

Confirmatory factor analysis of an instrument comparing Top-Down and Bottom-Up approaches to the Sustainable Development Goals (SDGs)

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Abstract – The top-down approach is characterized by the policies issued by the State towards the governed. In contrast, the bottom-up approach entails the construction of demands and participation from citizens towards their authorities. Both perspectives are of interest in the context of implementing the Sustainable Development Goals (SDGs) in local institutions. This study aimed to compare both approaches to confirm their theoretical structure. A cross-sectional, psychometric, confirmatory, and correlational study was conducted with university students selected to implement the SDGs in their institutions. The results confirmed two of the five factors of analysis. Based on the current state of research, it is recommended that the study be expanded to verify the factorial structure and anticipate implementation scenarios of policies related to the SDGs at a local level.

Keywords: Confirmatory Factor Analysis, Bottom-Up, Structural Equation Model, Sustainable Development Goals, Top-Down

Introduction

The history and theory of capabilities are based on the work of economist and philosopher Amartya Sen and philosopher Martha Nussbaum (Jiménez-Aceituno et al., 2020). This approach is central to human development and can be linked in meaningful ways to the Sustainable Development Goals (SDGs), as both seek to improve people's quality of life in an inclusive, equitable, and sustainable way.

Amartya Sen proposed this theory in the 1980s as an alternative to traditional approaches to development that focused primarily on economic growth or the satisfaction of basic needs (Espey, 2021). Sen argued that development should be measured by people's ability to lead lives they value, which includes their freedom to choose and act. Building on Sen's ideas, Martha Nussbaum expanded the approach with a list of core capabilities considered necessary for a dignified life, such as access to health, education, employment, and respect for human dignity.

The United Nations Development Programme (UNDP) Human Development Report of 1990 incorporated Sen's ideas, introducing the Human Development Index (HDI), which measures people's capabilities based on health, education, and income (Kaiser, 2020). This marked a fundamental shift towards a more comprehensive view of development.

The capabilities approach focuses on what people can "be" and "do" (Reuter, 2023). That is, capabilities represent the set of real opportunities that people have to lead a whole life. Sen's approach emphasizes the absolute freedom of individuals to make meaningful decisions in their lives, considering that factors such as inequality, poverty, or lack of rights can limit these opportunities. The theory focuses on well-being (material and non-material living conditions) and agency, which is the ability to act and make decisions to influence one's life and society.

The SDGs, adopted in 2015 by the United Nations, are designed to address the world's most pressing challenges, such as poverty, inequality, climate change, and education (Gau & Viswanathan, 2018). The capabilities approach helps understand how the SDGs seek to improve people's lives, as both focus on creating environments that enable individuals to develop their potential. SDG 1 (No poverty) and SDG 10 (Reduced inequalities) are directly related to people's absolute freedom to escape deprivation and poverty, central to capabilities theory. SDGs 3 (Good health and well-being) and 4 (Quality education) promote access to essential conditions for people to develop their capabilities and achieve a life they value.

The agency's approach is reflected in SDGs such as 5 (Gender Equality) and 16 (Peace et al.), which seek to empower people, particularly traditionally marginalized groups, to take an active role in their communities and decision-making (Bilsky et al., 2021). The capabilities theory shares a comprehensive approach to development with the SDGs. It is not just about economic growth or traditional development indicators but about improving people's lives equitably and sustainably. The history and theory of capabilities provide a conceptual framework that complements the SDGs, focusing on how people can live dignified and meaningful lives and under what conditions must be created for these capabilities to be fully developed.

Capabilities are for every person, without using any of them as a means for the capabilities of others or those of the whole (Nussbaum, 2011: p. 55). Such capabilities must be granted at least by the State by treating individuals as equals and as agents of capabilities. Consequently, development means longevity, health, and creativity. This indicates that women live less than men and live longer only in one region in the north because customs and traditions are reversed.

