Grant” relates to 1.3.1, “Property” relates to 1.4.2, “MPI” addresses 1.2.2 and 1.4.1 is captured in “Living Standard”. In 2014 three additional subjective indicators were added to to the GHS that are predicted to be relevant to the measurement of poverty. Q819Status is a self-reported assessment of what it means to be poor and Q812Netincome and Q813Mincome are subjective measurements of the absolute minimum net income the household requires to survive. Subsequently, a latent variable, “Subj Pov”, was added to the hypothesised SEM path diagram (Figure 3).

SDG 2: Zero Hunger. Numerous studies have proved that experiences of hunger during youth has lasting negative impacts on education, health and employment achievements (Kesternich, Siflinger, Smith, & Winter, 2015; Smith & Haddad, 2015; van den Berg, Pinger, & Schoch, 2016). Bertoni (2015) found that an event of starvation during childhood lowers the individual’s reference points concerning subjective wellbeing. He theorised that these effects could result in a bias which could mean an underestimated impact reported in the research findings.

Sustainable Development Solutions Network (SDSN) & Bertelsmann Stiftung (2016) identified six indicators to measure “Zero Hunger”. The proposed indicators aimed to address both the causes (food availability and intake, i.e. cereal yield, sustainable nitrogen management and undernourishment) as well as the consequences (i.e. stunting, wasting and obesity) associated with hunger. Various measures for agricultural sustainability have been developed and researched. Hayati, Ranjbar, & Karami (2010) recommended a number of agricultural indicators and advised that the chosen indicators should be location specific. Soriano & Garrido (2016) found that economic growth also improved undernourishment occurrences. Other elements resulting in an improvement included investment in health services, the education system and living conditions (i.e. access to portable/potable? drinking water). There were 14 indicators approved by the United Nations to measure SDG2. Five indicators can be measured at an individual and household level. However only two indicators can be measured, given the available data in the GHS. Table 2 summarises the key indicators that are used in the SEM for SDG2.

Table 2: Indicators to measure SDG2

Indicator	Measurement
2.1.2	Food uncertainty, as per the Food Insecurity Experience Scale (FIES)[1] GHS Variables: Q77Hung5, Q76Hung
2.3.2	The income of smaller farming operations GHS Variables: Q89aAgric, Q42msal_hh, Q88bHect

Note*:* [1] Skipped a meal or ate less that they thought they should because there was not they did not have sufficient money or other resources.

Based on the literature reviewed on hunger and the indicators outlined in Table 2, the SEM path diagram for the SDG2 SEM model was hypothesised (Figure 4).

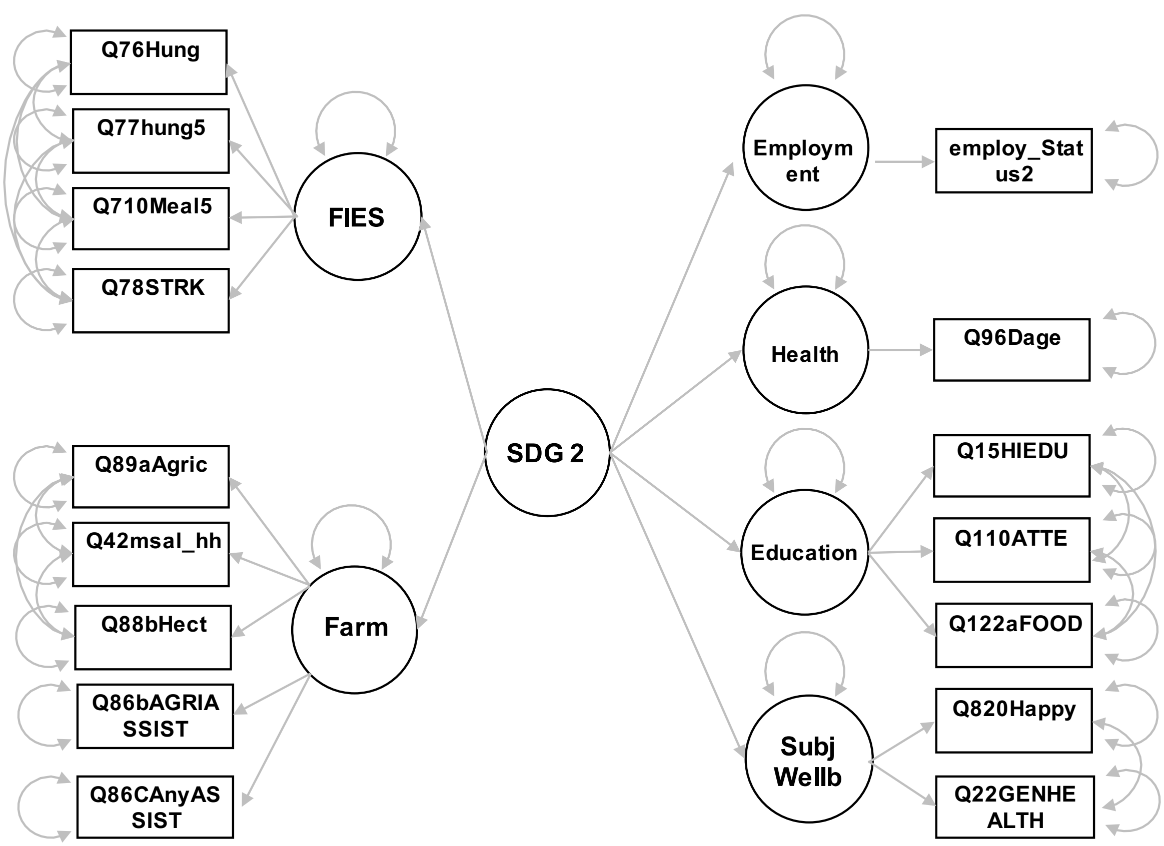

Figure 4: Hypothesised path diagram for the SDG2 SEM model

The latent variable “FIES” addresses indicator 2.1.2 in Table 2. In addition to the observed variables associated with food availability, “Q78STRK” was added to the hypothesised model. This variable measures the prevalence of young people living on the street. The prevalence of street children is considered an increasing social concern. These children experience hunger, but are also at risk of falling into a life of crime and personality disorders (Kidd & Scrimenti, 2004; Zarezadeh, 2013). As stated earlier, the exposure to hunger during childhood can have long-term negative impacts for the individual (Kesternich et al., 2015; Smith & Haddad, 2015; van den Berg et al., 2016). Governments need to put in place adequate policies and programmes to address hunger for vulnerable children (te Lintelo, Haddad, Leavy, & Lakshman, 2014).

The latent variable “Farm” addresses indicator 2.3.2 in Table 2. Two variables measuring the effectiveness of agricultural assistance (Q86bAGRIASSIST and Q86CAnyASSIST) have been included in the hypothesised model. Four of the 14 indicators approved by the United Nations to measure SDG2 related to agricultural assistance, but are positioned at a National level. Agricultural subsidy and assistance programs have increased in popularity in sub-Saharan Africa in response to fighting hunger. They also have a strong political strategy driving them (Dionne & Horowitz, 2016).

In addition to the education measures that were identified for SDG1 (Appendix 2), an additional measure, “Q122aFOOD”, has been included in Figure 4. This variable captures whether the child attends a school with a school feeding scheme or nutrition programme. There is extensive evidence in literature that school feeding schemes positively impact school enrolment and attendance. However, Kazianga, de Walque, & Alderman (2014) found that take-home meals had a larger impact on the weight-for-age ratio of their control group whereas the impact of the school feeding schemes was insignificant. The study, however, looked at the impact on the family, including young pre-school children at home, and subsequently was skewed to take-home meals as the impact would be larger for younger children. Lentz & Barrett (2013) found that the return on the feeding program was the most significant for very young children under the age of two, but that early childhood feeding programs were less well funded.

SDG 3: Good Health and Well-being. Sub-Saharan African has the highest occurrence of HIV/AIDS in the world and the importance of private and public companies in providing assistance to address the negative effects cannot be overvalued (Ntim, 2015). Tuberculosis (TB) is another major health problem worldwide. HIV/AIDS has been shown to have played an important role in the reappearance of this disease (Pinto & Carvalho, 2014).

South Africa complies with universal health care (UHC) but the country has a poorly functioning health system (van den Heever, 2016). Ssozi & Amlani (2015) examined the effectiveness of government health expenditure in Sub-Saharan Africa and found that countries with UHC systems have better health results, except for South Africa, where life expectancy is largely reduced by HIV/AIDS. Community-based health insurance can provide health cover and potentially significant health benefits. However it failed in the South African HIV/AIDS prevention project, because it did not address the social forces and hierarchies in the community (Mladovsky & Mossialos, 2008). There were 26 indicators approved by the United Nations to measure SDG3, 22 can be measured at an individual and household level but only 10 can be measured using the GHS. Table 3 reviews the key indicators for SDG3.

Table 3: Indicators to measure SDG3

Indicator	Measurement
3.2.1	Under-five mortality rate 5[1] - GHS Variables: Q96Dage
3.2.2	Neonatal mortality rate - GHS Variables: Q27bSTA
3.3.1	HIV infections - GHS Variables: Q26aHIV
3.3.2	Tuberculosis incidences - GHS Variables: Q26aTB
3.4.1	Cardiovascular disease, cancer, diabetes or chronic respiratory disease GHS Variables: Q26aASM, Q26aDBT, Q26aCAN, Q26aHEART
3.5.2	Prevalence of abuse of alcohol or drugs - GHS Variables: Q23SUB
3.6.1	Prevalence of road traffic injuries GHS Variables: Q25aMVHoccupant, Q25aMVHpedestrian
3.7.2	Teen-age birth rate (aged 10-14 years; aged 15-19 years) per women GHS Variables: Age, gender
3.8.2	Health insurance - GHS Variables: Q21MEDI, onemed_hh
3.9.3	Unintentional poisoning - GHS Variables: Q25aACCP

Note*:* [1] Also measured in SAMPI in the measurement of SDG1

Based on the literature reviewed on health and well-being and Table 3, the SEM path diagram for the SDG3 SEM model was hypothesised (Figure 5). *The* latent variable "Mortality" addresses indicators 3.2.1 and 3.2.2 in Table 3. "Illness" captures indicators 3.3.1, 3.3.2 and 3.4.1. "Sub Abuse" refers to 3.5.2 while "Accidents" refer to 3.6.1 and 3.9.3. "Reproductive" relates to 3.7.2 and "Med Access" refers to 3.8.2. "Q24cYNT" has been added to the SEM, as it captures the reason why a health practitioner was not consulted in a time of illness or injury. "Q27aPRE" indicates pregnancy status and has also been added to "Reproductive". In 2014 two additional subjective indicators were added to to the GHS that are predicted to be relevant to the measurement of health and well-being. "Q22GENHEALTH" is a self-reported subjective view of the person's health status and Q820Happy is a subjective view of the individual's happiness.

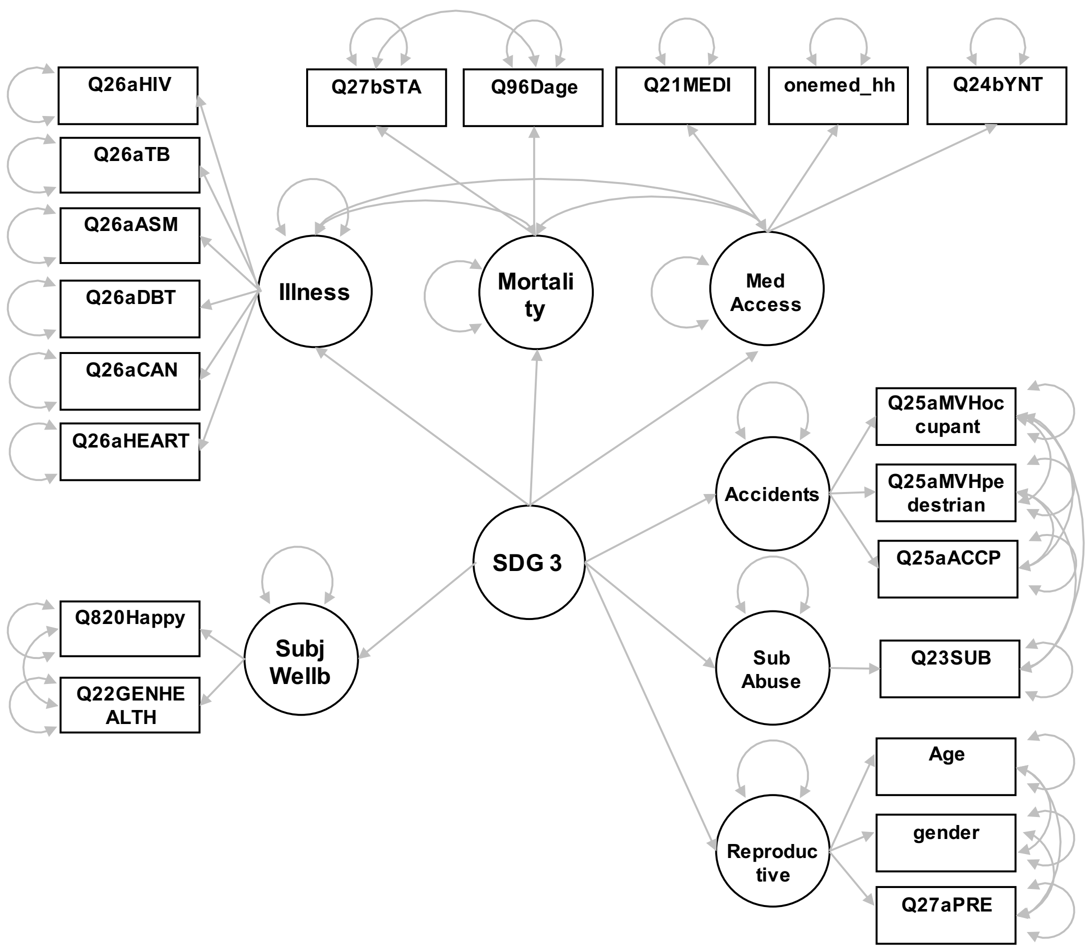

Figure 5: Hypothesised path diagram for the SDG3 SEM model

Composite Indices. Once the SEM models have been developed and validated, the next stage involves the development of a performance measurement scorecard. Composite indices are frequently developed to measure sustainable development and social welfare (Hatefi & Torabi, in press) and to compliment performance management scorecards (Suk, Chi, Mulva, Caldas, & An, 2016; Theriou, Demitriades, & Chatzoglou, 2004). Well-known composite indices include the Human Development Index (HDI), the Index of Economic Freedom (IEF) and the Environmental Performance Index (EPI) (Foster, McGillivray, & Seth, 2013). These composite indices often apply an equal weighting to indicators.

In this research study, the literature review formed the basis of the SEM. The SEM was used to establish the significant relationships between the indicators and the SDG. Once the significant indicators were established, they were weighted in order to construct the composite index. The three main approaches to weighting indicators are: data-driven, normative and a hybrid (Decancq & Lugo, 2013). SEM path coefficients or regression weights have been used as weighting parameters in indices such as the composite learning index (Saisana, 2008) and will be used for the weighting of the composite indices in this research study.

Kroeger & Weber framework. Once the composite index is developed, the index can be applied within the Kroeger & Weber (2015) framework. The framework is illustrated in Figure 6 and is centred around measuring relative, rather than absolute, effectiveness. The effectiveness signifies the extent to which the intervention reduces the treatment group's social need. Kroeger & Weber (2015) used the Domains of Life (DS) index as the basis of comparison in their framework. The DS measures the individual's self-reported perception of the difference between their aspired and achieved levels of need.

This research study tested the usage of the developed SDG composite index with the Kroeger & Weber (2015) framework and demonstrated the feasibility of this approach. Given the fact that the framework measures the impact as the relative change in the social need, it enables comparison between unrelated projects and across countries. This is possible, as the impact of the intervention would be expressed as the change in the social need of the country in which the intervention took place. It is still recommended that a control group be introduced to the framework, in order to address the counterfactual to some extent.

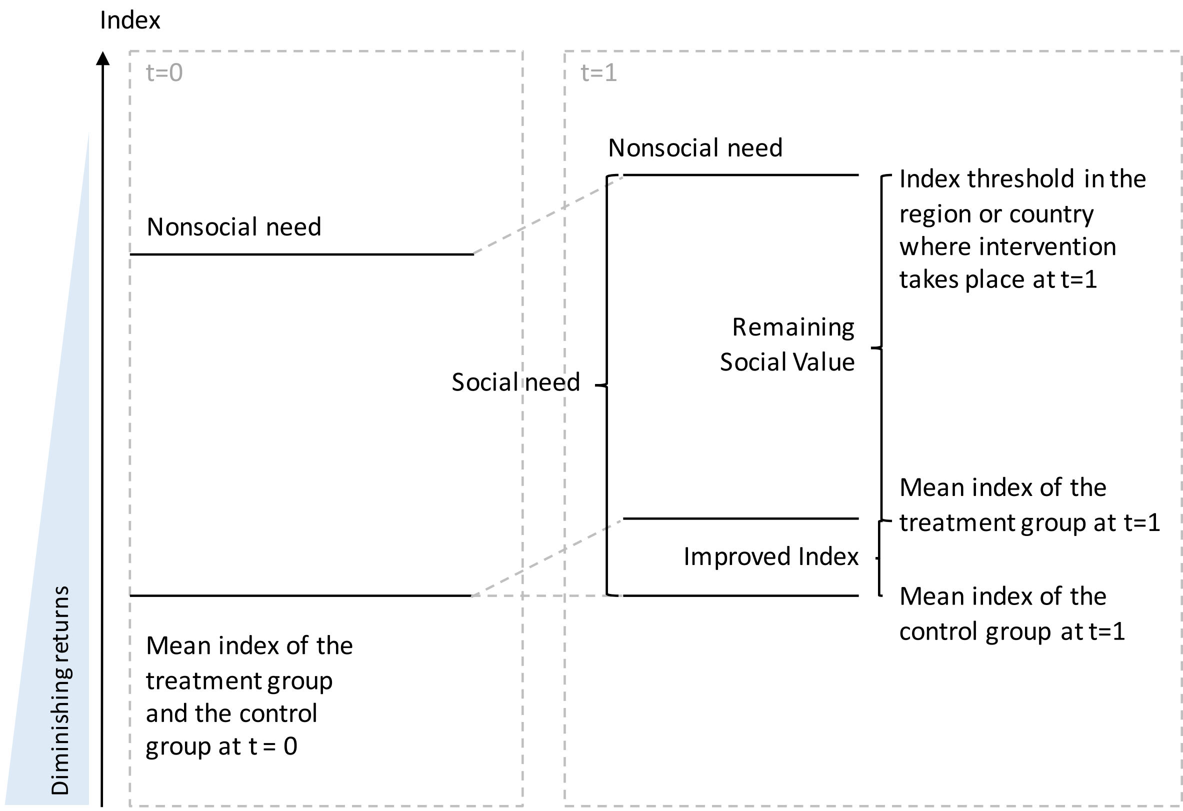

Figure 6: Kroeger & Weber social value measurement framework

2.6. Framework implementation and use

Smulowitz (2015) defines this phase as the process of data collection, collation, sorting and distribution that is centred around process “deficiencies” and “improvement opportunities”. During implementation there is a strong focus on enabling resources and infrastructure, i.e. processes, people, systems and culture. The last step of the process is the use of the framework. In this step the research brings together all the different parts of the framework. The individual components, as discussed in the literature review were consolidated into an integrated operationalisation framework, illustrated in Figure 7.

