

Governing from the future, leading with equity:

Policies, prospects, and pathways
for Aruba 2040



CENTRALE BANK VAN ARUBA

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A faint, historical-style map of Aruba and the surrounding Gulf of Paria region serves as the background. The map shows the island of Aruba at the top, with various coastal features and neighboring islands like Orubilla and Oruba. The Gulf of Paria is labeled in the center, with numerous smaller islands and peninsulas such as P. Macolla, S. Ana, Pan de S. Ana, P. Guyaque, and P. Barc. Rivers like R. Capalarie, R. Sesarido, R. Aigueque, R. Casiquas, R. Bareja, R. Catabria, R. Arenas, and R. Olivera are depicted. Other geographical features include S. Cruz Bay, Johannes Bay, S. Martha Bay, S. Michael, F. Am, C. de S. Roman, and the Valley Rio de. The map is overlaid with a grid of latitude and longitude lines.

Governing from the future, leading with equity: Prospects, policies, and pathways for Aruba 2040

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Foreword *Governing from the Future – Leading with Equity*

In an era defined by accelerating change and compounding global crises, the imperative for forward-looking, resilient, and equitable governance has never been more acute.

For small island developing states like Aruba, navigating this volatile, uncertain, complex, and ambiguous environment demands more than reactive problem-solving; it requires the institutional capability to lead anticipatorily, i.e., from an emerging future using forward-thinking strategies. It is with this fundamental understanding that the Centrale Bank van Aruba (CBA) presents the third volume in its flagship policy series, *Governing from the Future*.

This series serves as a cornerstone of our commitment to serve the public interest, foster economic wellbeing, and contribute meaningfully to the just and necessary transition towards a resilient and inclusive Aruba. This latest edition builds upon a strong intellectual foundation, continuing a journey of inquiry that began with identifying systemic risks and evolved to championing inclusive solutions. It seeks to translate the high-level frameworks of its predecessors into tangible, people-centric policy pathways that address the everyday securities and vulnerabilities of the Aruban community.

The “*Governing from the Future*” series was conceived as a platform for evidence-based dialogue, aimed at sharpening the focus of policymakers and stakeholders on achieving impactful and responsible outcomes for current and future generations. Each volume has progressively deepened the analysis of the challenges and opportunities facing Aruba.

The inaugural edition, *Leading with Impact* (2022), established the core philosophy of the series. It introduced the critical concept of “Gray Rhinos” – the large, obvious, yet often neglected threats that evolve over time and pose significant risks to sustainable development. These challenges, from demographic shifts and fiscal sustainability to climate change and resource management, require a proactive governance model. To address these Gray Rhinos, the report utilized the methodology of Futures Thinking, presenting three distinct policy scenarios for Aruba in 2040: a *policy as usual* scenario, a *policy reform* scenario, and a transformative *policy shift* scenario. This investigative policy framework underscored the profound consequences of our present policy choices. By examining critical areas such as demographic change, economic development, the future of social security, climate and energy security, financial inclusion, and public sector innovation, *Leading with Impact* laid the essential groundwork for a new, foresight-driven policy discourse in Aruba. It was a call to lead the economy as if the future truly matters, making responsible, evidence-based choices to safeguard opportunities for generations to come.

Building upon this foundation, the second volume, *Leading with Inclusion* (2024), argued that for any policy impact to be sustainable, it must be inclusive. It shifted the focus from merely identifying systemic risks to ensuring that the pathways to resilience are equitable and just. The central theme of this edition was the concept of *inclusive resilience*, i.e., the ability of a community to absorb, adapt, and transform in the face of shocks in a manner that empowers all members of society, leaving no one behind.

Leading with Inclusion advanced the dialogue by moving beyond sustainability toward regeneration, focusing on transitioning Aruba's economy and financial system to one that is not only resilient but also restorative. The report scrutinized the intricate links between human development and economic growth, the transformative potential of the future of work and digital transformation, the role of a retail digital florin in fostering inclusive resilience, the critical need for an inclusive energy transition, and the foundational importance of affordable housing. This volume cemented the principle that resilience is not merely a technical or economic challenge but a social one; its success is measured by how well it protects and empowers the most vulnerable.

This third edition continues this vital inquiry by delving into more granular, people-centric dimensions of security and wellbeing. More specifically, while the first two volumes established the *what* (systemic risks) and the *how* (through inclusive frameworks), this edition focuses intensely on the *who*, i.e., the individuals, families, and communities whose daily lives are shaped by policy decisions. The chapters within this volume examine the intricate ways in which economic forces, environmental pressures, and social structures impact the fundamental security of Aruban citizens. The collected works scrutinize the bedrock of a stable society: the ability to earn a fair wage, afford basic necessities, build financial literacy, live healthy, and work in a safe environment.

The seven studies presented here are woven together by a common thread: the urgent need to build a resilient Aruba from the ground up, ensuring that every individual has the tools, opportunities, and protections necessary to thrive. The research covers three critical domains: (I) *Economic Realities and Social Equity*, (II) *Foundational Security for Human Flourishing*, and (III) *Adapting to a Changing Climate* (see Figure 1). Each chapter in this volume provides a rigorous, data-driven

analysis of a specific challenge and offers concrete, actionable policy recommendations designed to foster a more secure, equitable, and resilient future for Aruba.

(I) Economic Realities and Social Equity

This section confronts the structural inequities that can undermine inclusive growth, focusing on gender, income class, and youth.

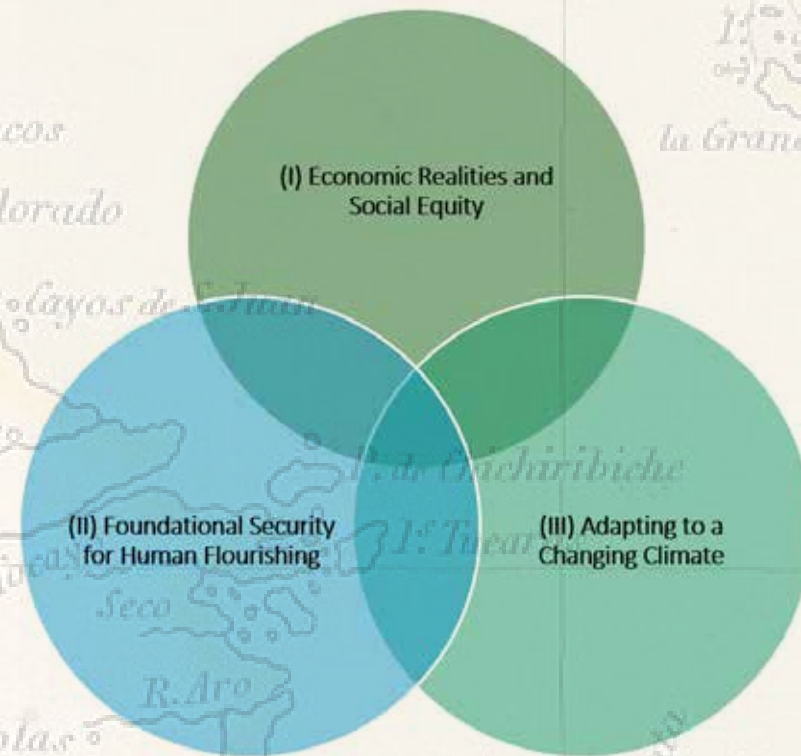
In “**Does Gender Equality Matter?**”, Stephanie Werleman investigates the nexus between gender inequality and economic growth in Aruba. While the analysis reveals a welcome long-term decline in the Gender Inequality Index, it uncovers a troubling disconnect: this progress has not significantly translated into economic growth. The chapter attributes this to the persistent stagnation in women's labor force participation and the enduring gender wage gap. It calls for targeted policy interventions, including mandatory gender pay audits and flexible work arrangements, alongside a robust framework for collecting gender-disaggregated statistics to guide future policy.

Daniella van den Berg's timely study, “**Is the Middle Class Being Squeezed?**”, explores the phenomenon of inflation inequality. Using detailed expenditure data, the chapter demonstrates that during recent inflationary periods, Aruba's middle-income households have borne the heaviest burden, disproportionately affected by rising transportation costs. This finding is critical, as a strong and stable middle class is the bedrock of inclusive growth. The research provides policymakers with a clear mandate to develop targeted support mechanisms to protect the economic foundation of our community from the erosive effects of inflation.

Completing this section, Rynall Kock addresses a crucial demographic in “**Achieving labor security for the Aruban youth.**” The chapter moves beyond the headline issue

of unemployment to construct a more holistic picture of labor security, encompassing income protection and voice representation. Recognizing that youth unemployment remains starkly high in the post-COVID landscape, this study examines the multifaceted challenges young Arubans face in the labor market and will propose policies designed to ensure they have not just jobs, but secure and meaningful work.

Figure 1.
Critical Domains in Governing from the Future – Leading with Equity.



(II) Foundational Security for Human Flourishing

This theme explores two essential pillars of individual and community wellbeing: food security and financial literacy.

Lorraine Tromp's chapter, **"Exploring Food Security in Aruba"**, provides a comprehensive assessment of Aruba's standing across the four dimensions of food security: availability, access, utilization, and stability. Leveraging recent survey data from the CBA, the study reveals that while Aruba performs relatively well compared to the Caribbean average in preventing moderate or severe food insecurity, there remains significant room for improvement. The chapter highlights a mix of successes and challenges, and concludes with actionable policy recommendations to strengthen Aruba's food systems and enhance its resilience against supply chain disruptions.

In **"Measuring Student Financial Literacy in Aruba: Insights from the OECD/INFE Framework"**, Elmelynn Croes examines the financial literacy of students in Aruba's public higher education institutions. Using the internationally recognized OECD/INFE framework, the study finds that while students exhibit positive financial attitudes and cautious day-to-day behaviors, important gaps remain in translating financial knowledge into more strategic practices that build long-term resilience. This research develops and provides initial validation of a tailored instrument for measuring financial literacy in a small island context and provides a clear call to action: to integrate practical, culturally relevant financial education into tertiary curricula and foster cross-sector partnerships to empower the next generation with the skills needed for a secure financial future.

The concluding section confronts the existential challenges posed by our changing climate, focusing on the macro issue of energy security and the micro impact of extreme heat on the Aruban workforce.

Finally, Ryan R. Peterson's research, **"Safeguarding Workforce Wellbeing Amid Extreme Heat"**, brings the climate crisis down to the human level. The chapter investigates the severe and escalating impact of rising temperatures on worker health and productivity, particularly in Aruba's vital, labor-intensive tourism sector. It introduces the concepts of Occupational Heat Resilience (OHR) and the Urban Heat Island (UHI) effect, arguing that current labor regulations and urban infrastructure are inadequate to mitigate and manage extreme heat. The study concludes with a set of policy recommendations, including national heat governance, revised OHR regulations, and strategic investments in nature-based urban restoration to protect our workforce and safeguard our economic productivity in a warming world.

The challenges facing our island are multidimensional and complex, requiring intergenerational solutions and deep commitments from all of us. Once we have the strategic insights and ingenuity, we can tap into the many opportunities to address the challenges. From closing the gender pay gap to protecting our middle class, securing our food and energy supplies, and adapting our workplaces to a new climate reality, the path forward requires courage, innovation, and an unwavering commitment to equity. The research presented here is more than an academic exercise; it is intended as a vital tool for policymakers, a catalyst for informed public debate, and a call for concerted, evidence-based policy actions. By continuing to look ahead, to anticipate challenges, and to place the wellbeing of all Arubans at the center of our policy agenda, we can collectively govern from the future, and in doing so, secure a prosperous, resilient, and inclusive future *for* all.

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Gender inequality in Aruba

Does Gender Equality Matter? Investigating the Impact of Gender Inequality on Economic Growth in a Small Island Tourism Economy: A Case Study for Aruba

Stephanie Werleman

Abstract

This paper addresses the questions: How does gender inequality impact economic growth in Aruba? Moreover, how has gender inequality changed over time in Aruba? First, we estimate the Gender Inequality Index (by the United Nations Development Programme) for Aruba from 1999 to 2021. We find a long-term declining trend in gender inequality during the past two decades. Then, we empirically investigate the gender inequality - economic growth nexus for Aruba by applying an autoregressive distributed lag estimation technique. According to the results, gender inequality does not significantly impact the Aruban economy, despite its long-term declining trend. This is due largely to the virtually unchanged proportion of women in the labor force over the past two decades despite a lower adolescent birth rate and more educated women. Furthermore, due to persistent wage inequality, women may self-opt out of the Aruban workforce or choose to earn extra income in the informal economy. We propose two policy recommendations with regard to gender inequality. First, the Government of Aruba should implement gender wage gap-reducing policies (e.g., introduce mandatory gender pay audits), in tandem with policies that increase women's participation in the labor force (e.g., promoting flexible working hours). Second, we encourage collecting and publishing gender statistics.

Keywords: gender inequality, economic growth, Small Island Developing States, Sub-National Island Jurisdictions

1. Introduction

“Women and girls represent half of the world’s population and, therefore, also half of its potential. But, today, gender inequality persists everywhere and stagnates social progress” (United Nations, 2020, para. 2). Extensive research exists on the impact of gender inequality on economic growth. These studies show that gender inequality has a significant and negative effect (see, for example, Koengkan et al., 2022). However, despite the increasing number of studies on the gender inequality - economic growth nexus, the empirical literature on this relationship in Small Island Developing States (SIDS) and Sub-National Island Jurisdictions (SNIJs) remains limited. Considering the – in general – differing circumstances faced by women and girls in Caribbean SIDS, such as higher unemployment rates, a high proportion of households headed by women, and lower-paying jobs compared to men despite being the majority of tourism employees (see, e.g., International Labour Organization, 2018), we argue that studying gender inequality in a Caribbean island setting is highly relevant for policymakers¹.

This paper focuses on the specific case of Aruba, a Caribbean SNIJ. The current knowledge signals the existence of gender inequality despite women making up most of Aruba’s

population². For instance, an existing research claims that Aruban women earn 80 percent of the salary received by their male counterparts in similar jobs (Central Bureau of Statistics Aruba, 2017). In addition, men dominate the political arena, and Aruban women are more likely to have health limitations (in the form of one or more disabilities) vis-à-vis males (Central Bureau of Statistics Aruba, 2017; United Nations Development Programme, n.d.). Furthermore, there exists gender disparity in terms of the unemployment rate (Nos Aruba 2025, 2016). In 2022, the unemployment rate for women stood at 5.2 percent (2023: 3.9 percent) while that for men was 3.2 percent (2023: 4.0 percent), according to the Labour Force Survey³ of the Department of Labor and Investigation Aruba. Moreover, Aruba has the second highest divorce rate (52.6 percent) (YMAM Aruba, 2021). This phenomenon is problematic for Aruban women as previous studies show that the economic costs of divorce fall more heavily on women vis-à-vis men (Leopold, 2018).

Despite these occurrences and the need to investigate, as well as advance gender equality, not many gender indicators are available for Aruba. According to the United Nations Women (n.d.), in 2020, only 6.7 percent of indicators needed to monitor the Sustainable Development Goals (SDGs) from a gender perspective were available. An important indicator,

¹ Examples of gender inequality-reducing policies include, but are not limited to, fighting women’s poverty through the reduction of the gender pay gap, increasing women’s participation in decision-making, and supporting victims of gender-based violence (see, European Commission, n.d.). Specific policy actions might include raising the minimum wage and encouraging mothers to remain in or return to employment (see, Rubery, 2016).

² According to the latest Quarterly Demographic Bulletin of the Central Bureau of Statistics Aruba (3rd quarter of 2022), women made up 52.9 percent of the total population.

³ See https://daoaruba.com/wp-content/uploads/2019/09/Tabelarbeidsmarktcijfers-2015-Nov2022_Def12.0NL-Website.pdf and <https://cuatro.sim-cdn.nl/verheid2858bd/uploads/lfsresults2023-def1.0.pdf?cb=QQ0pQh6E>

the Gender Inequality Index (GII), is not found within that 6.7 percent. The GII is a composite metric of gender inequality based on health, empowerment, and the labor market that allows for comparison across time and countries (United Nations Development Programme, 2023). Moreover, to our knowledge, no prior studies have empirically examined how gender inequality affects economic growth in Aruba. This lack of data availability, paired with a lack of research, hinder the investigation of gender inequality and make it difficult to generate policy advice and make data-informed decisions on this topic for Aruba.

Against this background, the aim of this paper is two-fold. First, we address the data gap by calculating the GII for Aruba. We follow the United Nations Development Programme (UNDP)⁴ to compute the GII. As the data needed to construct the GII for Aruba are not readily available, we asked several local institutions to provide information. Our resulting GII estimation spans 1999 to 2021. Second, we empirically investigate the gender inequality - economic growth nexus for Aruba. The gender inequality index-economic growth nexus is examined using the autoregressive distributed lag (ARDL) estimation technique. In doing so, this paper addresses the following research questions (RQs):

1. How does gender inequality impact economic growth in Aruba?
2. How has gender inequality changed over time in Aruba?

The structure of this paper is as follows. Section 2 presents the background for the study, and section 3 provides a brief literature review. Section 4 contains the methodology for the GII

computation and the ARDL estimation technique. In addition, section 4 presents the data. Section 5 shows and discusses the results. Finally, section 6 provides the conclusion, policy implications, and recommendations for future studies.

2. Background

2.1. Gender inequality and related measurements

There are numerous definitions of gender inequality.

For example, about thirty years ago, Young et al. (1994) defined gender inequality as the “departure from parity in the representation of women and men in key dimensions of social life” (p. 55). Similarly, the UNICEF Regional Office for South Asia (2017) provides a (broad) definition of gender (in)equality. According to the agency, gender equality is a concept that states that women and men, as well as girls and boys, have equal conditions, treatment, and opportunities for realizing their full potential. In addition, they have human rights and dignity in contributing to and benefitting from economic, social, cultural, and political development. Gender inequality emerges when these conditions do not hold in their entirety. Most recently, gender inequality was defined by Jose and Sivaraman (2023) as the “unequal attainment of outcomes between men and women in various dimensions of society” (p. 233). Therefore, while there are several definitions of gender inequality, all relate to the deviation from equality between women and men.

Consequently, gender inequality indicators measure women’s status relative to men’s (Buvinić et al., 2008). The

■ ⁴ See: <https://hdr.undp.org/data-center/thematic-composite-indices/gender-inequality-index#/indicies/GII>

existing literature reveals several indicators for gender inequality: the GII by the United Nations (formerly introduced in section 1), the Gender Development Index (GDI) by the United Nations, the Gender Gap Index (GGI) by the World Economic Forum, and the Gender Equity Index (GEI) by Social Watch, among others. We aim to measure GII for Aruba – and not alternative indicators like those presented above – for several reasons. First, there is a lack of data for the computation of the sub-components of the alternative indicators. Second, the GII is widely used by international organizations such as the United Nations in cross-country comparisons. Therefore, calculating the GII for Aruba allows for benchmarking with other countries, including other SIDS, that already have a GII estimation in place. Third, the GII is commonly used in existing empirical work on gender inequality and economic growth, allowing for comparison with our study's findings.

2.2. Evidence of gender inequality in Aruba

Currently, no estimation has been conducted for GII for Aruba. However, there is evidence of gender inequality – most often disadvantaging women and girls – in terms of income, politics, health, and employment in Aruba (Central Bureau of Statistics Aruba, 2017; Nos Aruba 2025, 2016; United Nations Development Programme, n.d.). In this section, we delineate the state of gender inequality in Aruba following a published report and data from the Central Bureau of Statistics Aruba after the 2010 and 2020 censuses.

2.2.1. A snapshot of 2010

In 2017, the CBS Aruba published the “Gender Gap in Aruba” report based on 2010 census data. At that time,

gender inequality in Aruba was discussed by the Central Bureau of Statistics Aruba (2017) in a wide range of aspects:

- a) **Education:** The gender gap in the literacy rate widens as the age category increases. This means that there are more literate men than women the higher the age group becomes. On the other hand, the level of education for the school-attending population seems to favor women. Specifically, the proportion of the school-attending population enrolled in primary and secondary education is virtually equal, yet about 47.0 percent of the males in the school-attending population are enrolled in tertiary education compared to 57.0 percent of the females (Central Bureau of Statistics Aruba, 2017).
- b) **Health and survival:** Life expectancy is higher for women than men, and both have increased at an equal pace. Nevertheless, this does not imply better health for Aruban women, as the number of women reporting to have at least one health limitation is generally higher than men (Central Bureau of Statistics Aruba, 2017).
- c) **Economic participation and opportunity:** There was evidence of a gender gap in the participation of women and men in the Aruban labor market. In 2010, the participation rate for men stood at 70.3 percent and women at 60.5 percent. Moreover, there was evidence of wage inequality for similar work: men were paid, on average, Afl. 700 more than women (Central Bureau of Statistics Aruba, 2017).
- d) **Political empowerment:** In 2010, seven of the twenty-one seats in the Aruban parliament were occupied by women (2023: eight of the twenty-one seats), and the Minister Council consisted of one woman and eight men (2023: two women and six men). These observations pointed out that men dominate the political arena despite women starting to position themselves in leadership occupations. In addition, at that point

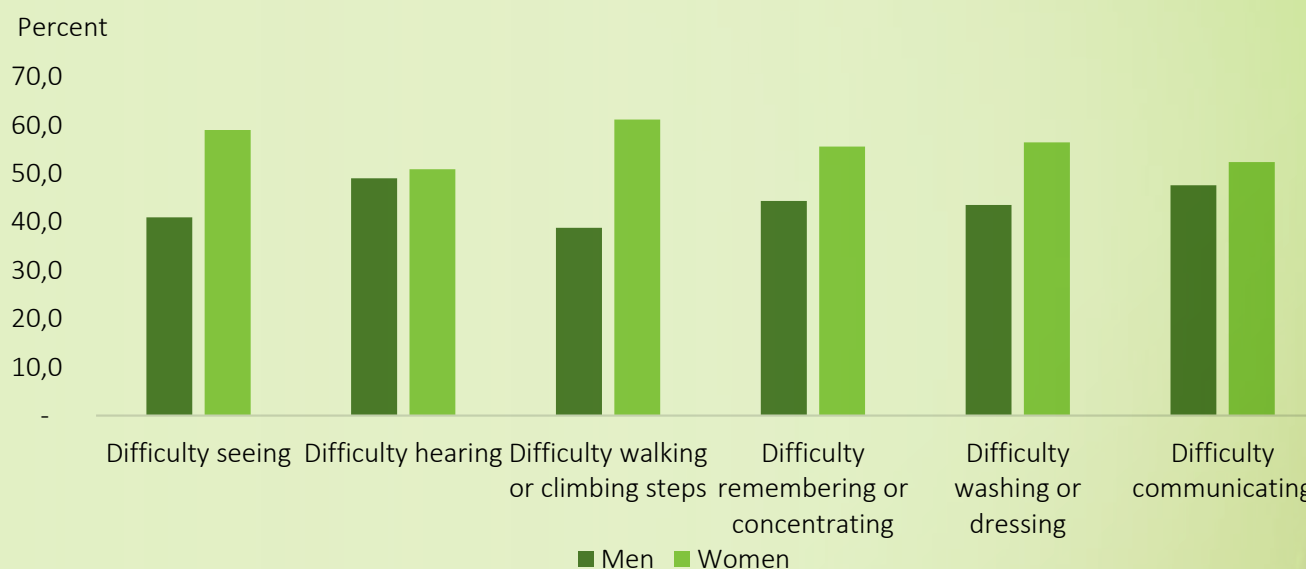
in time, Aruba had never had a female head of state (Central Bureau of Statistics Aruba, 2017).

2.2.2. Evidence of gender inequality in census 2020⁵

We use data from the Central Bureau of Statistics Aruba after the latest census to describe gender inequality in 2020.

a) **Health:** The 2020 census asked about health limitations,

including difficulties in seeing, hearing, walking or climbing steps, remembering or concentrating, washing or dressing, and communicating. According to these data, women are consistently more likely to experience a health limitation than men. This finding aligns with the 2010 census results, which show that women faced more health limitations vis-à-vis men (see previous subsection). The reported percentages based on the 2020 census are shown in Figure 1.



Note. Data was retrieved from the Central Bureau of Statistics Aruba. See <https://cbs.aw/wp/index.php/category/censo-2020-basic-tables/>

Figure 1. Persons with limitations by type of limitation and gender

■ ⁵ Based on published census data at the time of writing this paper. See <https://cbs.aw/wp/index.php/category/censo-2020-basic-tables/>

Moreover, regarding persons who need help due to a physical or mental limitation, the data shows that the proportion of women (59.6 percent) is higher than that for men (40.4 percent).

- b) **Economic participation:** The 2020 census questioned the activity status of the population 14 years of age and older. The responses varied across economically active, not economically active, and activity status unknown. According to these data, the participation rate for men stood at 59.1 percent and women at 52.0 percent, indicative of a gender gap where men are likely to be more economically active than women. This finding might explain why the Directie Sociale Zaken (2017) notes that most (66.0 percent in 2015) of the normative welfare entitlement population are female. On the other hand, in 2020, the unemployment rate stood at 9.2 percent for men and 8.0 percent for women. However, we note that according to the latest labor market data from the Directie Arbeid en Onderzoek (DAO) Aruba⁶, in November 2023, the participation rate of men stood at 67.6 percent and that of women at 58.5 percent. At the same time, men's unemployment rate reached 4.0 percent and women's 3.9 percent, which is in line with the dissipation of the COVID-19 pandemic. With regard to occupations, the 2020 census data shows a gender gap in managerial positions. Specifically, in 2020, women held 45.3 percent of all managerial positions in Aruba, indicating that men are more likely to be managers.

To summarize, the data reviewed shows evidence of gender inequality in Aruba. In most cases, gender inequality seems to favor men vis-à-vis women, indicating that in Aruba, men are more privileged compared to women.

3. Literature review and hypothesis development

The body of knowledge concerning the impact of gender equality or gender inequality on economic growth is exhaustive. Table 1 summarizes the literature reviewed.

Most studies use (real) GDP (per capita) as a measure of economic growth (see, e.g., Brummet, 2008) and a combination of regression analysis as their method (see, e.g., Goodwin et al., 2017). On the other hand, the studies vary with regard to the proxy used for gender inequality. Some studies – such as Seguino (2000), Klasen and Lamanna (2009), and Godslove and Sandra (2018) – do not apply a multidimensional measure for gender inequality, such as the GII. For example, Seguino (2000) uses education and wage gap data to measure inequality. Similarly, Godslove and Sandra (2018) apply the labor force participation rates and school enrollment for secondary education per gender as a measure of gender inequality. In addition, the studies vary considerably in the countries analyzed. To be specific, some studies use panel data (see, e.g., Altuzarra et al., 2021), and some are case studies (see, e.g., Akhtar et al., 2023). The studies also exhibit considerable differences in the applied data period, varying from 7 to 40 years.