The health system is delegated to the states, and the care service is better because it impacts the users (Nussbaum, 2011: p. 23). It is a system that limits the participation of women when they are not economically or academically empowered. The double shift consists of domestic work and child-rearing or palliative care. The capabilities approach evaluates the quality of life and social justice. In this way, the faculties of self-definition of people prevail in the face of injustice and social inequalities. The approach is one of capabilities without referring to fundamental justice or human dignity.

Capacity as substantive freedom or alternative combinations of functioning or totalities of choice opportunities in public spheres (Nussbaum, 2011: p. 40). Capabilities are internal instances and fluids of people or social, economic, and political interactions. This means that the development of capabilities is internal, through education or family. Basic capabilities are the

basis of tender and combined capabilities, but they differ from innate capabilities that do not require volitional interaction. In this sense, those who exceed the threshold are less worthy of attention than those who do not.

State functioning is the realization of capabilities (Nussbaum, 2011: p. 44). Functioning are beings and actions where capabilities are materialized. Capabilities are areas of freedom and choice. The State must treat people with respect and refrain from humiliating them. Mature capabilities are the development of primary, internal, and combined capabilities. Dignity is a condition of universal equality in people because they are considered agents. Treating people as equals does not mean equalizing the conditions of existence. The capabilities approach protects areas of freedom. The freedom given by the State is inherent to human dignity.

Each person is an end (Nussbaum, 2011: p. 55). Therefore, social justice is dignity above the ten thresholds that favor the development of capabilities. The best possible intervention is to create a future where people do not have to continue facing this choice. The capacities of practical reason as organizers of internal, essential, combined, and mature capacities. In this sense, membership is a social recognition of their capacities.

The capabilities approach addresses distributive problems based on minimum dignity thresholds but does not clarify how to proceed with injustice detected below these minimum dignity levels (Nussbaum, 2011: p. 60). Multilateral equality relative to capabilities inhibits local law and its autonomy from its respective contexts and histories. It functions as fertile because it favors other capabilities. This means that corrosive disadvantage prevails because it limits capabilities.

An attempt is made to outline the approach to capabilities based on their characterization as essential, internal, combined, mature, or practical reasons (Goel et al., 2021). The exposition of the order of the capabilities is mentioned when defining and placing them in diverse scenarios common to people. Some examples of groups whose rights and capabilities have been violated, but the theory is desirable rather than normative. The concept of capabilities is widely established in different contexts. The premise that capabilities underlie minimum thresholds the State grants is always defended. However, when they are realized in practical freedoms, they are self-responsibilities of choice of individuals, even when asymmetries prevail between them. The relationship of citizens with the State will solve the minimum problems of the distribution of resources and infrastructure for the development and consolidation of their capabilities.

While it is true that the modern State was born with the mandate to intervene in security, the capabilities approach seems to overlook the fact that the State intervenes in a coercive rather than a persuasive way (Allen et al., 2016). In this sense, the persuasive capabilities approach, according to which the coercive State grants freedoms that we can transform into all kinds of capabilities, seems to contravene the essence of the gendarme State. The claim of universality of the capabilities approach versus the autocratic coercion that distinguishes the intervening State seems to fit into a scenario in which individuals, even called agents, are mere spectators of their security and the conditions that allow them to develop their capabilities.

The capabilities approach seems to be the palliative that the coercive State needs to convince voters that their security precedes their dignity (Ballerin & Bergh, 2021). Such a relationship is substantial since dignity would be closer to freedom as a practical execution, even if established at minimum thresholds. On the other hand, security is inherent to the coercion of the State itself, which must be limited rather than opened up. Suppose the State is coercive to guarantee security at best. In that case, individuals, in the development of their capabilities, must limit the punitive initiatives and corrosive strategies that the State's inefficiency in the provision of justice reaches when it dictates who should or should not be prosecuted, tried, or convicted. The capabilities approach focuses on minimum thresholds of dignity and does not intend to solve the problem of distributing resources and functions among people.