This research study proposed the use of the BSC and strategy map with the PMS. The financial focus area of the BSC is closely aligned to the strategies dimension is the performance prism. The same is true for the following: the BSC customer perspective and the prism stakeholder satisfaction dimension, the BSC process perspective and the prism process dimension, the BSC learning and growth perspective and the prism capabilities dimension. The financial perspective is concerned with long term shareholder value and within the context of this study, the focus on sustainability should be included in this perspective. If the company is driving sustainability, then the customer perspective is concerned with sustainable products and services and the alignment with stakeholders on company performance against the selected SDGs. The specific social interventions that are related to the individual indicators that measure the SDG would be reported on as part of the process perspective of the BSC and socially responsible operations. Finally, the learning and growth perspective enables the performance plan implementation.

The logic model and partnership monitoring and evaluation framework is also well aligned with this the SDG operationalisation framework illustrated in Figure 7. The PMS operational performance indicators can be seen to be aligned to the internal efficiency measurements in the partnership monitoring and evaluation framework. The same is true for the PSM strategic performance indicators and the external effectiveness measurements in the partnership monitoring and evaluation framework. The SEM model in essence applies CA, as it establishes the power of the relationship between the indicator and the SDG. The SDG operationalisation framework principles and models could easily be applied within the logic model and partnership monitoring and evaluation framework proposed by van Tulder et al. (2015) for cross-sector collaboration.

The SDG operationalisation framework (Figure 7) is a continuous cycle within the business review process and then between the business review process and the performance management process. The SEM and composite index is key to the design of the performance management system. These models establish the strength (weight) of the relationships between the indicators and the SDG and enable analysis of individual indicators through the analysis of the means (ANOM). Applied within the Kroeger & Weber (2015) framework the composite index can enable the measurement and comparison of social value created, relative to the social need. The BSC is a well-established tool that is proposed for the performance management implementation phase. It is also well aligned with the different dimensions of the performance prism. Once implemented the business review cycle measures the business performance by analysing the individual operational indicators and the sets of indicators (SDGs). This is reported, analysed and new plans are developed if required. This would require a review of the performance management system design and implementation processes. At strategic milestones, alignment with the strategic objective, sustainability, is assessed.

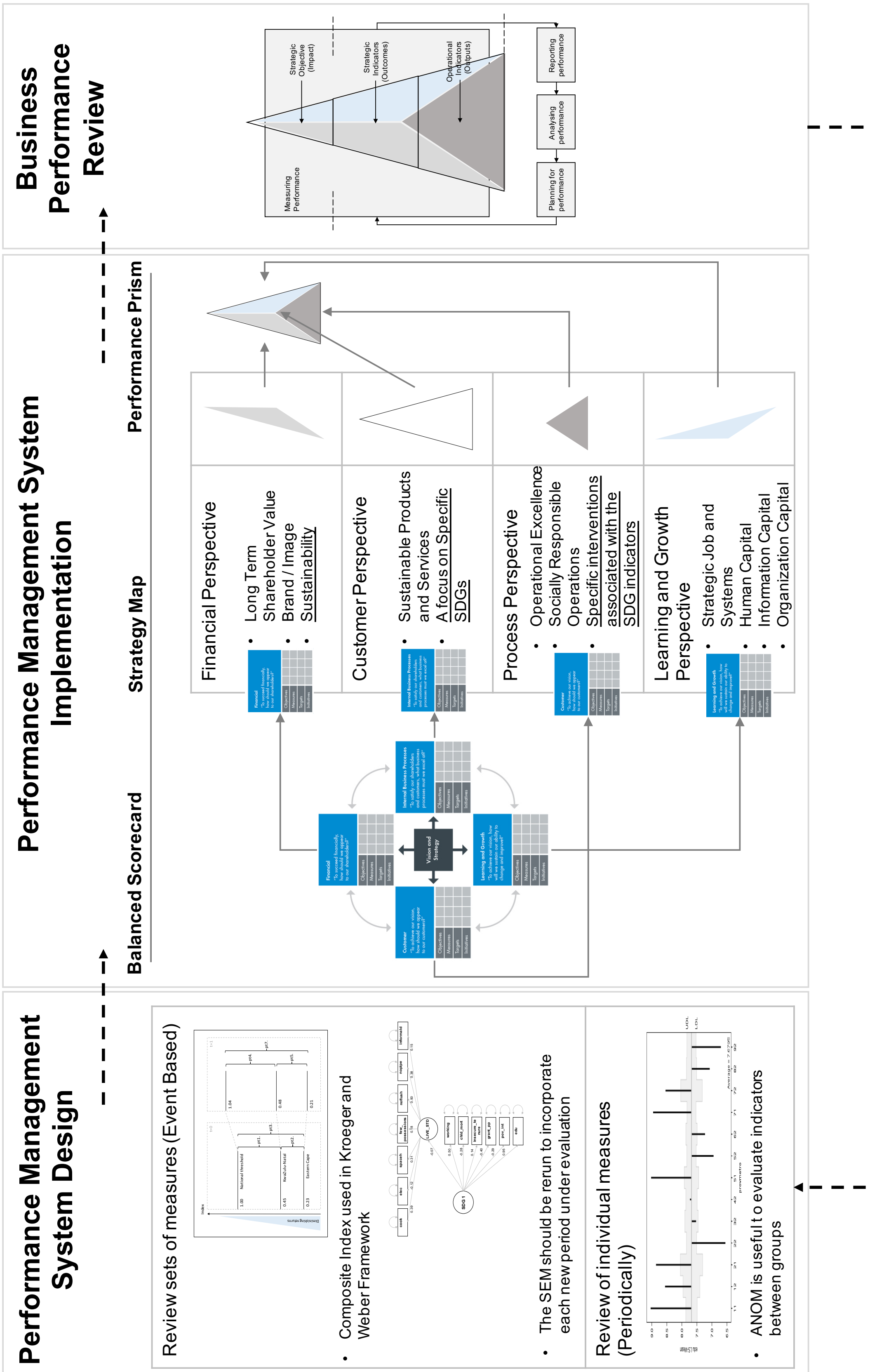

Figure 7: The SDG operationalisation framework

2.7. Conclusion

Strategy implementation aligns operational decisions and actions to the strategy and performance targets. Performance management is naturally essential to strategy implementation. The key limitations of the BSC and strategy maps are the absence of an objective weighting scheme for performance measures and an insufficient understanding of trade-offs between measures. A composite index, based on an SEM, has the potential to address this limitation by providing a measurement scorecard, weighted with the SEM path coefficients, based on the inter-relationships established in the SEM. Recent literature on CSR M&E that use the logic model and variations thereof, are closely aligned with the PMS. All of these frameworks require assumptions around the supposed links between operations and strategic level indicators. TOC and CA are often used to address this. The inter-relationships established in the SEM will be used to ascertain the contribution of the indicator to the SDG. When applying the Kroeger & Weber (2015) framework, a control group can be included in the analysis in order to address the counterfactual to some degree.

The PSM provides the primary theoretical foundation for this research study and the literature review was structured along the Smulowitz (2015) framework (Figure 1). To measure business performance, continuous planning, measuring, reporting and analysis is required. Essential to the planning stage is target setting and timelines, as these drive the development of the operational plan and the required resource allocation and also influence the structure of the performance scorecard. The United Nations has set specific goals for each of the SDGs up to 2030. All these targets will not be actively measured by each company, but once a company has committed to focus on specific SDGs, it will need to develop company specific targets aligned to the global targets.

Performance should be measured for strategic objectives (i.e. sustainable development), strategic performance indicators (i.e. selected SDGs) and operational performance indicators (i.e. the indicators that measure the selected SDDGs). The analysis and reporting should be done for individual measures and sets of measures. The SEM measures the inter-related relationship of the indicator with the SDG. The composite index can then be used for analysis and reporting. Technical guidelines for a good index have also been provided.

To measure the performance management system's performance itself, the focus is on framework design, implementation and use. Framework design focusses on the review of individual measures and sets of measures. The SEM technique was chosen because it avoids problems of instability and rotated solutions and enables the integration and understanding of numerous interactions within a complicated environment. The SEM, however, requires a strong theoretical base, as the model construct is predetermined. Therefore literature was reviewed and SEM path diagrams were then hypothesised for SDG1, SDG2 and SDG3, as examples, to demonstrate how an SEM model can be developed for an individual SDG. Appendix 3 summarises the breakdown of the 230 indicators approved by the United Nations for the SDGs. Note that the total indicates 241, as some of the indicators are used for multiple SDGs. This literature review also highlighted which indicators, of all the indicators that can be measured at an individual and household level, are currently measurable with the information contained in GHS.

Composite indices are frequently developed to measure sustainable development and social welfare and to compliment the development and use of performance management scorecards. Composite indices typically apply an equal weighting to indicators. However other normative, data-driven and hybrid weighting theories are also used. Even though the use of SEM path coefficients is less popular, due primarily to the difficulty of using them and the fact that they require recalculating for new periods, the approach solves some difficulties related to individual subjective evaluation, given that the weights are not explicitly chosen. The approach does, however, have the potential to create new sources of bias.

Once the composite index is developed, the index can be applied within the Kroeger & Weber (2015) framework. The framework measures relative rather than absolute effectiveness defined by how much the intervention reduces the treatment group's social need. The relative comparison attribute of this framework allows for measurement and comparison between unrelated interventions and across countries.

The final stage of measuring the actual performance of the performance management system's performance itself is measuring the framework implementation (i.e. process, systems, resource and infrastructure) and finally, using the framework. The proposed framework to operationalise the SDGs was consolidated and the framework is illustrated in Figure 7.

Chapter 3. Research Questions

The objective of this research study is to provide South African corporates with a framework to operationalise the new SDGs and to measure and compare the social value created within the context of CSR and the SDG targets.

This research study developed an SDG operationalisation framework during the literature review, illustrated in Figure 7, that enables corporates to incorporate CSR and their SDG strategy into their business review cycle and their performance management system design and implementation. The SDGs were positioned at a strategic indicator level and the UN approved indicators were proposed as the operational indicators. The performance management system framework design specifically focusses on the review of individual indicators and sets of indicators. The assumptions regarding the supposed links between operations and strategic level indicators are critical in the business review cycle and performance management system.

Three research problems were identified as the key challenges to the implementation of the SDG operationalisation framework.

1. The identification of social need.
2. The measurement of the social impact.
3. The comparison between social interventions.

The specific research objectives related to these research problems are as follows:

- The SDG operationalisation framework should enable corporates to identify and prioritise social interventions based on a shared definition of social need, as defined within the context of the SDGs.
- The SDG operationalisation framework should enable corporates to measure the social impact of their social intervention.
- The SDG operationalisation framework should enable corporates to compare the effectiveness of different social interventions, locally and internationally.

The following research questions were formulated to address the research problems and objectives.

Research question 1. Is it feasible to create a composite index from the GHS data, for each individual SDG, that will satisfy the technical properties of a good index, as specified by Masset (2011)? The main proposal of this research study was that the definition of social value should be linked to the SDGs. To demonstrate the feasibility of developing a composite index for each SDG, SEM models were hypothesised for the first three SDGs that address poverty, hunger and health and wellbeing.

Research question 2. Will the SDG composite indices enable the company to identify social need and prioritise social interventions?

Research question 3. Can the SDG composite indices be used to measure the impact of the social intervention?

Research question 4. How will the SDG indices enable the comparison of the social impact between social interventions, related or unrelated, nationally?

Research question 5. How will the SDG composite indices enable the comparison of the social impact between social interventions internationally?

Chapter 4. Research Methodology

The purpose of this chapter is to detail the proposed research strategy and methodology. The chapter concludes with the limitations and assumptions of the research.

4.1. Introduction

Research is seldom absolute. The research analysis can be subject to the researcher's own biases (Bryman & Bell, 2015) and the theoretical lenses that are used (Saunders, Lewis, & Lewis, 2012). Methodological fit is achieved through internal consistency between each of the research components i.e. the research question, the state of prior theory and research, the research design and the theoretical contribution (Edmondson & Mcmanus, 2007).

4.2. Research design

The research design offers the framework for data gathering and analysis (Bryman & Bell, 2015). The research objective drives the research philosophy, strategy and data collection choices (Saunders et al., 2012). As discussed earlier, the objective of this research study is to operationalise the SDGs and this will require a framework to define, measure and compare achievement against these goals. From the literature review it is evident that a mature body of prior research exists on sustainability monitoring and evaluation frameworks as well as on the specific sustainability indicators. The methodological fit framework developed by Edmondson & Mcmanus (2007) recommended that, with mature research, a descriptive, quantitative data analysis should be conducted and it should link existing constructs through focused research objectives and hypothesis testing.

A positivist research philosophy applies an explanatory study approach that is underpinned by cause and effect (Saunders et al., 2012). This philosophy and approach was used to hypothesise the relationship between the operations/efficiency indicators and the strategic/effectiveness goals during the construction of the SDG SEM models. An inductive approach develops the theory from the research observations and findings (Bryman, 2015). This approach was then applied to analyse each composite index and to leverage the index to identify, measure and compare social need.

The methodological approach to each of the research questions is discussed below and involved six steps, summarised in Table 4.

Research question 1. **Is it feasible to create an composite index from the GHS data, for each individual SDG, that will satisfy the technical properties of a good index, as specified by Masset (2011).** To demonstrate the feasibility of developing a composite index for each SDG, SEM models are hypothesised and validated for the first three SDGs that address poverty, hunger and health and wellbeing. An SDG Composite Index is then constructed for SDG1, from the SDG1 SEM model.

Research question 2. **Will the SDG Composite Indices enable the company to identify social need and prioritise social intervention**s? The question with regard to prioritising interventions is answered by evaluating the path coefficients in the SEM. The path coefficients measure the power of the relationship between the observed variable and the latent factor [citation]. This allows for the identification of the variables that would have the greatest effect on the latent factor SDG. The identified variable can then be anlaysed across geographies, gender, etc. in order to identify and prioritise focus areas for the social intervention. The social need is identified by using the Kroeger & Weber (2015) framework. The national threshold for the specific SDG is determined for the period. The geographical or social grouping that falls below the national threshold is determined to be “disadvantaged”. The difference between the “disadvantaged” group index and the national threshold is determined as the social need.

Research question 3. **Can the SDG Composite Indices be used to measure the impact of the social intervention?** Once the national threshold for the SDG has been established, the index level, relative to the national threshold, should be determined for the treatment group and the control group for the same period. The change in the treatment group’s index level in the next period should then be evaluated against the change in the national threshold and the control group’s index level for the next period. By comparing the changes in the national threshold, the treatment group and the control group, the impact of the intervention can be measured and the counterfactual is also incorporated to some degree. Kroeger & Weber (2015) define a control group as a group of individuals with similar attributes to the treatment group, but who did not receive the social intervention. It was not possible to introduce a control group into the analysis in this research study, since the analysis was done at a provincial level and did not focus on a specific intervention. To conceptualise the principle, two provinces were compared to the national threshold.

Research question 4. How will the SDG Composite Indices enable the comparison of the social impact between social interventions, related or unrelated, nationally? Based on the Kroeger & Weber (2015) framework the impact of the intervention can be measured in relative terms as a percentage of the social need. By expressing the value created as the degree of improvement on the social need, the impact, expressed as a percentage improvement, can then be compared across interventions. Kroeger & Weber (2015) proposed that for significantly different interventions, the percentage impact be weighted with the number of individuals affected by the intervention.

Research question 5. How will the SDG composite indices enable the comparison of the social impact between social interventions, internationally? Comparison internationally requires that an SDG Composite Index be developed for each country under evaluation. Once the SDG Composite Indices have been established the same approach followed in response to question 4 can be taken to compare social value created between countries, if it is expressed as a percentage.

Table 4: SDG component index methodology

Step	Description
1. Data preparation	Data preparation included merging datasets, preparing the data structures for categorical and ordinal variables and lastly transforming certain SEM variables to better measure the latent constructs, based on literature.
2. SEM model development	The SEM was developed and tested for validity and reliability. The SEM results were analysed and certain changes to the hypothesised path diagrams from chapter 2 had to be made in order to improve the fit of the model.
3. Indicator change	T-tests were conducted to estimate the change in the means of the relevant indicators between 2014 and 2015.
4. Indicator weights	The SEM was then used to estimate the weights to be attached to the indicators.

Step	Description
5. Component index development and change	The index change was calculated as the weighted average of the indicator scores. This was done by multiplying the standardised indicator change by the regression-derived weights.
6. Kroeger & Weber (2015) framework	The Kroeger & Weber (2015) framework was then used to demonstrate the measurement of a social intervention and the comparability between interventions.

4.3. Research instrument

The research instrument used in this study will be secondary data obtained from the South African GHS. The survey is conducted by Statistics South Africa annually and the data is publicly available (Statistics South Africa, 2016). The GHS was chosen as the appropriate data source for a number of reasons.

National household surveys are commonly used in literature to compare social studies between countries (Adams Jr, 2011). The purpose of the South African GHS is to determine the progress of development in South Africa (Statistics South Africa, 2016), which makes the survey the ideal instrument to use to measure progress against the SDGs. The GHS also contains the majority of the areas covered by the SDGs and is measured annually, which enables more frequent monitoring and evaluation. The GHS is also publicly available at no cost. As stated earlier, one of the criteria identified for developing the operationalisation framework in this research study is that the solution should enable better quality cost-effective monitoring and evaluation.