Despite these differences across the studies, it is evident that the results are homogenous. All studies, except for Seguino (2000), conclude that gender inequality deters economic growth or that gender equality stimulates economic growth. Against this background, we hypothesize:

H1. Gender inequality, measured as the GII, has a negative and statistically significant impact on economic growth (i.e., real GDP growth) in Aruba.

■ ⁶ See https://daoaruba.com/wp-content/uploads/2019/09/Tabelarbeidsmarkt cijfers-2015-Nov2023_Def15.ONLen-ENG-website.pdf

Table 1. Summary of literature reviewed

Author(s)	Proxy for economic growth	Proxy for gender inequality	Country(ies)	Period	Method	Conclusion
Seguino (2000)	Gross domestic product growth	The percentage of females and males 15 and over who have completed secondary education, the growth rate of secondary school attainment by sex, average years of total and secondary education per female and male, gender wage gap (measured as the difference between male and female earnings), wage gap corrected for educational attainment.	A set of semi-industrialized countries: Paraguay, El Salvador, Greece, Costa Rica, Brazil, Colombia, Sri Lanka, Chile, Türkiye, Mexico, Philippines, Indonesia, Portugal, Cyprus, Malaysia, Thailand, Hong Kong, Korea, Taiwan, and Singapore.	1975-1995	Cross-country and panel regression analysis	A positive association exists between gender wage inequality and gross domestic product growth.
Klasen and Lamanna (2009)	Per capita annual compound growth rate in purchasing power, parity-adjusted gross domestic product per capita	Gender gaps in education (e.g., female-male ratio of schooling) and employment (gender gaps in labor force participation)	A set of countries of the Middle East and North Africa, Sub-Saharan Africa, the Organisation for Economic Co-operation and Development, Latin American and Caribbean, and Eastern Europe and Central Asia.	1960-2000	Cross-country and panel regression analysis	Gender gaps in education and employment significantly reduce economic growth.
Altuzarra et al. (2021)	Gross domestic product per capita annual growth rate based on purchasing power parity PPP	The proportion of seats held by women in national parliaments, school enrolment, primary (gross), gender parity index, school enrolment, secondary (gross), gender parity index, the female-male ratio of labour force participation	A set of countries in the sub-Saharan Africa, Southeast Asia, the Middle East, Latin America and the Caribbean and East Asia and Pacific.	1990-2017	Cross-country and panel regression analysis	Gender equality in education is positively associated with economic growth. There is no statistically significant result for the relationship between the female-male ratio of labor market participation and economic growth. The relationship between women in parliaments and economic growth is positive for the complete sample but negative for the countries belonging to sub-Saharan Africa.
Godslove and Sandra (2018)	Gross domestic product	Labor force participation rate of males (% ages 15 and older), labor force participation rate of females (% ages 15 and older), school enrollment secondary education males (% gross), school enrollment secondary education females (% gross)	Nigeria	1990-2016	Ordinary Least Squares regression analysis	The coefficient of males enrolled in secondary education is negative and significant when regressing on gross domestic product. On the other hand, female labor force participation rate is positively associated with gross domestic product. All other variables are statistically insignificant.

Author(s)	Proxy for economic growth	Proxy for gender inequality	Country(ies)	Period	Method	Conclusion
Koengkan et al. (2022)	Gross domestic product per capita	Gender Inequality Index	Seventeen countries in the Latin America and Caribbean region	1990-2016	Ordinary Least Squares regression analysis with fixed effects and quantiles via moments model	Gender inequality negatively affects gross domestic product per capita.
Goodwin et al. (2017)	Growth rate of per capita gross domestic product	Gender Inequality Index	A set of 96 countries	1980-2015	Ordinary Least Squares regression analysis	Increases in gender inequality negatively impact the gross domestic product per capita growth rate.
Brummet (2008)	Real gross domestic product per capita	The ratio of average years of schooling in the male population to average years of schooling in the female population	A set of 71 developed and developing countries	1960-2000	Ordinary Least Squares regression analysis	Gender inequality in education is negatively associated with real gross domestic product per capita growth. However, this result is highly sensitive to the inclusion or exclusion of certain outliers.
Atiq and Qadri (2021)	Real gross domestic product per capita growth	The inverse gender parity index in primary education and tertiary education enrollment.	A set of 48 Asian countries	2003-2018	Fixed-effects regression analysis	Gender parity/disparity is almost ineffective in determining economic growth if used as a proxy through parity in primary education. On the other hand, the relationship between gender parity in the tertiary education level and real gross domestic product growth per capita is positive and statistically significant.

Author(s)	Proxy for economic growth	Proxy for gender inequality	Country(ies)	Period	Method	Conclusion
Akhtar et al. (2023)	Real gross domestic product per capita	Female labor force participation and the gender parity index in primary and secondary education.	Malaysia	1980-2019	Nonlinear autoregressive distributed lag model	More female labor force participation and a better gender parity index positively contribute to economic growth.
Baliamoune-Lutz and McGillivray (2009)	Gross domestic product per capita	The ratio of 15–24-year-old literate females to males	A set of 31 sub-Saharan African and 10 Arab countries	1974-2001	Arellano-Bond estimations	Gender inequalities in literacy have a statistically significant negative effect on economic growth.
Matthew et al. (2020)	Gross domestic product per capita growth	Maternal mortality rate, gender inequality (measured as the disparity and discrimination of rights that all persons should enjoy, regardless of whether one is born male or female), female primary and secondary education attainment, and female labor force.	Nigeria	1985-2017	Autoregressive distributed lag model	Gender inequality and maternal mortality ratio have negative and statistically significant effects on economic growth. The same observation holds for female primary and secondary education attainment and labor force.
Vásconez Rodríguez (2017)	Gross domestic product growth rate	Female labor force participation rate and the female labor supply as measured in hours	A set of 5 Latin American countries:	2003-2010	Ordinary Least Squares regression analysis and a non-autoregressive dynamic panel model	Feminization of the labor force is positively related to economic growth, but increases in female labor supply are not.
Pervaiz et al. (2023)	Gross domestic product per capita growth rate	Gender Inequality Index	A set of developing countries (low-income and lower-middle-income countries)	1988-2012	Fixed effects model, two-stage least square approach, and a generalized method of moments.	Gender equality has a positive and significant effect on economic growth.

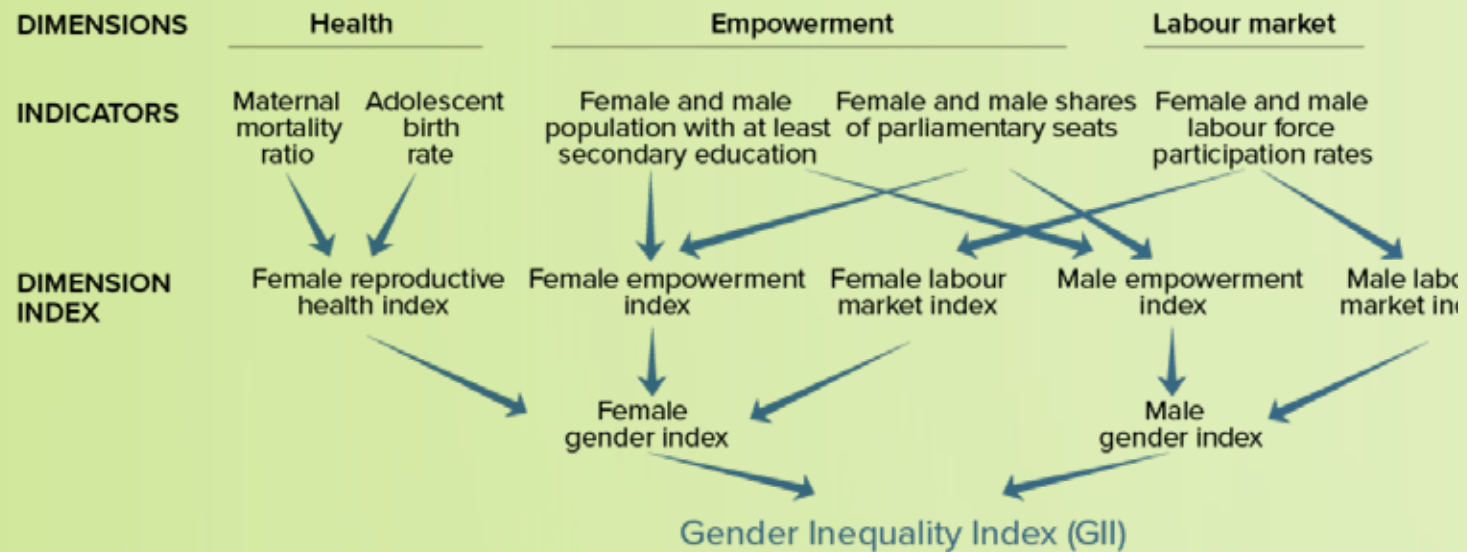
4. Methodology and data

This section delineates the methodology for estimating the GII and its impact on economic growth. It also describes the data (sources).

4.1. Gender Inequality Index calculation

The GII applies three dimensions to estimate gender inequality: (I) health, (II) empowerment, and (III) labor market. Each dimension consists of a set of indicators (Figure 1).

Figure 1. Gender Inequality Index



Note. Dimensions of the Gender Inequality Index. From the Gender Inequality Index webpage of the United Nations Development Programme., 2023 (<https://www.lib.sfu.ca/help/cite-write/citation-style-guides/apa/tables-figures>).

Table 2 illustrates the indicators and data sources for calculating the GII sub-components. We approximate some observations as there is a lack of data for some variables. The

exact treatment of missing variables is depicted in Table A1 of the Appendix.

Table 2: Sources for the Gender Inequality Index indicators

Indicator		Source(s) (for the calculation of:
Maternal mortality ratio	(MMR)	Department of Public Health Aruba
Adolescent birth rate	(ABR)	Central Bureau of Statistics Aruba
Share of seats in parliament held by females	(PR _F)	Central Bureau of Statistics Aruba
Share of seats in parliament held by males	(PR _M),	Central Bureau of Statistics Aruba
The percentage of the female population aged 25 and older with at least some (completed) secondary education	(SE _F)	UNESCO Institute for Statistics, Department of Education Aruba, Central Bureau of Statistics Aruba
The percentage of the male population aged 25 and older with at least some (completed) secondary education	(SE _M),	UNESCO Institute for Statistics, Department of Education Aruba, Central Bureau of Statistics Aruba
Labor force participation rate of the female population aged 15 and older	(LFPR _F)	Central Bureau of Statistics Aruba, Department of Labor and Investigation Aruba and Labour Force Surveys
Labor force participation rate of the male population aged 15 and older	(LFPR _M).	Central Bureau of Statistics Aruba, Department of Labor and Investigation Aruba and Labour Force Surveys

The resulting index ranges from 0, indicating full equality between males and females, to 1, suggesting complete inequality between genders. We apply the equations from the UNDP to estimate GII for Aruba. The GII index is calculated in five steps (United Nations Development Programme, 2021)⁷:

1. Treatment of zeros and extreme values. A minimum value of 0.1 percent is set for all GII component indicators, with the exception of maternal mortality, to allow for the calculation of a geometric mean. A maximum value of 1,000 deaths per 100,000 births and a minimum value of 10 deaths per 100,000 births are imposed for maternal mortality.
2. Use geometric means to aggregate across dimensions within each gender group. Apply the following aggregation formula for females:

$$G_F = \sqrt[3]{\left(\frac{10}{MMR} \cdot \frac{1}{ABR}\right)^{1/2} \cdot (PR_F \cdot SE_F)^{1/2} \cdot LFPR_F}$$

Where MMR is the maternal mortality ratio (deaths per 1000,000 live births), ABR is the adolescent birth rate (births per 1,000 women ages 15-19), PR_F is the share of seats in parliament held by females, SE_F is the percentage of the female population aged 25 and older with at least some (completed) secondary education, and $LFPR_F$ is the labor force participation rate of the female population aged 15 and older. For males, apply the following aggregation formula:

$$G_M = \sqrt[3]{1 \cdot (PR_M \cdot SE_M)^{1/2} \cdot LFPR_M}$$

Where PR_M is the share of seats in parliament held by males, SE_M is the percentage of the male population aged 25 and older with at least some secondary education, and $LFPR_M$ is the labor force participation rate of the male population aged 15 and older.

3. Aggregate across gender groups by applying a harmonic mean. Calculate the equally distributed gender index:

$$HARM(G_F, G_M) = \left[\frac{(G_F)^{-1} + (G_M)^{-1}}{2} \right]^{-1}$$

4. Calculate the geometric mean of the arithmetic mean for each indicator. Aggregate female and male indices using equal weights, and then aggregate the indices across dimensions:

$$G_{F,M} = \sqrt[3]{\overline{Health} \cdot \overline{Empowerment} \cdot \overline{LFPR}}$$

where,

$$\overline{Health} = \left(\sqrt{\frac{10}{MMR} \cdot \frac{1}{ABR}} + 1 \right) / 2$$

$$\overline{Empowerment} = (\sqrt{PR_F \cdot SE_F} + \sqrt{PR_M \cdot SE_M}) / 2$$

$$\overline{LFPR} = \frac{LFPR_F + LFPR_M}{2}$$

⁷ This section draws on UNDP (2021). For a detailed discussion on the methodology, see: https://hdr.undp.org/sites/default/files/2021-22_HDR/hdr2021-22_technical_notes.pdf

5. Compute the GII. The following formula is applied:

$$GII = 1 - \frac{HARM(G_F, G_M)}{G_{\bar{F}, \bar{M}}}$$

Therefore, to calculate the GII index, we need data for MMR, ABR, PR_F , PR_M , SE_F , SE_M , $LFPR_F$, and $LFPR_M$.

The developments in MMR, ABR, PR_F , PR_M , SE_F , SE_M , $LFPR_F$, and $LFPR_M$ are shown in Figure 2. The latter demonstrates that while maternal death (MMR) is absent in most years, spikes are observed in 2004, 2011, 2016, and 2017. These spikes indicate that during those years, one or

more deaths of women were registered as maternal deaths. The development in ABR indicates a decreasing trend in births among women ages 15-19 during the past decade. This development illustrates reduced fertility in that age group.

Meanwhile, PR_F shows improvement but remains unequal across the genders. Specifically, in 2021, females held 38.1 percent of the seats in parliament, while males held 61.9 percent. On the other hand, SE_F follows an increasing trend, indicating that more females have been able to complete some level of secondary education. $LFPR_F$ remained virtually unchanged until 2019, with a dip observed in 2020 likely due to the COVID-19-induced crisis.

Figure 2: Development in MMR, ABR, PR_F , PR_M , SE_F , SE_M , $LFPR_F$, and $LFPR_M$

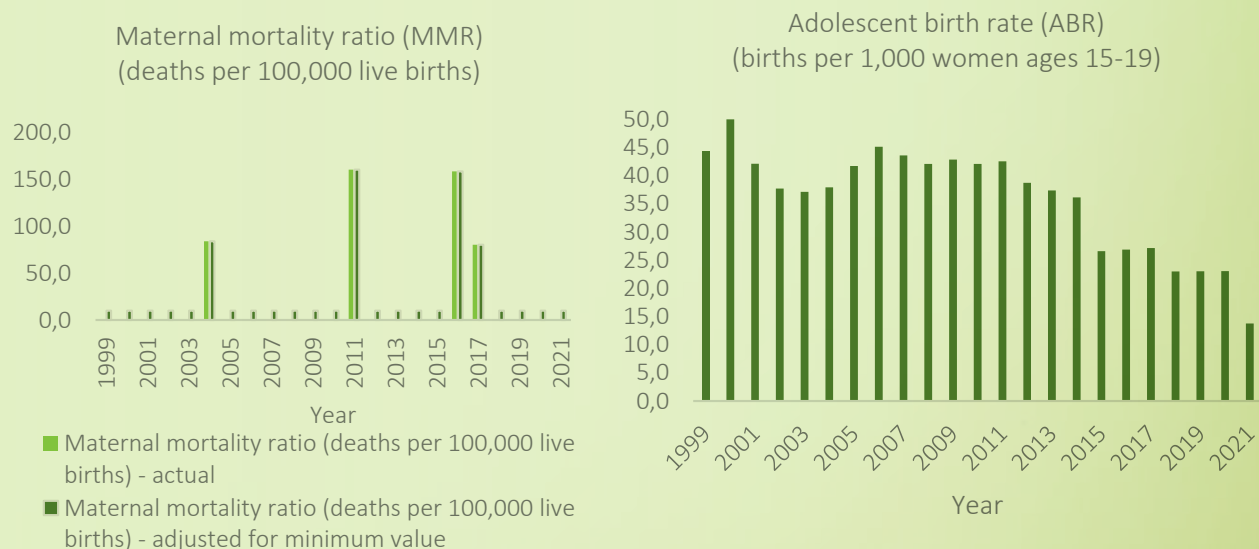
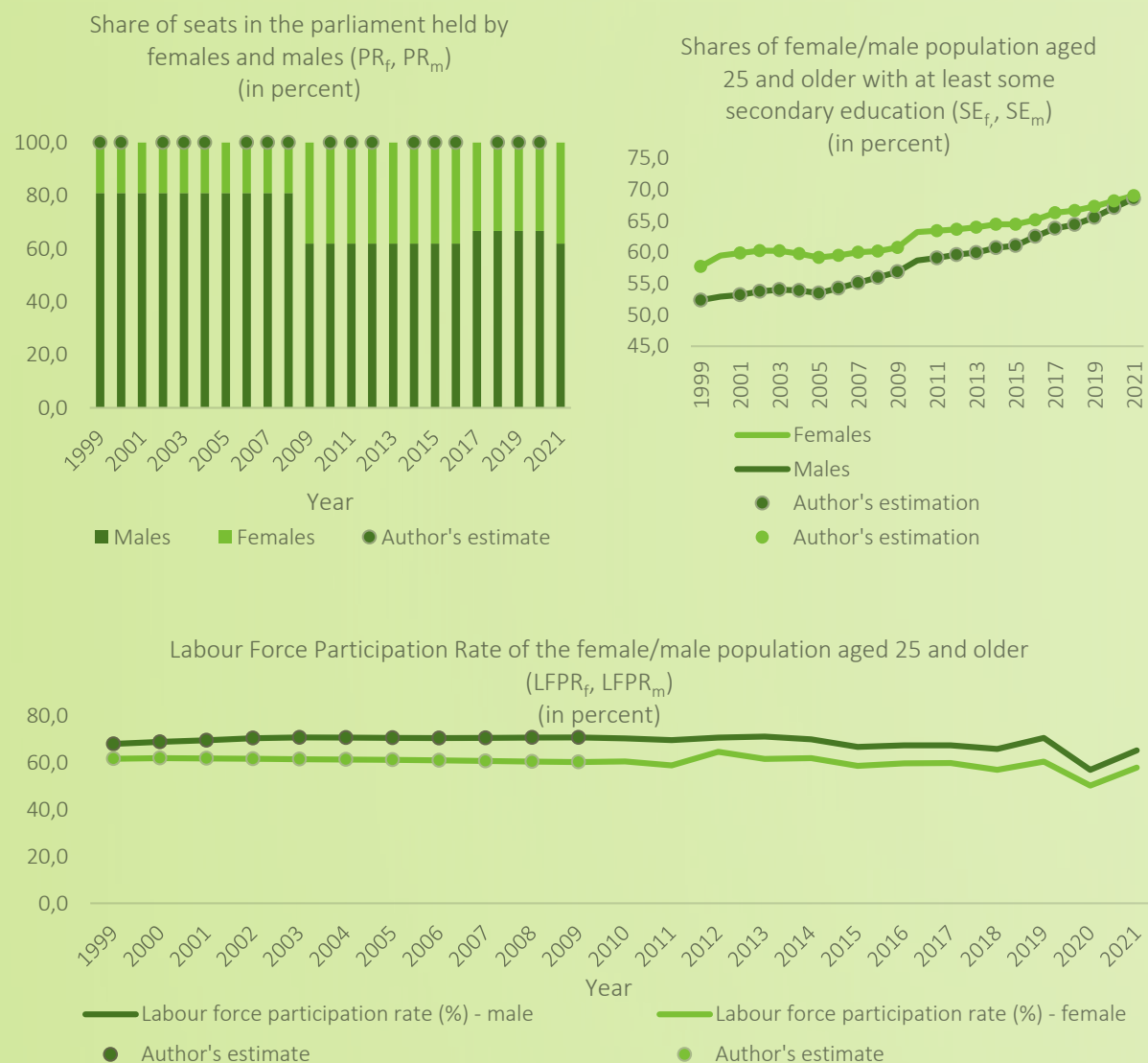


Figure 2: Continued



4.2. Autoregressive distributed lag technique

We employ the ARDL estimation technique by Pesaran et al. (2001) to investigate the gender inequality – economic growth nexus. The following function is applied:

$$GDP_t = f(GII_t, TOUR_t, CONS_t, INV_t, OIL_t) \quad (1)$$

Where, GDP_t is GDP in thousands of florins, GII_t is our estimation of the Gender Inequality Index for Aruba, $TOUR_t$ is the number of stay-over visitors, $CONS_t$ is total consumption in thousands of florins, INV_t is total investment in thousands of florins, and OIL_t is the quantity of refined oil in thousands of barrels⁸. The function draws on Koengkan

et al. (2022) and Pervaiz et al. (2011). We additionally include $TOUR_t$, INV_t , $CONS_t$, and OIL_t in the function to act as control variables given their suspected relationship with economic growth in Aruba.

$TOUR_t$, $CONS_t$, INV_t , and OIL_t data are obtained from the Central Bank of Aruba, the Central Bureau of Statistics of Aruba, and Aruba's oil refining company. In our final analysis, we apply annual data from 2000 through 2019.

The variables are converted to their natural logarithmic form to facilitate interpretation of results. With ε_t representing the time-varying error term, Equation 1 can also be written in the following econometric form:

$$GDP_t = \alpha_0 + \beta_1 GII_t + \beta_2 TOUR_t + \beta_3 CONS_t + \beta_4 INV_t + \beta_5 OIL_t + \varepsilon_t \quad (2)^9$$

Applying regression analysis on non-stationary time series data can give rise to spurious results (Granger & Newbold, 1974). We test for stationarity before proceeding with further analyses to avoid this occurrence. We use the Phillips-Perron (PP) test to check the stationarity of the time series because of its robustness with regard to unspecified autocorrelation

and heteroscedasticity in the disturbance process of the test equation (see Ndem et al., 2022). Before conducting the PP test, we determine the maximum (P_{max}) and optimal lags (P_{opt}). The maximum number of lags follows from Schwert's (1989) equation:

$$P_{max} = \text{int} \left[12x \left(\frac{T}{100} \right)^{\frac{1}{4}} \right] \quad (3)$$

⁸ GDP_t , $CONS_t$ and INV_t are in real terms.

⁹ Note that for some years, the value of OIL_t is equal to 0. We replace the years with $OIL_t=0$ with $OIL_t=1$ to facilitate a natural logarithm conversion.

$P_{\max}$ is the maximum number of lags and T is the number of observations, which equals 20 in our sample. Given this information, $P_{\max}$ stands at 8. Subsequently, we determine the optimal number of lags (i.e., P_{opt}) for GDP, GII, TOUR, CONS, INV, and OIL based on the Akaike Information Criterion (AIC). We repeat the same process for the first difference of the variables¹⁰. The results of the PP tests (Table 3) indicate that the variables are integrated at $I(1)$. The ADRL technique developed

by Pesaran et al. (2001) requires that all variables be either $I(0)$, $I(1)$ or a mixture of the two (see Javid and Sharif, 2016). Next to this condition, the ARDL approach is more robust than traditional estimation methods when confronted with a small sample size, as in this study (Nasrullah et al., 2021). In addition, it allows for the analysis of both short-term and long-term relationships (Adnan et al., 2020).

Table 3: Results of the Phillips-Perron test for unit root

	GDP			GII			TOUR			CONS			INV			OIL		
	PP		P _{op}	PP		P _{opt}	PP		P _{opt}	PP		P _{opt}	PP		P _{opt}	PP		P _{opt}
Level	-2.21		1	- 2.19		1	-3.11		8	-2.69		1	-3.40		8	-1.42		1
First diff.	-3.99	** *	0	- 4.43		*** 0	-3.78	** *	0	-3.94	** *	3	-3.44	** *	0	-7.47	** *	2

Note. P_{opt} was chosen based on the Akaike information criterion. The values under “PP” indicate the Phillips–Perron τ test statistic. The appropriate model for the Phillips-Perron test for each variable was chosen based on visual inspection of the data. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

The ARDL approach consists of two steps (see e.g., Hatmanu et al., 2022). First, we convert Equation 2 to the ARDL model in

Equation 4. The latter allows us to verify the existence of a long-run relationship among GDP, GII, TOUR, CONS, INV, and OIL.

■ ¹⁰ $P_{\max} = 7$ for the first difference of the variables.

$$\begin{aligned}
\Delta GDP_t = & \alpha_0 + \sum_{i=1}^o \gamma_i \Delta GDP_{t-i} + \sum_{j=0}^p \phi_j \Delta GII_{t-j} + \sum_{k=0}^q \delta_k \Delta TOUR_{t-k} + \sum_{l=0}^r \vartheta_l \Delta CONS_{t-l} \\
& + \sum_{m=0}^s \varphi_m \Delta INV_{t-m} + \sum_{n=0}^t \theta_n \Delta OIL_{t-n} + \beta_1 GDP_{t-1} + \beta_2 GII_{t-1} + \beta_3 TOUR_{t-1} \\
& + \beta_4 CONS_{t-1} + \beta_5 INV_{t-1} + \beta_6 OIL_{t-1} + \varepsilon_{0t}
\end{aligned} \tag{4}$$

In Equation 4, α_0 is the intercept, o is the lag length for the dependent variable, and p, q, r, s , and t are the lag lengths for the independent variables¹¹. $\gamma_i, \phi_j, \delta_k, \vartheta_l, \varphi_m$, and θ_n are short-run coefficients, $\beta_1 - \beta_6$ are coefficients that capture the long-term dynamics, Δ represent the difference operators, and ε_{0t} is the error term. The optimal lag lengths are chosen through the AIC: 0 for TOUR and CONS, 1 for GDP, GII, INV and OIL. Given these lags, our model can also be written in the following form: ARDL (1,1,0,0,1,1).