The capabilities approach refers to minimum levels of personal dignity that can only emerge from the thresholds of state security (Allen et al., 2017). Precisely, the capabilities approach seems contemplative in the face of the omnipresence and ubiquity of the State versus the individual responsibility for the development of capabilities or practical freedoms. Neither the state nor the individual seems to assume thresholds of responsibility that allow them to modify the relationship between the state gendarme, which allows the development of individual capabilities, only because such intervention results in practical reasoning. In Kundera's proposal (1984), such state and individual lightness would be resolved with the specific weight of responsibilities that anchor people and governments in a concrete and less symbolic dignity-related purpose. After security and capabilities, functioning and affiliation seem to be two underlying and collateral categories that seem to recall the importance of responsibility as an imperative of the consequences of decisions and actions.

Dimension	Robert Nozick (Theory of Justice as Liberty)	John Rawls (Theory of Justice as Equity)	Amartya Sen (Capability Theory)	Martha Nussbaum (Core et al.)
Justice	Justice is based on individual rights and non-intervention by the State. It focuses on justice as negative freedom, not being coerced.	Distributive justice is based on the principle of difference (benefiting the less favored) and equality of opportunity.	Justice is evaluated through people's ability to achieve a dignified life beyond the mere distribution of goods.	Similar to Sen, but more normative, it focuses on ensuring a list of core capabilities for all individuals as the basis for a just society.

Freedom	Negative liberty: The main concern is that individuals should not be impeded in pursuing goals. The state should guarantee private property and avoid coercion.	Liberty as justice: Rawls believes individual liberty must be balanced with social equality to ensure everyone has the same opportunities.	Positive liberty: the ability of individuals to lead valuable and meaningful lives depends on real opportunities, not just the absence of coercion.	Positive freedom, too, but with a specific list of capabilities that ensure a whole life, such as the right to health, education, and political participation.
Equality	Nozick opposes any form of wealth redistribution that interferes with private property. There is no emphasis on equality except in the protection of rights.	Equality must be guaranteed through fair institutions, which ensure equal opportunities and try to compensate for natural or social disadvantages.	It focuses on equal capabilities: Beyond distributing goods, Sen seeks to eliminate the barriers preventing people from developing their potential.	Equality of capabilities emphasizes that everyone should have access to a minimum list of capabilities necessary for a dignified life.
Human Development	Human development is not an explicit objective. The central goal is to protect private property and individual freedom.	Human development is indirect since it arises from guaranteeing a distributive justice scheme that offers all equal opportunities.	Human development is central to improving people's capabilities to lead the lives they value, regardless of their resources.	Human development is normative and articulated through a list of essential capabilities that must be guaranteed, such as health, employment, and political participation.
Dimensions of Capabilities	Nozick does not consider the capability approach. He focuses on protecting individual rights and ensuring the state's non-intervention.	Capabilities are considered indirectly through equitable redistribution and ensuring social justice, although they are not conceptualized as a specific approach.	Capabilities are central to his theory. People should be free to choose between different ways of life, depending on their capacity to act accordingly.	It defines a concrete list of core capabilities essential for any human being: life, health, physical integrity, affiliation, political participation, and others, which must be guaranteed for justice.
Role of the State	The state should be minimal, intervening only to protect property rights and prevent coercion.	The State must guarantee justice as equity, with a fair distribution of goods and opportunities. This includes designing institutions that ensure equality of opportunity.	The State must ensure people have the opportunities and capabilities to lead dignified and valuable lives.	The State is responsible for guaranteeing a list of basic capabilities so that people can lead fully human lives and participate in society.
Relationship with the SDGs	Nozick would not support state interventions to implement the SDGs, believing redistribution coerces property rights.	Rawls' distributive justice could support the SDGs, as it seeks to benefit the least advantaged and ensure equal opportunity.	Sen's capabilities approach is aligned with the SDGs, as it promotes human development and the improvement of real opportunities for all people.	Nussbaum also aligns herself with the SDGs, advocating for ensuring fundamental capabilities corresponding to human rights and dignity.

Table 1. Comparison between capacities, political systems, forms of State and government regimes

However, the discussion between Nozick, Rawls, Sen, and Nussbaum is a top-down perspective where decisions are established by the State (Günzel-Jensen *et al.*, 2020). The bottom-up approach is different and involves high participation in public affairs. Therefore, this work aimed to compare the top-down theory with the Bottom-up perspective to establish the capacities related to the SDGs.