Universe / population. The GHS's population includes all household members of households in the all provinces of South Africa, and residents in workers' hostels (Statistics South Africa, 2016). The GHS does not cover collective living quarters.

Sampling technique. The GHS sample used a stratified three-stage design (Statistics South Africa, 2016). Stage one used probability relative to size sampling of primary sampling units. Stage two entailed the sampling of the dwelling units using systematic sampling. After allocating the sample to the provinces, the sample was then stratified by geography and population attributes in stage three.

Sampling frame. The GHS uses the South African Master Sample Frame (Statistics South Africa, 2016). The frame was developed in 2013 by Statistics South Africa and is based on the 2011 Census. The Master Sample was established to be used for all Statistics South Africa household-related surveys.

Sampling size. The 2015 GHS included 21,601 households, 74,449 individuals. The 2014 GHS included 25,364 households, 92,459 individuals. The power of an SEM model fit index increases with sample size and for large samples this can mean that even a small discrepancy can be found to be statistically significant (Fan, Thompson, & Wang, 1999). However, large sample sizes are typically preferred for SEMs as covariances are less stable with small samples (Ullman & Bentler, 2003).

Unit of analysis. The unit of analysis is households and individuals. The survey is designed to be representative at a provincial level; within each province it is designed to be representative on metropolitan and non-metropolitan levels, and within each metro, to be representative within urban, traditional and farming geography types.

GHS validity and reliability. Procedures should first, accurately measure what they intend to analyse to be valid, and second, produce consistent findings in order to ensure reliability (Saunders et al., 2012). One of the technical properties of a good index, as specified by Masset (2011), is that it should be based on a reliable data. Statistics South Africa conduct a number of verification activities on their survey data in order to validate the outputs. Measures of sampling errors for key variables and non-sampling errors are calculated and checks for consistency are conducted against other national data sources (Statistics South Africa, 2010).

4.4. Data analysis

Statistical Analysis Software (SAS) Studio was used to do the data preparation and analysis and the SEM model development. SAS is currently the second largest business analytics software vendor in the world, with Oracle being the largest (Vesset, Gopal, Schubmehl, Bond, & Olofson, 2016). SAS Studio is a developmental web application of SAS that can be used free of charge (SAS Institute Inc., 2016).

Data preparation: merged datasets. Before the SEM could be constructed, data preparation was required. The primary source of data is the South African 2015 GHS, a survey of private households and workers' hostels. The survey has two parts: an individual survey and a household survey. The two parts were merged, so that each observation contained the responses to questions to individuals within a household and also the responses to household questions for the individual's household, so that two members of the same household would have different individual responses but identical household responses. The three SEM models that were developed used a subset of the survey questions. Many variables were categorical in nature or partly categorical. A partly categorical variable is one which has ordinal values, except for extreme values which indicate inapplicability. Usually such cases were treated as categorical variables, so as to avoid empty fields (missing values). In general, a categorical (or partly categorical) variable with n values is converted into n-1 binary dummy variables. The SEM procedures treat binary variables as if they were continuously varying between 0 and 1 and generally, binary dummy variables were used to indicate these categories. If it was possible to take answers as ordinal or continuous, this was done. There were exceptions. In some cases, where it was feasible, partly categorical variables were converted to ordinal variables by assuming that a "not applicable" or "don't know" code could be converted to an ordinal value. Other exceptions were made if there was a clear way to convert categories to ordinal variables.

The data preparation detail for the SEM variables for the three SDG SEM models will be discussed in the following section to illustrate the data preparation principles.

SDG1 SEM variable: edu (measured as number of years of education). Q15HIEDU measures the highest level of education obtained by the individual. Parts of the variable measurement scale were ordinal in nature ranging from GradeR/0 to Grade12/Standard10/Form5/Matric. Thereafter, however, the researcher had to attribute new scores based on the estimated years of education associated with the other levels of education (i.e. N4/NTC4, Bachelor's, Diploma). If the variable was unspecified or the individual indicated "do not know" the variable was treated the same as "no schooling".

SDG1 SEM variable: working. employ_Status2 measures the individual's employment status. According to SAMPI the indicator of relevance should measure all adults (aged 15 to 64) in the household that are unemployed. Consequently, the new variable "working" was developed as follows. If the employ_Status2 indicated employed and the individual was between the ages 15 and 64, the value for *working* was set to 1. Otherwise the variable value was set to 0.

SDG1 SEM variable: pov_int. Q42Msal_hh measures the total monthly income for the household and it includes overtime, allowances, bonuses and any deductions before tax. In order to measure point 1.1.1 in Table 1, the income per person was first determined by dividing the household income by the household size (hholdsz). From the frequency table it was evident that households that earned R800,000 per month (2 individuals out of 74447) indicated an outlier. These households were subsequently deleted. The new variable "inc_pp" was then evaluated against the international poverty line. If "inc_pp" is <= R732, then the new variable "pov_int" value was set to 1. Otherwise the value was set to 0.

SDG1 SEM variable: informald. Q51MainD measures the type of main dwelling. Traditional dwelling/hut, informal dwelling/shack in backyard, informal dwelling/shack on farm, caravan/tent and "other" were all taken to indicate that the household lived in an informal dwelling. The new variable "informald" was in these instances set to 1. Otherwise the value was set to 0.

SDG1 SEM variable: few_possessions. *This variable is based on the methodology outlined in SAMPI (Appendix 2). The following condition was applied to create the new "few_possessions" variable. If the household owned less than two of Q816Rad, Q821TV, Q61Phon or Q821Fridge and no vehicle (Q815Vehicle) then the new variable "few possessions" was set to 1. Otherwise the value was set to 0. For each of the individual variables, "unspecified" was taken as equivalent to "no".*

SDG1 SEM variable: grant_pp. soc_grant_hh measures the number of members of the household who were recipients of social grants. The new variable "grant_pp" is equal to the soc_grant_hh divided by the household size.

SDG1 SEM variable: elec. Q527Access measures access to electricity. This is a yes (1) /no (2) variable, however in some instances "do not know" was selected. For the new variable "elec", "do not know" was treated as a "no" and the value was set to 0.

SDG1 SEM variable: cook. Q531Cook measures the type of energy used for cooking. If the household used anything other than electricity, solar and gas, the new variable "cook", was set to 1, otherwise the value was set to 0. This was based on the methodology outlined in SAMPI (Appendix 2).

SDG1 SEM variable: spaceh. Similar to Q531Cook, Q531SpaceHeat measures the type of energy used for heating living spaces. Using the SAMPI guideline, if the household used anything other than electricity, solar and gas, the new variable "spaceh", was set to 1. Otherwise the value was set to 0.

SDG1 SEM variable: noflush. Q522Toil measures the type of toilet facility in the household. Based on SAMPI, if the household used a flush toilet the new variable "noflush" was set to 0. Otherwise the value was set to 1.

SDG1 SEM variable: nopipe. Q512Drin measures the main source of drinking water. If the source of water was not piped, the new variable "nopipe" was set to 1. Otherwise the value was set to 0.

SDG1 SEM variable: insecure_tenure. Q88cTenu measures the tenure status of land. If the status was indicated as "state land", "other" and "do not know", the new variable "insecure_tenure" was set to 1. Otherwise the value was set to 0. "Owns the land", "rents the land", "sharecropping" and "tribal authority" were taken to indicate secure tenure.

SDG1 SEM variable: chld_mort. Q96Dage measures the age of the deceased. In order to determine the prevalence of child mortality, the new variable *chld_mort* was calculated as follows. If the age of the deceased was ≤ five years, then "chld_mort" was equal to 1 divided by the household size. Otherwise the value was set to 0. The reason for dividing by the household size was to eliminate duplication due to the fact that Q96Dage is a household measure. Thus all members in the household would have the same information pertaining to number of deaths and the age of the deceased next to their name.

SDG2 SEM variable: happy. Q820Happy measures the subjective happiness of the subject compared to ten years previously. Answers left blank or unspecified were deemed to be 2 ("the same"), so that responses could be ordered: 1 ("happier"), 2 ("the same"), 3 ("less happy").

SDG2 SEM variable: health. Derived from Q22GENHEALTH (subjective health), which ranged from 1 ("Excellent") to 5 ("Poor"). Responses of 6 ("Unsure") or 9 ("Unspecified") were taken to be 3 ("Good").

SDG2 SEM variable: *skipmeal*. Derived from Q710Meal5. If meals were skipped or decreased in size due to lack of food in the previous 5 days, then *skipmeal* was set to 1/hholdsz (dividing by household size because this answer would be the same for all members of the same household).

SDG2 SEM variable: hungry. Derived from Q76Hung, Q77hung5. If any household member went hungry in the past 12 months, this was set to 1/hholdsz.

SDG2 SEM variable: *streetkid*. Derived from Q78STRK. If a child left the household in the past 12 months, with unknown whereabouts, or living on the streets, this variable is 1; answers of "not applicable" or "do not know" were taken as "no".

SDG2 SEM variable: landsize. Derived from Q88bHect, the size of land used to produce crops. The variable is ordinal, except for answers of 8, 88 or 99 ("Do not know", "not applicable" or "unspecified") which were taken to be 1 ("Less than 500 m^2").

SDG2 SEM variable: *agrihelp*. Derived from Q86bAGRIASSIST, which measures the usefulness of any agriculture-related assistance the household received. Answers of 3, 8 or 9 ("Not useful", "not applicable" or "unspecified") were given an *agrihelp* value of 0. Answers of 2 ("Somewhat useful") were given an *agrihelp* value of 1, and answers of 1 ("Very useful") were given an *agrihelp* value of 2.

SDG2 SEM variable: *anyhelp*. Derived from Q86CAnyASSIST, which determined whether a household was receiving any other form of assistance; if so, *anyhelp* is 1, otherwise *anyhelp* is 0.

SDG3 SEM variables: asthma, diabetes, cancer, heart_disease, hiv, tb. Derived from Q26aASM, Q26aDBT, Q26aCAN, Q26aHEART, Q26aHIV, Q26aTB. If the subject had ever been diagnosed with asthma, diabetes, cancer, heart attack, HIV or tuberculosis, the value of the corresponding variable is 1, otherwise it is 0. Answers of "Unspecified" were taken to be "no".

SDG3 SEM variables: preg_problem. Derived from Q27bSTA, an ordinal variable. Subjects not pregnant (including males) were deemed to have no pregnancy problems (0), as were subjects currently pregnant or who successfully gave birth. Subjects whose pregnancies ended were assigned numbers from 1 to 3 (1= "stillbirth", 2= "spontaneous abortion/miscarriage" and 3= "termination of pregnancy/abortion by choice").

SDG3 SEM variables: medaid. Derived from Q21MEDI. For a subject covered by medical aid, *medaid* is 1, otherwise it is zero (including answers of "Do nt know" and "unspecified").

SDG3 SEM variables: preg. Derived from Q27aPRE. If any member of the household was pregnant in the past 12 months, preg was assigned the value 1/hholdsz, otherwise it was 0. Any answer other than "yes" was taken to be "no".

Data assumptions. Socio-economic measurement variables are rarely distributed normally. Standard normality tests such as Shapiro–Wilk, Kolmogorov-Smirnov, Cramer-von Mises and Anderson-Darling (Yap & Sim, 2011) all show that the values of the variables were not normally distributed; the exact results were omitted. However, the results from the skewness and kurtosis values in chapter 5, descriptive statistics, bear this out. For the binary variables, this comes as no surprise. According to Reinartz, Haenlein, & Henseler (2009), the standard errors generated with maximum-likelihood (ML) based, covariance based (CB) SEMs and non-normally distributed indicators will tend to be inflated. Hancock & Mueller (2013) suggest that if the data is severely non-normal, S-B scaling or bootstrapping should be used. There is no conclusive settlement on the sample size requirements for path analysis with the SAS SEM procedure, PROC CALIS, however this analysis is based on covariance structures, which is based on large sample theory (O'Rourke & Hatcher, 2013). O'Rourke & Hatcher (2013) recommend 100 as the minimal sample size for path analysis. The GHS sample is sufficiently large for path analysis.

4.5. SAS SEM model construct

The maximum likelihood estimation in the SAS PROC CALIS procedure was used for the structural equation models. The models used the PATH modeling language. Fixed path coefficients with initial values were only specified for the latent factors in the model and were set equal to 1. This was done to fix the scales of the latent factors. All other parameters were free parameters without initial values. The SAS PROC CALIS generated the initial values automatically. The SAS PROC CALIS application was also used to generate the optimising starting points in the model. The application used a combination of three initial estimation methods; the instrumental variables method, the McDonald method and the two-stage least squares method (SAS Institute Inc., 2013). It also used the Levenberg-Marquardt optimization method. Before analysing the outputs that were generated, it was important that the condition of model convergence was satisfied. Poor initial values can result in convergence problems (SAS Institute Inc., 2013).

Model validity. To establish SEM model validity five indicators are often used; the chi-square, the goodness-of-fit index (GFI), the root mean error of approximation (RMEA), the root mean square residual (RMR) and the comparative fit index (Ningaye, Alexi, & Virginie, 2013). Fit indices are typically grouped as either absolute or covariance matrix reproduction indices (i.e. GFI, adjusted GFI), incremental or comparative model fit indices (i.e. Bentler and Bonnet’s normed fit index and nonormed fit index and Bollen’s incremental fit index) or parsimony weighted indices (Fan et al., 1999). If the model fit is not acceptable, adjustments can be made, while always maintaining theoretical validity, until the model is accepted.

Bentler (1990) evaluated the cut-off criteria for various model fit indexes using the maximum likelihood method. Bentler (1990) concluded that only after these criteria had been met could the researcher conclude a good fit between the hypothesised model and the observed data. Table 5 summarises the key model fit indexes and their cut-off criteria as tested by Bentler (1990).

SAS PROC CALIS can also perform a detailed residual analysis. This analysis is useful as large residuals might indicate the model construct is misspecified. SAS recommends evaluating the “raw residuals” but to focus on the standardised residuals (SAS Institute Inc., 2013). With regard to the approximate critical value for the observed *t* values, researchers typically use the value of 2. The number is based on the two-sided asymptotically normal critical point ∂ = 0.5 which is 1.96, and thus 2 is frequently used to support the presence of the parameter in the model (SAS Institute Inc., 2013).

Table 5: Model fit index cut-off criteria

Abbreviation	Index name	Cut-off criteria Bentler (1990)
SRMR	Standardised root mean squared residual	<0.08
TLI	*Tucker-Lewis index*	>0.95
BL89	*Bollen's (1989) fit index*	>0.95
RNI	*Relative noncentrality index*	>0.95
CFI	*Comparative fit index*	>0.95
Gamma Hat		>0.95
Mc	*McDonald's centrality index*	>0.9
RMSEA	*Root mean squared error of approximation*	<0.06

Model reliability. Yang & Green (2010) found that researchers are more likely to achieve reliable and stable SEM estimates by satisfying the following requirements. The model should use a large sample, with well-constructed scales and a good model fit. Well-constructed scales translate to higher factor loadings and a larger number of items per factor.

Model solution. Once the model is accepted as valid and reliable, relationships between factors can be analysed. When variables are measured on different scales, comparison of path coefficients cannot be made directly. In this instance the standardised solution provides a better comparison (SAS Institute Inc., 2013). SAS PROC CALIS computes the standardised estimates with standard error estimates and values so that statistical inferences can be developed on the standardised estimates. Error variances in the standardised solution of SAS PROC CALIS are also rescaled to keep the mathematical consistency of the model (SAS Institute Inc., 2013).

4.6. Component index construct

Voth-Gaeddert & Oerther (2014) note that it is feasible to develop a composite index from a set of measures for one year and to fix it for use in later years. This allows change in the composite index to be accurately measured over time.

An SEM for SDG1 was constructed using data derived from the GHS datasets from 2014 and 2015, and the standardised path coefficients recorded. These coefficients were assumed to be fixed, and were used as regression coefficients: any change in the indicator variables will affect the value of the latent SDG variable, by way of the path coefficients. An indicator that was connected to the SDG variable via two paths was given a coefficient equal to the product of the coefficients of the two paths. The actual value of the latent SDG variable was unknown; however, using standardised variables, it was possible to estimate an increase or decrease in the SDG variable, measured in standard deviations.

To compare the index for two groups (say samples taken from two provinces), it was necessary to measure the difference in their respective indicator variables, which was done using two-sample t-tests. Means which were not significantly different from each other were deemed not to have changed; otherwise the change was taken as the change in mean. This change was then standardised by dividing it by the standard deviation of that indicator for the entire population. The standardised significant change in each indicator variable was then multiplied by the appropriate path coefficient (or the composite coefficient if necessary), which gave the change (in standard deviations) of the SDG variable that would occur if that indicator had been the only one that changed. These changes were added over all indicator variables, to give a first estimate of the total change to that SDG variable.

This estimate did not take into account the fact that the indicators may co-vary. To refine this estimate, the squared multiple correlation values were examined, and the indicator with the largest one (i.e. the one that gave the largest *variance inflation factor* or VIF) was multiplied by $1\text{-}R^2$ (or divided by the VIF) to remove the variance explained by the other indicator variables.

In order to position the national threshold relative to the target groups, graphically, in the Kroeger & Weber (2015) framework, the national threshold for the first period, t=0, was set to 1. Subsequently, changes to the national index and the target group indices were analysed relative to this value.

4.7. Kroeger & Weber (2015) framework implementation

The principles as outlined in Figure 6 will be applied, using the composite index for SDG1 and evaluating non-metropolitan Kwazulu-Natal with non-metropolitan Eastern Cape with the National composite index for SDG1.

4.8. Research Assumptions

A key assumption was that the 230 indicators that had been identified by the UN for the measure of the SGDs were empirically and theoretically sound. So it was therefore assumed that the indicators identified for the three SDGs SEM models in this research study are theoretically sound.

4.9. Research limitations

The following research limitations are acknowledged:

While the GHS is widely used in poverty analysis and other social studies, there are a number of limitations. The data is not always consistent or collected in all waves. Some variables, such as the subjective variables, have only been included since 2014. The SEM constructed in this research study was thus forced to focus on the 2014 and 2015 datasets only, as these datasets contained a similar list of variables, but this two-year period is not necessarily sufficient to observe a significant trend.