Equation 4 allows us to verify co-integration among the variables by applying the bound co-integration test by Pesaran et al. (2001). In other words, this test confirms whether there is a

long-run relationship among the variables. The bound co-integration test produces an F-statistic. If the latter is greater than the bound critical values of $I(1)$, then we conclude that there is co-integration and we reject the null hypothesis of no long-term association among the variables ($H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$). If the F-statistic is lower than the bound critical values of $I(0)$, there is no co-integration and we do not reject the null hypothesis. If the F-statistic is between the critical bound values of $I(0)$ and $I(1)$, we deduce that the test is inconclusive. Given an established long-run relationship between the variables in Equation 4 (see section 4 for results), we can apply the following equation that includes the error correction term:

$$\begin{aligned}
\Delta GDP_t = & \alpha_1 + \sum_{i=1}^o \gamma_{1i} \Delta GDP_{t-i} + \sum_{j=0}^p \phi_{1j} \Delta GII_{t-j} + \sum_{k=0}^q \delta_{1k} \Delta TOUR_{t-k} + \sum_{l=0}^r \vartheta_{1l} \Delta CONS_{t-l} \\
& + \sum_{m=0}^s \varphi_{1m} \Delta INV_{t-m} + \sum_{n=0}^t \theta_{1n} \Delta OIL_{t-n} + \lambda ECT_{t-1} + \varepsilon_{1t}
\end{aligned} \tag{5}$$

■ ¹¹ ARDL (p,q,r,s,t).

where ECT is the error correction term, and λ is the parameter for the speed of adjustment to long-run equilibrium. Given existing studies, we expect the value of λ to be negative (between 0 and -1) and statistically significant (see, e.g., Chandio et al., 2019; Tao et al., 2023).

4.3. Diagnostic tests

Post-estimation tests verify the reliability of estimated coefficients and assess the stability of the model (Rahman & Alam, 2022). We conduct several diagnostic tests following those performed by Adelodun et al. (2023). The post-estimation tests include the Shapiro--Wilk W test statistic test for normality, the Breusch-Godfrey Lagrange Multiplier test for serial correlation, the Breusch-Pagan-Godfrey test for heteroscedasticity, the Ramsey Regression Specification Error Test (RESET) for omitted variables and the cumulative sum of squares (CUSUMSQ) plot test for stability.

5. Results and Discussion

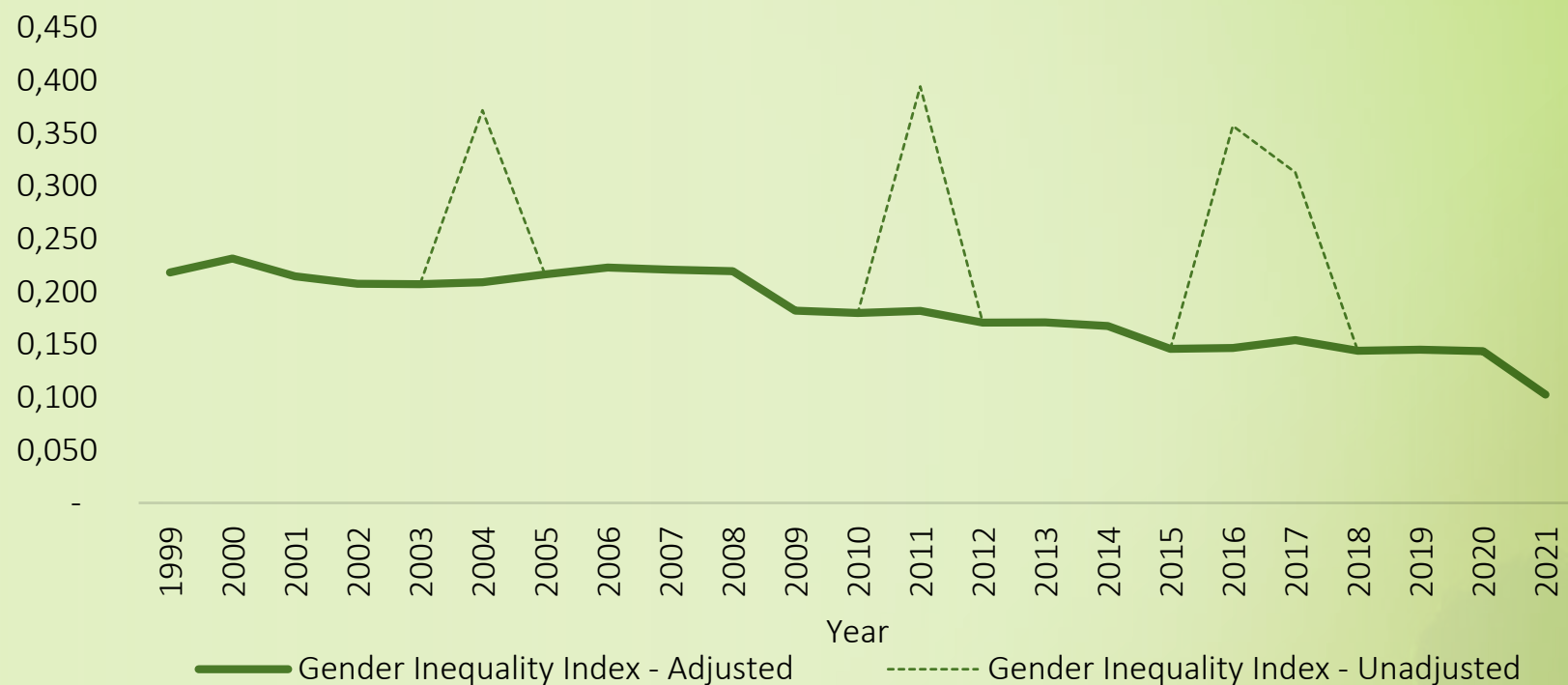
5.1. Resulting Gender Inequality Index

The resulting GII for Aruba is shown in Figure 3 and Table 4. The latter shows an adjusted and an unadjusted GII. In the adjusted GII, the MMR is set to 10 deaths per 1000,000 births (in line with the minimum value according to the United Nations)¹² throughout 1999-2021. In this way, we correct for the outliers in the MMR in 2004, 2011, 2016, and 2017. In the remainder of this paper, we refer to the adjusted GII as the GII.

As shown in Figure 3, the GII for Aruba portrays a long-term declining trend, mirroring less gender inequality in Aruba. In 1999, the GII stood at 0.218; in 2021, it was at 0.103, reflecting a decline of 0.110 in two decades. Several factors led to improvements in gender inequality in Aruba: 1) a decreasing adolescent birth rate, 2) a more significant share of seats held by females in the parliament, and 3) more females having finished at least some secondary education. See Appendix B for past (policy) actions that might have contributed to this decrease.

■ ¹² See: https://hdr.undp.org/sites/default/files/2021-22_HDR/hdr2021-22_technical_notes.pdf

Figure 3: Gender Inequality Index for Aruba



Note. The Maternal Mortality Ratio is set to 10.0 for 1999-2021 in the adjusted Gender Inequality Index. The Gender Inequality Index ranges between 0.000 and 1.000.

Table 3: Gender Inequality Index for Aruba

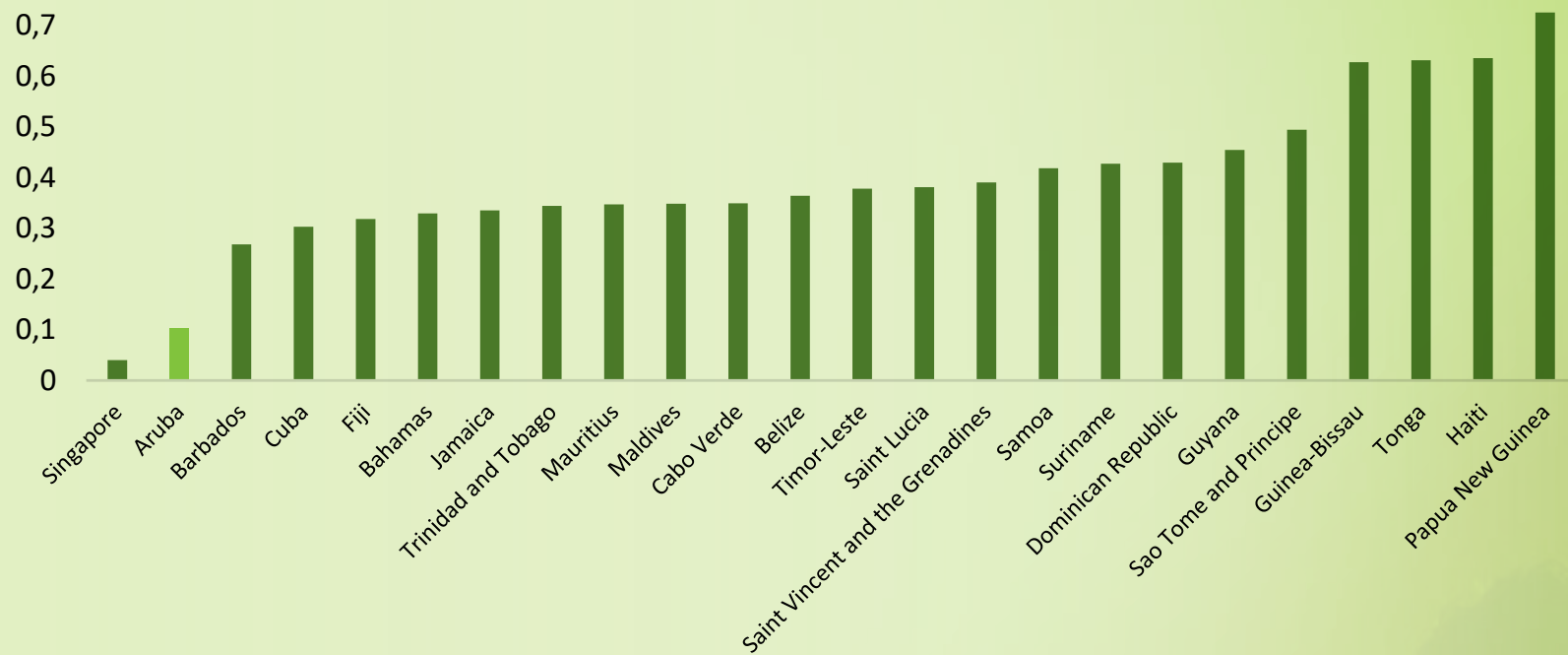
GII	Unadjusted	Adjusted
1999	0.218	0.218
2000	0.232	0.232
2001	0.215	0.215
2002	0.208	0.208
2003	0.207	0.207
2004	0.372	0.209
2005	0.216	0.216
2006	0.223	0.223
2007	0.221	0.221
2008	0.219	0.219
2009	0.182	0.182
2010	0.180	0.180
2011	0.395	0.182
2012	0.171	0.171
2013	0.171	0.171
2014	0.168	0.168
2015	0.146	0.146
2016	0.357	0.147
2017	0.313	0.154
2018	0.144	0.144
2019	0.145	0.145
2020	0.144	0.144
2021	0.103	0.103

Note. The Maternal Mortality Ratio is set to 10.0 for 1999-2021 in the adjusted Gender Inequality Index (GII).

Figure 4 illustrates how the Aruban GII compared to other SIDS (for which data was available) in 2021. When benchmarked against other SIDS, Aruba stands out as the country with the next to lowest GII within the group. This

observation is likely the result of a lower adolescent birth rate, higher share of seats held by women in the parliament, and higher female labor force participation rate in Aruba vis-à-vis other SIDS.

Figure 4: Gender Inequality Index of Aruba vis-à-vis other Small Island Developing States in 2021



Note. Data for the Gender Inequality Index of other Small Island Developing States is based on the United Nations. See <https://hdr.undp.org/data-center/thematic-composite-indices/gender-inequality-index#/indicies/GII>

5.2. Results of Autoregressive distributed lag technique

Our model can also be written in the following form given the lag selection: ARDL (1,1,0,0,1,1). We perform the bound

co-integration test by Pesaran et al. (2001) to determine if there is a long-run relationship among GDP, GII, TOUR,CONS, INV, and OIL when GDP acts as the dependent variable. Table 4 shows the results of this test.

Table 4: Results of bound co-integration test by Pesaran et al. (2001)

<u>Model</u>	<u>Model lags</u>	<u>F-Statistic</u>	<u>Conclusion</u>
$GDP_t = f(GII_t, TOUR_t, CONS_t, INV_t, OIL_t)$	ARDL(1,1,0,0,1,1).	4.47**	
<u>Level of significance</u>	<u>Lower bound I(0)</u>	<u>Upper bound I(1)</u>	Co-integration (at 5% significance level)
10%	2.26	3.35	
5%	2.62	3.79	
1%	3.41	4.68	

Note. The critical values are based on Pesaran et al. (2001), where *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

As Table 4 illustrates, the F-Statistic of the bound co-integration test stands at 4.47. The latter is significantly higher than the bound critical values of I(1) at a 5 percent significance level. Therefore, we reject the null hypothesis of no

co-integration and conclude that GII, TOUR,CONS, INV, and OIL have a long-term relationship with GDP. Given the established long-run relationship, we estimate both the long-run and short-run dynamics (Table 5).

Table 5: Long-run and short-run dynamics according to the Autoregressive Distributed Lag model

The dependent variable is GDP				
<u>Variables</u>	<u>Coefficient</u>	<u>Std. Error</u>	<u>t-Statistic</u>	
Long-run dynamics				
GII	0.17	0.28	0.59	
TOUR	0.33	0.19	1.67	
CONS	1.27	0.56	2.26	*
INV	-0.10	0.18	-0.56	
OIL	0.01	0.01	1.38	
Short-run dynamics				
Δ GII	0.30	0.17	1.77	
Δ TOUR	0.18	0.09	1.99	*
Δ CONS	0.69	0.26	2.69	**
Δ INV	0.17	0.12	1.43	
Δ OIL	0.00	0.00	1.19	
Constant	-3.67	3.02	-1.22	
ECT_{t-1}	-0.54	0.18	-3.00	**
R^2	0.88			
Adjusted R^2	0.75			

Note. ***p< 0.01. **p< 0.05. *p< 0.10.

In the long run, the coefficient of CONS (total consumption) is significant at 10 percent. This means that over the long term, a 1 percent increase in CONS is associated with an expansion in GDP of 1.27 percent, indicative of a ripple effect of local consumption on economic growth. In the short run, the coefficients of ΔTOUR (at the 10 percent significance level) and ΔCONS are significant (at the 5 percent significance level). This finding implies that in the short run, a 1 percent increase in TOUR is related to a 0.18 percent growth in GDP, *ceteris paribus*. Table 5 also shows that a 1 percent rise in CONS is associated with a GDP growth of 0.69 percent. In addition, the estimated coefficient of ECT_{t-1} is negative and significant at the 1 percent level. This finding confirms the long-term relationship among the variables included in the equation. Specifically, in the case of any disequilibrium in the model, GDP converges toward its equilibrium in the long run at a rate of 54.33 percent each year.

The results show that the primary variable of interest, GII, does not impact economic growth in the long or short run despite a negative correlation of -0.28 between GII and GDP. This outcome aligns with Bandiera and Natraj (2013), who found no evidence of a relationship between gender inequality and economic growth in a sample of cross-country studies. Following Bandiera and Natraj (2013), we argue that this finding does not necessarily mean that the gender inequality-reducing policies in Aruba are ineffective. After all, the Aruban GII did decrease substantially during the past two decades and Aruba remained in the top three countries with the lowest gender inequality when benchmarked against SIDS.

We hypothesize the following explanations for the lack of a significant interaction between GII and GDP. The downward trend in GII was mainly caused by a lower adolescent birth rate, a higher share of seats held by females in the parliament, and a higher proportion of women completing some form of secondary education. Meanwhile, the

percentage of women in the labor force remained virtually unchanged during the years under review. Following Braunstein (2022), one could assume that a lower adolescent birth rate translates to more female contribution to the economy through paid labor due to less time spent on childcare. Similarly, a higher proportion of women with a secondary education leads to increased female labor force participation.

Nevertheless, these assumptions do not hold for Aruba, as the labor force participation rate of females did not display significant movements. This might mean that not all women who have fewer children and a secondary education necessarily elect to participate in the labor force. Therefore, other factors are at play that hinder women from contributing to the Aruban labor market. According to previous studies, these factors range from poorer working conditions compared to men, disproportionate care responsibilities, stereotyped gender roles, more difficulties in the employment search, expensive childcare, lack of transport, greater likelihood of spending time on unpaid work, and the work-family balance (International Labour Organization, 2022; Organisation for Economic Co-operation and Development, 2023; World Economic Forum, 2022). Moreover, subsidies (e.g., rental subsidies) and welfare payments paid by the Government of Aruba also discourage recipients – most of whom are women – from participating in the Aruban labor market.

For the specific case of Aruba, the existing gender wage gap also plays a role in women's self-opting out of the labor force. To be precise, in 2019, women earned, on average, 14.7 percent less than men (based on the difference in average wage between females and males). When corrected for job similarities (using 2010 data), Aruban women earn 80 percent of the wages received by their male counterparts (Central Bureau of Statistics Aruba, 2017; United Nations Development Programme, n.d.). Although not the main objective of this study, the findings raise

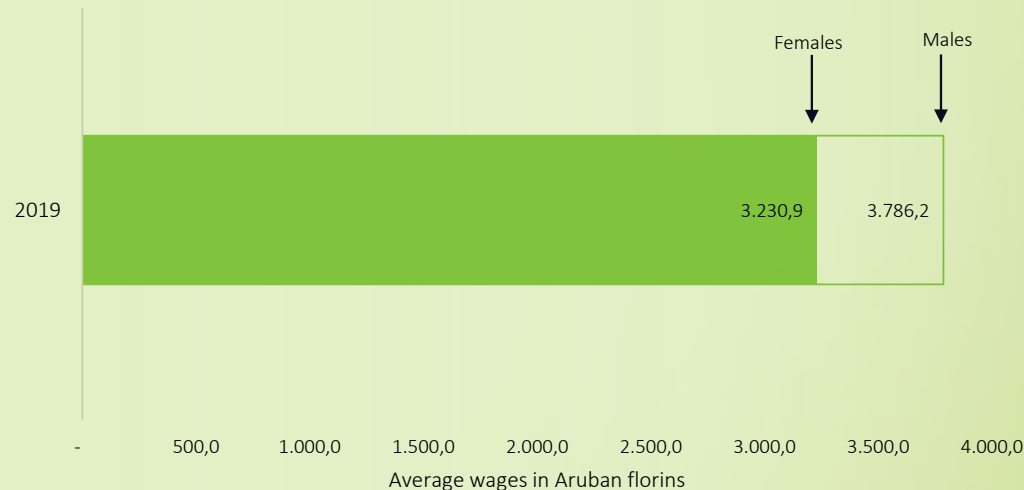
questions about a ‘gender equality conditioning’ in a mature (non-diversified) and small island tourism economy.

More specifically, Braunstein (2022) argues that employers in labor-intensive export sectors (such as the tourism sector in Aruba) prefer to hire women due to lower wages, which in turn leads to higher profitability for businesses. Applying this notion to Aruba, we observe that Aruban women are indeed overrepresented in the “accommodation and food service activities” sector¹³, which is known for offering one of the lowest monthly wages¹⁴. Moreover, data from the CBS shows the existence of a gender wage gap in Aruba’s “accommodation and food service activities” sector. To be specific, in

2023, the median monthly income for females in this sector was Afl. 2,000 compared to Afl. 2,250 for males.

Considering that the tourism sector is the primary source of foreign exchange earnings for Aruba, this situation suggests a phenomenon termed as the “feminization of foreign exchange earnings” (see Braunstein, 2022). In this context, Aruban women significantly contribute to generating foreign exchange earnings through their participation in the tourism sector, yet they continue to face wage inequality. This disparity highlights an issue where the economic benefits derived from women’s labor are not equitably shared with them, likely perpetuating gender-based economic inequality.

Figure 5: Evidence of gender pay gap in Aruba



Note. The source for the data is the Social Insurance Bank Aruba

¹³ See <https://cbs.aw/wp/index.php/2021/12/02/tables-dealing-with-the-economic-activity-of-the-population/>

¹⁴ See <https://cbs.aw/wp/index.php/2020/07/02/median-monthly-wages-by-economic-activity-in-afl-2015-2020/>

Besides the main result for GII and GDP, the ARDL model provides a view of the interaction between TOUR and GDP for Aruba. Namely, the coefficient of TOUR is only significant in the short run: a 1 percent hike in TOUR is related to a 0.18 percent GDP growth. In the long term, this effect becomes insignificant, indicating that the impact of heightened tourism on economic growth becomes weaker in the long term. This finding implies that tourism has a muted effect on Aruba's economic growth in the long run, echoing the results and conclusions of the Central Bank of Aruba (2021), International Monetary Fund (2019), Peterson (2019a), and Peterson (2019b). These existing studies, in one way or another, indicate that tourism has reached a maturity point where more tourism (volume) results in diminishing gains in economic growth. Particularly, our result is in line with Adamou and Clerides (2010), who find that the contribution of tourism to economic growth in countries with an elevated level of tourism specialization – where tourism receipts as a percentage of GDP surpass 20.8 percent – becomes minimal and can even become a hindrance to future economic growth. For the specific case of Aruba, tourism specialization results in tourism receipts of, on average, 52.0 percent in terms of GDP (2000-2021).

Although this paper is not able to provide a comprehensive explanation as to why the contribution of tourism is insignificant in the long run, we consider that this finding might be related to the concept of “over-tourism.” The latter is defined by Peterson (2019b) as the adverse impact of uncontrolled tourism growth that results in increased economic vulnerability, social costs, and environmental degradation, among other factors. Based on previous studies (see, e.g., Peterson, 2020), it seems as the adverse effects of over-tourism and associated costs accrue and accumulate over the medium to long term, resulting in a muted impact of TOUR in the long run.

5.3. Diagnostic test results

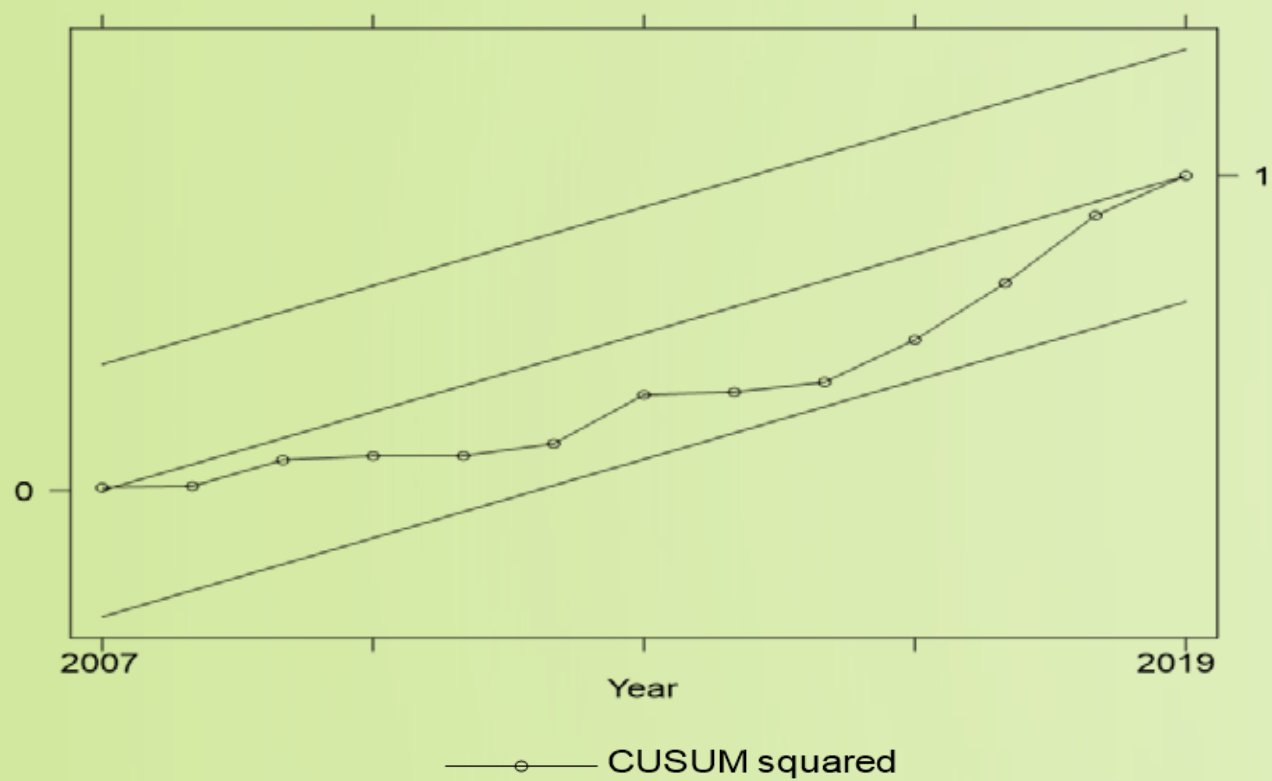
Table 7 shows the results of the diagnostic tests. Specifically, the Shapiro-Wilk W statistic test is insignificant at the 5 percent significance level, failing to reject the null hypothesis and confirming normality in the residuals of the ARDL model at this level. However, at the 1 percent significance level, normality in the residuals will be rejected. This could be related to our small (≤ 30) sample size (see, e.g., Razali and Wah, 2011). The outcome of the Breusch-Godfrey LM test is not significant and suggests an absence of serial correlation. The result of the Breusch-Pagan-Godfrey test is also statistically insignificant, which means that the model does not suffer from heteroscedasticity. The Ramsey RESET test indicates that the model has no omitted variables. Finally, Figure 6 displays the CUSUMSQ plot test and reveals that the CUSUMSQ plot remains well between the 5% critical bound. This outcome suggests that the model is stable. Against these results, we conclude that our model is suitable and that we can apply its results to provide policy implications.

Table 7: Diagnostic test results

<u>Test for</u>	<u>Concernment</u>	<u>Test applied</u>	<u>H₀</u>	<u>Statistic</u>	<u>P-value</u>
Normality	Normally distributed residuals provide accurate standard errors estimates for the model coefficients	Shapiro--Wilk W test	The residuals follow a normal distribution	0.95 (W)	0.08*
Serial correlation	Serial correlation in the residuals indicates a mis specified model	Breusch-Godfrey Langrage Multiplier test	No serial correlation in the residuals	4.00 (F)	0.31
Heteroscedasticity	Heteroscedasticity in the residuals can lead to biased standard errors	Breusch-Pagan-Godfrey test	Constant variance in the residuals	3.00 (F)	0.92
Omitted variables	Omitted variables can result in biased coefficient estimates	Ramsey Regression Specification Error Test	The model has no omitted variables	0.25 (F)	0.24
Stability	Unstable coefficients might imply unreliable results and inferences	CUSUMSQ	-	The model is stable (see Figure 5)	

Note. ***p< 0.01. **p< 0.05. *p< 0.1.

Figure 6: Cumulative sum of squares (CUSUMSQ) plot test for stability



6. Conclusion and policy implications

This paper aimed to estimate the GII — a widely used gender inequality indicator that allows for comparison across time and countries — for Aruba and to, subsequently, use the GII to investigate the impact of gender inequality on Aruban economic growth.

To calculate the GII, we followed the methodology proposed by the United Nations Development Programme (2021) and consulted different Aruban stakeholders to obtain necessary input data. According to our estimation of GII, Aruba has experienced a declining trend in gender inequality during the past two decades, mainly due to a lower adolescent birth rate, a higher share of seats held by females in the parliament, and an increased proportion of women completing some level of secondary education. While we did not empirically test the effectiveness of gender inequality-reducing policies in Aruba, the long-term declining trend in GII indicates they may have been effective.