Are there significant differences between the capabilities a top-down theory defines concerning these emerging categories in the bottom-up perspective?

This paper assumes that the Top-down perspective is precisely distinguished from the Bottom-up perspective in the capabilities concept. Therefore, differences are expected even within Top-down theories.

Method

Design. A psychometric, confirmatory, cross-sectional, and correlational study was conducted with 100 students selected for their affiliation with institutions committed to the SDGs as vocational training guidelines.

Instrument. The Bottom-Up Scale was used (see Appendix A). It includes dimensions related to 1) freedom, 2) justice, 3) equity, 4) capabilities, and 5) satisfaction. Reliability reached values above the minimum required of 0.60, with alphas and omegas between 0.762 and 0.780. Sphericity was significant, and adequacy exceeded the minimum requirement of 0.60 with a KMO value of 0.760. Validity ranged between 0.345 and 0.547.

Procedure. A communication of the project's objectives, responsibilities, and functions was distributed via email to the sample surveyed. They were sent a letter to attend a focus group to homogenize freedom, justice, equity, capabilities, and satisfaction. They were invited to the Delphi study to evaluate the reagents and collect comments. The survey was applied at the facilities of the public university.

Analysis. The reliability, adequacy, sphericity, validity, adjustment, and residual coefficients were estimated to contrast the null hypothesis regarding significant differences between the theoretical structure known as Top-Down and an empirical study from the bottom-up logic.

Results

The analysis of the factorial weights reveals the latent factors. The values exceed the threshold of 0.300 to consider the construct validity. The residual analysis indicates the degree of adjustment of the observed structure concerning the empirical structure. The findings show significant values between half of the measurement errors, indicating one substructure's prevalence over the other. In the case of the intercept analysis, which indicates the prediction of the factorial structure, the values were significant. On the other hand, the covariance and residual matrices reach values more significant than one, which indicates the non-inclusion of other factors and indicators in the model. Finally, the covariance matrix analysis between the selected indicators includes a diagonal of zero, which indicates the non-inclusion of more variables in the model (see Fig. 1).

	liberty1	liberty2	liberty3	equity1	equity2	equity3
liberty1	o					
liberty2	o	o				
liberty3	o	o	o			
equity1	.05	.14	.1	o		
equity2	.43	.16	.31	o	o	
equity3	.03	.09	.26	o	o	o

Figure 1. Covariances between indicators of liberty and equity

Structural analysis of the relationships between factors, indicators, and measurement errors suggests the model's parsimony (see Fig. 2). The findings show three Heywood cases that suggest reducing the model to three indicators with their respective factors.

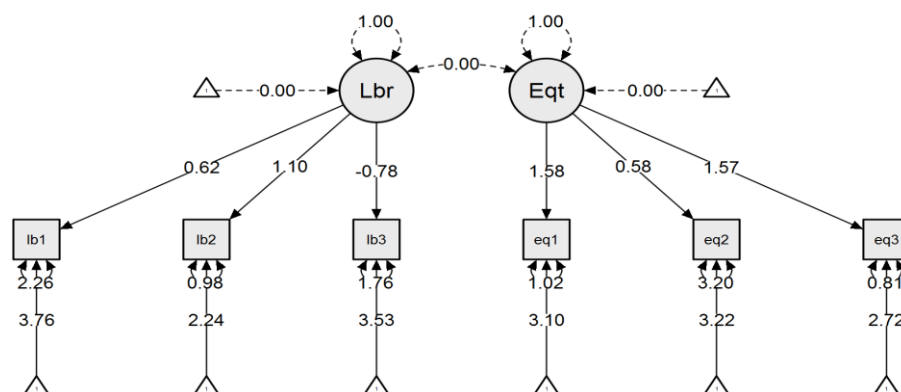


Figure 2. Model of confirmatory factor analysis of bottom-up perspective

The fit and residual values [$\chi^2 = 73.252$ (9gl) $p > 0.001$; GFI = 0.976; MFI = 0.725; RMSEA = 0.212] suggest the non-rejection of the null hypothesis regarding significant differences between the theoretical structure and the structure empirical. There are differences between the top-down approach and the bottom-up perspective, although only two of the five possible factors are confirmed.