The SEM models were only constructed for the first three SDGs to illustrate the feasibility of this modelling approach. The SDG composite index was only then developed for SDG1 to demonstrate the application of the Kroeger & Weber (2015) approach. The SDG models for the remaining SDGs have not been included in this research study.

The variables that were used to construct the SDG index were limited to the variables collected by Statistics South Africa in the GHS. As evident from the literature review, key individual and household variables were omitted from the GHS and the available variables constituted an imprecise index of the concepts of interest.

Composite index weights that are based on statistical approaches can change over different periods, which complicates comparability over time. Furthermore, this method involves some level of implicit subjective weighting as the SEM model structure is pre-determined. Even though the model structure was based on literature, it could still contain some selection bias.

4.10. Conclusion

The purpose of this chapter was to detail the proposed research strategy and methodology and highlight the key limitations and assumptions of the research. The methodological approach to address the five research questions was outlined and involved six steps; data preparation, SEM model development, indicator changes, indicator weights, component index development and the Kroeger & Weber (2015) framework application.

The SEM validity and reliability tests and the composite index and Kroeger & Weber (2015) framework application results are presented in chapter 5.

Chapter 5. Results

This chapter will present the results from three SEM models and the results from the application of the composite index and the Kroeger & Weber (2015) framework.

5.1. Overview of the research sample / descriptive statistics

Descriptive statistical analyses were completed on the sample groups to gain better insight into the population. Measures of distribution (standard deviations, ranges) were calculated. The descriptive statistics are contained in Table 6, Table 7, Table 8, Table 9, Table 10 and Table 11.

Of specific interest is the skewness and kurtosis for each of the variables. Hancock & Mueller (2013) note that multivariate kurtosis greater than 3 could lead to inaccurate results.

Table 6: Descriptive statistics SDG1, year = 2014

Variable	*Mean*	*Std Dev*	*Minimum*	*Maximum*	*Skewness*	*Kurtosis*
working	0.26638	0.44207	0	1	1.05695	-0.88288
chld_mort	0.00065	0.01334	0	1	30.9274	1342.19
edu	7.67950	5.11450	0	18	-0.30207	-1.28146
cook	0.19975	0.39981	0	1	1.50199	0.25598
spaceh	0.67133	0.46973	0	1	-0.72951	-1.46784
noflush	0.44381	0.49684	0	1	0.22622	-1.94887
nopipe	0.29819	0.45747	0	1	0.88230	-1.22157
few_possessions	0.17564	0.38052	0	1	1.70487	0.90661
informald	0.16897	0.37473	0	1	1.76678	1.12152
pov_int	0.58721	0.49234	0	1	-0.35429	-1.87452
grant_pp	0.34224	0.29304	0	1	0.28933	-0.96095
insecure_tenure	0.78260	0.41248	0	1	-1.37028	-0.12234
elec	0.93527	0.24605	0	1	-3.53809	10.5183

Table 7: Descriptive statistics SDG1, year = 2015

Variable	*Mean*	*Std Dev*	*Minimum*	*Maximum*	*Skewness*	*Kurtosis*
working	0.28431	0.45109	0	1	0.95632	-1.08549
chld_mort	0.00053	0.01190	0	1	35.7851	1953.09
edu	7.88361	5.09493	0	18	-0.34872	-1.23299
cook	0.19417	0.39556	0	1	1.54633	0.39115
spaceh	0.64916	0.47724	0	1	-0.62510	-1.60929
noflush	0.43383	0.49561	0	1	0.26706	-1.92874
nopipe	0.31060	0.46274	0	1	0.81862	-1.32989
few_possessions	0.18799	0.39070	0	1	1.59723	0.55116
informald	0.20082	0.40061	0	1	1.49367	0.23105
pov_int	0.63115	0.48250	0	1	-0.54362	-1.70452
grant_pp	0.34015	0.29485	0	1	0.28299	-0.99839
insecure_tenure	0.81094	0.39156	0	1	-1.58827	0.52260
elec	0.92630	0.26129	0	1	-3.26309	8.64801

Table 8: Descriptive statistics SDG2, year = 2014

Variable	*Mean*	*Std Dev*	*Minimum*	*Maximum*	*Skewness*	*Kurtosis*
working	0.26644	0.44210	0	1	1.05660	-0.88361
edu	7.67890	5.12189	0	18	-0.30063	-1.28342
food	0.23360	0.42312	0	1	1.25927	-0.41426
happy	2.06546	0.77804	1	3	-0.11401	-1.34051
health	2.27755	1.08708	1	5	0.35527	-0.68463
skipmeal	0.02033	0.08825	0	1	6.82035	60.1380
hungry	1.10905	0.86086	0.09583	10	2.81576	12.3086
streetkid	0.00758	0.08674	0	1	11.3537	126.910
agrihelp	0.07361	0.36698	0	2	4.91516	22.5316
anyhelp	0.00692	0.08291	0	1	11.8945	139.482
inc_pp	2012.32	4780.90	0	256000	10.6145	315.930

Table 9: Descriptive statistics SDG2, year = 2015

Variable	*Mean*	*Std Dev*	*Minimum*	*Maximum*	*Skewness*	*Kurtosis*
working	0.28489	0.45136	0	1	0.95319	-1.09145
edu	7.89171	5.09734	0	18	-0.35112	-1.23240
food	0.22896	0.42016	0	1	1.29023	-0.33533
happy	2.05857	0.79384	1	3	-0.10466	-1.40632
health	2.29117	1.05779	1	5	0.29140	-0.66086
skipmeal	0.02070	0.09048	0	1	6.88476	60.5243
hungry	1.11932	0.84996	0.11111	10	2.65679	10.5150
streetkid	0.00819	0.09015	0	1	10.9113	117.061
agrihelp	0.05893	0.32700	0	2	5.55528	29.4689
anyhelp	0.00433	0.06563	0	1	15.1068	226.222
inc_pp	1843.49	4964.31	0	333333	11.5145	382.364

Table 10: Descriptive statistics SDG3, year = 2014

Variable	*Mean*	*Std Dev*	*Minimum*	*Maximum*	*Skewness*	*Kurtosis*
asthma	0.02176	0.14590	0	1	6.55572	40.9783
diabetes	0.03230	0.17678	0	1	5.29136	25.9990
cancer	0.00387	0.06210	0	1	15.9774	253.283
heart_disease	0.00756	0.08662	0	1	11.3704	127.288
hiv	0.02388	0.15268	0	1	6.23701	36.9011
tb	0.00764	0.08705	0	1	11.3125	125.976
chld_mort	0.00067	0.01341	0	1	30.2196	1290.37
preg_problem	0.00246	0.08244	0	4	34.6334	1230.20
medaid	0.15331	0.36029	0	1	1.92455	1.70391

Table 11: Descriptive statistics SDG3, year = 2015

Variable	Mean	Std Dev	Minimum	Maximum	Skewness	Kurtosis
asthma	0.02214	0.14713	0	1	6.49613	40.2008
diabetes	0.03053	0.17204	0	1	5.45769	27.7871
cancer	0.00407	0.06367	0	1	15.5795	240.727
heart_disease	0.00767	0.08724	0	1	11.2870	125.400
hiv	0.02813	0.16534	0	1	5.70822	30.5846
tb	0.00789	0.08845	0	1	11.1285	121.846
chld_mort	0.00054	0.01197	0	1	34.8878	1860.52
preg_problem	0.00234	0.07942	0	4	35.7883	1342.64
medaid	0.15032	0.35739	0	1	1.95695	1.82969

5.2. SEM model outputs

The following section summarises the model output for each of the three SDG SEM models.

SDG1 SEM. The 13 manifest variables were all endogenous. One endogenous latent factor was hypothesised (i.e. LIVE_STD) and SGD1 was exogenous in the model. Random samples of 50,000 from 2014 and 50,000 from 2015 were consolidated and analysed. In the final model 99,992 records were used. Table 12 summarises the descriptive statistics for the manifest variables in the SDG1 SEM model for the combined 2014-2015 sample.

The initial objective function value for the SDG1 SEM model was 7.74763 and the model convergence condition was satisfied. There were no active constraints in the model. Table 13 summarises the SDG1 SEM model fit statistics. Most notably, the *p*-value of the chi-square was <0.0001, the SRMR was 0.0165 and the goodness of fit index (i.e. Gamma Hat) was 0.9951. The RMSEA estimate was 0.0382 and the Mc was 0.9841. The Bentler comparative fit index (i.e. CFI) was 0.9841, the Bentler-Bonett non-normed index (i.e. TLI) was 0.9630 and the Bollen non-normed index (i.e. BL89) index was 0.9896.

Analysis of the 10 largest asymptotically standardised residuals highlighted the covariances where the model performed the least satisfactorily. This analysis was useful for identifying model misspecification and steered the researcher in refining the model structure.

Table 12: SDG1 SEM descriptive statistics

Simple Statistics		
Variable	*Mean*	*Std Dev*
working	0.27634	0.44719
chld_mort	0.00058	0.01230
edu	7.78247	5.10337
cook	0.19670	0.39750
spaceh	0.66044	0.47356
noflush	0.43707	0.49603
nopipe	0.30373	0.45987
few_possessions	0.18043	0.38455
informald	0.18441	0.38782
pov_int	0.60972	0.48782
grant_pp	0.34126	0.29420
insecure_tenure	0.79741	0.40193
elec	0.93043	0.25441

Figure 8 illustrates the distribution of the asymptotically standardised residuals. The residual distribution looks quite symmetrical. There is however a large departure from the normal distribution, as demonstrated by the differences between the kernel and the normal distribution curves.

Analysis of the *t* values of the estimated results found that in most cases the estimates shown were significantly different from zero, supporting the presence of these parameters in the model. Table 14 summarises the parameters that did not meet this condition, using the non-standardised results. Using the standardised results for covariance among errors, *chld_mort* - LIVE_STD was the only parameter that remained insignificant.

The standardised results for the SDG1 SEM PATH list are summarised in Table 15. All the SEM paths were found to be significant. The path coefficients indicate the strength of the relationship between the two variables.

Table 13: SDG1 SEM model fit summary

	Fit Summary	
Absolute Index	Fit Function	0.0323
	Chi-Square	3227.2224
	Chi-Square DF	22
	Pr > Chi-Square	<.0001
	Z-Test of Wilson & Hilferty	42.6257
	Hoelter Critical N	1052
	Root Mean Square Residual (RMR)	0.0166
	Standardized RMR (SRMR)	0.0165
	Goodness of Fit Index (GFI)	0.9951
Parsimony Index	Adjusted GFI (AGFI)	0.9798
	Parsimonious GFI	0.2807
	RMSEA Estimate	0.0382
	RMSEA Lower 90% Confidence Limit	0.0371
	RMSEA Upper 90% Confidence Limit	0.0393
	Probability of Close Fit	1.0000
	ECVI Estimate	0.0337
	ECVI Lower 90% Confidence Limit	0.0318
	ECVI Upper 90% Confidence Limit	0.0356
	Akaike Information Criterion	3365.2224
	Bozdogan CAIC	4090.6087
	Schwarz Bayesian Criterion	4021.6087
	McDonald Centrality	0.9841
Incremental Index	Bentler Comparative Fit Index	0.9896
	Bentler-Bonett NFI	0.9895
	Bentler-Bonett Non-normed Index	0.9630
	Bollen Normed Index Rho1	0.9627
	Bollen Non-normed Index Delta2	0.9896
	James et al. Parsimonious NFI	0.2791

Note*: The relative noncentrality index (RNI) is not included in the SAS PROC CALIS model output and will not be measured.*

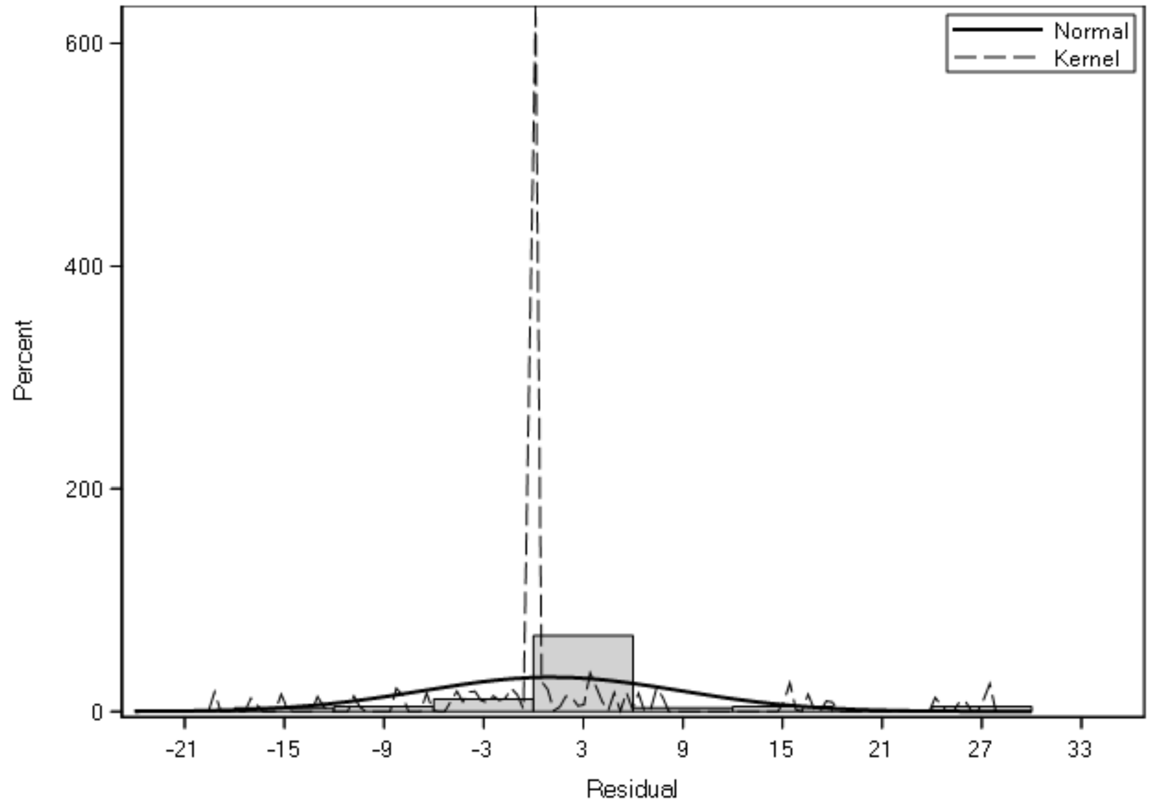

Figure 8: Asymptotically standardised residuals for SDG1 SEM

Table 14: Summary of parameters with non-significant t values for SDG1 SEM

Covariances Among Errors

Error of	Error of	Parameter	Estimate	Standard Error	t Value	Pr > |t|
chld_mort	*LIVE_STD*	_Parm26	-1.5841E-6	0.00007	-0.0231	0.9816
insecure_tenure	*chld_mort*	_Parm29	0.00016	.	.	.
pov_int	*edu*	_Parm30	0.07733	.	.	.
edu	*LIVE_STD*	_Parm31	-1.92924	.	.	.
working	*edu*	_Parm32	-0.09368	.	.	.
grant_pp	*edu*	_Parm33	0.06099	.	.	.
insecure_tenure	*edu*	_Parm34	-0.03245	.	.	.
chld_mort	*edu*	_Parm35	0.01623	.	.	.
nopipe	*spaceh*	_Parm56	0.03535	.	.	.

Table 15: Standardised results for the PATH list for the SDG1 SEM

Standardised Results for PATH List

Path			Parameter	Estimate	Standard Error	t Value	Pr > |t|
LIVE_STD	===>	cook	_Parm01	0.39054	0.00542	72.1078	<.0001
LIVE_STD	===>	elec	_Parm02	-0.11855	0.00340	-34.8739	<.0001
LIVE_STD	===>	few_possessions	_Parm03	0.17591	0.00371	47.4731	<.0001
LIVE_STD	===>	informald	_Parm04	0.14816	0.00355	41.7809	<.0001
LIVE_STD	===>	noflush	_Parm05	0.50305	0.00649	77.5546	<.0001
LIVE_STD	===>	nopipe	_Parm06	0.37637	0.00520	72.3427	<.0001
LIVE_STD	===>	spaceh	_Parm07	0.30556	0.00460	66.4566	<.0001
SDG01	===>	pov_int	_Parm08	-0.28917	0.01210	-23.9039	<.0001
SDG01	===>	LIVE_STD	_Parm09	-0.07532	0.00859	-8.7657	<.0001
SDG01	===>	working	_Parm10	0.49728	0.02048	24.2847	<.0001
SDG01	===>	grant_pp	_Parm11	-0.40167	0.01655	-24.2642	<.0001
SDG01	===>	insecure_tenure	_Parm12	0.14106	0.00580	24.3092	<.0001
SDG01	===>	chld_mort	_Parm13	-0.28316	0.01199	-23.6257	<.0001
SDG01	===>	edu	_Parm14	0.94580	0.03874	24.4168	<.0001

SDG2 SEM. The 11 manifest variables were all endogenous. Three endogenous latent factors were hypothesised (i.e. EDUCATION, FIES, SUB_WELL) and SGD2 was exogenous in the model. A random sample of 50,000 from 2014 and 50,000 from 2015 were consolidated and analysed. 99,990 records were used in the final model. Table 16 summarises the descriptive statistics for the manifest variables in the SDG2 SEM model.

The initial objective function value for the SDG2 SEM model was 0.76673 and the model convergence condition was satisfied. It should however be noted that the Moore-Penrose inverse was used in computing the covariance matrix for the parameter estimates. The standard errors and *t* values might not be accurate with the use of the Moore-Penrose inverse. There were no active constraints in the model.

Table 16: SDG2 SEM Descriptive Statistics

Simple Statistics		
Variable	*Mean*	*Std Dev*
working	0.27562	0.44683
edu	7.78437	5.11207
food	0.23151	0.42180
happy	2.05898	0.78577
health	2.28373	1.07376
skipmeal	0.02060	0.08976
hungry	1.11512	0.85923
streetkid	0.00794	0.08876
agrihelp	0.06536	0.34565
anyhelp	0.00574	0.07555
inc_pp	1925	4846

Table 17 summarises the SDG2 SEM model fit statistics. Most notably, the *p*-value of the chi-square was <0.0001, the SRMR was 0.0100 and the goodness of fit index (i.e. Gamma Hat) was 0.9987. The RMSEA estimate was 0.0255 the Mc was 0.9964. The Bentler comparative fit index (i.e. CFI) was 0.9915, the Bentler-Bonett non-normed index (i.e. TLI) was 0.9573 and the Bollen non-normed index (i.e. BL89) index was 0.9915.