On the other hand, however, fitting an ARDL model to our data showed that gender inequality does not significantly influence the Aruban economy. We contend that this might be related to the fact that the proportion of women in the labor force remained virtually unchanged during the past two decades, despite a lower adolescent birth rate and more educated women. This means, that contrary to our expectations, a lower adolescent birth rate and more educated women did not lead to increased labor force participation, and thereby generate positive externalities for economic growth (see, Braunstein, 2022).

For the specific case of Aruba, the lack of significant movement

in the proportion of women in the labor force implies that other factors at play hamper women's full participation in the labor market. Going back to existing studies (see e.g., International Labour Organization, 2022; Organisation for Economic Co-operation and Development, 2023; World Economic Forum, 2022), we argued that these factors might include, but are not limited to, poorer working conditions compared to those for men, disproportionate care responsibilities, stereotyped gender roles, greater difficulties in the employment search, expensive childcare for those who have children, lack of transport, greater likelihood of spending time on unpaid work, and work-family balance. In addition, this study provides evidence of a gender wage gap in which women earn, on average, 14.7 percent less than males (based on the difference in average wage between females and males). This wage inequality might be causing women to self-opt out of the Aruban workforce or to earn extra income in the informal economy. In addition, subsidies and welfare payments paid by the Government of Aruba would also discourage recipients – most of whom are women – from participating in the Aruban labor market.

Besides the main results on gender inequality, the findings from this study also offered insights into the dynamics between tourism expansion and economic growth in Aruba. Specifically, tourism has a positive and statistically significant impact on short-term economic growth. However, the effect is muted in the long term, implying that the contribution of one extra (stay-over) tourist to the Aruban economy diminishes in the long run. Consistent with previous studies, to be specific, Central Bank of Aruba (2021), International Monetary Fund (2019), Peterson (2019a), and Peterson (2019b), this finding corroborates the notion that tourism growth in Aruba has reached an economic saturation point of diminishing returns.

The empirical evidence presented in this paper carries several policy implications. First, we suggest implementing gender wage gap-reducing policies in Aruba in tandem with policies that increase women's participation in the labor force. Examples include executing compulsory gender pay audits, raising the minimum wage¹⁵, enacting flexible working hours, and extending paid maternal and paternal leave for both men and women (Rubery, 2016; Federal Ministry for Economic Cooperation and Development). Other pathways include subsidizing (quality) childcare services and stimulating women's entrepreneurship.

Second, given the lack of data on gender inequality indicators, we encourage collecting and publishing gender statistics. The latter could aid in investigating gender inequality and in making data-informed decisions in Aruba.

Future research should investigate how the gender wage gap impacts female participation in the labor force and economic growth. Moreover, additional investigation into the lack of significant movement in the female labor force participation rate could increase our knowledge of the factors that deter women's workforce participation. Future research may also thoroughly investigate the phenomenon of "feminization of foreign exchange earnings" in Aruba, to better understand its implications and address the underlying causes of wage inequality in the tourism sector. Lastly, it is important for future research to expand on the applied data when more data is available and to replicate our estimations for the GII.

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¹² Data from the Central Bureau of Statistics indicate that Aruban women are more likely than men to earn equal to or below the minimum wage. See: <https://cbs.aw/wp/index.php/2009/07/28/personal-gross-monthly-income-for-persons-with-salary-as-main-source-of-income-by-gender/>

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Appendix A

Table A1: Treatment of missing data

<i>Dimension and indicators</i>	<i>Data source</i>	<i>Treatment of missing variables</i>
Health		
Maternal mortality ratio (<i>MMR</i>)	Department of Public Health Aruba (1999-2021)	N/A
Adolescent birth rate (<i>ABR</i>)	Central Bureau of Statistics Aruba (1999-2021)	The adolescent birth rate was calculated by dividing the number of live births born to women aged 15-19 by the total female population aged 15-19.
Empowerment		
Share of seats in parliament held by females (<i>PR_F</i>)	Central Bureau of Statistics Aruba (1997, 2001, 2005, 2009, 2013, 2017, 2021)	Assumed constant within each four-year term.
Share of seats in parliament held by males (<i>PR_M</i>)	Central Bureau of Statistics Aruba (1997, 2001, 2005, 2009, 2013, 2017, 2021)	Assumed constant within each four-year term.
Share of female population aged 25 and older with at least some secondary education (<i>SE_F</i>)	UNESCO Institute for Statistics (2000 and 2010). Department of Education Aruba and Central Bureau of Statistics Aruba.	All years except for 1999 and 2010 are approximated using the following inputs: secondary education graduates (total) for females (Department of Education Aruba) and female population aged 25 and older (Central Bureau of Statistics Aruba). Note that the data obtained from the Department of Education Aruba was incomplete for 2019 to 2021. For most of these years, we applied a moving average, or we assumed that the share of female and male graduates was equal to the previous year(s).
The 2000 and 2010 values are used to calculate how many females had at least some secondary education in the respective years. Given these calculations, we estimate that the contribution (to the share of female population aged 25 and older with at least some secondary education) of secondary graduates (except for EPI and “avondonderwijs”) is 86.9 percent for female graduates. We assume these rates remain constant and multiply them with the cumulative female graduates from 1999 to 2021. We		

		calculate the share of female population aged 25 and older with at least some secondary education as total females aged 25 and older divided by the total population of females aged 25 and older.
Share of male population aged 25 and older with at least some secondary education (SE_M)	UNESCO Institute for Statistics (2000 and 2010). Department of Education Aruba and Central Bureau of Statistics Aruba.	All years except for 1999 and 2010 are approximated using the following inputs: secondary education graduates (total) for males (Department of Education Aruba) and male population aged 25 and older (Central Bureau of Statistics Aruba). Note that the data obtained from the Department of Education Aruba was incomplete for 2019 to 2021. For most of these years, we applied a moving average, or we assumed that the share of female and male graduates was equal to the previous year(s).
		The 2000 and 2010 values are used to calculate how many males had at least some secondary education in the respective years. Given these calculations, we estimate that the contribution (to the share of the male population aged 25 and older with at least some secondary education) of secondary graduates (except for EPI and “avondonderwijs”) is 58.5 for male graduates. We assume these rates remain constant and multiply them with the cumulative male graduates from 1999 to 2021. We calculate the share of the male population aged 25 and older with at least some secondary education as total males aged 25 and older divided by the total population of males aged 25 and older.
Labour Market		
Labour force participation rate of the female population aged 15 and older ($LFPR_M$)	Department of Labor and Investigation Aruba, Labour Force Surveys, and Central Bureau of Statistics Aruba (2000, 2007, and 2010-2021)	The female labour force in the years with missing data (and 2000 and 2007) was estimated based on the growth in the female population between 15 and 69 years old. The respective age category was chosen based on its significant correlation with the female labour force from 2010 to 2021. Population data is from the Central Bureau of Statistics Aruba.
		The labour force participation rate of females aged 15 and older is estimated by dividing the female labour force by the female population aged 15 and older.
Labour force participation rate of the female population aged 15 and older ($LFPR_F$)	Department of Labor and Investigation Aruba, Labour Force Surveys and Central Bureau of	The male labour force in the years with missing data (and 2000 and 2007) was estimated based on the growth in the male population between 30-74 years old. The respective age category was chosen based

Statistics Aruba (2000, 2007, and 2010-2021)

on its significant correlation with the male labour force from 2010 to 2021. Population data is from the Central Bureau of Statistics Aruba.

The labour force participation rate of males aged 15 and older is estimated by dividing the male labour force by the male population aged 15 and older.

Appendix B

Historical perspective on women's equality in Aruba

In this appendix, we delineate past (policy) actions that may have helped to reduce gender inequality in Aruba. Actions have been identified from reports submitted by the intergovernmental Aruban Human Rights Committee to the United Nations under the Convention on the Elimination of All Forms of Discrimination Against Women. We also use the Aruba National Gender Policy of 2022¹ in this regard.

A synopsis of the reported actions is presented below.

Year	Action
1948	Aruban women are enfranchised.
1949	An Aruban woman stands for election for the first time.
	Various women's groups are formed to support women in their struggle for equal rights in the 1970's.
1970	Various childcare centers are opened.
	Famia Planea Aruba is set up with the goal of promoting responsible parenthood in Aruba.
1974	In the public sector, women are entitled to six weeks of maternity leave before the expected date of delivery and six weeks after delivery while retaining full pay. In the private sector, maternity leave is equated with sick leave and women are entitled to four weeks of leave before and four weeks of leave after the expected date of delivery. However, in the private sector, women do not retain their complete salary.
1975	The contractual incapacity of married women is abolished.
1983	It is decided that married women can remain in public sector employment and are entitled to a pension.
1984	The Netherlands Nationality Act of 1984 provides that the nationality of the father or mother determines whether a person acquires the Netherlands nationality by law. Previously the nationality of the father was the crucial factor.
1986	An official is appointed at the Social Affairs Department to act as a "focal point" for women's affairs.

¹ See https://issuu.com/gabinetewevercroesaruba/docs/aruba_nacional_gender_policy_2022?fr=sNzBjYzlwOTgzNQ

1988	A new curriculum is developed in which efforts are made to eliminate the stereotyping of girls and boys that has existed hitherto.
1989	The “Enseñansa pa Empleo” (a training for employment programme) is established by Aruban authorities with the goal of increasing members’ chances of finding work, securing a promotion, or getting a better paying job. The percentage of women successfully completing the courses are higher than that of men.
1990	In the public sector, the distinction in legal status by sex and marital status – where married men receive 25% more salary than unmarried men and married women – is abolished. The levying of taxes on married women is now partially separate to attract women into the labour market and to align with the principles of equality as stated in the Constitution of Aruba.
1991	The United Nation’s Convention on the Elimination of All Forms of Discrimination Against Women” takes effect in the Kingdom of the Netherlands, including Aruba.
1992	The court stands in favor of a flight attendant who was dismissed from Air Aruba on the ground of pregnancy.
1993	Three women are following a training course for prospective members of the judiciary. The number of women studying at the University of Aruba catches up with men. The Educacion Profesional Basico (EPB) is introduced allowing both girls and boys to take domestic and technical subjects.
1995	A national symposium on “Hende Muher Rumbo pa Siglo 21” is held with the purpose to initiate a public debate on the position of women in Aruba. The Foundation for Women in Distress is established. The Bureau of Women’s Affairs is set up under the Social Affairs Department. A national women’s Council is set up. The Document on Cooperation on Gender Policy between the Netherlands Antilles, the Republic of Suriname and Aruba is signed with the goal of promoting regional cooperation in the advancement of gender policy.
1996	A project known as “NAN” (Netherlands Antilles, Aruba, and the Netherlands) is established as a cooperative effort between various welfare institutions and women’s organizations. The aim of this project is to exchange information between institutions within the Kingdom on topics related to education, training, and emancipation of women. The Bureau of Women’s Affairs starts to cooperate with a local newspaper in publishing a monthly women’s supplement titled “Bringamosa.” The aim of this initiative is to combat the existence of stereotypes of women as subordinates in the Aruban society.

	A seminar on “gender awareness and the image of women in the media” is held to raise awareness of the issue of gender and the image of women in the media.
	The general old-age pension is modified and benefits now both men and women. For example, if a married women turns 60 years of age before her husband, she is now also eligible for the married person’s pension.
1997	An Aruban delegation assists the Regional Conference on Women in Latin America and the Caribbean in Santiago de Chile.
	A meeting on the theme of “identity and Politics” is held in Bonaire in the context of regional cooperation with the goal to encourage the participation of women in political processes.
2000	The project titled “Hende Muher den Progreso” is set up to stimulate female entrepreneurship. This project is financed by the UNESCO.
	The Korps Politie Aruba (KPA) includes more modules on dealing with victims in its basic training program and follow-up courses
2001	The non-profit organization “Fundacion Pro Lechi Mama Aruba” is set up.
	The shelter at Foundation for Women in Distress opens its doors.
2002	A new civil code is introduced. This abolishes previous inequalities in the Aruban Civil Code. Previously, if a married couple could not agree on where the marital home should be or in the upbringing of children, the will of the father prevailed.
	The Ministry of Social Affairs and Infrastructure establishes a working group that focuses on gender.
	Aruba ratifies the United Nations Convention on the Elimination of all Forms of Discrimination of Women.

	A conference is held to flesh out recommendations proposed by the gender working group. The youth parliament is introduced. Young people, including women, can campaign for rights crucial to their individual development through the youth parliament. An empowerment training for women is held.
2003	A domestic violence committee is established within the KPA. Domestic violence in Aruba is mainly directed towards women and children. A new legislation on sexual offences enters into force. The new legislation includes provisions on martial rape and forced prostitution, amongst others. The new Netherlands Nationality Act 2003 takes effect. Under this act, women and men have equal status.
	The public prosecutor's office launches an investigation into urban prostitution, child prostitution, and trafficking of women in Aruba. The KPA sets up a data collection and analysis system for the registration of trafficking of women and children, sex tourism, pornography, and any other relevant items. A new subject (i.e., personal development) is introduced in general secondary education, covering the development of certain skills among adolescents. A reintegration project is launched by the Social Affairs Department to help benefit claimants find work. Most of the participants are women.
2005	CEMBRAH – a network of organizations that provide assistance to teenage parents – is set up.
	A human right coordination center – focusing especially on socially vulnerable groups such as women and children – is established within the Social Affairs Department.
2006	The Aruban Criminal Code is amended to comply with international treaties such as the Protocol to Prevent, Suppress, and Punish Trafficking in Persons, especially Women and Children.
2007	The Aruban law is changed to codify the right to pregnancy and maternity leave and related matters. Under this law, all female workers are entitled to pregnancy leave of four to six weeks before the official due date and maternity leave of six to eight weeks after the birth. Moreover, female workers are entitled to 100% of their salary during pregnancy and maternity leave. Under this law, female workers are also granted the right to interrupt their work to nurse the child or express breast milk during the first nine months after delivery (without loss of wages).

	The civil code is amended to include a provision nullifying any clause distinguishing between men and women in the context of entering into a contract of employment; issuing instructions to workers; employment terms and conditions; and renewal and termination of a contract of employment. An exception is made for provisions in an employment contract that protect female workers. Moreover, any stipulation leading to termination of employment due to marriage, pregnancy or childbirth is void. In addition, employers are prohibited from giving notice of termination during pregnancy and maternity leave.
2008	The Social Affairs Department begins developing a gender policy for which Afl. 750,000 is set aside in the 'Fondo di Desaroyo.'
2010	New legislation strengthens the position of the most vulnerable in Aruba. The changes include a 25 percent raise in monthly welfare benefits and the introduction of a school allowance for children of benefit recipients. The Centro di Desaroyo di Hende Muher is established.
	The Centro di Desaroyo di Hende muher launches a pilot project "Big Sister Little Sister Mentorship" program to provide guidance and support to girls between 10 and 14 who are exposed to risk factors in their immediate surroundings. A new criminal code for Aruba is approved by the Parliament and adopted by the Government of Aruba. With this new criminal code, the term of imprisonment for assault against a spouse or partner is increased by one-third.
2012	The KPA includes modules related to domestic violence in its programs. The Iniciativa pa Desaroyo di Empresa Arubano (IDEA) is set up to promote entrepreneurship. Most participants are females. The Compulsory Education Act enters into force. The court hears a case in which a school board expelled a pregnant schoolgirl. The court rules that this action violates the right of the person concerned to education and concludes that this is unlawful.
	The Ministry of Justice and Social Affairs makes the Centro di Desaroyo di Hende Muher a government department.
2013	A new labor law legislation comes into effect. With this new legislation, the duration of paid parental leave is set at two days. In addition, the responsibility of employers to ensure that employees are not exposed to actions that undermine employees' dignity are expressly regulated. The working hours, rest periods, and overtime pay of live-in housekeepers (most are females) are now regulated by law. Sex education is included in the school curriculum of Catholic primary and secondary schools.
2016	An amendment on the Civil Code of Aruba related to the law of persons and family is approved by the Parliament. This amendment regulates subjects related to the United Nations Convention on the Elimination of All Forms of Discrimination of Women.
2019	The Prime Minister of Aruba and the Minister of Social Affairs and Labor installs a steering committee for the development of a national gender policy in Aruba.



Is the Middle Class Being Squeezed?

The Case of Inflation
Inequality in Aruba

Daniella van den Berg

Abstract

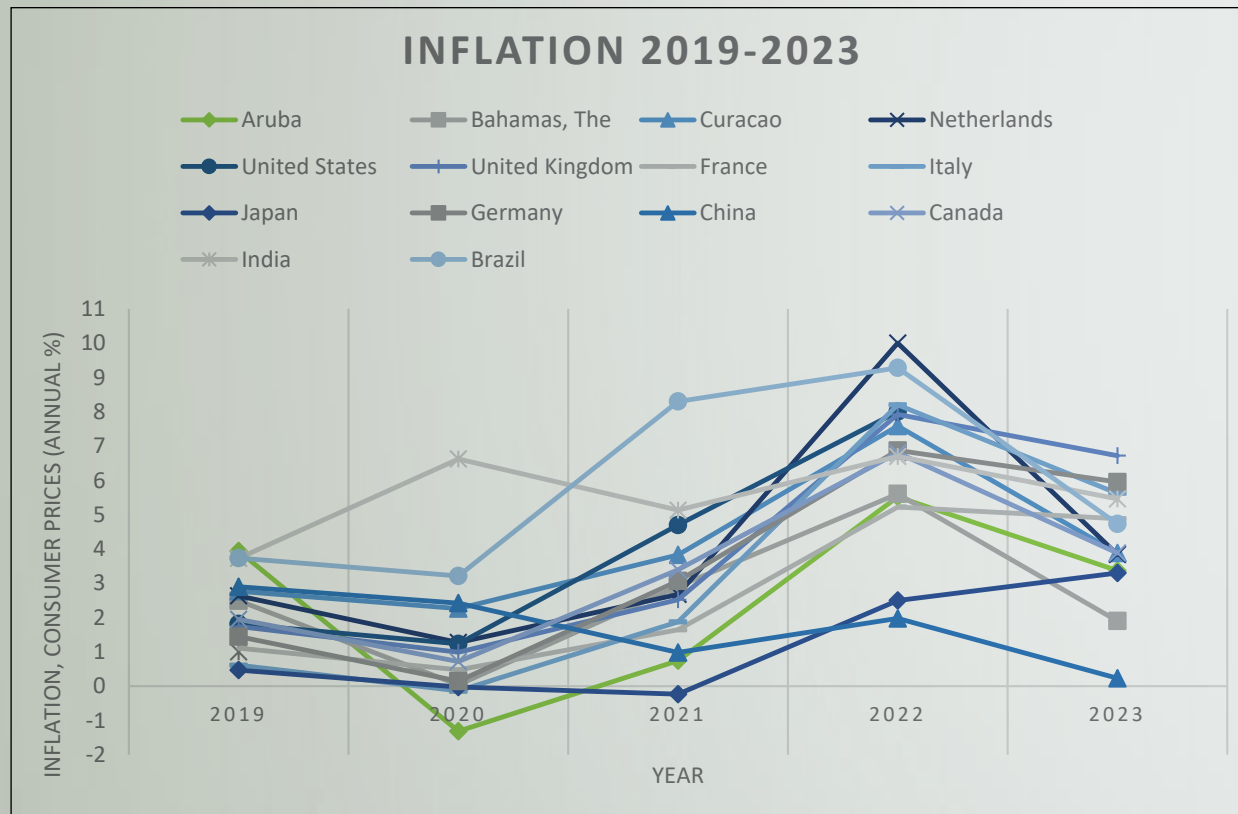
This chapter explores the inflation – income inequality nexus in Aruba between 2016 and 2022. Using the Income and Expenditure Survey data (Central Bureau of Statistics Aruba, 2019) as an indicator of consumption, and CPI figures for inflation (Central Bureau of Statistics Aruba, 2023), the investigation decomposes expenditure shares – defined as the proportion of a group's income spent on a certain component — into socioeconomic subgroups based on income quartiles. This study examines whether there is a significant difference in the impact of inflation among various (low, middle, high) income groups. The findings indicate that the middle class experienced the highest price level changes during inflationary periods, in comparison to the higher and lower income groups, primarily due to the components affected by inflation and the expenditure shares of this income group on those components. For this study, the component with the differential impact is the transportation component. The findings from this research are important to consider as, at the macro-level, a strong middle class is considered the very foundation and driver of inclusive growth. This study is critical for policymakers to determine the cost factors impacting certain income classes more heavily than others. It allows for the development of policy actions targeted towards those income group(s) most vulnerable in high-price environments and during inflationary periods.

I. INTRODUCTION

In 2023, inflation was one of the key topics covered in economics (WEF, 2023; OECD, 2023; WEO, 2023). The global economy had little to no time to recover coming out of the COVID-19 pandemic and being confronted right away with

the Russian invasion of Ukraine. Consequently, these crises compounded the effect on the supply chain of global markets, which did not leave (global) prices untouched. In addition, governments' fiscal stimulus contributed to elevated price levels (Jaramillo & O'Brien, 2022).

Graph 1: Inflation across the United States, the Netherlands, and other major economies.



For an extended period, prices were stable, with inflation remaining consistently below many central banks' target rates (DeSilver, 2022). However, since the summer of 2021, prices rose faster than anticipated, increasing worries among economists and central bankers on future instability. With Central Banks worldwide tightening financing conditions to rein in inflation rates and cool down the economy, fears of recession among consumers and businesses were widespread. However, in January of 2024, the IMF's World Economic Outlook update mentions inflation in most regions receding more steadily than was earlier anticipated (International Monetary Fund, 2024). This is partly due to resolved supply-chain issues and monetary policy remaining tight. In major economies, the gradual decrease of inflation could also mean a steadier easing of monetary policy than was expected in previous projections (IMF, 2024).

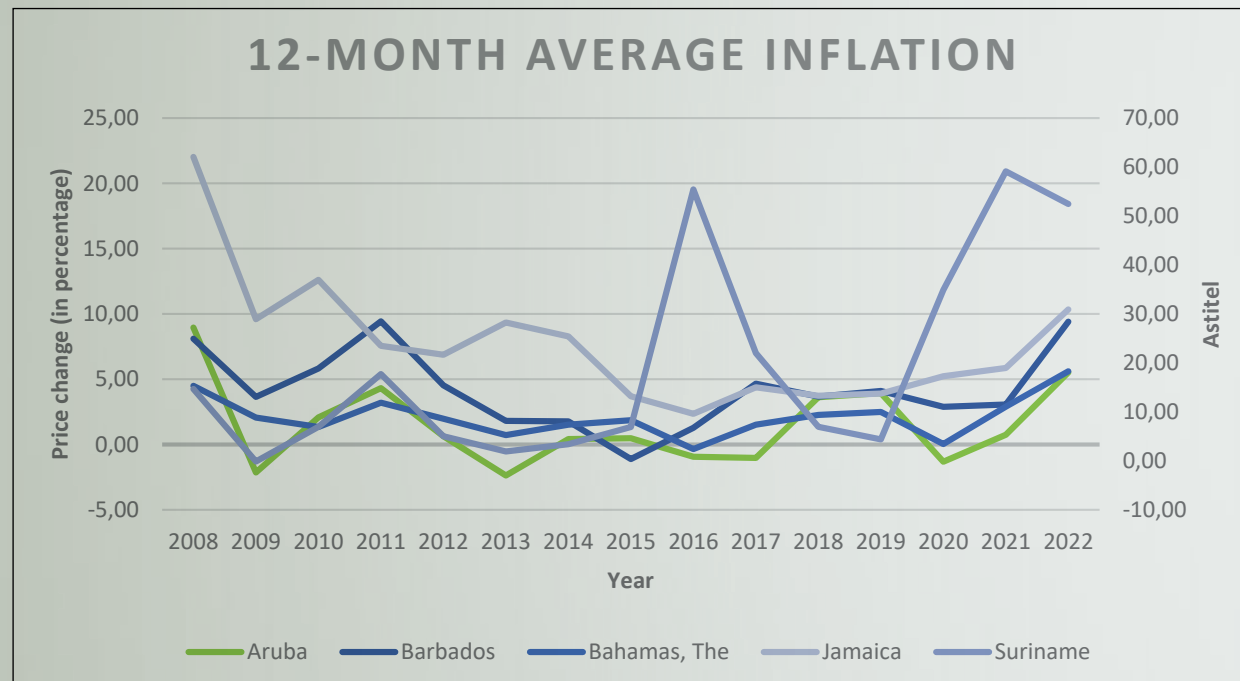
Although inflation has always been a fundamental matter in relation to economic development and growth, today, inflation is an even more relevant topic to study given the environment we find ourselves in. Pinpointing its determinants and determining the appropriate route and tools to undertake surging price levels is a crucial task of central banks globally.

In the Caribbean and among small islands, this research is even more critical as small islands and Caribbean states tend to be price takers and exhibit limited control over imported inflation (Boz et al., 2022). Considering that most products, including food items, are imported, it is of utmost importance that the factors influencing inflation are known by government policy advisors and central banks,

which hold the mandate to maintain financial stability. In Graph 2, the 12-month average inflation of Aruba is benchmarked against its regional peers. Historically, Aruba experienced inflationary periods ranging from -2.4 to 9.0 percent, with an average of 1.5 percent during the last 15 years. While the range could imply Aruba incurred rather volatile periods of inflation, the average (1.5 percent) is the lowest among its peers. Additionally, the standard deviation of 3.2 percent compared to peers from the region indicates that Aruba is not an outlier and experiences comparable variability as other islands in the Caribbean. The explanation for this is likely due to the open and trade dependent nature of small islands and countries in the region, as explained above.

The main objective of this study is to determine whether there is an occurrence of inflation inequality among the income quartiles in Aruba for the period 2016 through 2022. By using consumer expenditure data from the 2016 income and expenditure survey in Aruba and official inflation (consumer price index) statistics from the Central Bureau of Statistics, this paper sets out to estimate the impact of inflation across households from different socioeconomic subgroups. Consumer-price inflation measures, such as the CPI, are calculated using a basket of goods representative of the average consumer. However, the actual composition of spending and consumption can vary significantly by income group (Gill & Nagle, 2022). By decomposing the expenditure shares into socioeconomic strata, policymakers can better identify the cost factors affecting vulnerable segments of the population and design more targeted policies to provide assistance in high-price environments.

Graph 2: 12-month average inflation for Aruba and peers, Barbados, Bahamas, Jamaica, and Suriname throughout the last 15-year period. Right axis is applicable for Suriname only, while left axis applies to other countries including Aruba.



Inflation Inequality

Inflation inequality is defined as the spread of the inflation burden among income, ethnic, and other minority groups (Claeys et al., 2022).