Discussion

This work's contribution to the state of the art lies in comparing the factorial structure of the theoretical perspective known as Top-Down concerning the Bottom-Up approximation. The results suggest the null hypothesis is not rejected relative to the differences between the perspectives, although it was only possible to confirm two of the five factors analyzed.

Freedom and equity are crucial in the context of sustainable development goals (SDGs). The National Strategy on Equity and Gender Equality emphasizes the importance of the idea that every individual should have equal opportunities (Nagati et al.,

2023). Equity, justice, and the SDGs are interconnected, with justice being vital to achieving equality, liberty, and fraternity. Peace is also highlighted as a fundamental precondition for social and economic development, emphasizing a peaceful environment to work towards equity and freedom.

In pursuing sustainable development, organizations focus on enabling sustainable growth through strategic initiatives and partnerships that promote diversity and equity (Zhou *et al.*, 2023). The Sustainable Development Imperatives highlight the importance of needs, equity, and limits in guiding policymaking for a sustainable future. Intergenerational equity is also highlighted as a critical indicator of sustainable development, and renewable energy plays a crucial role in achieving this goal. Furthermore, the link between human rights, climate change, and sustainable development is highlighted, with efforts to limit the effects of climate change being necessary to achieve equity and poverty eradication (Mara, 2018). The commitment to achieving equity and opportunity through sustainable corporate practices further underscores the importance of incorporating these values into business strategies. In conclusion, the literature reviewed highlights the interconnection of freedom, equity, and the SDGs in pursuing sustainable development. By prioritizing justice, peace, and diversity, organizations and policymakers can work towards a more equitable and sustainable future for all people, leaving no one behind in pursuing health and well-being.

Unlike the state of the art, which emphasizes the link between freedom and equity regarding the SDGs from the perspective of organizations, this work demonstrated that the bottom-up approach confirms the relationship between freedom and equity from a scenario of SDG adoption. Therefore, the area of opportunity of this work lies in extending the sample to confirm the theoretical structure and excluding the reagents that measure the unconfirmed factors.

Conclusion

This study aimed to compare the theoretical framework known as top-down with the practical implementation of a framework referred to as bottom-up. The findings support two out of five factors and indicate that the null hypothesis regarding the differences between the two frameworks in implementing the Sustainable Development Goals (SDGs) in a public university in central Mexico should not be rejected. Based on the reviewed literature, which emphasizes the relationship between the two factors of booklet and equity, this study recommends further external research to validate the five theoretical factors outlined in the existing body of knowledge.

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APPENDIX A

Instructions:

Below, you will find a series of statements. For each one, mark the level with which you agree using the following scale:

1. Totally disagree
2. Disagree
3. Neutral
4. Agreed

5. Totally agree

Section 1: Justice and Freedom (Robert Nozick's Theory)

1. People should be free to accumulate and use their resources without interference from the State.
2. Justice is guaranteed when private property is protected without redistributing it.
3. Government intervention in the redistribution of resources reduces individual freedom.
4. The State should limit itself to protecting fundamental rights, such as private property and contracts.
5. There should be no redistribution mechanism to correct economic inequalities.

Section 2: Equity and Distributive Justice (John Rawls' Theory)

1. Social and economic inequalities are only fair if they benefit the least favored.
2. A fair system must ensure that all people have equal opportunities.
3. The State must intervene to correct people's natural or social disadvantages.
4. Justice implies that resources and opportunities should be distributed equitably.
5. Access to education and health must be guaranteed, regardless of social or economic origin.