Analysis of the 10 largest asymptotically standardised residuals highlighted the covariances where the model performed the least satisfactorily. This analysis was useful for identifying model misspecification and steered the researcher in refining the model structure.

Figure 9 illustrates the distribution of the asymptotically standardised residuals. The residual distribution looks quite symmetrical. It shows a small to medium departure from the normal distribution, as demonstrated by the differences between the kernel and the normal distribution curves.

Table 17: SDG2 SEM model fit summary

Fit Summary		
Absolute Index	Fit Function	0.0072
	Chi-Square	724.4994
	Chi-Square DF	11
	Pr > Chi-Square	<.0001
	Z-Test of Wilson & Hilferty	21.5196
	Hoelter Critical N	2716
	Root Mean Square Residual (RMR)	43.8936
	Standardized RMR (SRMR)	0.0100
	Goodness of Fit Index (GFI)	0.9987
Parsimony Index	Adjusted GFI (AGFI)	0.9921
	Parsimonious GFI	0.1997
	RMSEA Estimate	0.0255
	RMSEA Lower 90% Confidence Limit	0.0239
	RMSEA Upper 90% Confidence Limit	0.0271
	Probability of Close Fit	1.0000
	ECVI Estimate	0.0083
	ECVI Lower 90% Confidence Limit	0.0075
	ECVI Upper 90% Confidence Limit	0.0093
	Akaike Information Criterion	834.4994
	Bozdogan CAIC	1412.7048
	Schwarz Bayesian Criterion	1357.7048
	McDonald Centrality	0.9964
Incremental Index	Bentler Comparative Fit Index	0.9915
	Bentler-Bonett NFI	0.9913
	Bentler-Bonett Non-normed Index	0.9573
	Bollen Normed Index Rho1	0.9567
	Bollen Non-normed Index Delta2	0.9915
	James et al. Parsimonious NFI	0.1983

Note*: The relative noncentrality index (RNI) is not included in the SAS PROC CALIS model output and will not be measured.*

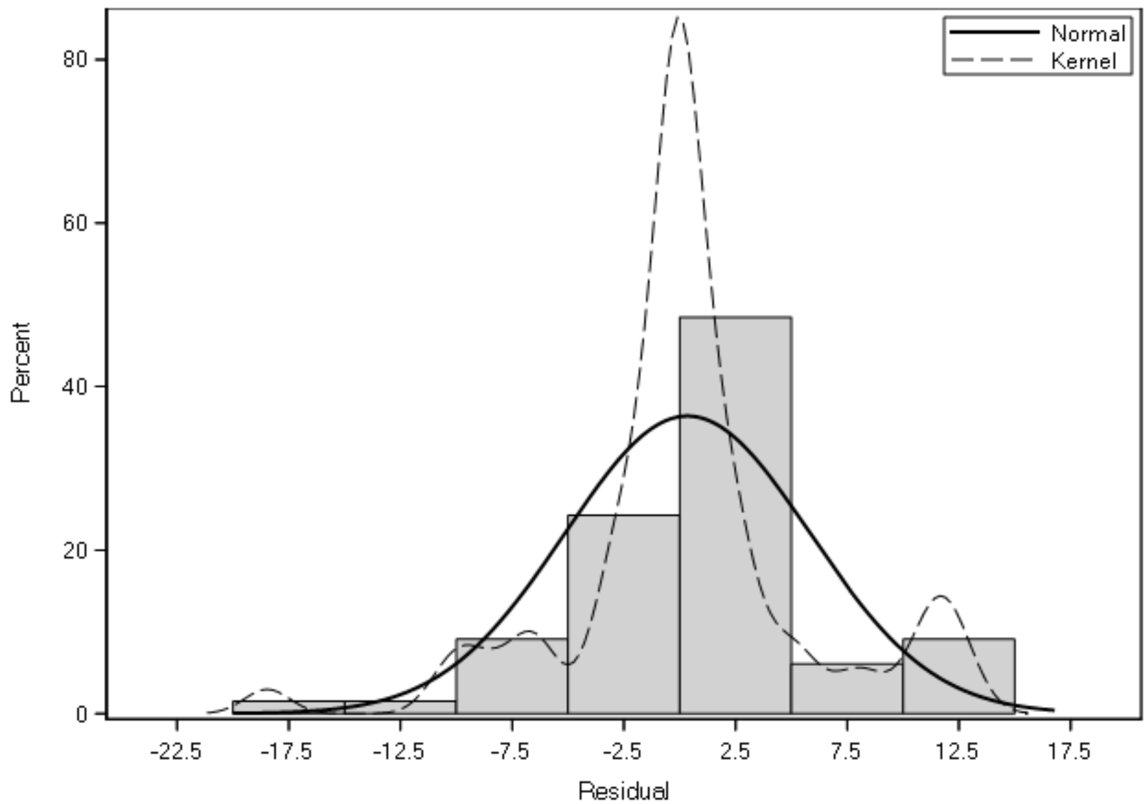

Figure 9: Asymptotically standardised residuals for SDG2 SEM

Analysis of the *t* values of the estimated results found that in most cases the estimates shown were significantly different from zero, supporting the presence of these parameters in the model. Table 18 summarises the parameters that did not meet this condition, using the non-standardised results. Using the standardised results for covariance among errors, these parameters remained insignificant.

The standardised results for the SDG2 SEM PATH list are summarised in Table 19. All the SEM paths were found to be significant.

Table 18: Summary of parameters with non-significant t values for SDG2 SEM

Covariances Among Errors

Error of	Error of	Parameter	Estimate	Standard Error	t Value	Pr > |t|
food	*happy*	_Parm19	-0.00333	0.00110	-3.0207	0.0025
edu	*happy*	_Parm20	-0.01399	0.01125	-1.2437	0.2136
FIES	*EDUCATION*	_Parm24	0.00392	0.01930	0.2029	0.8392
agrihelp	*EDUCATION*	_Parm35	0.01755	0.00714	2.4577	0.0140
working	*agrihelp*	_Parm37	0.00271	0.00072	3.7558	0.0002
anyhelp	*EDUCATION*	_Parm40	-0.00177	0.00149	-1.1814	0.2374
working	*anyhelp*	_Parm42	-0.00006	0.00015	-0.3605	0.7185

Table 19: Standardised results for the PATH list for the SDG2 SEM

Standardised Results for PATH List

Path			Parameter	Estimate	Standard Error	t Value	Pr > |t|
FIES	===>	*hungry*	_Parm01	0.96665	0.00202	479.2	<.0001
FIES	===>	*skipmeal*	_Parm02	0.65774	0.01902	34.5814	<.0001
FIES	===>	*streetkid*	_Parm03	0.13764	0.01946	7.0722	<.0001
EDUCATION	===>	*food*	_Parm04	-0.44562	0.00421	-105.8	<.0001
EDUCATION	===>	*edu*	_Parm05	0.58162	0.00282	206.1	<.0001
SUB_WELL	===>	*happy*	_Parm06	0.86579	0.00855	101.2	<.0001
SUB_WELL	===>	*health*	_Parm07	0.41501	0.01145	36.2297	<.0001
SDG02	===>	*FIES*	_Parm08	0.13516	0.00620	21.8032	<.0001
SDG02	===>	*EDUCATION*	_Parm09	-0.93852	0.00408	-230.2	<.0001
SDG02	===>	*SUB_WELL*	_Parm10	0.22422	0.00583	38.4764	<.0001
SDG02	===>	*working*	_Parm11	-0.63441	0.00692	-91.6417	<.0001
SDG02	===>	*inc_pp*	_Parm12	-0.47740	0.00362	-132.0	<.0001
SDG02	===>	*agrihelp*	_Parm13	0.14088	0.00665	21.1855	<.0001
SDG02	===>	*anyhelp*	_Parm14	0.04892	0.00663	7.3837	<.0001

SDG3 SEM. The 10 manifest variables were all endogenous. Two endogenous latent factors were hypothesised (i.e. CARDIO_D, MORTALITY) and SGD3 was exogenous in the model. A random sample of 50,000 from 2014 and 50,000 from 2015 were consolidated and analysed. In the final model 99,990 records were used. Table 20 summarises the descriptive statistics for the manifest variables in the SDG3 SEM model.

Table 20: SDG3 SEM Descriptive Statistics

Simple Statistics		
Variable	*Mean*	*Std Dev*
asthma	0.02233	0.14776
diabetes	0.03093	0.17314
cancer	0.00402	0.06328
heart_disease	0.00787	0.08837
hiv	0.02616	0.15962
tb	0.00785	0.08826
chld_mort	0.00061	0.01268
preg_problem	0.00237	0.07903
medaid	0.15126	0.35830
preg	0.00558	0.04113

The initial objective function value for the SDG3 SEM model was 4.80306 and the model convergence condition was satisfied. It should, however, be noted that the Moore-Penrose inverse was used in computing the covariance matrix for the parameter estimates. The standard errors and t values might not be accurate with the use of the Moore-Penrose inverse. There were no active constraints in the model.

Table 21 summarises the SDG3 SEM model fit statistics. Most notably, the *p*-value of the chi-square was <0.0001, the SRMR was 0.0086 and the goodness of fit index (i.e. Gamma Hat) was 0.9991. The RMSEA estimate was 0.0157 and the Mc was 0.9978. The Bentler comparative fit index (i.e. CFI) was 0.9784, the Bentler-Bonett non-normed index (i.e. TLI) was 0.9460 and the Bollen non-normed index (i.e. BL89) index was 0.9784.

Table 21: SDG3 SEM model fit summary

Fit Summary		
Absolute Index	Fit Function	0.0046
	Chi-Square	464.1293
	Chi-Square DF	18
	Pr > Chi-Square	<.0001
	Z-Test of Wilson & Hilferty	17.6999
	Hoelter Critical N	6220
	Root Mean Square Residual (RMR)	0.0002
	Standardized RMR (SRMR)	0.0086
	Goodness of Fit Index (GFI)	0.9991
Parsimony Index	Adjusted GFI (AGFI)	0.9972
	Parsimonious GFI	0.3996
	RMSEA Estimate	0.0157
	RMSEA Lower 90% Confidence Limit	0.0145
	RMSEA Upper 90% Confidence Limit	0.0170
	Probability of Close Fit	1.0000
	ECVI Estimate	0.0054
	ECVI Lower 90% Confidence Limit	0.0047
	ECVI Upper 90% Confidence Limit	0.0061
	Akaike Information Criterion	538.1293
	Bozdogan CAIC	927.1038
	Schwarz Bayesian Criterion	890.1038
	McDonald Centrality	0.9978
Incremental Index	Bentler Comparative Fit Index	0.9784
	Bentler-Bonett NFI	0.9776
	Bentler-Bonett Non-normed Index	0.9460
	Bollen Normed Index Rho1	0.9440
	Bollen Non-normed Index Delta2	0.9784
	James et al. Parsimonious NFI	0.3910

Note*: The relative noncentrality index (RNI) is not included in the SAS PROC CALIS model output and will not be measured.*

Analysis of the 10 largest asymptotically standardised residuals highlighted the covariances where the model performed the worst/least satisfactorily. This analysis was useful for identifying model misspecification and steered the researcher in refining the model structure. Figure 10 illustrates the distribution of the asymptotically standardised residuals. The residual distribution looks quite symmetrical. It shows a small to medium departure from the normal distribution, as demonstrated by the differences between the kernel and the normal distribution curves.

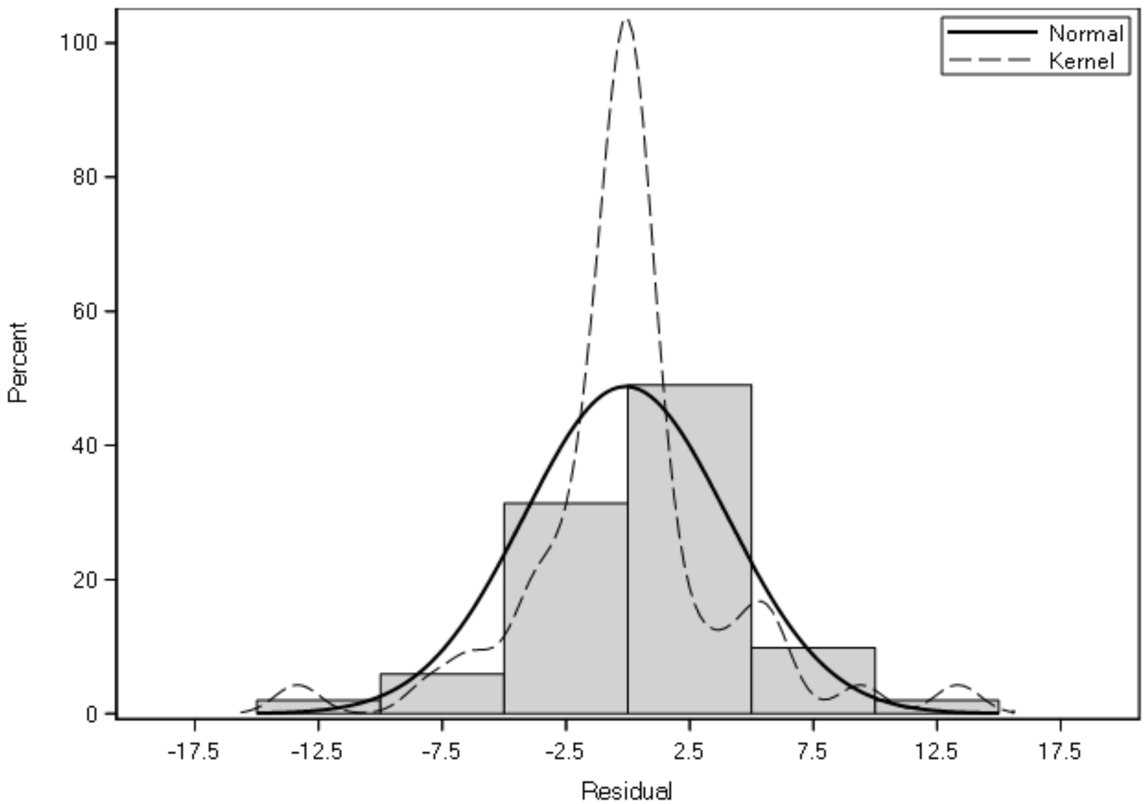

Figure 10: Asymptotically standardised residuals for SDG3 SEM

Analysis of the *t* values of the estimated results found that in most cases the estimates shown were significantly different from zero, supporting the presence of these parameters in the model. Table 22 summarises the parameters that did not meet this condition, using the non-standardised results. Using the standardised results for covariance among errors, these parameters remained insignificant. The standardised results for the SDG1 SEM PATH list are summarised in Table 23. All the SEM paths were significant.

Table 22: Summary of parameters with non-significant t values for SDG3 SEM

Covariances Among Errors						
Error of	Error of	Parameter	Estimate	Standard Error	t Value	Pr > |t|
MORTALITY	*CARDIO_D*	_Parm13	0.01188	0.01123	1.0583	0.2899
preg	*CARDIO_D*	_Parm24	-0.00061	0.00023	-2.7054	0.0068
hiv	*preg*	_Parm26	0.00007	0.00002	3.5279	0.0004

Table 23: Standardised results for the PATH list for the SDG3 SEM

Standardised Results for PATH List							
Path			Parameter	Estimate	Standard Error	t Value	Pr > |t|
CARDIO_D	===>	*asthma*	_Parm01	0.23401	0.00520	45.0096	<.0001
CARDIO_D	===>	*cancer*	_Parm02	0.41294	0.00583	70.8814	<.0001
CARDIO_D	===>	*diabetes*	_Parm03	0.29531	0.00530	55.6812	<.0001
CARDIO_D	===>	*heart_disease*	_Parm04	0.35618	0.00551	64.6033	<.0001
MORTALITY	===>	*preg_problem*	_Parm05	0.48136	0.02024	23.7870	<.0001
MORTALITY	===>	*chld_mort*	_Parm06	0.08564	0.00476	18.0026	<.0001
SDG03	===>	*CARDIO_D*	_Parm07	0.02862	0.00088	32.5909	<.0001
SDG03	===>	*medaid*	_Parm08	0.96032	0.00142	674.5	<.0001
SDG03	===>	*hiv*	_Parm09	0.13155	0.00060	219.2	<.0001
SDG03	===>	*tb*	_Parm10	0.59532	0.00138	431.7	<.0001
SDG03	===>	*preg*	_Parm11	0.06395	0.00151	42.4400	<.0001
SDG03	===>	*MORTALITY*	_Parm12	-0.06417	0.00078	-82.0112	<.0001

5.3. Composite index construct: SDG1

The standardised path coefficients for each indicator variable are displayed in Table 24, along with a supplementary "multiplier" column (for indicators that follow a composite path to SDG1). Also present are columns for the 2014-2015 national standard deviation of each variable. Next, the differences in means of four subsamples were found using two-sample t-tests.

The subsamples in question included respondents from:

- Non-metropolitan KwaZulu-Natal in 2014
- Non-metropolitan KwaZulu-Natal in 2015
- Non-metropolitan Eastern Cape in 2014
- Non-metropolitan Eastern Cape in 2015.

The differences in means were computed between different years for the groups. These are summarised in Table 25. It is extremely unlikely that the difference in means would ever be exactly zero; a zero here indicates that no significant ($p<0.05$) difference was found between 2014 and 2015.

Table 24: Building blocks for the composite index

Variable	σ	Coefficient	Multiplier
edu	5.107	0.950	1.000
cook	0.398	0.390	-0.075
elec	0.253	-0.119	-0.075
few_possessions	0.385	0.176	-0.075
informald	0.387	0.148	-0.075
noflush	0.496	0.500	-0.075
nopipe	0.460	0.376	-0.075
spaceh	0.473	0.305	-0.075
pov_int	0.488	-0.290	1.000
working	0.446	0.500	1.000
grant_pp	0.294	-0.400	1.000
insecure_tenure	0.404	0.140	1.000
chld_mort	0.013	-0.280	1.000

The differences in means (Table 25) were then divided by the corresponding standard deviation and multiplied by the SEM path coefficient and SEM second-factor multiplier in Table 24. The products for each of the indicators were finally added to give a first estimate of the change in the latent variable SDG1.