In this chapter, inflation inequality is used in the context of varying inflation effects on households of different income groups.

Box 1: Inflation Inequality definition.

The following section covers the literature on inflation among income groups. Section three describes the data used, while section four explains the methodology. Subsequently, section five presents the results and accompanying discussion. Section six concludes with the policy recommendations.

II. LITERATURE REVIEW

The impact of inflation on various income groups has been broadly studied, particularly in the last few years. A large part of the literature, while using varying methods, concludes that poorer households tend to experience higher inflation (Claeys & Guetta-Jeanrenaud, 2022; Gill & Nagle, 2022; He & Sun, 2021; Jayashankar & Murphy, 2023; Klick & Stockburger, 2021;).

The Federal Reserve of Dallas published one of these studies. In the study, “High inflation disproportionately hurts low-income households,” the researchers use stress caused

by rising inflation as a proxy to determine the population most affected by rising prices (Jayashankar & Murphy, 2023). In contrast, the US Department of Labor implements a more commonly used method known as the Laspeyres Price Index (LPI). A similar method has been applied in this research paper for Aruba. The LPI provides the relation price change for the average household between the current time (current month or year) and the most recent equivalent period before (respective month or year). Nonetheless, the results can be compared to previous research, i.e., the LPI for poorer households grew faster than the average of all urban households (Klick & Stockburger, 2021). For wealthier households, the study found slower price growth compared to the average. The Wharton School of Business also researched this topic for the US population. This time, they estimated how much inflation would cost the average US household in 2021 to maintain the same level of consumption as opposed to 2020 and 2019. The researchers’ report indicated that an estimated additional \$ 3,500 would be needed for the average US household to maintain the same level of consumption in 2021 as in 2020 and 2019. In addition, lower-income households would have to spend seven percent more on goods and services as prices rise on the goods and services they consume, while for wealthier households, this percentage is six (He & Sun, 2021).

Aside from the research on the US population, there is also literature highlighting the effect of inflation on people with low incomes in other parts of the world (Claeys & Guetta-Jeanrenaud, 2022; Gill & Nagle, 2022). Breugel, an economic think tank based in Belgium, also published an analysis of the situation in Europe, focusing on Italy, France, and Belgium. This analysis underscores that in early 2022, low-income households in the above-mentioned countries

suffered the most as a large share of their income went to housing expenses, which includes energy prices (Claeys & Guetta-Jeanrenaud, 2022). In this article, the authors single out energy prices “as the main culprit” in the impact of inflation on lower-income households in France, Italy, and Belgium (Claeys & Guetta-Jeanrenaud, 2022). Another study focusing on the world’s poorer households from the Brookings Institution clarified why lower-income households are more impacted during inflationary periods (Gill & Nagle, 2022). The study mentions the composition of income, assets, and consumption baskets as factors influencing the impact of rising prices on poorer households (Gill & Nagle, 2022). On the composition of income and assets, the authors emphasize that poorer households often rely on wages and transfers, which can be eroded during inflationary periods, while wealthier households have access to financial products such as savings accounts, certificates of deposits (CDs) or investment funds, that may shield them from inflationary periods in the long term. On the other hand, poorer households are more likely to rely on nonmonetary income, such as agriculture workers consuming their yield or, in the Aruban context, fishers putting food on the table. Consumption baskets also play a role in the impact of inflation, as higher-income households can substitute for less expensive products when prices rise. In comparison, lower-income households are likely to purchase already the least expensive option (Gill & Nagle, 2022).

However, there is a portion of the literature on inflation inequality between income groups that does not conclude the fact that poorer households experience higher inflation compared to other income groups. A study by Breugel titled “Does inflation Hit the Poor Hardest Everywhere?” sets out to determine the factors that allow the

inflation burden to be felt more equally or unequally among income groups (Claeys et al., 2022). The research homes in on the term inflation inequality, measuring the spread of the inflation burden among income, ethnic, and other minority groups. For income groups in particular, the authors argue that in countries with low inflation inequality, consumption patterns, or share of income spent on specific categories, may not be vastly different between lower and higher income households. Another factor that plays a role is a significant price increase in luxury items, which may offset the increase in the price of food and energy prices, for example. Lastly, the article mentions certain national policies controlling prices on specific goods (Claeys et al., 2022).

Middle-income households may also be the most affected under certain conditions, according to the Federal Reserve Bank of New York (Chakrabarti et al., 2023). The study provides evidence that between 2021 and June 2022, the most affected households included middle-income households and households of Black or Hispanic ethnic background. The authors posit that the income group affected depends on the goods and services experiencing inflation at the time. During the period in question, prices rose steadily in the transportation component, for used cars and motor fuel. These are goods on which a more significant share of these groups’ expenditures is spent. The pattern can be further supported considering that as inflation in transportation started to decline, inflation for the mentioned groups also declined (Chakrabarti et al., 2023). This research highlights the importance of determining the source of inflation, pinpointing the most affected groups, and developing targeted policies to alleviate the burden for specific income or ethnic groups. The above-mentioned actions are vital in combatting inflation inequality.

In comparison to larger countries in the Latin American and Caribbean (LAC) region, smaller economies face more significant inflation challenges according to the IMF (Boz et al., 2022). This research paper highlights the reasons why smaller economies in Central America, the Caribbean, and South America are more vulnerable to inflationary episodes, including their reliance on imports, low diversification of economies, higher public debt, and fewer monetary policy tools at their disposal due to pegged exchange rates (Boz et al., 2022). Since food prices drove the inflation waves in 2022, it impacted poorer households the most due to a more considerable proportion of these households' income being devoted to food. The World Bank also published a paper on the impact of inflation on the LAC region, reiterating food and energy as the main drivers of inflation during the 2021 wave (Jaramillo & O'Brien, 2022). As previously mentioned, poorer households spend more of their income on basic needs such as food and shelter. In the LAC, on average, approximately 40 percent of the budget share goes to food and energy, with inflation only putting further pressure on the disposable income of lower-income households (Jaramillo & O'Brien, 2022). Empirical analysis pointed to demand-side pressures pushing up inflation, particularly the expansionary policies during the pandemic alongside supply chain disruptions. In addition to these factors, the Russian invasion of Ukraine exacerbated the inflationary pressure (Jaramillo & O'Brien, 2022). Lastly, to compare against a peer in the region, the study titled *Inflation Across Different Groups in Trinidad and Tobago* is a good comparison in which using the Laspeyres Price Index, the authors find that poorer households are more affected by high inflation, in particular when the latter is driven by food and energy (Mahabir et al., 2016).

Based on the literature, there seems to be growing consensus that poor households are disproportionately affected by higher inflation (Claeys & Guetta-Jeanrenaud, 2022; Gill & Nagle, 2022; He & Sun, 2021; Jayashankar & Murphy, 2023; Klick & Stockburger, 2021). However, research also provides evidence of the contrary under exceptional circumstances (i.e., contextual, or idiosyncratic factors). Therefore, the research question this study intends to answer is: What is the differential impact of inflation on different income groups in Aruba?

III. DATA & METHODOLOGY

III.1. Data

This study uses consumer expenditure data from the 2016 Income & Expenditure Survey (Central Bureau of Statistics Aruba, 2019). The data is broken down by income groups and number of children, provided by the CBS of Aruba. As for inflation figures, the paper uses the official Consumer Price Index (CPI) for 2016 through 2022 (Central Bureau of Statistics, 2023). The consumer expenditure data and CPI are the main variables in this study. In 2019, based on the new IES conducted in 2016, the CBS undertook a reweighting of the inflation calculation components. The new weights were retroactively applied to the years 2017 and 2018. Prior to 2019, the last reweighting was conducted in 2006.

As previously stated, the CBS calculates the country's inflation statistics using the CPI. However, even though the CPI is the most used measure of inflation, other measures, such as the Harmonized Index of Consumer Prices (HICP) and the Personal Consumption Expenditure Index (PCE), may be better

suited in other areas. For this reason, we include the distinction between the CPI, HICP, and PCE in this study.

Firstly, the CPI is the most widely used measure of inflation as it aligns with international standards, making it suitable for comparing countries. The CPI measures the percentage change in the price of a basket of household goods and services (Measures of consumer price inflation, 2023). The Harmonized Index of Consumer Prices (HICP) is commonly used in the Eurozone and the EU. The main difference between the HICP and CPI is the composition of the basket of goods and services on which the index is based. Three main groups of goods and services are included in the CPI but excluded from the HICP, namely: i) Services related to owner-occupied dwellings; ii) Contributions to sport and leisure clubs; and iii) Consumption-related taxes (Statistics Netherlands, 2022). Owner-occupied dwellings are excluded, as these dwellings are considered investments, and there is no actual rent price to be observed or measured; rather, it is imputed. Thus, in the case of HICP, only rental housing is included. Consumption-related taxes, such as motor vehicle and dog taxes, also fall outside the scope of the HICP. Conversely, co-payments for living in an institution or a home are included in the HICP but not in the CPI. Specifically, groups excluded from HICP are:

1. COICOP 042100 Imputed rentals of owner-occupied dwellings;
2. COICOP 094130 Contribution to sports and leisure associations;

3. COICOP 130000 Consumption-related taxes;
4. COICOP 140000 Consumption abroad by residents.

A third measure, particularly used by the Bureau of Economic Analysis, and preferred by the US Federal Reserve Bank, is the Personal Consumption Expenditure Price Index (PCE). The US Federal Reserve Bank prefers this measure over the CPI used by the US Bureau of Labor Statistics (US Bureau of Economic Analysis, 2021). The FOMC (Federal Open Market Committee) focused on CPI inflation prior to 2000 but, after extensive analysis, changed to PCE inflation for three main reasons: 1) The expenditure weights in the PCE can change as people substitute away from some goods and services toward others, 2) the PCE includes more comprehensive coverage of goods and services, and 3) historical PCE data can be revised (more than for seasonal factors only) (US Bureau of Economic Analysis, 2021).

III.2. DATA LIMITATIONS

It is important to highlight some data limitations of this current study in Aruba. Firstly, the housing component level and weight are likely understated in the inflation calculation. The lower level of expenditure on housing is due to an adjustment made by the researcher to match the IES data to the official weights used to calculate CPI figures¹. Additionally, the housing prices in the CPI calculation are currently imputed

¹ Initially, the weights assigned to the housing component in the 2016 IES and CPI figures contained a discrepancy of about 12 percentage points. For consistency, the researcher made the decision to adjust the weight in the overall IES 2016 down to reach near the weight included in the CPI calculation. The difference, in Aruban florins, was excluded from the total expenditure, and the difference in weight then redistributed among the remainder of the components. The proportion between the new and old levels based on amounts in Aruban florins, was then applied to each quartile, allowing the weight to be calculated based on this “new” level.

as a rental survey needs to be conducted regularly. Instead, the 2010 Census and 2016 IES are used to determine a factor to account for increases in accommodation costs. Notably, since 2016, the island has also experienced an increase in economic activities in the rental property market, such as Airbnb accommodations, which has set upward pressure on prices in the housing market in Aruba (Peterson, 2024). Furthermore, in August of 2022, utility companies also increased the water and electricity prices in line with international petroleum prices. An additional reason as to why the housing component is likely understated.

Furthermore, the IES data is from 2016 and reflects the consumption patterns per income group that were applicable then. With the COVID-19 pandemic (in 2020-2021) and tax reforms introduced thereafter, this data would not capture any behavioral shifts amongst consumers that may have taken place. An income and expenditure study has been conducted in 2023-2024 by the CBS, and the second part of this research could be conducted when updated IES data is available.

III.3. METHODOLOGY

This study uses the official headline inflation of Aruba (as measured by CBS). The headline inflation rate of a country refers to the average inflation experienced in each country. It is computed based on the price changes of items in a predetermined basket of goods and services. The basket varies from country to country as it is meant to constitute a nationally representative collection of expenditures in each country. In Aruba, major commodity items and services are calculated based on the most recent Income and Expenditure Survey 2016.

Throughout the region, the components included in baskets include measures of food and non-alcoholic beverages, alcohol and tobacco, housing, clothing and footwear, medical items and services or health expenditures, transport including taxi fares and cost of vehicles, communication, education, recreation and culture, and miscellaneous items. Table 1 lays out the results of the 2016 IES in Aruban Florins (Afl.) and in a share of the total (percentage).

Table 1: Income and Expenditure Survey 2016 results in Aruba Florins (Afl.) and the percentage of total (share).

Budget Component	In Afl.	As share of total
Food and non-alcoholic beverages	374	8.7%
Alcoholic beverages and tobacco	27	0.6%
Clothing and footwear	95	2.2%
Housing	1613	37.6%
Household operation	320	7.5%
Health	77	1.8%
Transport	518	12.1%
Communications	316	7.3%
Recreation and Culture	346	8.1%
Education	34	0.8%
Restaurants and hotels	152	3.5%
Miscellaneous goods and services	421	9.8%
Total	4,294	100.0%

To compute the rate of headline inflation, the annual average changes in the overall basket's total price, the Laspeyres Price Index (LPI) is used. The LPI provides the relation price change for the average household between the current time (current month or year) and the most recent equivalent period before (respective month or year). In theory, the LPI requires the presence of quantity and price indicators; however, quantity is often only available at the time of the national survey of expenditures. Thus, this is constructed as a baseline where

prices are measured, and quantities are used to define the weight or shares of expenditures on the respective items. In subsequent measurement periods, the quantity is held constant and constructed as an inherent weighting of the shares of expenditures. At the same time, the change in prices registered by market surveys of the respective items is used as the variable component. This way, the index can capture the change in expenditure on the items included in the basket, through the price component.

The formula denotes the LPI:

$$LPI_t^n = \sum \frac{Q_{io}^n P_{it}}{\sum_{t=1}^n Q_{io}^n P_{io}} \times 100$$

Where,

Q is the quantity consumed

P is the base year price

t is time

To account for the missing data on quantity in the subsequent years, the LPI is modified to hold the expenditure shares constant. This is done by adjusting the formula to reflect the weight of the items consumed in the base year (W). As such, the formula is adjusted to:

$$LPI = \sum w_{io}^n \left(\frac{P_{it}}{P_{io}} \right) \times 100$$

Where,

$$W_{io}^h = \frac{Q_{io}^n P_{io}}{\sum_{t=1}^n Q_{io}^n P_{io}}$$

This study takes the analysis of inflation a couple of steps further. It seeks to separate the basket of goods into four strata, clustering the country's population into socioeconomic subgroups. The boundaries of these subgroups are determined based on the most recent Income and Expenditure Survey (2016). The disaggregation helps to identify the differences in consumption between the income groups. Section II states that the literature broadly supports the hypothesis that lower-income groups devote a larger share of their household income to food and housing.

In contrast, the higher incomes assign a more significant share to the components: transportation and consumer durables. By decomposing the expenditure shares into socioeconomic strata, policymakers can better identify the cost factors affecting poor and vulnerable populations and can consequently design more targeted policies to assist in high-price environments.

As such, the formula used in this study for inflation is denoted as:

$$LPI = \sum QI_{i=1}^4 \left(w_{io}^n \left(\frac{P_{it}}{P_{io}} \right) \right) \times 100$$

Where,

QI is the income quartile.

Once the respective inflation rate for each quartile is computed, the results are compared among the income groups to show the dispersion of price pressures according to socioeconomic strata. This is a critical part of this research as it facilitates the estimation of the actual inflationary pressures felt according to the relative expenditure patterns of households. Consequently, the inflation per quartile can be further broken down by component level to determine the exact goods or services impacting certain groups the hardest. This does not require changing the formula but rather separating the components into sub-groups rather than computing the overall basket.

A similar representation of this is:

$$LPI = \sum QI_{i=1}^4 \left(\sum C_{i=1}^n \left(w_{io}^n \left(\frac{P_{it}}{P_{io}} \right) \right) \right) \times 100$$

Where,

C is the commodity subgroup.

IV. RESULTS & DISCUSSION

Table 2 shows the weights associated with each component per socioeconomic subgroup based on the 2016 IES, including an adjustment for the housing component. These weights are to be compared among the income groups. Considering quartile 1, this income group devotes a significant share to the housing component, namely 36.2 percent. When combining housing with food and non-

alcoholic beverages, this proportion of quartile 1 income rises to 50 percent. Another finding that stands out is that housing represents the largest share of expenditure among all income groups. In contrast, the second largest component varies depending on the income (food for lower-income, transport for income quartiles 2, 3, and 4). The miscellaneous category is also noteworthy as this component rises steadily between the income quartiles 1 and 2 compared to income quartiles 3 and 4.

Table 2: Consumption share by income quartile based on IES 2016.

Component of expenditure		I bottom 25 percentile	II 50 th percentile	III 75 th percentile	IV top 25 percentile
01	Food and non-alcoholic beverages	13.8%	12.0%	10.5%	8.7%
02	Alcoholic beverages and tobacco	0.5%	1.7%	0.4%	0.6%
03	Clothing and footwear	1.9%	2.7%	2.9%	2.7%
04	Housing	36.2%	27.4%	25.5%	20.6%
05	Household operation	8.4%	8.8%	9.0%	9.2%
06	Health	2.3%	2.6%	2.5%	1.7%
07	Transport	8.4%	14.4%	15.9%	15.5%
08	Communications	8.6%	9.4%	9.3%	8.3%
09	Recreation and Culture	5.9%	7.2%	8.2%	12.7%
10	Education	1.3%	0.7%	0.9%	0.9%
11	Restaurants and hotels	3.0%	3.2%	3.3%	5.7%
12	Miscellaneous goods and services	9.6%	9.8%	11.6%	13.4%
Total		100.0%	100.0%	100.0%	100.0%

Table 3 lists the 12-month average inflation rates per component for 2016 through 2022. At the bottom, the row 'all items' refers to the overall 12-month average inflation for the year in Aruba. The table shows that Aruba experienced deflation in 2016, 2017, and

2020, while 2018, 2019, 2021, and 2022 experienced inflation. In 2019, food, beverages, and tobacco were the main drivers of high inflation, while in 2022, this was a result of higher transport and food prices.

Table 3: Inflation per component from 2016 through 2022

Inflation per component	2016	2017	2018	2019	2020	2021	2022
Food and non-alcoholic beverages	-0.6	-3.0	7.6	11.1	-0.4	-0.2	10.1
Alcoholic beverages and tobacco	2.6	-5.7	6.2	19.1	3.3	0.1	4.2
Clothing and footwear	0.9	0.2	2.0	4.8	-4.0	-6.8	5.9
Housing	-2.5	-1.5	-0.1	2.1	-1.8	0.7	5.0
Household operation	-1.5	-2.6	3.3	-0.6	-2.8	-1.1	3.9
Health	1.1	-1.3	8.8	5.4	-0.4	-3.6	1.2
Transport	-1.6	1.2	8.6	2.6	-5.8	9.5	16.4
Communications	0.6	-1.0	5.1	8.7	0.2	-0.1	-2.6
Recreation and Culture	-0.8	-4.4	3.7	1.2	1.1	-1.9	1.8
Education	1.8	2.0	3.9	2.8	0.7	1.9	2.6
Restaurants and hotels	1.9	-0.7	4.9	7.0	3.0	0.3	5.7
Miscellaneous goods and services	0.7	-1.2	2.0	3.9	0.0	-0.1	1.9
All items	-0.9	-1.0	3.6	3.9	-1.3	0.7	5.5

In Graph 3, the components of headline inflation measured as the average over 12 months are presented. What can be observed is that in some years, there are one or two components that drive the overall headline inflation, while in other years an overall increased price level for all components can be noted. In 2016, 2018, and 2020, the components contributed relatively equal to the overall composition of headline inflation. In 2018, as part of a broader fiscal reform, the BAZV was increased from two percent to three percent. Additionally, the BAVP, a purely consumptive tax levied to be able to pay the costs associated with the PPP infrastructure projects, was introduced at 1.5 percent. This led to a higher overall tax on consumption on goods and services, rising from 3.5 to six percent.

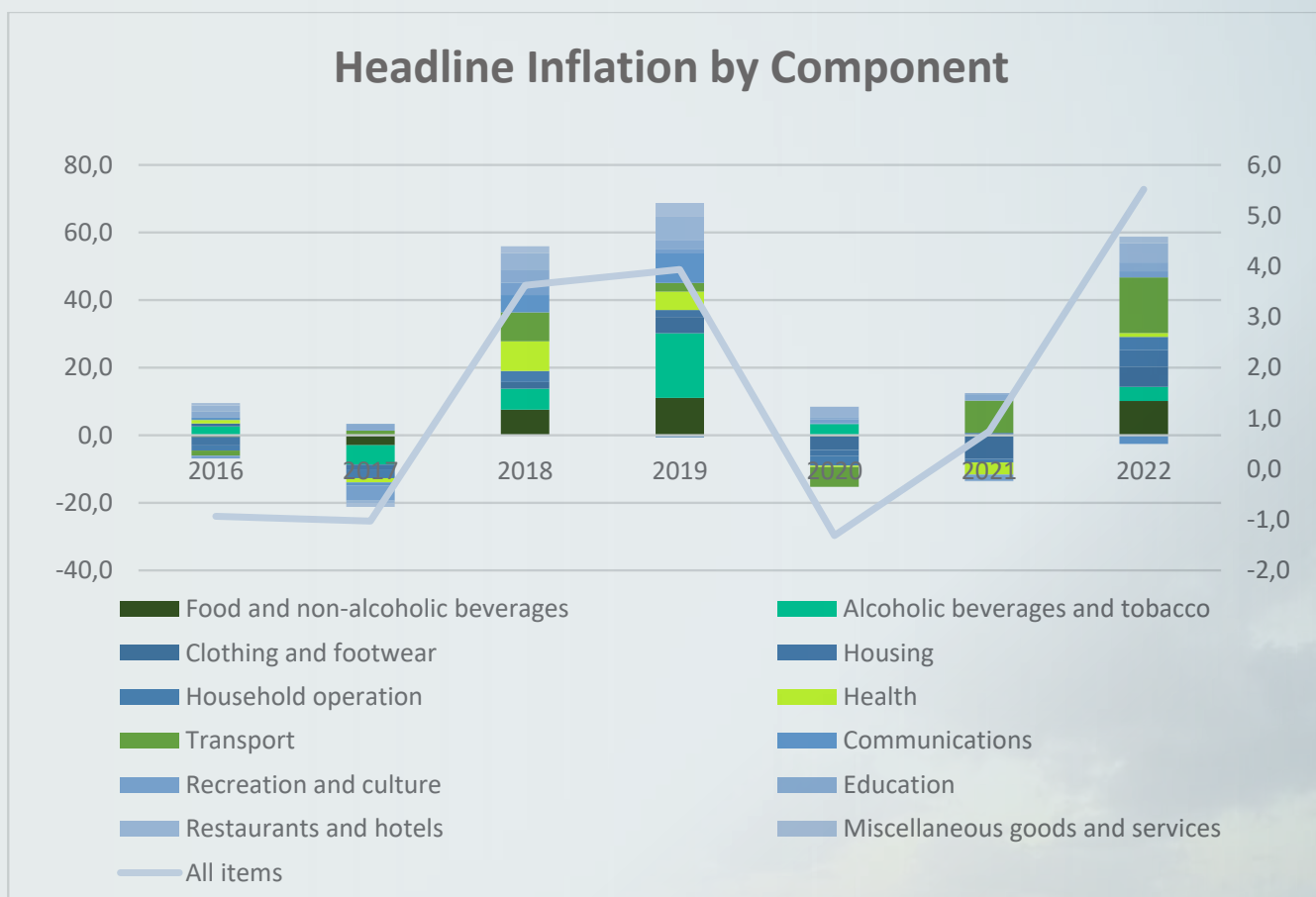
On the other hand, in 2017, 2019, 2021, and 2022, the size of some components stands out in comparison to the others.

In 2017 and 2019, this is the component alcoholic beverages and tobacco, while in 2021 and 2022, the component transport increasingly drove headline inflation. In 2019, the alcoholic beverages and tobacco component represented a large part of the headline inflation as there was a rise in the excise tax on these products. In 2021 and 2022, the contribution of the transport component was due to higher international fuel products and motor vehicles. Both of which are imported in Aruba. Lastly, it is also important to note that earlier years 2018 and 2019, the price increases were primarily due to local policy changes², while more recently, in 2021 and 2022, the increases were partly due to local pressures and partly due to international

prices and brings to forefront the vulnerability of small islands as price takers.

² The policy changes referred to here are mainly 1) the increase in the turnover tax (specifically the BAZV portion) – from 2 percent to 3 percent as per July 1st, 2018, and the introduction of the BAVP as a new component of the turnover tax, at 1.5 percent. Overall, this means that the turnover tax (BBO, BAZV and BAVP) rose from 3.5 percent to 6 percent as per July 1st, 2018. Additionally, 2) the excise tax on tobacco and alcoholic products was raised shortly after in 2019 (+44.0 percent).

Graph 3: Headline inflation broken down into inflation per components throughout 2016-2022 for Aruba.



Lastly, the compilation of tables 4 through 7 provides details on the expenditure of households in each quartile. The bottom row, 'Δ in percentage,' represents the change experienced in

expenditure due to pricing changes only. The central assumption here is that consumption patterns remained constant over the sample period.

Table 4: Development of expenditure for the lowest income group (quartile 1) per component and total inflation experienced through 2016-2022.

Quartile 1	2016	2017	2018	2019	2020	2021	2022
Food and non-alcoholic beverages	259.2	251.5	270.5	300.5	299.3	298.6	328.9
Alcoholic beverages and tobacco	9.8	9.2	9.8	11.7	12.1	12.1	12.6
Clothing and footwear	35.4	35.5	36.2	37.9	36.4	33.9	35.9
Housing	678.2	668.3	667.4	681.2	669.1	673.5	706.9
Household operation	157.9	153.8	158.8	157.8	153.3	151.7	157.6
Health	42.9	42.4	46.1	48.6	48.4	46.7	47.3
Transport	156.8	158.7	172.3	176.8	166.4	182.3	212.3
Communications	161.1	159.6	167.7	182.4	182.7	182.6	177.9
Recreation and Culture	109.7	104.8	108.7	110.0	111.2	109.2	111.1
Education	25.0	25.5	26.5	27.2	27.4	28.0	28.7
Restaurants and hotels	56.1	55.7	58.4	62.5	64.4	64.6	68.3
Miscellaneous goods and services	179.8	177.7	181.3	188.3	188.4	188.2	191.8
Total expenditure	1,871.9	1,842.7	1,903.8	1,984.9	1,959.2	1,971.4	2,079.2
Δ in percentage		-1.6	3.3	4.3	-1.3	0.6	5.5

For Quartile 1, Table 2 shows us that most of this group's income goes towards the components 'food and non-alcoholic beverages' and 'housing'. In Table 4, the results show the amount

of Aruban florins as expenditure on each component. For 'food and non-alcoholic beverages', the rise in amounts between 2016 and 2022 represents 26.8 percent, which is a basic necessity.