Section 3: Capabilities and Human Development (Amartya Sen's Theory)

1. True freedom is having the ability to live a life I value.
2. Beyond income, it is essential that I am given opportunities to develop my skills and talents.
3. Public policies should focus on improving people's quality of life and real opportunities.
4. A society's well-being is measured by its citizens' ability to participate fully in social, political, and economic life.
5. The distribution of resources is only a means to improve people's capabilities, not an end.

Section 4: Core Capabilities (Martha Nussbaum's Theory)

1. The State must guarantee that all individuals have access to health, education, and employment to live with dignity.
2. A dignified life includes actively participating in political decisions that affect my community.
3. People must have the freedom and ability to develop physically, emotionally, and socially.
4. Women and minorities must be guaranteed equal rights and opportunities to develop their capabilities.
5. My well-being depends on material goods and opportunities to enjoy a whole and meaningful life.

Section 5: Gender Equity and Social Justice

1. Access to opportunities must be equal for men and women, regardless of context.
2. Public policies should focus on eliminating barriers that prevent gender equality in all areas.
3. Social justice means ensuring all marginalized groups have equitable access to resources.
4. A society's well-being is achieved when all citizens, regardless of gender or social class, can participate in decisions that affect them.
5. Quality education for all is essential to building a fair and equitable society.

Section 6: Satisfaction with Justice and Capabilities in Today's Society

1. I believe that in my country, people have enough freedom to develop their abilities without interference.
2. Current policies are effective in ensuring equity among different social groups.
3. Access to health and education is well distributed among all population sectors.
4. Public policies promote comprehensive human development that goes beyond economic growth.
5. Justice and equity in my country are reflected in the ability of everyone to participate fully in society.

Interpretation of the instrument:

- Section 1 (Nozick): Measures the perception of negative freedom and the non-intervention of the State in the redistribution of resources.
- Section 2 (Rawls): Evaluates the perception of distributive justice and the principle of equity.
- Section 3 (Sen): Assesses the understanding and importance of capabilities as a basis for absolute freedom and human development.

Section 4 (Nussbaum) measures the perception of the need to ensure a list of core capabilities for all individuals.

- Section 5: Explores perceptions of gender equity and social justice within the capability's framework.

- Section 6: Evaluate respondents' satisfaction with the current state of justice and human development policies in their society.

APPENDIX B

Install required libraries

! pip install factor_analyzer

Import the libraries

import pandas as pd

from factor_analyzer import ConfirmatoryFactorAnalyzer, ModelSpecificationParser

import numpy as np

Upload the file (already uploaded in your case)

file_path = '/path_to_your_file/SEM CFA Capabilities.ods'

data = pd.read_excel(file_path, sheet_name='Sheet 1')

Select the variables that belong to the theoretical dimensions

Adjust these variables according to the factors you want to analyze

justice_vars = ['justice1', 'justice2', 'justice3']

liberty_vars = ['liberty1', 'liberty2', 'liberty3']

equity_vars = ['equity1', 'equity2']

capability_vars = ['capability1', 'capability2', 'capability3']

satisfaction_vars = ['satisfaction1', 'satisfaction2', 'satisfaction3']

Combine the variables into a single dataset for the CFA

cfa_data = data [justice_vars + liberty_vars + equity_vars + capability_vars + satisfaction_vars]

Define the model based on the theoretical dimensions

```
model_dict = {
'Justice': justice_vars,
'Liberty': liberty_vars,
'Equity': equity_vars,
'Capability': capability_vars,
'Satisfaction': satisfaction_vars
}
# Convert the model to a structure compatible for analysis
model_spec = ModelSpecificationParser.parse_model_specification_from_dict(cfa_data, model_dict)
# Create the CFA model
cfa = ConfirmatoryFactorAnalyzer(model_spec, disp=True)
cfa.fit(cfa_data)
# Get CFA results
loadings = cfa.loadings_
print ("Factor loadings:\n", loadings)
# Check model fit
print ("Chi-square of model:", cfa.chi_square_)
print ("Degrees of freedom:", cfa.df_)
print ("p-value:", cfa.p_value_)
print ("RMSEA:", cfa.rmsea_)
print ("CFI:", cfa.cfi_)
```