Table 25: Differences in means between 2014 and 2015

	Difference between years 2014 to 2015		
Variable	SA	EC	KZN
edu	0.20410	0.00000	0.00000
cook	-0.00558	0.04410	0.00000
elec	-0.00897	0.00000	0.00000
few_possessions	0.01230	0.05000	0.00000
informald	0.03180	0.03670	0.00000
noflush	-0.00998	0.06360	0.00000
nopipe	0.01240	0.02940	0.00000
spaceh	-0.02220	0.01440	-0.01280
pov_int	0.04390	0.02050	0.00000
working	0.01790	0.00000	0.01470
grant_pp	0.00000	0.01220	0.00000
insecure_tenure	0.02830	0.00000	0.03190
chld_mort	0.00000	-0.00086	0.00000

However, this result had not yet taken into account multiple correlations. From Table 26 it is clear that the only indicator variable with a large variance inflation factor (VIF) is *edu* (R^2=0.8020), so the contribution of *edu* is multiplied by 1-R^2. In this case, it makes no difference, as the said contribution was zero.

Table 26: SDG1 SEM Squared Multiple Correlations

Squared Multiple Correlations			
Variable	*Error Variance*	*Total Variance*	*R-Square*
chld_mort	0.0001391	0.0001513	0.0802
cook	0.13391	0.15801	0.1525
edu	2.74649	26.04434	0.8945
elec	0.06382	0.06473	0.0141
few_possessions	0.14330	0.14788	0.0309
grant_pp	0.07259	0.08655	0.1613
informald	0.14711	0.15041	0.0220

Squared Multiple Correlations			
Variable	*Error Variance*	*Total Variance*	*R-Square*
insecure_tenure	0.15833	0.16155	0.0199
noflush	0.18378	0.24604	0.2531
nopipe	0.18152	0.21148	0.1417
pov_int	0.21807	0.23796	0.0836
spaceh	0.20332	0.22426	0.0934
working	0.15053	0.19998	0.2473
LIVE_STD	1.00000	1.00571	0.00567

Table 27: Differences in SDG1 between 2014 and 2015

Change in SDG1 between years 2014 to 2015			
Variable	SA	EC	KZN
edu	0.03492	0.00000	0.00000
cook	0.00041	-0.00324	0.00000
elec	-0.00032	0.00000	0.00000
few_possessions	-0.00042	-0.00171	0.00000
informald	-0.00091	-0.00105	0.00000
noflush	0.00075	-0.00481	0.00000
nopipe	-0.00076	-0.00180	0.00000
spaceh	0.00107	-0.00070	0.00062
pov_int	-0.02606	-0.01217	0.00000
working	0.02006	0.00000	0.01647
grant_pp	0.00000	-0.01661	0.00000
insecure_tenure	0.00982	0.00000	0.01107
chld_mort	0.00000	0.01902	0.00000
Total	0.03856	-0.02307	0.02816

An analysis was also done for the change in means in each indicator, compared between all the provinces-metropolitan combinations and the national threshold. Figure 13 illustrates the analyses of the change in means for the *edu* variable. The SAS PROC GLM procedure was used to generate the analysis of means plots as illustrated in Figure 13.

Figure 13 highlights where (in this case province-metropolitan) the deviation from the national threshold mean for the SDG1 education indicator is significant. The provincial-metropolitan code is a combination of the provincial code and the metropolitan code. The codes are summarised in Table 28.

Of specific interest is 11 (Western Cape – Metropolitan), 51 (KwaZulu-Natal - Metro) and 71 (Gauteng - Metro). These groups all preformed significantly higher than the national threshold for the SDG1 education indicator. In contrast, 22 (Eastern Cape - Non-Metro), 92 (Limpopo - Non-Metro) and 52 (KwaZulu-Natal - Non-Metro) preformed significantly lower than the national threshold for the SDG1 education indicator.

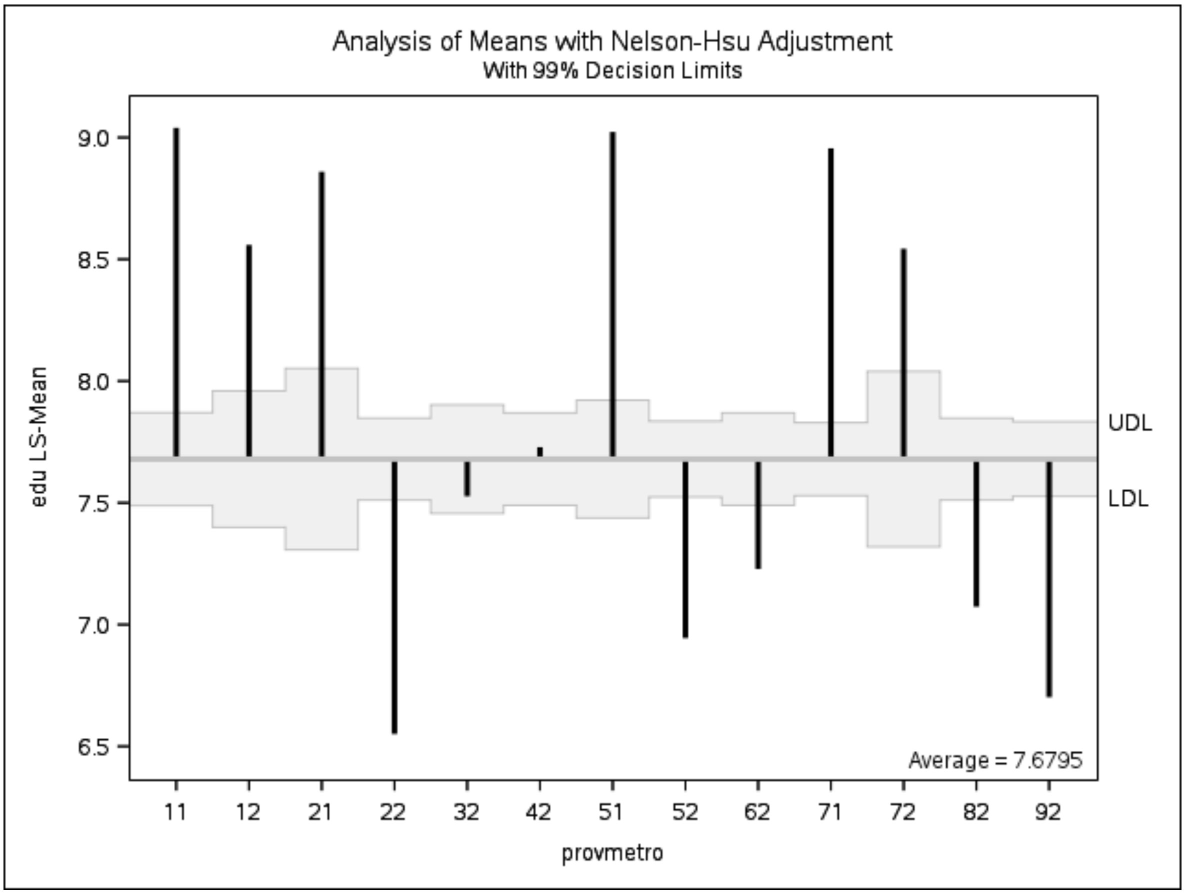

Figure 11: Analysis of means (ANOM) of edu variable

Table 28: Provincial-Metropolitan codes

No.	Description	No.	Description
11	Western Cape - Metro	52	KwaZulu-Natal - Non-Metro
12	Western Cape - Non-Metro	61	North West - Metro
21	Eastern Cape - Metro	62	North West - Non-Metro
22	Eastern Cape - Non-Metro	71	Gauteng - Metro
31	Northern Cape - Metro	72	Gauteng - Non-Metro
32	Northern Cape - Non-Metro	81	Mpumalanga - Metro
41	Free State - Metro	82	Mpumalanga - Non-Metro
42	Free State - Non-Metro	91	Limpopo - Metro
51	KwaZulu-Natal - Metro	92	Limpopo - Non-Metro

5.4. Kroeger and Weber Framework

The Kroeger and Weber Framework is a relative comparison framework and the composite index compares differences in the standard deviation changes between groups.

To use the Kroeger and Weber Framework the national threshold in t=0 for SDG1 was set to one. The t=0 values for non-metropolitan KwaZulu-Natal and non-metropolitan Eastern Cape were based on the differences in the standardised means between the provinces and the national threshold. Table 29 contains the weighted difference in means compared between South Africa and non-metropolitan KwaZulu-Natal and non-metropolitan Eastern Cape. In 2014, the non-metropolitan Eastern Cape group was 0.77 standard deviation points less than the national threshold compared to non-metropolitan KwaZulu-Natal, which was 0.55 standard deviation points below the national threshold. If the geographical or social grouping falls below the national threshold it is determined to be "disadvantaged". The difference between the "disadvantaged" group index and the national threshold is determined as the social need. Figure 12 illustrates the how the composite indices would be used in the Kroeger & Weber (2015) framework.

Taking the year 2014 as t=0 and 2015 as t=1, the t=1 values were determined based on the composite index methodology discussed in the previous section. For example, if the t=0 value for non-metropolitan KwaZulu-Natal was 0.45 and from section 5.3 it was calculated that the change in SDG1 for non-metropolitan KwaZulu-Natal from 2014 to 2015 was 0.028, then the t=1 value was equal to 0.45 + 0.028 = 0.48.

Table 29: Weighted difference in means 2014

	Weighted difference in means	
Variable	SA EC 14	SA KZN 14
edu	-0.19310	-0.12573
cook	-0.00854	-0.01163
elec	-0.00315	-0.00375
few_possessions	-0.00609	-0.00317
informald	-0.00813	-0.00381
noflush	-0.02224	-0.02536
nopipe	-0.02611	-0.01285
spaceh	-0.01179	-0.00449
pov_int	-0.12244	-0.10428
working	-0.10472	-0.09108
grant_pp	-0.16907	-0.13113
insecure_tenure	-0.07856	-0.04215
chld_mort	-0.01723	0.00796
Total	-0.77115	-0.55148

At t=0, the SDG1 social need in the non-metropolitan Eastern Cape, as defined by Kroeger & Weber (2015), was 0.77 standard deviation points (Figure 12 – pt3.). The SDG1 social need in non-metropolitan KwaZulu-Natal was 0.55 standard deviation points (Figure 12 – pt1.). The SDG1 social need between non-metropolitan Eastern Cape and non-metropolitan KwaZulu-Natal was 0.22 standard deviation points (Figure 12 – pt2.).

At t=1, the mean SDG1 for non-metropolitan Eastern Cape was 0.21, non-metropolitan KwaZulu-Natal 0.48 and nationally 1.04. At t=1, the SDG1 social need in the non-metropolitan Eastern Cape, as defined by Kroeger & Weber (2015), was 0.83 standard deviation points (Figure 12 – pt7.). The SDG1 social need in non-metropolitan KwaZulu-Natal was 0.56 standard deviation points (Figure 12 – pt4.). The SDG1 social need between non-metropolitan Eastern Cape and non-metropolitan KwaZulu-Natal increased to 0.27

standard deviation points (Figure 12 – pt5.). The degree of social value created for non-metropolitan Eastern Cape between 2014 and 2015 was calculated then as -0.023/0.83. This means that social value associated with SDG1 (poverty) was actually destroyed in the non-metropolitan Eastern Cape and the social need increased by 3%. In non-metropolitan KwaZulu-Natal, the social need was reduced by 5% over the period.

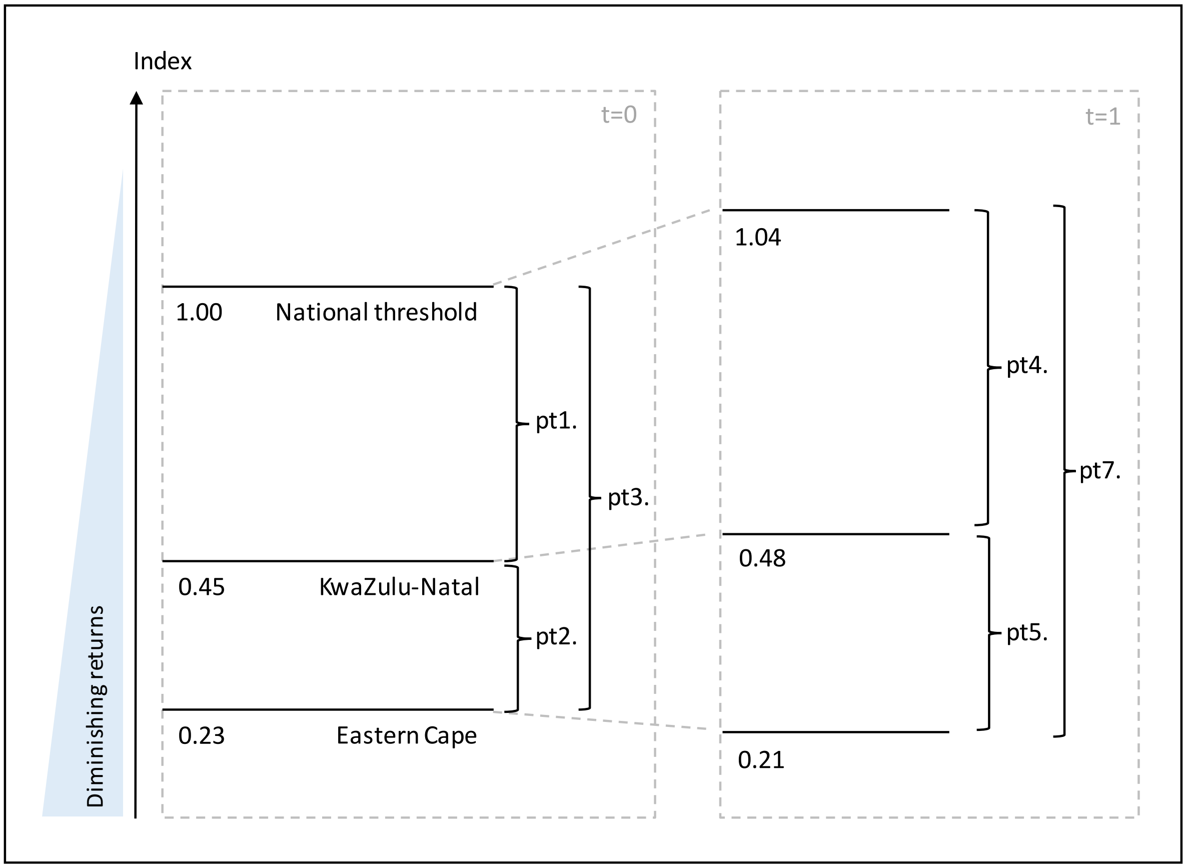

Figure 12: Kroeger and Weber Framework implementation

5.5. Conclusion

This chapter presented the descriptive statistics and the results from three SEM models and the results from the application of the composite index and the Kroeger & Weber (2015) framework. The results from chapter 5 will be discussed in chapter 6 in the context of the research questions and the literature reviewed.

Chapter 6. Discussion of Results

This chapter will discuss the results summarised in chapter 5. The chapter is structured according to the five research questions outlined in chapter 3.

6.1. Results addressing research question 1

Research question 1 evaluated/asked about the feasibility of creating a composite index from the GHS data, for each individual SDG, that will satisfy the technical properties of a good index, as specified by Masset (2011).

SEM models were constructed for SDG1, SDG2 and SDG3 to demonstrate the feasibility of using GHS measured variables to measure the SDG. Even though the model data did not satisfy the condition of multivariate normality, the models met all the model fit criteria and it can be concluded that the models achieved a good fit between the hypothesised model and the observed data. Analysis of the parameter standard errors supported the finding that the SEM models met the requirements for validity and reliability.

A composite index was constructed for SDG1, from the relevant indicators that were verified in the SEM model, and weighted with the SEM path coefficients. The composite index was based on reliable data from the national household survey. Validity and reliability of the survey data was confirmed in chapter 4. The SEM technique was chosen because it avoided problems of instability, rotated solutions and enabled the integration and understanding of numerous interactions within a complicated environment over time. A good index should be distribution sensitive. The use of the composite index within the Kroeger & Weber (2015) framework allowed the target group index to be viewed relative to the national threshold, thus targeting the socially “disadvantaged”. The use of globally accepted indicators, together with the national household survey, enables the composite index to be reproduced for different countries. It can thus be concluded that it is feasible to create a composite index from the GHS data, for each individual SDG, that will satisfy the technical properties of a good index, as specified by Masset (2011).

The results from the SEM model’s validity and reliability tests and the SDG1 composite index are now discussed in more detail.

SDG1 SEM. The descriptive statistics were assessed first. The descriptive statistics for the SDG1 SEM sample (Table 6 and Table 7) illustrated that 12 of the 13 endogenous manifest variables were 0-1 categorical variables, with the exception of edu, which measured the estimated years of schooling as a continuous variable between 0-18.

Apart from child mortality (chld_mort) and electricity (elec) the skewness and kurtosis for the remaining variables ranged between -2 and 2. There is no clear consensus around an acceptable degree of non-normality. Hancock & Mueller (2013) note, however, that prior literature indicates cause for concern in ML-based results if univariate skewness approaches 2 and univariate kurtosis approaches 7. Hancock & Mueller (2013) note that multivariate kurtosis greater than 3 could lead to inaccurate results. It should thus be noted that *chld_mort* and *elec* fall outside this acceptable range.

The following variables, that were hypothesised in the original SEM path diagram (Figure 3), were excluded from the final SEM. Q531Ligh was excluded from the final SEM, due to its high multicollinearity to electricity (elec). Q531Ligh measured the source of energy used in lighting the home, where *elec* measures access to electricity. The variable *eduyn* measured if the individual aged over 15 had completed at least 5 years of education. The variable was excluded as it exhibited multicollinearity with edu. Poverty was measured by *pov_int* in the context of household income and the international poverty line. *FPL*, *UBPL* and *UBPL* are in principle the same measure, but were applied with the three South African poverty lines. All four lines were tested in the SEM and the international poverty line measure *pov_int* was found to have the best relationship with the SDG. The *FPL*, *UBPL* and *UBPL* measures were consequently excluded. The indicator that measures the type of energy used for heating water (Q531Wheat) was removed as it was found to exhibit multicollinearity with elec. The Q532Rub variable measured how rubbish is collected or removed. This variable was, however, found to negatively impact the fit of the model and was excluded. Lastly, three new subjective indicators were proposed for inclusion in the SEM, Q819Status (an ordinal subjective rating of wealth status), Q812Netincome (a continuous, subjective variable of the individual's perception of what the household poverty line, or absolute minimum income, should be) and Q813Mincome (an ordinal subjective rating of how the household's monthly income compares to their perception of the absolute minimum income required). These variables were, however, found to negatively impact the fit of the model and were excluded.