Table 5: Development of expenditure for lower middle-class (quartile 2) per component and total inflation experienced through 2016-2022.

Quartile 2	2016	2017	2018	2019	2020	2021	2022
Food and non-alcoholic beverages	332.1	322.3	346.7	385.0	383.5	382.7	421.5
Alcoholic beverages and tobacco	47.5	44.8	47.6	56.7	58.6	58.7	61.1
Clothing and footwear	74.8	74.9	76.4	80.1	76.9	71.7	75.9
Housing	755.1	744.1	743.1	758.5	745.0	749.9	787.1
Household operation	241.5	235.2	242.9	241.4	234.5	232.0	241.1
Health	72.3	71.3	77.6	81.8	81.5	78.6	79.5
Transport	397.0	401.8	436.3	447.6	421.4	461.5	537.5
Communications	259.6	257.1	270.2	293.8	294.4	294.2	286.7
Recreation and Culture	199.8	191.0	198.1	200.4	202.7	198.9	202.4
Education	19.6	19.9	20.7	21.3	21.4	21.9	22.4
Restaurants and hotels	87.0	86.4	90.6	96.9	99.9	100.2	105.9
Miscellaneous goods and services	271.6	268.4	273.8	284.4	284.5	284.2	289.6
Total expenditure	2,757.9	2,717.3	2,824.0	2,948.0	2,904.3	2,934.5	3,110.7
Δ in percentage		-1.5	3.9	4.4	-1.5	1.0	6.0

In Quartile 2, the component ‘transport’ starts to play a relatively larger role. This component saw a growth of 35.4 percent between 2016 and 2022. This increase, especially after 2020, was driven by international fuel product prices and motor

vehicle prices. Similarly to Quartile 2, Quartile 3 also sees a relatively substantial impact of the transport component on total inflation for this income group.

Table 6: Development of expenditure for upper middle-class (quartile 3) per component and total inflation experienced through 2016-2022.

Quartile 3	2016	2017	2018	2019	2020	2021	2022
Food and non-alcoholic beverages	369.5	358.6	385.7	428.4	426.7	425.7	468.9
Alcoholic beverages and tobacco	14.6	13.8	14.7	17.5	18.0	18.1	18.8
Clothing and footwear	102.0	102.2	104.2	109.2	104.8	97.7	103.5
Housing	900.7	887.5	886.3	904.7	888.6	894.4	938.8
Household operation	315.7	307.6	317.6	315.6	306.6	303.4	315.2
Health	88.0	86.9	94.5	99.7	99.3	95.7	96.9
Transport	560.0	566.8	615.4	631.3	594.4	651.0	758.1
Communications	328.0	324.8	341.5	371.3	372.0	371.8	362.2
Recreation and Culture	290.0	277.1	287.4	290.8	294.1	288.6	293.7
Education	32.4	33.1	34.3	35.3	35.6	36.3	37.2
Restaurants and hotels	116.6	115.8	121.5	130.0	133.9	134.4	142.0
Miscellaneous goods and services	408.5	403.8	411.8	427.8	428.0	427.6	435.7
Total expenditure	3,526.1	3,477.9	3,614.9	3,761.5	3,701.9	3,744.6	3,971.0
Δ in percentage		-1.4	3.9	4.1	-1.6	1.2	6.0

Table 7: Development of expenditure for the highest income (quartile 4) per component and total inflation experienced through 2016-2022

Quartile 4	2016	2017	2018	2019	2020	2021	2022
Food and non-alcoholic beverages	536.9	521.0	560.4	622.5	620.0	618.6	681.3
Alcoholic beverages and tobacco	35.7	33.7	35.8	42.6	44.0	44.1	45.9
Clothing and footwear	168.9	169.2	172.5	180.8	173.6	161.8	171.4
Housing	1,270.4	1,251.8	1,250.1	1,276.1	1,253.3	1,261.5	1,324.1
Household operation	564.6	550.0	567.9	564.4	548.4	542.6	563.7
Health	103.9	102.6	111.6	117.6	117.2	113.0	114.3
Transport	957.8	969.4	1,052.5	1,079.7	1,016.7	1,113.4	1,296.6
Communications	513.5	508.5	534.5	581.2	582.3	582.0	567.0
Recreation and Culture	786.5	751.7	779.6	788.8	797.7	782.8	796.8
Education	58.0	59.1	61.4	63.1	63.6	64.8	66.5
Restaurants and hotels	349.3	346.8	363.8	389.2	401.0	402.3	425.4
Miscellaneous goods and services	824.0	814.5	830.7	862.9	863.2	862.4	878.8
Total expenditure	6,169.5	6,078.2	6,320.9	6,569.0	6,480.9	6,549.4	6,931.7
Δ in percentage		-1.5	4.0	3.9	-1.3	1.1	5.8

Table 8: Summary of inflation experienced by quartiles 1-4

	2017	2018	2019	2020	2021	2022
Quartile 1	-1.6	3.3	4.3	-1.3	0.6	5.5
Quartile 2	-1.5	3.9	4.4	-1.5	1.0	6.0
Quartile 3	-1.4	3.9	4.1	-1.6	1.2	6.0
Quartile 4	-1.5	4.0	3.9	-1.3	1.1	5.8

Considering the inflationary years 2018, 2019, 2021, and 2022, the findings indicate that quartile 1 experienced the lowest inflation among the income groups in 2018 and 2021.

In contrast to most of the literature, the lowest income group did not experience the highest inflation level among income groups during any of the years included in the research period. For Aruba, this may reflect several social protection measures, which are enacted in the Aruban fiscal and economic system to protect vulnerable groups (in this case in terms of income³). The social protection measures referred to here, include 1) a progressive tax system with a tax-free base of Afl. 30,000 for personal income tax, where the first two brackets have been reduced from 14% to 12% and from 25% to 23% as of January 1st 2021, ensuring that minimum wage earners pay little to no income tax on their salaries, 2) the 'canasta basico' which sets a price ceiling on basic goods and services, and 3) targeted exemptions to the BBO on products and services that make up a larger share of the

vulnerable groups monthly expenditure.

For quartile 2, we see that the income group experienced higher price level changes than the other income groups in 2019 and 2022. Likewise, quartile 3 experienced higher inflation in 2019 and 2021, while quartile 4 experienced a higher price level only in 2018.

By analyzing the shares of consumption per income group and inflation experienced per category, there are several possible explanations for the most impacted groups in each of the inflationary years. First, in 2018, quartile 4 experienced higher inflation compared to other income groups. The largest contribution to the elevated price level during 2018 was the component health. Aruba has a general healthcare system coordinated by the executive body Algemene Ziektekosten Verzekering (AZV). The AZV is financed partly by social contributions through a share of income of the employed

³ The protection measures included in the Aruban tax regime, such as in the income tax, includes an exemption for those earning up to Afl. 30,000 yearly. As a result, it allows protection to those earning minimum wage – and to some earning a bit above the minimum wage.

population, while another (consumptive) tax, the BAZV, is levied on most goods and services. During 2018, as a part of a broader fiscal reform, the BAZV was increased from two percent to three percent. Additionally, the BAVP, a purely consumptive tax levied to be able to pay the costs associated with the PPP infrastructure projects, was introduced at 1.5 percent. This led to a higher overall tax on consumption on goods and services, rising from 3.5 to six percent. A higher overall tax rate could have contributed to this group experiencing higher price levels compared to other groups when considering the higher share of income by quartile 4 spent on the components restaurant and hotels, recreation and culture, household operation (which includes furniture), as well as miscellaneous goods and services. Miscellaneous goods and services component includes goods such as makeup, hair products, lotions but also jewelry and watches. Services included in this component comprise of childcare, hair salon and beautician services, barber, and insurance services. These components do not include goods and services classified as needs and thus are less consumed by lower income groups.

Research from the US Department of Agriculture has shown that higher income groups, due to time constraints, spend more on convenience foods including all-service restaurants which tend to be more expensive (Rahkovsky & Jo, 2018). Additionally, the higher inflation experienced by quartile 4 during 2018 can also be explained by considering the exemptions to the turnover tax, most notably water supply and electricity services. Water and electricity⁴ are included in the housing component,

for which a meaningfully smaller share of income is devoted by quartile 4 compared to the other quartiles (see Table 2). Quartile 4 devotes 20.6 percent of its income to the housing component while for quartile 3, this is 25.5 percent, for quartile 2 27.4 percent and for quartile 1 36.2 percent.

In 2019, quartile 2, considered a portion of the middle class, experienced highest inflation among the socioeconomic groups in Aruba. This group devotes relatively more of its income on alcoholic beverages and tobacco, and on communications as compared to the other groups. The higher price level changes experienced during 2019 can, therefore, be explained by a rise in the import duties and excise duty on alcoholic beverages and tobacco products which disproportionately affected quartile 2. Inflation in 2021, and partly in 2022, was largely affected by the transport component, in particular gasoline prices and prices of car rental and leasing. The group with the largest share of their income going to transport, compared to other income groups is quartile 3, which in turn caused them to experience higher inflation during 2021. This group is most likely to drive larger, and perhaps second hand, vehicles which may be less fuel efficient. In comparison to group 1 who may use public transport, and group 4 who may have the latest, most fuel-efficient models or even drive electric vehicles (EVs).

Lastly, for 2022, in addition to fuel prices driving inflation during the year, the Russian invasion of Ukraine also contributed to elevated price levels in the food components

⁴ In Aruba, there are different rates for water and electricity usage depending on if the property is considered residential, commercial, or (in the case of water) farming, horticulture, and husbandries. Furthermore, based on the usage, additional tiers of differing rates are applied to the bill, with the higher the consumption, the higher the charged rate.

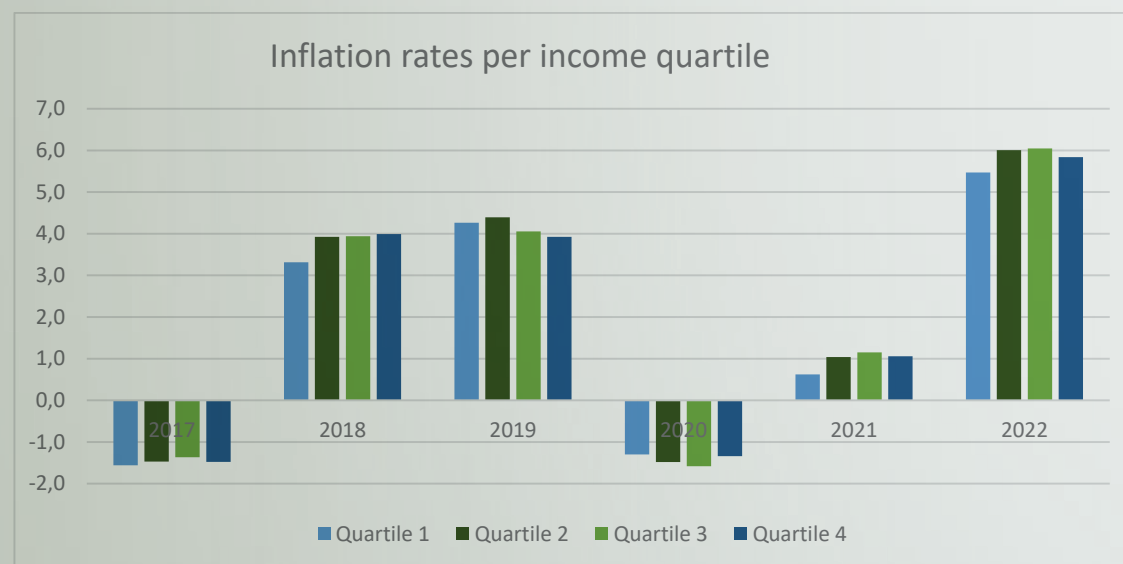
which affected quartiles 2 and 3 the most. This finding can be explained by analyzing the compounding effect of having high transportation prices and thereafter adding food prices on top. For lower income households, while food takes up a large part of their income, the effects of fuel prices are felt less as they might take public transportation for which the prices are capped or have smaller vehicles which use less fuel. As for high income households, the transportation may be felt more, perhaps due to larger vehicles but food make up a considerably smaller share of their income and, therefore, the effects are partly offset.

In 2017 and 2020, Aruba experienced deflation, a period in which prices dropped compared to the previous year.

Negative inflation in 2017 likely resulted from an Aruban recession that started in mid-2015 and 2016, where real GDP declined by 0.5 and 0.2 percent, respectively. As for 2020, the COVID-19 pandemic impacted Aruba's economy heavily, resulting in a drop in domestic demand and deflation.

In Graph 4, the Tables 4 through 8 are summarized, where we can conclude that there is evidence of inflation inequality between the income groups in Aruba. Further, the findings also show that during inflationary periods, the middle-income groups (in this case quartile 2 and/or 3) are likely to be affected more disproportionately compared to the lower and higher income groups.

Graph 4: Inflation rates per income quartile.



V. CONCLUSION & POLICY RECOMMENDATIONS

In this study, we used the income quartile expenditures based on IES 2016, and the national average CPI figures for Aruba, and provided a modeled estimation of what the inflation levels could be per income quartiles throughout the 2016 to 2022 period. The objective of this chapter is to determine if the data for Aruba supports findings in the literature that lower-income households are more affected during high inflation periods than higher income groups, owing to the larger share of lower income household incomes spent on needs, like food and housing.

However, the data for Aruba does not support these findings in the literature. Instead, based on the findings presented in the previous section, it can be concluded that a substantial portion of the burden in the Aruban society falls the heaviest on the middle⁵ class. The results indicate that the Aruban middle class, comprising the quartiles 2 and 3, experienced the highest inflation among all quartiles in this study. In the pre-Covid period, this was predominantly due to the policy reforms undertaken. More recently, the transport component including international fuel product pricing and motor vehicle prices disproportionately placed the burden on income groups 2 and 3. More specifically, this result can be attributed to high inflation on alcoholic beverages and tobacco, and communications in 2019, while in 2022, the transport component played a vital role. For the years 2019 and 2022, in particular, it is notable that food and non-alcoholic beverages

pushed up inflation for all income groups. It is also noteworthy that in 2018, quartile 4 experienced the most inflation. The high inflation in 2018 was due to an overall elevated price level in connection with the increase of the turnover tax (BBO), alongside the included exemptions on services in which a larger share of income is devoted to by lower income households (such as utilities).

This study finds that a specific income group, i.e., the middle class, is differentially affected compared to lower and higher income groups. Theoretically, the disproportionate impacts on the group known as the middle class has been studied under the term “the middle-class squeeze.” The middle-class squeeze is simply put a result of stagnant – in some cases, declining – real income, while costs rose significantly over the last 30 years (Erickson, 2014; OECD, 2019). In many advanced economies, in particular in the United States of America and in Europe, studies on this phenomenon do not refer to overall inflation as part of the cause, but rather to “core elements of middle-class security” (Erickson, 2014). The middle-class is statistically households making between the 20th and 80th percentile, in advanced economies (Erickson, 2014). In more broad terms, however, middle-class families have a certain standard of living that includes specific elements such as the three H’s – Housing, Healthcare and Higher education (Semuels & Luscombe, 2022). In addition, others argue that childcare and retirement also play key roles in the middle-class household, and are critical components in which costs have risen exponentially over the past few decades (Erickson, 2014; OECD, 2019).

⁵ In this study, we classify quartiles 2 and 3 as the “middle class” due to similar patterns of consumption. Further, quartile 1 is classified as “low income”, while quartile 4 is classified as “high income”. Quartiles 1 and 4 display a distinguishing pattern of consumption to be able to differentiate themselves from the other groups.

In Aruba, the differential impact of inflation on the middle-class households, and not on the lowest income groups, may reflect that traditional targeting programs, such as a progressive tax system and allowances already in place, or NGOs providing assistance through food baskets, may be achieving their goals in ensuring that financially disadvantaged households are able to obtain their basic needs. It may also be those particular policies, such as the “canasta basico⁶”, are in place to protect the most vulnerable and are effective in doing so. However, a considerable proportion of the Aruban population, between 38 and 46 percent (depending on the survey used, whether the Income and Expenditure Survey data from 2016 by the CBS or the Financial Wellbeing of Households 2021 report by the CBA) lives below the minimum subsistence level. Any shocks or inflationary pressures on these groups may make a difference in allowing these families to have enough food on the table or not.

Furthermore, the reasoning for studying a weakening or smaller middle class is due to this group’s significance in driving economic – and inclusive – growth. In the OECD report titled ‘Under Pressure: The Middle-Income Squeeze’ (2019), the essence and effect of the middle-class is well captured in:

“At the macro level, the presence of a strong and prosperous middle class supports healthy economies and societies. Through their consumption, investment in education, health, and housing, their support for good quality public services, their intolerance of corruption, and their trust in others and in democratic institutions they are the very foundations of inclusive growth.”

In Aruba, 48.3 percent of households are considered middle class using the 2016 Income and Expenditure Survey (IES) data, and based on the OECD income brackets⁷. Additionally, an average of 45.3 percent of households are classified as pertaining to the middle class, if using several Censuses and other survey data between 2010 and 2022 . This provides the insight that middle class families, in addition to their contributions to society highlighted above, also represent the majority in the Aruban community.

While an analysis of the rising costs vs. stagnant incomes of the middle class is beyond the scope of this study, there are indications to show that similar patterns have taken place

⁶ The “Canasta basico” translates to basic basket which refers to price regulation applied on basic consumer goods providing a price ceiling to protect the most vulnerable.

⁷ The OECD distinguishes between lower, middle-, and higher-income households. Lower income households are defined as households earning less than 50 % of the median household income, middle income households as those earning between 50% and 150% of the median household income, and higher income households as those earning more than 150% of the median household income.

⁸ Data used here include household income from the 2010 and 2020 Census, the 2016 IES, the 2019 Pilot Census, and the 2021 and 2022 Labor Force Surveys (LFS).

in Aruba. A study of the middle class of Aruba could be an area for further research. Additionally, further research could also look into other measures of inflation to be able to compare with the commonly used CPI.

Recommendations to mitigate the effects of inflation on the middle-income group are not commonly studied in literature, as often the lower income group are those most affected.

These recommendations should be carefully crafted to avoid shifting the burden to the most vulnerable, while also preventing increasing the – already heavy – tax burden on the highest income earners in Aruba. Taking these considerations into account, one recommendation, mentioned by Boz et al. (2022) from the IMF for more persistent inflationary shocks, and adjusted to the Aruban context, can be to reduce import duties and/or excise tax for food products and fuel products, temporarily and for specific groups, during periods of high inflation. However, the recent introduction of similar initiatives hereto has had differing success levels, contingent on the reductions to be translated into prices. Still, it can be argued that a reduction in import duties and excises on certain products for specified groups may be too complex to conduct and that a blanket reduction may have a negative effect on the fiscal balance of the government. Hence, to avoid a negative effect on the financial situation of the government, it is important that the GoA has financial buffers to be able to support crisis related measures when needed. In August 2023, as part of a broader tax reform, a simplification of the import duty brackets was implemented. Even though some food products (i.e., frozen fruit, frozen vegetables,

yoghurt) had import duties reduced to 0 percent, a translation into lower food prices is yet to be observed (EY, 2023). Additionally, in May 2025, a reduction in the excise tax on fuel products was introduced to improve purchasing power. Nonetheless, a gap between the recommendation and implementation remains, as the critical “targeted” and “temporary” nature of the recommendations was not included in the execution. Moreover, another suggestion would be to begin conducting actual rentals/housing surveys to be included in the national inflation calculation. As the housing component makes up the biggest portion of all households, more current data could provide better understandings into the Aruban housing market and inflation trends. Furthermore, recommendations on strengthening the middle class could also be useful in addressing the differential impact of inflation on this particular group in Aruban society. Contrary to the recent introduction of the ‘Landsverordening Normering Topinkomens’ (LNT)⁹, policies recommended by the OECD (2019) target the boosting of disposable income of middle income households, increasing wealth accumulation by these groups, finding ways to containing costs of critical elements, and providing support in developing skills needed for the changing labor market (Erickson, 2014; OECD, 2019). In the Aruban context, possible ways to boost the disposable income of the middle-income groups may be to adjust the second and third brackets of the income tax, and social contributions including the AOV/AWW and AZV contributions for the middle-income groups. In this respect, the January 2025 implementation of lower rates (from 10% to 0%) on the first income tax bracket (up to a monthly income of Afl. 5,410) is a welcome development. This is an

⁹ The LNT translates to the National Ordinance on Limitation of the Top Incomes of government affiliated entities, which caps the income of top officials in semi-government entities to 130 percent of that of the Prime Minister.

example of a policy that boosts the disposable income of the middle class, as a considerable proportion of these laborers will no longer have to pay income taxes. However, as noted above, these measures may also come at the expense of government and collective sector revenues. Hence, the importance of fiscal buffers for not only the central government, but also the social insurance bank (SVB) and the general health insurance (AZV) funds.

Lastly, even though the housing component may be understated and the 2016 IES may not take into account behavioral shifts undertaken by the Aruban population groups, due to fiscal reforms and the COVID-19 pandemic, this paper provides a preliminary insight on how inflation, or high inflation, is dispersed across socioeconomic quartiles on a small island like Aruba.

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A photograph of a sunset over the ocean. The sun is low on the horizon, casting a golden glow across the sky and water. Several seagulls are in flight, silhouetted against the bright sky. On the right side, a wooden pier or dock extends into the water. The image is framed by a light blue and green curved border at the top and bottom.

3.

Achieving Labor Security for the Aruban youth

Rynall Kock

Abstract

While existing domestic studies have primarily focused on youth job opportunities, this chapter goes beyond traditional metrics by evaluating the state of youth labor security in Aruba. Explicitly, this chapter examines income protection, voice representation, and labor market security. Utilizing microdata from the Labor Force Survey, the Central Bank of Aruba's Youth Labor Security Survey, and online scraping data for labor market tightness, this chapter evaluates these three dimensions. The findings indicate that Aruba generally has higher youth labor security than its Latin American and Caribbean peers, yet it lags advanced economies such as the Netherlands and the United States. Specifically, Aruba surpasses regional benchmarks in income security outcomes and resource allocation but remains below advanced economies regarding GDP per capita and income equality. Similarly, Aruba outperforms regional peers in youth voice representation security, as evidenced by better voice and accountability metrics, in addition to stronger unionization rates, though it falls short of advanced economies in collective bargaining coverage. Moreover, Aruba commits more resources and demonstrates better processes to achieve labor market security than its neighboring peers, reflected by higher public consumption and more robust GDP growth. However, it struggles with higher youth unemployment and lower employment rates compared to advanced economies. Consequently, policy recommendations include extending the minimum wage coverage to the youth, enhancing social security sustainability by switching social security premiums from an employee-employer contribution system to an earmarked VAT system, embedding responsible labor practices into public procurement criteria, create minimum collective bargaining standards, formalizing full employment commitments, and establishing a tripartite advisory

council to reach the latter. Future research should explore additional labor security dimensions and develop age-specific indicators to refine policy guidance further.

Keywords: labor security, youth, SIDS, employment

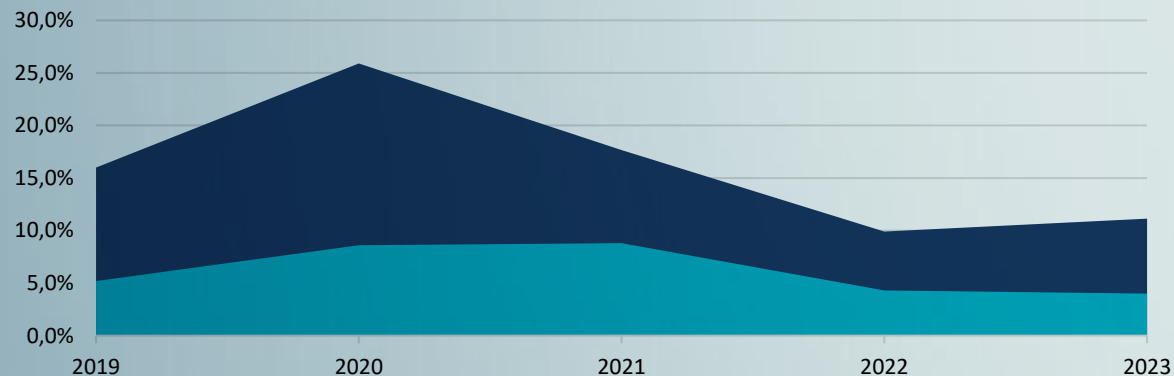
1. Introduction

Youth employment has a far-reaching impact on individuals, families, and societies. Achieving decent employment opportunities for people is essential for their well-being, social inclusion, and overall economic development (ILO, 2004). The United Nations recognizes its importance, as youth employment touches SDG target 4.4 (by 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for decent jobs and entrepreneurship), SDG target 8.5 (by 2030, achieve full and productive employment and decent work for all women and men, including for young people), SDG target 8.6 (by 2020,

substantially reduce the proportion of youth not in employment, education or training) and SDG target 8.b (by 2020, develop and operationalize a global strategy for youth employment and implement the Global Jobs Pact of the ILO).

However, youth unemployment remains a pressing challenge worldwide, with those aged between 15 and 24 consistently facing higher joblessness rates than the age cohort of 25 and older (ILO, 2023a). Aruba is no exception to that rule. The youth unemployment rate sits at 11.1 percent, visibly higher than the overall 4.0 percent for the overall group according to the Labor Force Survey (LFS) of November 2023 (Figure 1).

Figure 1: The youth unemployment rate in Aruba is consistently higher than the overall age cohort

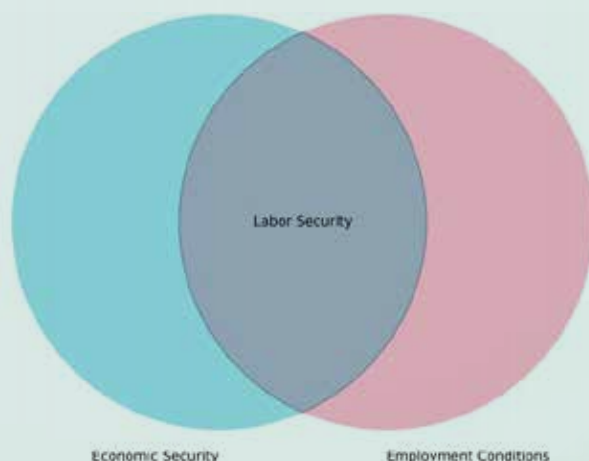


Source: Aruba Labor Force Survey 2019-2023. Joint venture by DAO, CBS, and CBA.

Besides unemployment, the youth can be disadvantaged in other areas of labor security. Labor security connects tightly to economic security. An OECD study by Hacker et al. (2018) defines economic security as (a person's or country's) vulnerability to hardship-causing economic losses. Inspired by that definition, **this chapter describes labor security as a person's vulnerability to hardships because of their employment conditions.**

Essentially, labor security is the economic security people enjoy solely due to their employment conditions (Figure 2). Drawing from ILO (2004), **labor security connects to seven employment conditions.** These consist of income protection (topics such as minimum wages), voice representation (e.g., labor unions), job opportunities (related to unemployment), protection from unfair dismissal, control over the job content and opportunity to grow within a company, workers' safety and (mental) wellbeing, and finally, access to basic education and vocational training.

Figure 2: Labor security at the intersection of employment conditions and economic security.



Thus, labor security is a seven-dimensional concept that stretches beyond job opportunities. Yet, domestic studies (CBS, 2015; DAS, 2017; DEACI, 2019) have focused solely on one aspect of labor security i.e., job opportunities. Furthermore, these studies only cover developments before the COVID-19 pandemic. **Therefore, to fill the research gap in labor security in Aruba, this chapter addresses the research question: what is the post-COVID state of youth labor security in Aruba, specifically on income protection, voice representation, and job opportunities?** Central to answering the research question is the microdata from the LFS of November 2023. In addition, the Central Bank of Aruba's (CBA) Youth Labor Security Survey of 2024 provides insights in some outcomes of youth representation and labor market security. Online scraping data further proxies labor market tightness, which is relevant for labor market security. **The results of the three focus areas generate several policy recommendations.**

In the remainder of this chapter, the first section treats important concepts such as labor security, dimensions of vulnerability, and facets of employment conditions. After introducing key concepts, the second section presents the state of youth labor security in Aruba by reviewing existing literature, analyzing the results of the LFS and Youth Labor Security Survey (YLSS), and applying quantitative methods and benchmarking to other countries. The third section offers policy recommendations, given the findings about youth labor security in Aruba.

2. Theory on labor security

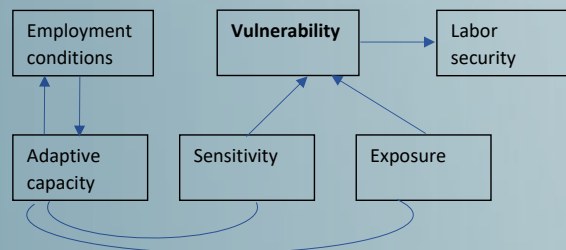
This section familiarizes the reader with the concept of labor security. The introduction defined labor security as a person's vulnerability to hardships because of their employment

conditions. Central to understanding the concept of labor security are vulnerability and employment conditions, the two topics of Section 1. This helps to narrow the chapter's scope and provides context for the policy recommendations in the last section.

2.1 Vulnerability

The first key term in labor security is vulnerability. Borrowing from the climate change literature (IPCC, 2007), vulnerability is a function of exposure and sensitivity, with the latter two depending on adaptive capacity (Figure 3). Multiple people can be simultaneously exposed to job loss. However, people are unequally sensitive to economic losses after a job loss. This discrepancy can occur due to different savings behaviors, for example. For those that experience more hardship, they can improve their adaptive capacity. That is, working to alter employment conditions in the future to avoid exposure and lessen their sensitivity to economic losses. Reeducation and starting a savings plan are actions to improve adaptive capacity. Nevertheless, these actions are easier for those with better access to financial, technical, educational, regulatory and community resources (Siders, 2019). Accordingly, there is space for government intervention. Based on the state of Aruban youth labor security, the section on policy recommendations will discuss how that resource gap can be narrowed.

Figure 3: The relationship between employment conditions, vulnerability, and labor security.



2.2 Employment conditions

The second major term from the definition of labor security is employment conditions because employment conditions determine how vulnerable people become to hardships. Drawing inspiration from ILO's (2004) framework and definitions, seven facets shape people's employment conditions (Figure 4).

To begin with, **income security** denotes adequate income, either from labor or in the form of social security and other benefits. It encompasses income assurance and level, both during working life and in old age or disability retirement. Classic income security protection mechanisms include minimum wage, wage indexation, and comprehensive social security. Another common protection mechanism is progressive taxation, to the extent that proceeds thereof are used to provide income security to lower income groups.

Representation security refers to both individual representation and collective representation. Individual representation is about the individual rights enshrined in laws as well as the individuals' access to institutions, such as legal courts, arbitration boards, and legal clinics. Collective representation means the right of any individual or group to be represented by a body that can bargain on their behalf and that is sufficiently large, appropriately independent, and aptly competent to do so. Independent trade unions with the right to collectively bargain over wages, benefits and working conditions, as well as to strike have been typical forms of granting representation security to groups and individuals.

Labor market security arises when there are ample opportunities for adequate income-earning activities. It has an objective component and represents the types and quantity of opportunities. Furthermore, it has a cognitive side, as it also features expectations that opportunities are or will become adequate.

Policies aimed at enhancing this form of security have included full-employment oriented macro-economic policies, the creation of employment agencies, and other job matching services.

Employment protection security is protection against loss of income-earning work. For salary workers, employment protection security exists in organizations and countries, in which there is strong protection against unfair or arbitrary dismissal and where workers can redress unfair dismissal. Typical forms of enhancing employment security for salary workers have been protection against arbitrary dismissal, regulations on hiring and firing, and penalties for employers that breach regulations. For the self-employed, it means protection against sudden loss of independent work, and/or business failure. Protection mechanisms may include business restructuring or debt-relief frameworks to avoid abrupt closure.

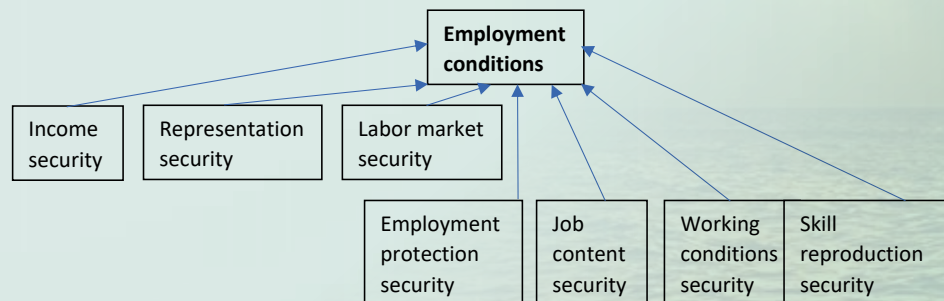
Job content security signifies niches in organizations that enable workers to gain some control over the content of a job and the opportunity to build a career. Whereas employment security refers to the opportunity of a worker to continue working in an enterprise, job content security refers to the workers' ability

to pursue tasks that align with their interests, training, and skills. For instance, ILO (2004) recommends governments to implement policies that promote equal opportunities, helping to eliminate discrimination, and ensuring that all workers have the chance to advance in their careers.

Work conditions security denotes safe working conditions and conditions that promote workers' well-being. Classic "occupational health and safety" provisions shield workers from occupational hazards, diseases, and injuries. However, work conditions security goes beyond this, in addressing the modern occurrence of stress, overwork, absenteeism, and harassment. Protection devices for work conditions security include provisions and insurance against accidents and illness at work, and limits on working time.

Skill reproduction security denotes workers' access to basic education as well as vocational training to develop capacities and acquire the qualifications needed for valuable occupations. Ways to further skill reproduction security include policies that promote skills gain and retention, through education, apprenticeships, and employment training.

Figure 4: The seven dimensions of employment conditions. Adapted from ILO (2004).



3 Methodology

Given that seven facets (Figure 4) impact employment conditions, which in turn determine labor security, a one-dimensional index cannot adequately guide labor policy. That is, **a composite index is better suited to represent youth labor security**. In the past, ILO (2004) generated a composite index, named the socio-economic security index from the indices of the seven security dimensions (Figure 4).

This chapter maintains a subset of the ILO (2004) composite index, named the **partial youth labor security index (PYLSI)**. The PYLSI is a weighted sum of three security indices:

$$(1) \text{ PYLSI} = 2 * \text{IncomeSecurityIndex} + 2 * \text{RepresentationSecurityIndex} + \text{LaborMarketSecurityIndex}$$

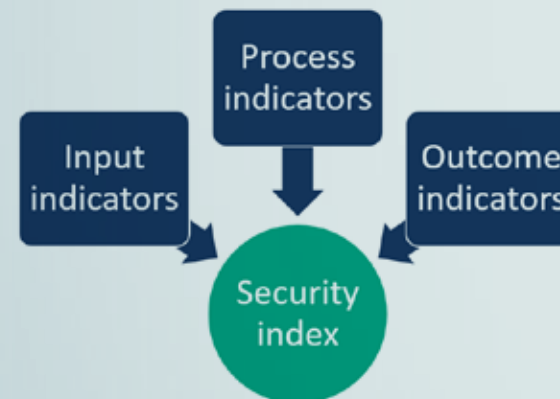
The choice to include only these three security indices is based on ILO's (2004) ranking of security indices, and Aruba's policy priorities (GoA, 2019)¹. From equation (1), one can notice that the income and representation security indices have double weights, in keeping with ILO (2004). Classical literature by Sen (1997) contends that labor market outcomes are a means to achieve distributional equity and representation.

In turn, Figure 5 indicates that **each security index results from the aggregation of input, process, and outcome indicators**. Input indicators are the national and international instruments necessary to protect workers. For instance, these instruments encompass basic laws or ratified ILO Conventions on work-

related hazards, unfair dismissal, and the right to organize. Process indicators are the mechanisms or resources in place to realize the necessary instruments that protect workers, i.e., the input variables. Examples hereof are the level of public expenditure on a particular form of security, or the existence of labor inspectors.

Outcome indicators measure whether the input and process indicators are effective, notably in ensuring protection to workers. For example, outcome indicators would assess the proportion of workers participating in collective agreements or pension plans.

Figure 5: The three determinants of the security indices for income, representation, and the labor market.



¹ The National Strategic Plan 2020-2022 states that "Aruba will increase decent job opportunities for the youth through direct actions tailored to improve their access to the labor market and fostering their employability, and increased economic opportunities by promoting youth self-employment and entrepreneurship."

When aggregating input, process, and outcome indicators to a single security index, ILO (2004) sets a double weight on outcome indicators, as shown in equation (2). ILO (2004) contends that countries with better employment conditions should be favored regardless of proper rules and regulations, although

other research argues that purely focusing on labor outcomes may bring the risk that countries (unintentionally) do not respect basic labor rights (Langille, 2005). For comparability, this chapter follows ILO's (2004) approach:

$$(2) \begin{pmatrix} IncomeSecurityIndex \\ RepresentationIndex \\ LaborMarketIndex \end{pmatrix} = \begin{pmatrix} IncomeInputIndex & IncomeProcessIndex & IncomeOutcomeIndex \\ RepresentationInputIndex & RepresentationProcessIndex & RepresentationOutcomeIndex \\ LaborMarketInputIndex & LaborMarketProcessIndex & LaborMarketOutcomeIndex \end{pmatrix} * \begin{pmatrix} 1 \\ 1 \\ 2 \end{pmatrix}$$

At the most microlevel, the input, process, and outcome indices for each security index depend on the unweighted aggregation of two to eight (normalized) national indicators. Fundamentally, these national indicators produce a PYSI for Aruba, which can then be benchmarked against other countries.

4. State of youth labor security

This section evaluates the (relative) state of youth labor security in Aruba. To this end, the previous section's methodology is implemented, comparing Aruba with the Netherlands, the United States, and Latin America and the Caribbean. These efforts form the base of the analysis. Furthermore, this section provides deep dive analyses on youth labor market tightness (relevant to labor market security).

4.1 Youth income security

4.1.1 Input assessment

Table 1 summarizes how Aruba fares in terms of income security. On the input indicators, Aruba fulfills some requirements. For instance, Aruba has legislated the minimum wage law “Landsverordenening minimumlonen”. As per January 1, 2024, those who are 18 or older and work in industry, construction, or commerce, receive a minimum monthly wage of Afl. 1,986,20. Starting January 1, 2025, there is a new hourly minimum wage of Afl. 20.85 per hour for employees working 40 hours per week, which will result in a monthly salary of Afl. 2,007.05. Nonetheless, the minimum wage law does not apply to workers younger than 18 years. Additionally, the minimum wage falls short of the April 2025 subsistence level of Afl. 2,625 for a single-person household (CBS, 2025).

Table 1: Summary of the input, process, and outcome indicators for the income security index.

	Input	Process	Outcome
Income SI	-ILO Convention No. 102 on Social Security Minimum Standards ⊗ -ILO Conventions No. 26 ⊗ and 131 on Minimum Wage Fixing ✓ -ILO Convention No. 95 on Protection of Wages ✓ -Minimum wage law ✓ -Laws promoting or legitimizing collective bargaining ✓	-Social security expenditure as a share of GDP (=16.7% in 2023) ✓ -An unemployment benefits scheme ✓ -A state pension ✓	-Multidimensional poverty index (=0.008 in 2023) ✓ -Real GDP per capita at PPP (=USD 44,121 in 2023) ✓ -GINI coefficient (=0.44 in 2019) ⊗ -Debt-to-GDP ⊗ (=85.2% in 2023) -Life expectancy (=76.4 years in 2023) ⊗ -Wage share in GDP (=59.9% in 2013) ✓
✓: a) indicates that Aruba has properly implemented a national or international convention or b) signals when a quantitative indicator in Aruba is at a level of the United States or the Netherlands ✓: a) indicates that Aruba has partially or improperly implemented a national or international convention or b) signals when Aruba outperforms Latin America and the Caribbean in a quantitative indicator ⊗: a) indicates that Aruba has yet to implement a national or international convention or b) signals when Aruba performs at a level of Latin America and the Caribbean in a quantitative indicator			

As for the national law on collective bargaining, article I.11 of the Aruban Constitution guarantees the right (of the youth) to form and join unions. This article is complemented by the “Landsverordening collectieve arbeidsovereenkomst”, which defines the legal framework for collective bargaining between (young) employees and employers. **However, half of the ILO conventions are not ratified.** Especially the absence of ILO No. 26 may be detrimental to the Aruban youth, as it requires

countries to establish a system for fixing minimum wages in sectors where wages are especially low and not effectively regulated by collective agreements (although the extent to which this affects the Aruban youth is unknown). While having less practical relevancy in Aruba, ILO No. 102 sets minimum standards for nine branches of social security, obliging countries to implement at least three to ratify this convention.

4.1.2 Process assessment

Aruba meets all qualitative process indicators. Specifically, there is an unemployment benefits scheme for the youth, and a state pension in their later stages of life. Concerning the unemployment benefits scheme, Aruba has enacted the “Cessantiaverordening”, and the Social Security Bank (SVB) oversees its administration. Laid-off workers receive a one-time payment, equal to the number of years of service multiplied by their last weekly salary. Moreover, adjustment factors of 1, 1.25 and 2 are respectively maintained for the first 10 years of service, the next 10 years of service, and 20+ years of service. **Consequently, younger laid-off workers typically receive minimal compensation due to their limited years of service and relatively low starting wages.**

Including state pension may seem at odds with the age scope of this chapter, but by definition (see Chapter 2), income security encompasses income assurance and level, both during working life and in old age or disability retirement. In terms of the state pension in Aruba, it is established under the “Landsverordening algemeene pensioen” (LAP). This national ordinance grants employees in the private sector a pension right based on a defined contribution system, or a defined benefit system. However, in practice, only the defined contribution is common in the private sector. In this system, the minimum premium is 6 percent of the pensionable salary, with the employer and employee each contributing at least 3 percent.

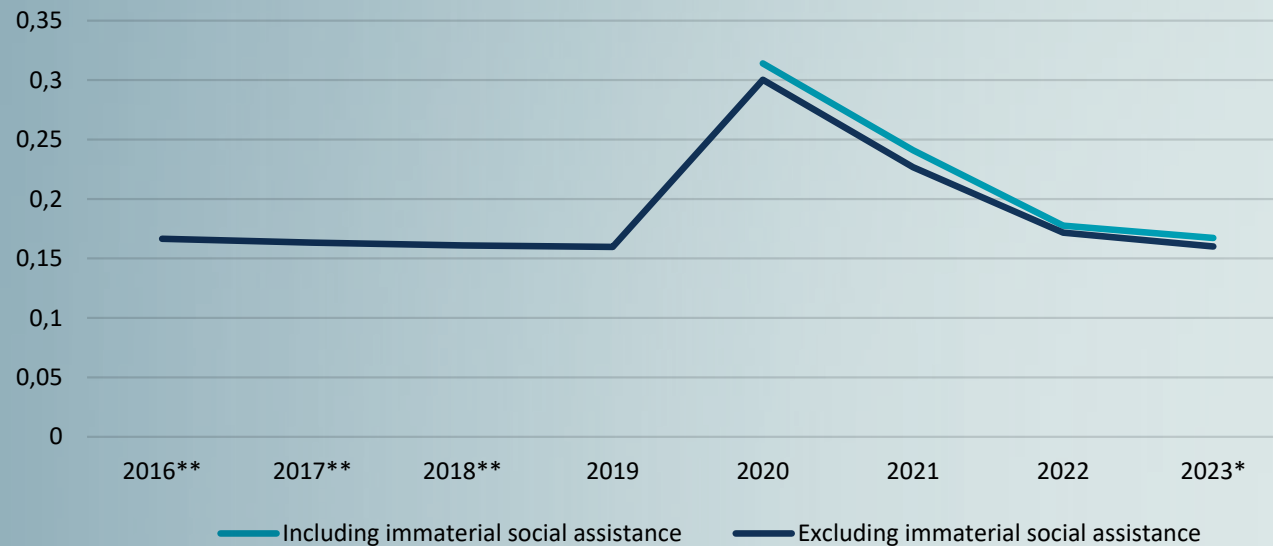
In addition, Aruba has an old age insurance, regulated under the “Landsverordening algemene ouderdomsverzekering” (AOV) and

the SVB directs its administration. This old age insurance intends to support individuals who have lived in Aruba at some time between the age of 15 and the retirement age of 65 years (the pension age of 65 is in effect since January 1, 2024). For a single person, the maximum pension is Afl. 1,265 per month. Although outside the AOV coverage, pensioners receive an additional “reparatietoeslag” of Afl. 200 per month since August 1, 2024. Summed together, **the old age insurance payout is below the subsistence level of Afl. 2,625 for a single-person household** (CBS, 2025), which may signal future problems for the young workers that do not supplement their state pension.

The process indicators also have a quantitative aspect, measured by social security expenditure² as a share of GDP, with the presumption that the (working) youth can also appeal to the social security programs, and eventually receive income security. For Aruba, this share amounted to 16.7 percent in 2023 (Figure 6a) including immaterial social assistance, which involves non-cash assistance such as social work counseling.

■ ² See Appendix 1 for more information about the scope of social security expenditure.

Figure 6a: Social security expenditure as a share of GDP in Aruba

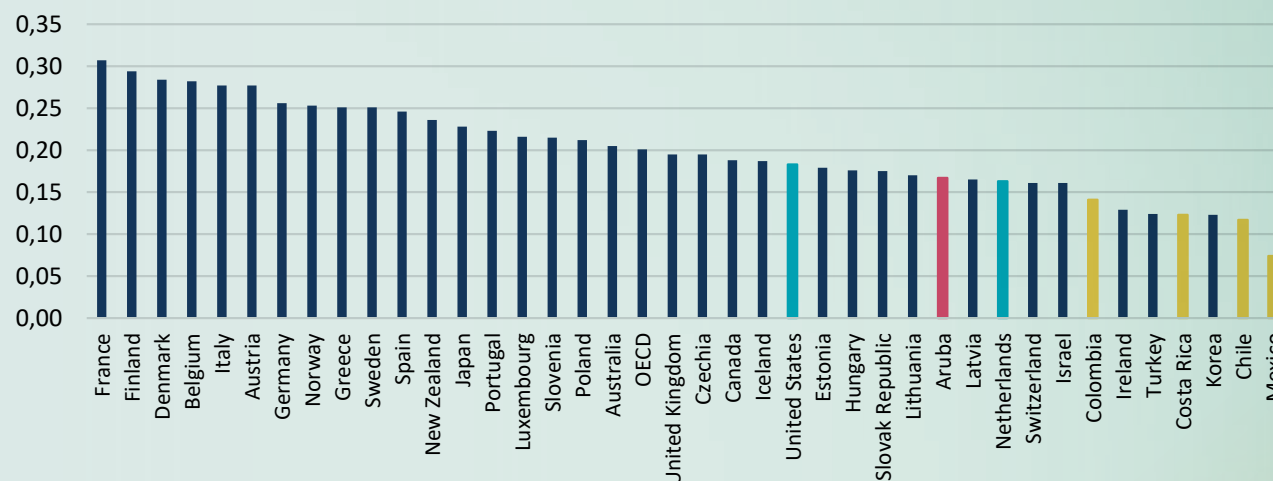


**The SVB insurance data source changed from the SVB Annual report to the quarterly SVB statement. **The social assistance data was sourced from the cash report of the Department of Finance and later the “Uitvoeringsrapportage Land Aruba”.*

Nonetheless, allocating 16.7 percent of GDP in social security conveys limited meaning to income security. A relative context offers more insight into income security. In this regard, Aruba generally spends more on social security than countries with a lower GDP per capita (Figure 6b). Conversely, compared to countries with a higher GDP per capita, Aruba spends less on social security, except the Netherlands for example. Given that Aruba has one of the highest GDP per capita in the region, **Aruba likely ranks above Latin America and the Caribbean**

on social security spending (that may benefit the youth). A UN report by Podestá (2023) confirms the higher social security spending in Aruba, in which public social expenditure in Latin America and the Caribbean represented 12.1 percent of GDP in 2018. **While income security in Aruba benefits from a higher social security spending relative to Latin America and the Caribbean, the government has to be mindful to ensure that the social security funds of AZV and SVB remain financially sustainable (Tromp, 2022).**

Figure 6b: Social security spending as a share of GDP in 2019 for Aruba and selected countries.



Source: Author's own calculation and the OECD Social Expenditure Database (2024)

4.1.3 Outcome assessment

Aruba has mixed performance on the outcome indicators.

With regard to poverty, Aruba's relative performance seems positive. While it does not possess a globally comparable multidimensional poverty index (MPI), a national MPI is available. A conservative, rough estimate for the globally comparable MPI of Aruba would be 0.009 in 2023, calculated as the unweighted average of countries in the region that are also dependent on tourism: Saint Lucia (0.007), Barbados (0.009), Jamaica (0.011), and the Dominican Republic (0.009) (UNDP, 2024). This estimate strikes a balance between knowing Aruba maintains a higher GDP per capita than these Caribbean countries, while also

acknowledging the data unavailability. Following this conservative approach, Table 2 infers that Aruban households generally experience a lower MPI than most regions. **Therefore, under certain assumptions (see below), the Aruban youth likely experience less multidimensional poverty than their peers in the Latin American and Caribbean region.**

This finding rests on the assumption that the household position reflects the youths' position. For the inactive youth, this assumption should largely hold, since their poverty status likely depends on the parents' income. Labor Fore Survey data of November 2023 indicate that this group is potentially large,

where 65 percent of the youth, such as students, are inactive. Furthermore, in terms of the active youth who do not live with their parents, household position should be indicative of the youths' position.

For the Netherlands and the United States, this section posits a global MPI close to zero, considering that even some developing economies in Europe exhibit a MPI close to zero.

Table 2: The estimated global MPI of Aruba compared to various regions.

Europe and Central Asia (developing economies only)*	0.004
Latin America and the Caribbean (excluding Aruba)*	0.025
The United States**	≈0
The Netherlands**	≈0
Aruba**	0.009

*Source: UNDP Global Multidimensional Poverty Index (2024). **Estimate: Author’s rough assumptions

Despite the absence of a survey to deduce the globally comparable MPI of Aruba, the CBS produced a national MPI. Using the Census data of 2010, the national MPI amounted to 0.068 (CBS, 2018). Meaning, the proportion of multidimensionally poor households (15.9 percent) adjusted for the weighted percentage of deprivations they experience (42.9 percent) equaled 6.8 percent. It is worth noting that the global and national MPI are not fully comparable. The CBS adapted the indicators, cut-offs, and weights according to local reality and data availability. For instance, electricity is practically a given in Aruba (not included in the national MPI) but may be more relevant to less developed nations (included in the global MPI).

Aruba enjoys one of the highest levels of real GDP per capita (at PPP, in constant 2017 international dollars) in the region, although below advanced economies (Table 3). Therefore, if real GDP per capita translates well to youth real GDP per youth capita, **the Aruban youth on average have decent living standards compared to the youth in Latin America and the Caribbean.** Conceptually, real GDP per capita translates poorly to its youth variant if there are large age wage gaps, varying unemployment rates, and diverging inflation experiences. Although much of these gaps exist empirically (Fournier & Koske, 2012; ILO, 2023a; Pallotti et al., 2024), data on youth real GDP per capita youth are absent.

Table 3: Real GDP per capita of Aruba and selected regions (at PPP, in constant 2017 international dollars)

	2019	2020	2021	2022	2023
Latin America and the Caribbean (including Aruba)	18,298	16,846	17,952	18,576	18,850
The United States	69,466	67,405	71,258	72,790	74,528
The Netherlands	68,844	65,698	69,552	72,556	71,709
Aruba	38,435	29,383	37,813	41,920	44,121

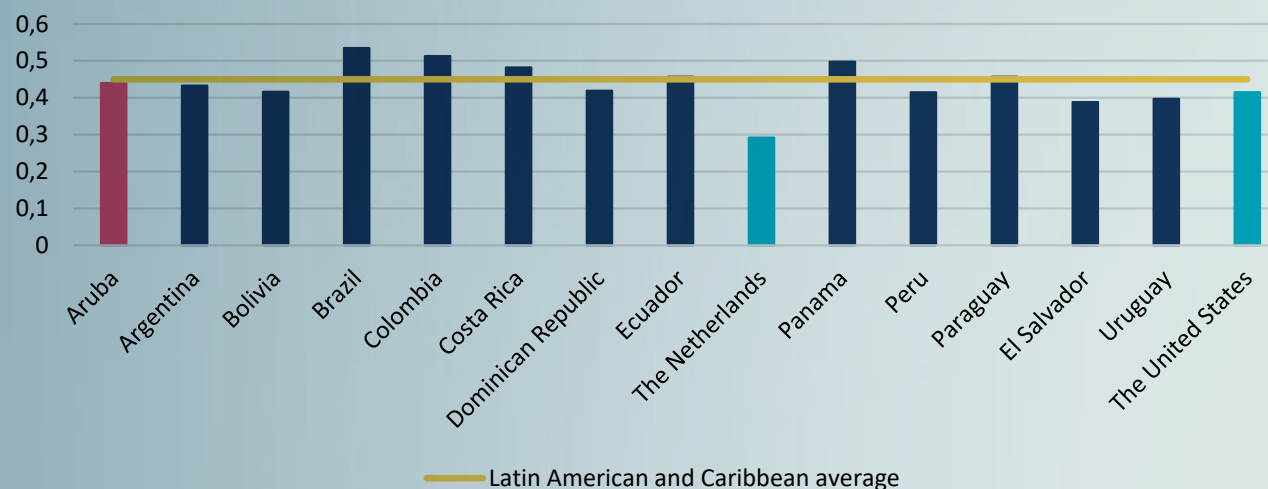
Source: IMF World Economic Outlook Database (October 2024)

While GDP per capita captures the average living standard, it overlooks income inequality, which can be a product of income insecurity. Against this background, Aruba had a Gini coefficient of 0.44 in 2019, signaling that the average income gap as a share of the maximum income gap possible amounted to 44 percent. This figure in Aruba represents high income inequality, following the cutoff of 0.40 maintained by Haddad et al. (2024) in a World Bank working paper (Figure 7). Therefore, **assuming general income inequality applies to the youth³, youth income inequality is an issue in Aruba**. Even if current general income inequality does not signify current youth income inequality, it may do so in the future. An OECD paper by Stand & Rising (2011) finds that intergenerational earnings mobility is low in countries with high inequality such as Italy, the United Kingdom, and the United States, and much higher in the Nordic

countries, where income is distributed more evenly. In Latin American and Caribbean countries, inequality is also an issue, as the unweighted Gini sample average stood at 0.45 (excluding Aruba). Regarding the more advanced economies, there is heterogeneity in the sampled countries, with the Netherlands having significantly lower income inequality than the United States.