The model fit was then analysed. The model convergence condition was satisfied and there were also no active constraints. With the exception of the RNI index, which was not measured in the SAS PROC CALIS output, all the model fit criteria specified by Bentler (1990) were met. Based on the model fit indices, it can be concluded that the model achieved a good fit between the hypothesised model and the observed data. The analysis of the asymptotically standardised residuals highlighted a large departure from the normal distribution. This is primarily caused by the inclusion of the *chld_mort* variable in the model. A model variation was run where *chld_mort* was excluded. The model fit results were marginally better, including the Akaike Information Criterion (AIC). AIC has a high success rate in identifying the true model (Liu, Rovine, & Molenaar, 2012). It should however be noted that the most important criterion in model selection and evaluation of equivalent models is congruity with the theoretical assessment (Boomsma, 2000). Child mortality was the only indicator that captured the “health” dimension in the South African Multi-Dimensional Poverty Index (Appendix 2). The exclusion of the variable also negatively impacted certain variance parameters on some of the theoretically fundamental relationships. The researcher therefore decided to keep *chld_mort* in the final SEM model for SDG1.

Next, the reliability of the parameter estimates was reviewed. Figure 13 illustrates the SDG1 SEM path diagram and the path coefficients that represent the postulated relationship between the variables (also see Table 15). In order to address the reliability of the parameter estimates, the standard errors and *t* values of the (primary) parameter estimates were analysed. The *t* values for all variables were found to differ significantly from zero. Insignificant *t* values for path coefficients would challenge the validity of the model. The parameter estimates are thus confirmed to be valid. Using the standardised results for covariance among errors (Table 14), *chld_mort* - LIVE_STD was the only parameter that remained insignificant.

In interpreting the model, of specific interest are the indicators that have the greatest relationship with the SDG. With regard to SDG1 (i.e. poverty), education had the strongest relationship with poverty, followed by employment status. Surprisingly, access to electricity, possessions such as TVs and fridges and the type of settlement had the weakest relationships with poverty.

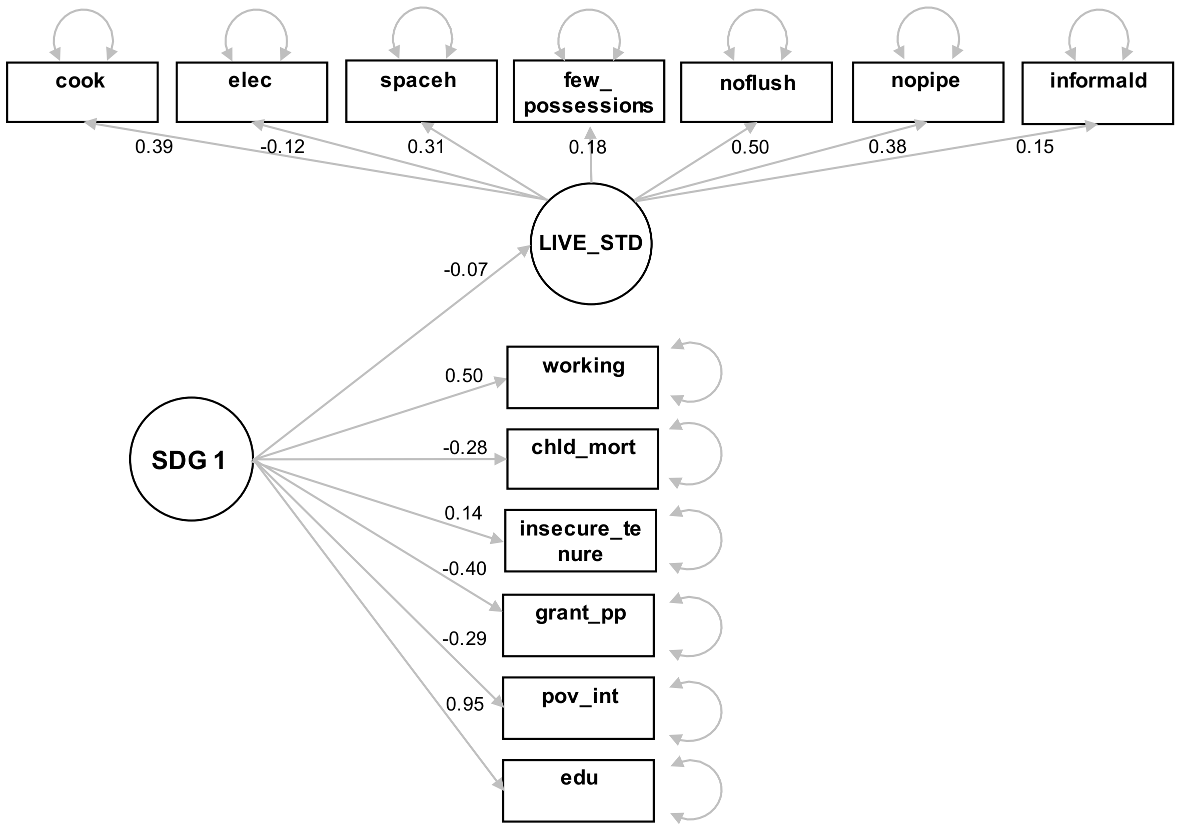

Figure 13: Final SDG1 SEM path diagram

Note*: The following sets of variables were allowed to covary:*

Set 1: pov_int, LIVE_STD, working, grant_pp, insecure_tenure, chld_mort, edu

Set 2: cook, elec, few_possessions, informald, noflush, nopipe, spaceh

After reviewing the descriptive statistics, the model fit indices and the parameter standard errors, the SEM model for SDG1 was found to meet the requirements for validity and reliability.

SDG2 SEM. The descriptive statistics were first assessed. The descriptive statistics for the SDG2 SEM sample (Table 8 and Table 9) illustrate that 5 of the 11 endogenous manifest variables were 0-1 categorical variables. Monthly income per person was measured by *inc_pp* as a continuous variable. Estimated years of schooling was measured by *edu* as a continuous variable between 0-18. How frequently an adult (Q76Hung) or child (Q77hung5) had gone hungry in the past 12 months because there wasn't enough food was measured by the derived variable *hungry* on an ordinal scale. The individual's self-reported view of their state of health was measured by *health* on an ordinal scale. This was similar to *happy* that measures on an ordinal scale the individual's self-reported view of their state of happiness. The individual's self-reported view of the usefulness of agricultural assistance received was measured by *agrihelp* on an ordinal scale. Falling outside the acceptable kurtosis range are *skipmeal*, *hungry*, *streetkid*, *agrihelp*, *anyhelp* and *inc_pp*.

The following variables, that were hypothesised in the original SEM path diagram (Figure 4), were excluded from the final SEM. Q89aAgric indicated whether the household made any sales of farm products and services. Q88bHect was an approximation of the size of the land the household used for production. Indicator 2.3.2 (Table 2) should measure the average income of small-scale food producers. Using Q89aAgric and Q88bHect together with the *inc_pp* was found to negatively impact the model fit. Q89aAgric and Q88bHect were removed from the model and *inc_pp* was retained, together with the two indicators that assessed agricultural assistance (*agrihelp* and *anyhelp*). The variable *eduyn* (Q110ATTE) measured if the individual aged 5-15 had completed at least 5 years of education. The variable was excluded as it exhibited multicollinearity with edu. D96Age, measuring child mortality was not identified as an indicator by the United Nations, but was included in the original model as literature states the negative impact of hunger on health. The variable *chld_mort* was, however, found to negatively impact the model fit and was excluded.

The model fit was then analysed. The model convergence condition was satisfied and there were also no active constraints. With the exception of the RNI index, all the model fit criteria specified (by Bentler, 1990) were met. Based on the model fit indices, it can be concluded that the model achieved a good fit between the hypothesised model and the observed data. The analysis of the asymptotically standardised residuals showed only a small to medium departure from the normal distribution. (Boomsma, 2000). It should however be noted that the Moore-Penrose inverse was used in computing the covariance matrix for the parameter estimates. The standard errors and t values might not be accurate with the use of the Moore-Penrose inverse.

Next, the reliability of the parameter estimates was reviewed. Figure 14 illustrates the SDG2 SEM path diagram and the path coefficients that represent the postulated relationship between the variables (also see Table 19).

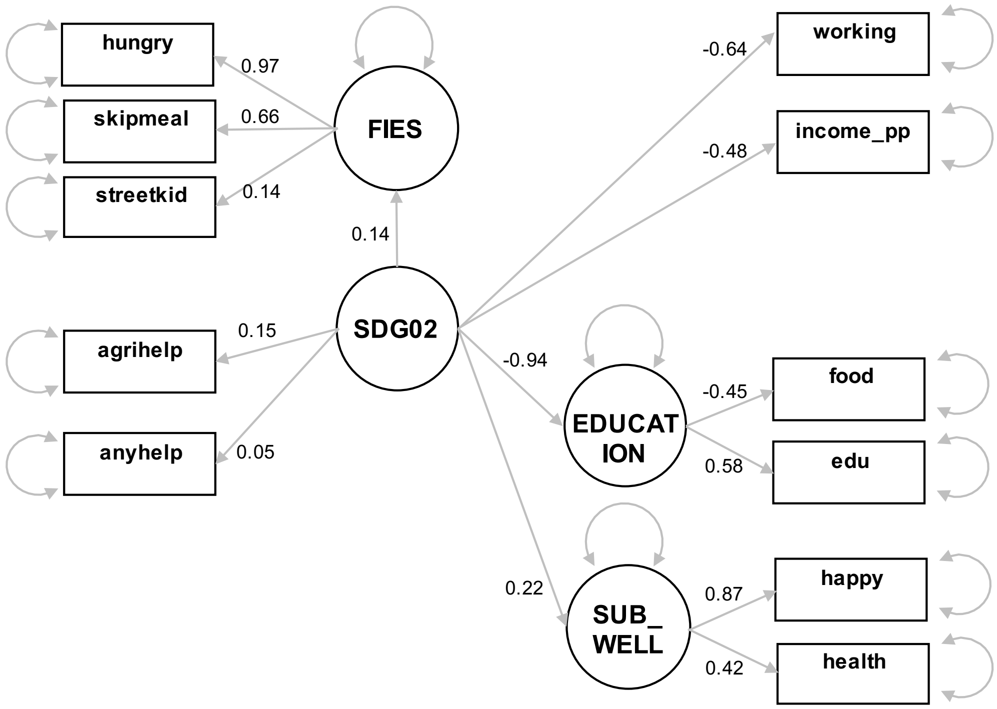

Figure 14: Final SDG2 SEM path diagram

Note*: The following sets of variables were allowed to covary:*

Set 1: FIES, EDUCATION, SUB_WELL, working, inc_pp

Set 2: hungry, skipmeal, streetkid

Set 3: food, edu

Set 4: happy, health

The t values for all variables were found to differ significantly from zero. The parameter estimates were thus confirmed to be valid. Using the standardised results for covariance among errors (Table 18), the following paths were found to be insignificant: *food-happy*, *edu-happy*, FIES-EDUCATION, *agrihelp*-EDUCATION, *working-agrihelp*, *anyhelp*-EDUCATION, *working-anyhelp*. It should however also be noted that the Moore-Penrose inverse was used in computing the covariance matrix for the parameter estimates. The standard errors and t values might not be accurate with the use of the Moore-Penrose inverse.

In interpreting the model, of specific interest are the indicators that have the greatest relationship with the SDG. With regard to SDG2 (i.e. hunger), education once again had the strongest relationship with the SDG, followed by employment status and income per person. Surprisingly, the relationship with the Food Insecurity Experience Scale (FIES) indicators were not that strong.

After reviewing the descriptive statistics, the model fit indices and the parameter standard errors, the SEM model for SDG2 was found to meet the requirements for validity and reliability to an acceptable degree.

SDG3 SEM. The descriptive statistics were first assessed. The descriptive statistics for the SDG3 SEM sample (Table 10and Table 11) illustrated that 9 of the 10 endogenous manifest variables were 0-1 categorical variables. Only *preg_problem* measures, on an ordinal scale, the status of the pregnancy. All of the variables used in the SDG3 SEM fall outside the acceptable kurtosis range.

The following variables, that were hypothesised in the original SEM path diagram (Figure 4), were excluded from the final SEM; *happy* (Q820Happy) and *health* (Q22GENHEALTH). They were subjective self-reported ordinal measurements of happiness and health. These variables were not identified as indicators by the United Nations, but were included in the original model to test the relationship of the subjective measurements with the SDG. The variables were, however, found to negatively impact the model fit and were excluded. Indicator 3.6.1 (Table 3) should measure the prevalence of road traffic injuries. This is not directly measured in the GHS. Q25aMVHoccupan and Q25aMVHpedestrian measure whether the individual suffered an injury associated with a motor vehicle accident (either as the occupant or pedestrian). The variables were found to negatively impact the model fit and were excluded. The variable *onemed_hh*, that measures the number of household members who belong to a medical aid scheme was removed because it was found to exhibit multicollinearity with *medaid* (Q21MEDI), which asks the individual if they are covered by medical aid or medical benefits. Q24bYNT was added to the SEM, as it captures the reason why a health practitioner was not consulted in a time of illness or injury. The variable was however found to negatively impact the model fit and was excluded. Q23SUB was included as a potential measure of the prevalence of abuse of alcohol or drugs (3.5.2, Table 3). Q25aACCP was included to measure unintentional poisoning (3.9.3, Table

3). Finally, *Age*, *gender* and Q27aPRE were proposed as measures of adolescent birth rate (3.7.2, Table 3). These variables were, however, found to negatively impact the model fit and were excluded.

The model fit was then analysed. The model convergence condition was satisfied and there were also no active constraints. With the exception of the RNI index, all the model fit criteria specified (by Bentler, 1990) were met. The Bentler-Bonett Non-normed Index score was 0.9460 compared to the cut-off criteria of 0.95. Based on the model fit indices, it can be concluded that the model achieved a good fit between the hypothesised model and the observed data. The analysis of the asymptotically standardised residuals showed only a small to medium departure from the normal distribution (Boomsma, 2000). It should however be noted that the Moore-Penrose inverse was used in computing the covariance matrix for the parameter estimates. The standard errors and t values might not be accurate with the use of the Moore-Penrose inverse.

Next, the reliability of the parameter estimates was reviewed. Figure 14 illustrates the SDG3 SEM path diagram and the path coefficients that represent the postulated relationship between the variables (also see Table 23). The t values for all variables were found to differ significantly from zero. The parameter estimates were thus confirmed to be valid. Using the standardised results for covariance among errors (Table 22), the following paths were found to be in insignificant: MORTALITY-CARDIO_D, *preg*-CARDIO_D and *hiv-preg*. It should however be noted that the Moore-Penrose inverse was used in computing the covariance matrix for the parameter estimates. The standard errors and t values might not be accurate with the use of the Moore-Penrose inverse.

In this model, of specific interest are the indicators that have the greatest relationship with the SDG. With regards to SDG3 (i.e. health and wellbeing), belonging to a medical aid had the greatest relationship with the SDG, followed by TB. The relationship with pregnancy was weak, as well as, surprisingly, the relationship with HIV.

After reviewing the descriptive statistics, the model fit indices and the parameter standard errors, the SEM model for SDG3 was found to meet the requirements for validity and reliability to an acceptable degree.

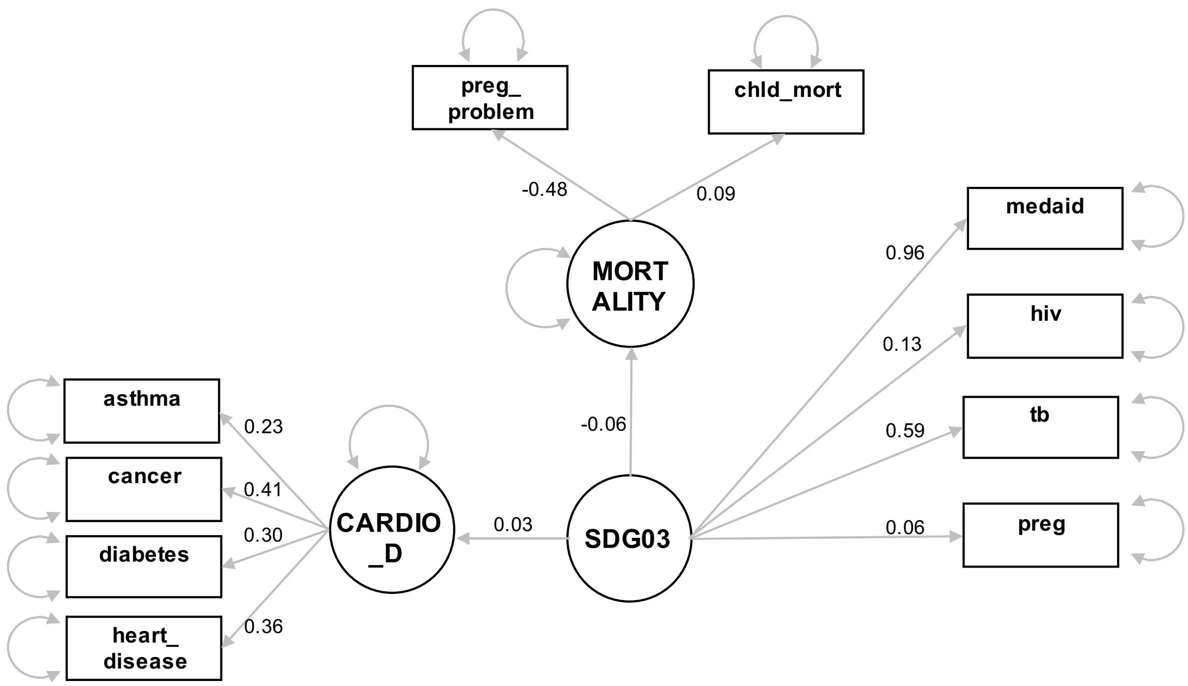

Figure 15: Final SDG3 SEM path diagram

Note*: The following sets of variables were allowed to covary:*

Set 1: MORTALITY, CARDIO_D, medaid, hiv, tb

Conclusion. Research question 1 evaluated the feasibility of creating a composite index from the GHS data for each individual SDG that would satisfy the technical properties of a good index, as specified by Masset (2011). This study has demonstrated through the construction of SEM models for the first three SDGs that it is feasible to developed valid and reliable SEM models from the GHS data for an individual SDG. The composite index was then constructed and tested for SDG1 and evaluated against the good index criteria. The composite index was found to satisfy the requirements specified by Masset (2011). This research study has thus confirmed the feasibility of research question 1.

6.2. Results addressing research question 2

Research question 2 evaluated whether the SDG composite indices would enable the company to identify social need and prioritise social interventions.

The first way in which the SDG SEM enables prioritisation is through the path coefficients. The path coefficients illustrate the strength of the relationship of the variable with the SDG. They do not, however, account for how difficult it might be to achieve one standard deviation point change in that variable compared to other variables with slightly lower coefficients. As an example, *edu* was found to have a much greater relationship with SDG1 than LIVE_STD (Figure 13), but it is much more difficult to effect change in the education system, than it is to address service delivery (i.e. flush toilets, piped water). The SEM has thus created a better understanding of the relationship of the individual indicators with the SDG.

The difference in the analysis of means (ANOM) enables the analysis of the indicator for sub-groups. This is demonstrated with the analysis of means with the Nelson-Hsu adjustment in Figure 11. Of specific interest was number 22 (Eastern Cape - Non-Metro), 92 (Limpopo - Non-Metro) and 52 (KwaZulu-Natal - Non-Metro) as these have the most significantly lower means compared to the national threshold for the SDG1 education indicator.

The SDG composite index weights the indicator with the path coefficient from the SEM and calculates the social need as per the Kroeger & Weber (2015) framework (Figure 12). If the geographical or social grouping falls below the national threshold it is determined to be “disadvantaged”. The difference between the “disadvantaged” group index and the national threshold is determined as the social need. It was clear from the analysis in chapter 5 that, within the context of SDG1 (i.e. poverty), the non-metropolitan Eastern Cape was more “disadvantaged” than non-metropolitan KwaZulu-Natal. However, both provincial non-metropolitans fell below the national threshold and would benefit from social interventions.

Based on the above analysis, it can thus be concluded that the SDG composite indices can enable a company to identify social need and prioritise social interventions.

6.3. Results addressing research question 3

Research question 3 evaluated if the SDG composite indices could be used to measure the impact of the social intervention.

The Kroeger & Weber (2015) framework was used to determine the impact of the social intervention. The change in the treatment group’s SDG1 composite index between 2014 and 2015 was evaluated against the change in the national SDG1 composite index threshold. This research study did not introduce a control group, but it compared two target groups with the national threshold. By comparing the changes in the national threshold and the treatment groups, the impact of the intervention was measured. The use of a control group would enable the counterfactual to be addressed to some degree and corporates are encouraged to introduce control groups for their specific interventions.

From the analysis in chapter 5 it could be seen that for the non-metropolitan Eastern Cape, the social value associated with SDG1 (poverty) was actually destroyed and the social need increased by 3%. In non-metropolitan KwaZulu-Natal, the social need was reduced by 5% over the period. The composite index then further reveals exactly which indicators drove the change in the SDG. The indicators in the composite index were weighted, so the direct change in the indicator and the weighted impact of the indicator could both be assessed. From Table 27 it is clear that *grant_pp* and *pov_int* had the largest negative impact on the non-metropolitan Eastern Cape SDG1. At the other end of the spectrum, in non-metropolitan KwaZulu-Natal, *working* is the key driver for positive change in SDG1.

Based on the above analysis, it can thus be concluded that if a specific intervention associated with a specific indicator was tracked, then the SDG composite indices could be used to measure the impact of that social intervention.

6.4. Results addressing research question 4

Research question 4 evaluated how the SDG composite indices would enable the comparison of the social impact between social interventions, related or unrelated, nationally.

By expressing the value created as the degree of improvement on the social need, the impact, expressed as a percentage improvement, could be compared across interventions. Kroeger & Weber (2015) proposed that for significantly different interventions the percentage impact be weighted with the number of individuals affected by the intervention. In this example, this can be demonstrated in two ways. First, if there are two interventions that focus on two different indicators, but that both impact SDG1, then their impact is measured and compared by using the absolute degree of change in SDG1. If the interventions are focussed on different SDGs, composite indices would first need to be constructed for each SDG and the % increase in social need, as defined for that SDG, would then be compared.

Based on the analysis in question 3 and the theoretical principles discussed in this section, it can thus be concluded that the SDG composite indices would enable the comparison of the social impact between social interventions, related or unrelated, nationally.

6.5. Results addressing research question 5

Research question 4 evaluated how the SDG composite indices would enable the comparison of the social impact between social interventions, internationally.

Comparison internationally requires that an SDG composite index be developed for the targeted SDG for each country under evaluation. Once the SDG Indices have been established, the same approach followed in response to question 4 can be taken to compare social value created between countries, if it is expressed as a percentage. It can thus be concluded that the SDG composite indices would enable the comparison of the social impact between social interventions, internationally.

6.6. Summary of research findings

Five research questions were identified to address the three research objectives that were identified in chapter 1 and reiterated in chapter 3.

The three SEM models were tested for validity and reliability. Even though the sample data did not adhere to multivariate normality, the SEM model fit tests indicated that the model achieved a good fit between the hypothesised model and the observed data. The *t* values also confirmed that all variables were found to differ significantly from zero. The composite index was found to satisfy the good index requirements specified by Masset (2011). This research study thus confirmed the feasibility of research question 1.

It was concluded that the SDG composite index could enable a company to identify social need and prioritise social interventions. This was first demonstrated at an indicator level by comparing the difference in the standardised means between the provinces and the national threshold. It was next demonstrated at an SDG level, through the use of the SDG1 composite index with the Kroeger & Weber (2015) framework. The difference between the national SDG1 threshold and the SDG1 index for the provinces enabled the identification of the provinces with the greatest social need.

The Kroeger & Weber (2015) framework can enable the researcher to measure the impact of the intervention in the context of the SDG and this was successfully demonstrated. Given that the Kroeger & Weber (2015) framework uses a relative measurement philosophy, quantifying impact as a percentage of social value created or destroyed, comparison between multiple interventions are possible. If interventions related to different SDGs are compared or projects within different countries, SEM models and composite indices will have to be constructed for those SDGs or countries.

6.7. Conclusion

Chapter 6 discussed the results summarised in chapter 5. Each of the five research questions were evaluated. This research study demonstrated the feasibility of constructing an SEM model and composite index for an SDG. The SEM and the composite index, used within the Kroeger & Weber (2015) framework adequately addressed all the research questions.

Chapter 7. Conclusion

7.1. Introduction

With the recent adoption of the SDGs, the CSR expectations on corporates are immense. Companies will need to incorporate CSR into their short-, medium- and long-term strategies if they are to remain sustainable in the new operating environment.

7.2. Research objectives and findings

The objective of this research study was to to provide South African corporates with a framework to operationalise the new SDGs and to measure and compare the social value, i.e. the impact, created within the context of CSR and the SDG targets.

This research study proposed an SDG operationalisation framework that enables corporates to incorporate CSR and their SDG strategy into their business review cycle and their performance management system design and implementation. The SDG operationalisation framework is illustrated in Figure 7. The SDG operationalisation framework is a continuous cycle within the business review process and then between the business review process and the performance management process.

The SDGs were positioned at a strategic indicator level and the UN approved indicators were proposed as the operational indicators. The performance management system framework design specifically focusses on the review of individual indicators and sets of indicators. The assumptions regarding the supposed links between operations and strategic level indicators are critical in the business review cycle and performance management system.

Three research problems were identified as the key challenges to the implementation of the SDG operationalisation framework.

1. The identification of social need.
2. The measurement of the social impact.
3. The comparison between social interventions.

Specific research objectives were then identified for the SDG operationalisation framework to address these research problems:

- The SDG operationalisation framework should enable corporates to identify and prioritise social interventions based on a shared definition of social need, as defined within the context of the SDGs.
- The SDG operationalisation framework should enable corporates to measure the social impact of their social intervention.
- The SDG operationalisation framework should enable corporates to compare the effectiveness of different social interventions, locally and internationally.

Five research questions were developed to address these research objectives. This research study addressed all the research questions and solved the inherent research problems through the following methodology. A composite index was constructed for SDG1, as an example. The index was developed from a SEM and the South African General Household Survey was used as the research instrument. Three SEM models were developed and validated for three different SDGs. This was done to demonstrate and validate the feasibility of constructing SEM models for each of the SDGs. The Kroeger & Weber (2015) methodology was finally applied to the SDG1 composite index to demonstrate the measurement and comparison of social value.

7.3. Research limitations

This research study developed the SEM models for three SDGs and then developed the SDG correspondence index for SDG1. The validity and reliability of the SEM models demonstrate the feasibility of constructing this SDG operationalisation framework, but they have not demonstrated the implementation with the other SDGs.

The SEM constructed in this research study was forced to focus on the 2014 and 2015 datasets only, as these datasets contained a similar list of variables, but this two-year period is not necessarily sufficient to observe a significant trend.

The variables that were used to construct the SDG index were limited to the variables collected by Statistics South Africa in the GHS. As evident from the literature review, key individual and household variables were omitted from the GHS and the available variables will constitute an imprecise index of the concepts of interest.

Composite index weights that are based on statistical approaches can change over different periods, which complicates comparability over time. Furthermore, this method involves some level of implicit subjective weighting as the SEM model structure is pre-determined. Even though the model structure is based on literature, it could still contain some selection bias.

The dataset did not adhere to the multivariate normality condition. Even though the model fit indices indicate that the model achieved a good fit between the hypothesised model and the observed data, it is recommended that a bootstrapping procedure is run on the models and that they are further analysed for reliability.

7.4. Managerial recommendations

This research study enables companies to identify, prioritise, measure and compare the impact of CSR interventions and investments, measured in the context of the SDG(s) that the company wants to focus on as part of their CSR and sustainability strategy. Companies are encouraged to first compare the social need within the areas in their scope. Then, based on an assessment of the weights of the indicator and the ease of implementation, they can position CSR interventions within their strategy portfolio. The SDG composite index also allows the corporate to generate a performance scorecard for reporting and analysis as part of the business review cycle. Once the company has determined which SDGs it will focus on, the SDG operationalisation framework can be applied to embed the SDG and operational indicators in the business review process and performance management system.

Companies that were previously not assessing their impact, due to the cost of rigorous impact assessments, can also use this tool retrospectively to determine the impact and effectiveness of existing interventions. The companies will, however, have to ensure that similar indicators are compared for the years under investigation, as some of the indicators were only introduced in 2014 to the survey.

The composite index and Kroeger & Weber (2015) framework was tested at a provincial – metropolitan level. Companies can conduct their own pre- and post- intervention surveys, using the same questions used in the GHS, but with smaller focus groups, and even introduce a control group. This will enable more focussed analysis of the intervention but they will still be able to analyse the social value created in the context of the national, provincial, metro, etc. context of social need with the greater group.

7.5. Institutional recommendations

This research hoped to contribute towards the development of a shared SDG framework that will create transparency and contribute towards increased trust, collaboration, joint prioritisation of social need and the achievement of the SDGs. It is clear from the analysis in the literature that the majority of SDG indicators can only be measured at a national level. Institutions are encouraged to review the Individual and household level indicators that are not measured in the GHS and to recommend these indicators for inclusion in the GHS. This will enable the construction of a more comprehensive and representative SEM model and composite index for the individual SDGs.

Institutions will also benefit from using the framework to identify, prioritise, measure and compare social value, especially when devising provincial and metropolitan development strategies. The SDG composite index can allow the institution to generate a performance scorecard that can be used to facilitate discussion in cross-sector collaboration platforms. This scorecard can also be linked to the National Development Plan.

7.6. Academic considerations and recommendations for future research

This research study demonstrated the feasibility of constructing an SDG composite index that could be used within the Kroeger & Weber (2015) framework to prioritise, measure and compare social value created. The SEM model was constructed for three SDGs and the composite index was developed for SDG1. Future research should develop SEM models for all the SDGs that can be measured at an individual and household level. Once each of the SEM models have been validated a new, two-factor SEM model should be constructed, where each of the SDGs are latent factors that feed into a “global” SDG latent factor, sustainability. The same methodology can then be applied to develop a weighted composite index that measures integrated sustainability performance.

The composite index was weighted with the strength of the relationship between the indicator and the SDG. The composite index was however not weighted with the complexity, cost and effort required to effect change in the different indicators. Future research can expand on the composite index methodology used in this research study, by introducing another weighting dimension that offsets the inputs with the outputs, versus the impacts of the social intervention on the SDG.

If smaller focussed surveys and samples are used with this framework the smaller sample size might impact the validity of the SEM model construct. This would have to be tested and validated for smaller sample sizes.

7.7. Conclusion

This research study developed a framework that South African corporates can use to operationalise the recently adopted SDGs. This study extends upon the research of Smulowitz (2015) and Kroeger & Weber (2015) and proposes a SDG operationalisation framework, in which performance is measured relative to the social need. The SDG operationalisation framework applied strategy implementation and performance measurement theory to contextualise the CSR strategy and the achievement of the SDGs within a corporate environment. The framework will however also be useful for institutions, especially with regards to policy setting and cross-sector collaboration.

The research study also addressed the three most prominent challenges to the SDG operationalisation framework. These challenges have also been identified by the World Economic Form as key obstacles to achieving the SDGs and have emerged as key debates in recent CSR literature. This research study addressed these challenges through combining a SEM and composite index and finally applying the index with the Kroeger & Weber (2015) framework.

In conclusion, there has been a positive trend observed in monitoring and evaluation research in Africa, fuelled by the social need of the continent. This research study aims to contribute towards the further theoretical development of this field.

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Appendices

Appendix 1: Pilot provincial poverty lines (expressed 2011 PPP equivalents)

Province	FPL	LBPL	UBPL
5 KwaZulu-Natal	$74 | R354	$113 | R539	$159 | R757
1 Western Cape	$74 | R352	$114 | R545	$168 | R804
8 Mpumalanga	$72 | R343	$108 | R517	$204 | R974
7 Gauteng	$71 | R339	$110 | R523	$202 | R963
9 Limpopo	$71 | R338	$102 | R485	$131 | R627
6 North West	$71 | R337	$110 | R525	$161 | R767
2 Eastern Cape	$70 | R335	$100 | R477	$142 | R678
4 Free State	$70 | R334	$109 | R520	$150 | R718
3 Northern Cape	$65 | R310	$96 | R457	$148 | R705
National	$70 | R335	$105 | R501	$163 | R779

Note*: United States Dollars and South African Rand, per capita, per month.*

Source: Statistics South Africa (2015)

Appendix 2: Dimensions and indicators used in different Poverty Indices

Dimension	Indicator	MPI	SAMPI	PPI	SDG Link
Health	Nutrition	X			SDG 2
	Child Mortality	X	X[1]		SDG 3
Education	Years of schooling	X	X[2]		SDG 4
	School attendance	X	X[3]		SDG 4
Living standard	Cooking fuel	X	X[4]	X	
	Fuel for lighting		X[5]		
	Fuel for heating		X[4]		
	Sanitation	X	X[6]	X	SDG 6
	Water	X	X[7]		SDG 6
	Electricity	X			SDG 7
	Floor	X			
	Assets	X	X[8]	X	
	Roof			X	
	Type of dwelling		X[9]		
	Household size			X	SDG 11
	No. of rooms			X	SDG 11
	Employment		X[10]	X	SDG 8

Note*: SAMPI poverty conditions and their GHS variables are specified below:*

[1] *If any child under the age of 5 has died in the past 12 months (Q96Dage)*

[2] *If no household member 15 or older has completed 5 years of schooling (Q15HIEDU)*

[3] *If any school-aged child (aged 7 to 15) is out of school (Q110ATTE)*

[4] *If household is using paraffin/wood/coal/dung/candles/other/none (Q531Cook, Q531WHeat, Q531SpaceHeat)*

[5] *If household is using paraffin/wood/coal/dung/candles/other/none (Q531Ligh)*

[6] *If not a flush toilet (Q522Toil)*

[7] *If no piped water in dwelling or on stand (Q512Drin)*

[8] *If household does not own more than one of radio, television, telephone or refrigerator and does not own a car (Q816Rad, Q821TV, Q61phon, Q821Fridge, Q815Vehicle)*

[9] *If an informal shack/traditional dwelling/caravan/tent/other (Q51MainD)*

[10] *If all adults (aged 15 to 64) in the household are unemployed (employ_Status2)*

Appendix 3: Summary of SDG indicators measured in the GHS

SDG	National	Household / Individual	GHS	Grand Total
Society	52	69	32	121
	43%	57%	26%	100%
1	6	6	6	12
2	9	5	2	14
3	4	22	10	26
4	3	8	6	11
5	6	8	2	14
7	4	2	2	6
11	12	3	2	15
16	8	15	2	23
Economy	39	14	7	53
	74%	26%	13%	100%
8	10	7	4	17
9	9	3	0	12
10	7	4	3	11
12	13	0	0	13
Biosphere	40	2	2	42
	95%	5%	5%	100%
6	9	2	2	11
13	7	0	0	7
14	10	0	0	10
15	14	0	0	14
Goal Partnerships	92%	8%	8%	100%
17	23	2	2	25
Grand Total	154	87	43	241
	64%	36%	18%	100%

Appendix 4: Ethical clearance letter

Dear Ms Rilet de Witt

Protocol Number: **Temp2016-01363**

Title: **INDICES AS MEASURES OF SOCIAL UPLIFTMENT OF EDUCATION INTERVENTIONS IN SOUTH AFRICA**

Please be advised that your application for Ethical Clearance has been APPROVED.

You are therefore allowed to continue collecting your data.

We wish you everything of the best for the rest of the project.

Kind Regards,

Adele Bekker

Appendix 5: Turnitin originality assessment

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Gordon Institute of Business Science
University of Pretoria

A FRAMEWORK FOR SOUTH AFRICAN COMPANIES TO OPERATIONALISE THE SUSTAINABLE DEVELOPMENT GOALS

Rilet Davison
14448191

A research project submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration.

07 November 2016

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