³ This presumption is reasonable if there is a large non-active youth population that depend on their parents' income. The share of non-active youth population is 65.0 percent according to Aruba Labor Force Survey of 2023.

Figure 7: Gini coefficients of Aruba and selected countries in 2019.



Note: A Gini coefficient less or equal than 0.40 represents low/moderate inequality, whereas above 0.40 constitutes high inequality.

Source: World Bank Poverty and Inequality Platform (2024)

Government indebtedness is another variable relevant to income security since it may impede governments from adequately compensating income loss during crises periods (ILO, 2004). This impediment can disadvantage the youth in employment, or those dependent on the employment of others. Furthermore, **the younger generation tends to carry the burden of high fiscal debt in the future.** The Covid-19 pandemic especially exposed Aruba's dependency on tourism and its indebtedness. In this period, central government debt peaked at 115.8 percent of GDP, before falling back to 85.2 percent of GDP in 2023. Consequently, it took some time before the economy and government debt levels allowed the recuperation of government wages, which may also have

influenced wage growth in the private sector.

A debt-to-GDP ratio of 70.2 percent is still above the IMF's (2025) recommended target of 50 percent by 2035. **Comparatively speaking, Aruba's debt-to-GDP ratio was (worryingly) above its Latin American and Caribbean peers in 2022**, except Barbados. Relative to more advanced economies such as the United States, Aruba was less indebted, but the U.S. dollar is the world's primary reserve currency. This high demand for the U.S. dollar allows the United States to borrow at low interest rates (Weiss, 2022). Additionally, the United States' economic size and diversification allow it to sustain high debt levels (Choi et al., 2024).

Table 4: Central government debt-to-GDP ratios of Aruba and selected countries.

	2019	2020	2021	2022	2023	2024
Antigua and Barbuda*	81.3%	101.5%	102.4%	90.6%	NA	
Bahamas*	59.7%	87.5%	90.7%	84.3%	NA	
Barbados*	119.6%	140.9%	141.5%	126.8%	NA	
Dominican Republic*	39.6%	55.9%	50.0%	45.2%	NA	
Jamaica*	94.7%	108.7%	99.0%	88.0%	NA	
Saint Kitts and Nevis*	23.9%	28.2%	27.8%	24.3%	NA	
Saint Lucia*	62.1%	99.7%	96.0%	85.3%	NA	
Saint Vincent and the Grenadines*	61.2%	72.9%	83.5%	86.3%	NA	
Trinidad and Tobago*	45.5%	62.0%	57.9%	52.1%	NA	
Latin America and the Caribbean (including Aruba)**	70.4%	77.4%	NA	NA	NA	
The United States*	93.1%	118.4%	113.7%	110.1%	NA	
The Netherlands***	35.1%	42.1%	41.3%	43.2%	43.4%	
Aruba****	71.1%	115.8%	107.9%	97.4%	85.2%	70.2%

Source: *IMF Global Debt Database (September 2023). **IMF Government Finance Statistics Yearbook and data files, and World Bank and OECD GDP estimates. ***IMF Dutch State Treasury Agency and IMF World Economic Outlook Database (October 2024). ****CBA Annual Statistical Digest 2023 (2024), CBA GDP forecast 2024 round 2 (2025) and CBA quarterly tables – government sector 2025Q1 (2025)

Life expectancy at birth is another indicator that correlates with income security as higher income is usually associated with better access to healthcare (Marmot, 2005), healthier lifestyle choices (Duncan et al., 2010), improved living conditions (Kawachi & Berkman, 2001), higher health literacy (Cutler & Lleras-Muney, 2006), and reduced stress (Cohen et al., 2007).

In Aruba, life expectancy edges the unweighted average of Latin America and the Caribbean, and is below advanced economies (Table 5). **This finding may highlight insufficient youth income security in the past** that now manifests as poor health and low life expectancy, which contrasts with the GDP per capita status of Aruba.

Table 5: The average life expectancy at birth in Aruba and across various regions.

Latin America and the Caribbean (excluding Aruba, Bolivia and Haiti)	76.2
The United States	79.3
The Netherlands	82.2
Aruba	76.4

Source: UN World Population Prospects (2024)

Wage share of GDP also reflects income security as wages are usually a secure form of income earning. Consistent with the GDP by income approach, wages in Aruba (before taxes and social premiums) amounted to 58.9 percent of GDP in 2013 (CBS, 2022). Thus, the Aruban figure is considerably higher than the average of Latin America and the Caribbean (Table 6). In fact, Aruba's wage share of GDP is at the level of advanced

economies. **A rough interpretation would be that young workers in Aruba earn higher wages and can, thus, rely on a secure form of income earning relative to its developing neighboring peers.** This interpretation is reinforced by the higher employee share in total young employment in Aruba (91.2 percent) compared to Latin America and the Caribbean (73.5 percent) (Table 9).

Table 6: Wage share of GDP in Aruba (2013) and among different regions (2019).

Latin America and the Caribbean*	49.0%
The United States**	58.4%
The Netherlands**	60.9%
Aruba***	59.9%

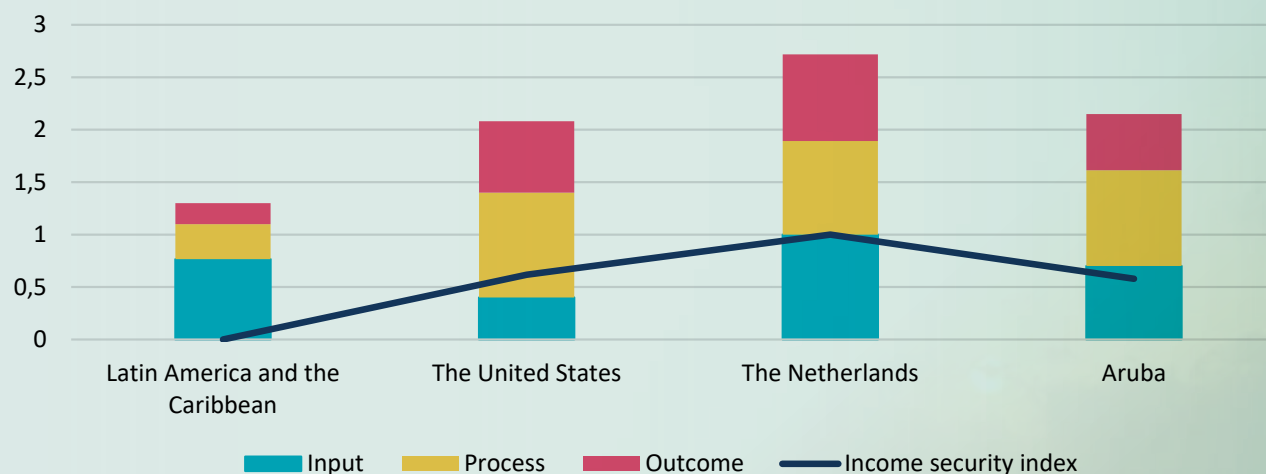
Source: *UN SDG Indicator Database (2024). **ILO Database (2024). ***CBS (2023)

4.1.4 Youth income security index

Given the input, the process, and the outcome components of youth income security, Figure 8 displays the youth income security index. **The main take-away is that Aruba has a youth income security level comparable to the United States, although solely due to Aruba having ratified more ILO conventions. Moreover, Aruba outperforms Latin America and the Caribbean in youth income security due to better**

processes or resources (e.g., social security expenditure) to **carry out the inputs** (e.g., social security laws) **necessary for youth income security**. Furthermore, many outcome indicators of youth income security (e.g., GDP per capita) are higher in Aruba than in its developing peers. Nevertheless, there is room for improvement in input and output indicators to reach the level of the Netherlands. These recommendations are provided in the section about policy recommendations.

Figure 8: The income security index of Aruba and selected territories using 2023 data or earlier.



4.2 Youth representation security

4.2.1 Input assessment

Table 7 highlights Aruba's performance in youth representation security. The data show that Aruba largely meets the input indicators. For example, Aruba fulfills half

of the ILO conventions. Explicitly, Aruba supports Convention No. 87 on Freedom of Association, though it has foregone Convention No. 98 on Collective Bargaining. On Convention No. 98 there is considerable heterogeneity across the selected regions and countries. For instance, the Latin American and

Caribbean region has generally adopted No. 98, as well as the Netherlands, but not the United States.

On the national law requirements, Aruba fully meets the freedom to unionize. Specifically, there is no Aruban law prohibiting unionization at the national level or in certain sectors. The local situation contrasts with the United States where certain laws limit the unionization of agricultural and domestic workers. **In terms of the right to collectively bargain, Aruba complies through the “Landsverordening**

collectieve arbeidsovereenkomst”. To represent employees in a collective labor agreement, a union must secure a majority vote from the employees, which is the international standard. **Regarding the right to strike, Aruba also abides through the “Arbeidsgeschillenverordening”.** However, **Article 3a of this labor dispute decree permits striking only after 30 days of dispute.** That amount is excessive by international standards, which tends to be 14 days or less. Meanwhile, the labor dispute decree does require the reinstatement of workers illegally fired for union activities.

Table 7: Summary of the input, process, and outcome indicators of the representation security index.

	Input	Process	Outcome
Representation SI	-ILO Convention No. 87 on Freedom of Association ✓ -No. 98 on the Right to Organize and Collective Bargaining ⊗ -Freedom to unionize ✓, bargain collectively ✓, and strike ✓	-A national tripartite council dealing with labor and social policies ✓ -Percentage of total employed covered by collective agreements (=14.8% in 2000) ⊗ -Share of youth employees in total youth employment (=91.2% in 2023) ✓	-Youth unionization rate (=5.0% in 2023) ✓ -Voice & accountability index (=80.4 in 2023) ✓
✓: a) indicates that Aruba has properly implemented a national or international convention or b) signals when a quantitative indicator in Aruba is at a level of the United States or the Netherlands ✓: a) indicates that Aruba has partially or improperly implemented a national or international convention or b) signals when Aruba outperforms Latin America and the Caribbean in a quantitative indicator ⊗: a) indicates that Aruba has yet to implement a national or international convention or b) signals when Aruba performs at a level of Latin America and the Caribbean in a quantitative indicator			

4.2.2 Process assessment

Aruba passes the qualitative prerequisite with regard to the process indicators. Specifically, it has a national tripartite council dealing with (occasionally youth) socio-economic policies called the “Sociaal Economische Raad” (SER), just as the Netherlands. The SER consists of nine council members who are evenly divided among three parties, i.e., employee organizations, employer organizations and independent experts. The government approves the nominees of the employee and employer organizations, while the independent experts get appointed by the government. Such tripartite councils are also found across the selected territories of Latin America and the Caribbean, the Netherlands, and the United States.

In terms of the quantitative process indicators, Aruba excels in some areas while lagging in others. Although recent data for the Aruban youth are unavailable, the overall percentage of workers covered by collective bargaining seems lower than the Latin American and Caribbean region (Table 8). Assuming that general developments are representative of youth developments, **the Aruban youth are potentially less protected by collective bargaining relative to their regional, developing peers.** In comparison to more advanced economies, Aruba’s level is above that of the United States, but well below that of the Netherlands. The collective bargaining coverage of the United States and of the region falls significantly short of Dutch standards.

Table 8: Percentage of employees covered by collective bargaining in Aruba and among different territories, by period.

Latin America and the Caribbean*	27.8%	2010-2020
The United States**	11.6%	2019
The Netherlands**	75.6%	2019
Aruba***	14.8%	2000

*Source: *ILOSTAT database Industrial Relations (2020). ** OECD/AIAS ICTWSS database (September 2023). *** SER (2001) and CBS Census 2000*

As for the other quantitative process indicator, the employee share in total employment⁴ is relatively high in Aruba.

This indicator echoes the potential for voice representation, as employees tend to be better organized than entrepreneurs, as noted by Bogg (2021). In Aruba, youth employees represented

91.2 percent of total youth employment, considerably higher than the (unweighted) average of Latin America and the Caribbean (Table 9). Furthermore, Aruba’s level is in the vicinity of advanced economies. From a more updated perspective, the CBA’s Youth Labor Security Survey points to an employee share of 91.1

■ ⁴ Which includes employees, self-employed, contributing family member, internships and volunteers.

percent in 2024. Therefore, the Aruban youth has a relatively high level of potential voice representation. Nevertheless,

an elevated employee share can also be indicative of stifled entrepreneurship, possibly suppressing job content security.

Table 9: Young employees as a percentage share of total young employment in 2023 for Aruba and selected territories.

Latin America and the Caribbean*	73.5%
The United States*	97.7%
The Netherlands*	94.9%
Aruba**	91.2%

*Source: *ILO Labor Force Statistics (November 2024). ** Aruba Labor Force Survey 2023 (2024). Joint venture by DAO, CBS, and CBA.*

4.2.3 Outcome assessment

Unions are a key medium to express collective voices.

These need to be measured by an outcome indicator. One way to gauge union strength is the unionization rate. Aruba fares well in youth unionization since it has a rate similar to advanced

economies (Table 10). It is challenging though to compare Aruba with Latin America and the Caribbean due to limited access to youth data. However, if the findings for the 15+ age cohort are indicative of the 15-24 age cohort, then Aruba likely has a better position than its regional peers.

Table 10: Unionization rate for Aruba and relevant territories, by age, and period.

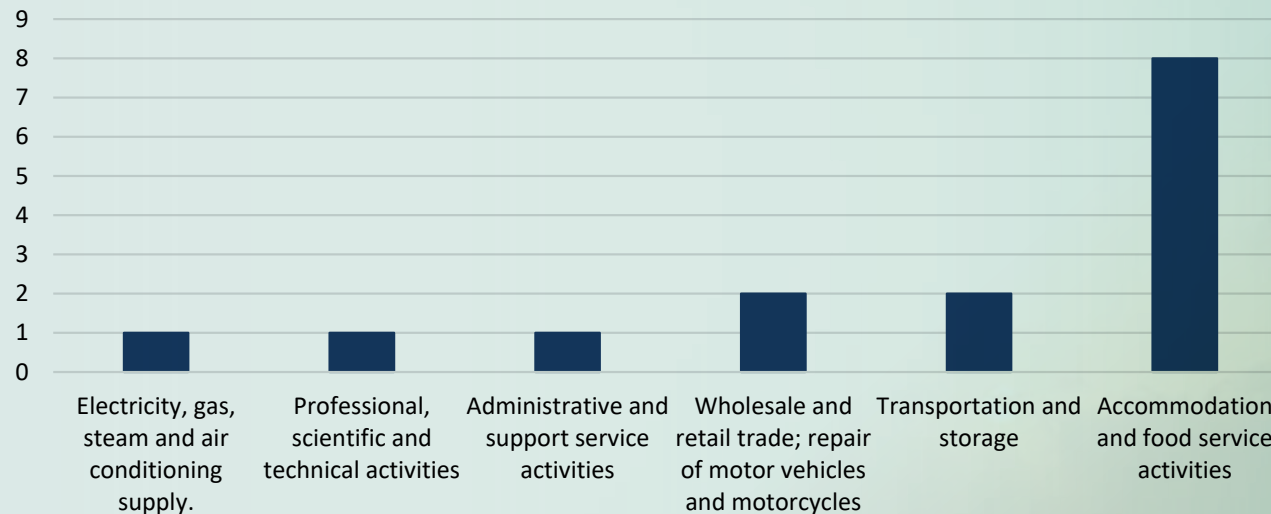
	Age 15-24	Age 15+	Period
Latin America and the Caribbean*	4.7%	13.7%	2014-2020
The United States**	4.4%	10.0%	2023
The Netherlands***	5.6%	15.4%	2023
Aruba****	5.0%	19.0%	2023

*Source: *Author's estimation for the ages 15-24 and ILO Industrial Relations Data for the 15+ age group (November 2024). ** BLS Members Union 2023 (January 2024). *** CBS the Netherlands Working Conditions Survey. **** Aruba Labor Force Survey 2023 (2024). Joint venture by DAO, CBS, and CBA.*

There are even indications that the youth unionization rate improved in 2024 compared to 2023. Based on the CBA's Youth Labor Security Survey (2024), 13.0 percent of the eligible respondents, i.e., residents between 15 and 24, reported that they are a labor union member. Yet, readers should interpret this 13.0 percent with caution due to the wide confidence

interval of 6.9 percent to 19.2 percent. The wide confidence interval stemmed from the small sample size of 115, in which 15 respondents reported being a union member. Most of these 15 respondents work in the accommodation and food service sector, suggesting that this sector has the most robust unionization among youth (Figure 9).

Figure 9: Union membership count by sector under the Aruban youth in 2024.



Source: CBA Youth Labor Security Survey (2024). Sector classification pursuant to the International Standard Industrial Classification (ISIC) by the UN.

Another outcome indicator is the voice and accountability index of the World Bank. The voice and accountability index captures people’s perception on freedom in selecting their government, as well as freedom of expression, freedom of association, and a free media. These elements are crucial during

times of discontent and labor strikes, ensuring voices are heard. In this regard, Aruba ranks in the top percentiles. **Ranking in the 81st percentile, Aruba surpasses its regional developing peers and the United States in voice and accountability, although its ranking is below the Netherlands.**

Table 11: The percentile rank of Aruba and selected territories for the voice and accountability index in 2023.

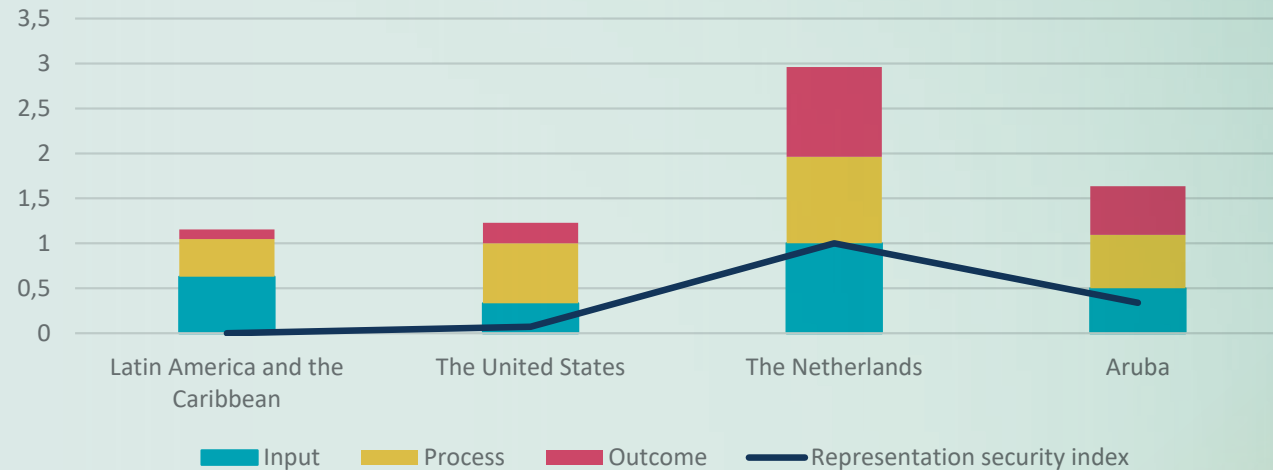
Latin America and the Caribbean*	57.8
The United States*	75.5
The Netherlands*	96.6
Aruba**	80.4

Source: *World Bank Worldwide Governance Indicators (March 18, 2024)

4.2.4 Youth representation security index
Considering the inputs, processes, and outcomes of income security, Figure 10 presents the representation security index. **The primary observation is that Aruba surpasses Latin America and the Caribbean in youth representation security. This Aruban merit stems largely from the superior outcomes indicators.** Examples include the unionization rate, greater voice, and accountability. Additionally, Aruba has better processes or resources that complement the inputs (e.g., bargaining laws) needed for youth representation security. At the same time, it trails behind the Netherlands in input, process,

and outcome indicators. Solutions exist for this gap, which are discussed in the section about policy recommendations.

Figure 10: The representation security index of Aruba and selected territories using 2023 data or earlier.



4.3 Youth labor market security

4.3.1 Input assessment

Table 12 illustrates Aruba’s standing in youth labor market security. The data indicate that Aruba mostly adheres to the input requirements. For example, Aruba has ratified ILO Convention No. 122, which calls for member states to pursue a policy designed to promote full, productive, and freely chosen employment. Aruba shares this compliance with its regional peers and the Netherlands, but not with the United States. In addition, Aruba also offers an unemployment social security scheme, called the “Cessantiaverordening”. The specifics hereof were discussed in the beginning of Section 3.2.2. Comparatively speaking, 88.9 percent of the countries in Latin America and the Caribbean countries have that scheme, while the United States

and the Netherlands also enforce such a scheme.

Nevertheless, a formal national commitment to full employment⁵ is absent in Aruba, as it is in Latin America and the Caribbean. In contrast, the United States does have a formal commitment to full employment. The Federal Reserve exemplifies this formal commitment through its mandate of maximum employment and stable prices, as established in the Federal Reserve Act of 1913, and reinforced by the Full Employment and Balanced Growth Act of 1978. Similarly, the Netherlands is committed to full employment through Article 3 of the Treaty on European Union (TEU). It states that the internal market shall work for the sustainable development of Europe ... aiming at full employment and social progress.

⁵ Full employment in this chapter is defined as the maximum level of employment achievable without causing inflation pressures (Arsenev et al., 2024).

Table 12: Summary of the input, process, and outcome indicators of the labor market security index.

	Input	Process	Outcome
Labor market SI	-ILO Convention No. 122 on Full Employment ✓ -Formal commitment to full employment ⊗ -Unemployment social security scheme ✓	-A public employment service to help labor demand meet supply ✓ -Public consumption as a percent of GDP (=19.9% in 2022) ✓ -The 10-year average growth rate of GDP (=2.6% between 2014-2023) ✓ -The coefficient of variation of the GDP growth rate ⊗ (=12.1% between 2014-2023)	-Youth unemployment rate (=11.1% in 2023) ✓ -Youth employment as a share of the young population (=37.5% in 2023) ⊗ -Wage share in GDP (=59.9% in 2013) ✓
✓: a) indicates that Aruba has properly implemented a national or international convention or b) signals when a quantitative indicator in Aruba is at a level of the United States or the Netherlands ✓: a) indicates that Aruba has partially or improperly implemented a national or international convention or b) signals when Aruba outperforms Latin America and the Caribbean in a quantitative indicator ⊗: a) indicates that Aruba has yet to implement a national or international convention or b) signals when Aruba performs at a level of Latin America and the Caribbean in a quantitative indicator			

4.3.2 Process assessment

Aruba excels in three of the four indicators for labor market processes. A public employment service to help (youth) labor demand meet labor supply supports this positive assessment. In Aruba, the Department of Labor Progress (DPL) offers employment intermediation services specifically for those not requiring a work permit in Aruba (DPL, 2024). Explicitly, the DPL aims to inform, encourage labor participation, and support local job seekers and employers in connecting more effectively within the labor market.

Nevertheless, the Aruban experience is not unique. In the Latin American and Caribbean region, all sampled public employment services involve job brokerage duties (OECD, IDB & WAPES, 2016). Similarly, in the Netherlands, job brokerage duties are the responsibility of the “Uitvoeringsinstituut Werknemersverzekeringen,” and in the United States, of the Employment and Training Administration.

Another factor contributing to the competent score for youth labor market processes is the high number of public

sector employees, proxied by public consumption as a percent of GDP. After all, workers tend to feel more secure in public sector jobs than private sector jobs (Clark & Postel-Vinay, 2009). Comparative findings show that Aruba has a larger public consumption than its regional peers and even the United States, although that may be related in part to the generous social

security coverage in Aruba (see Chapter 3.2.1). **Furthermore, caution is warranted about the significance of the public sector as a provider of secure work to young people.** The LFS of November 2023 highlights that only 2.5 percent of workers at government institutions are between the ages of 15 and 24.

Table 13: Public consumption as a share of GDP in Aruba and selected territories in 2022.

Latin America and the Caribbean	15.1%
The United States	13.9%
The Netherlands	25.1%
Aruba	19.9%

Source: World Bank national accounts data, and OECD National Accounts data files. Scope: General government

The average real GDP growth is an additional indicator that can be used to judge commitment to sound youth labor market processes. This link depends on whether labor market reforms – aimed at the youth or indirectly benefiting the youth – meaningfully impact GDP. In this context, **Aruba’s average real GDP growth of 2.6% outperforms Latin America and the Caribbean (Table 13).** It is slightly higher than the Netherlands and comparable to the United States. However, Aruba lags behind Central America, the strongest regional performer, potentially due to the latter’s more diversified economies in manufacturing and agriculture. A caveat is that emerging economies may experience higher growth rates solely due to the catching-up effect. In these cases, labor market processes are not necessarily better in the countries experiencing

higher growth. Furthermore, real GDP growth may be correlated to extreme labor market flexibility and poor labor rights.

Because of Aruba’s one-sided economy, it has a relatively volatile real GDP growth. **This volatility is reflected in the coefficient of variation⁶, with Aruba having the highest among the sampled countries (Table 13).** More diversified economies, such as those in Central America, tend to have greater resilience to external shocks (Delechat et al., 2024). Accordingly, they tend to have less volatile economies, which can attract foreign direct investment (Amal et al., 2010) and support job creation. In contrast, Aruba’s reliance on tourism heightens its economic vulnerability, potentially discouraging investment and limiting job creation.

■ ⁶ Defined as the ratio of between the standard deviation and the mean.

Table 14: Descriptive statistics of real GDP growth during the period 2014-2023.

	Average	Coefficient of variation
Caribbean	2.4%	0.048
Central America	4.0%	0.041
South America	0.5%	0.034
Latin America and the Caribbean	1.1%	0.035
The United States	2.5%	0.019
The Netherlands	2.1%	0.026
Aruba	2.6%	0.121

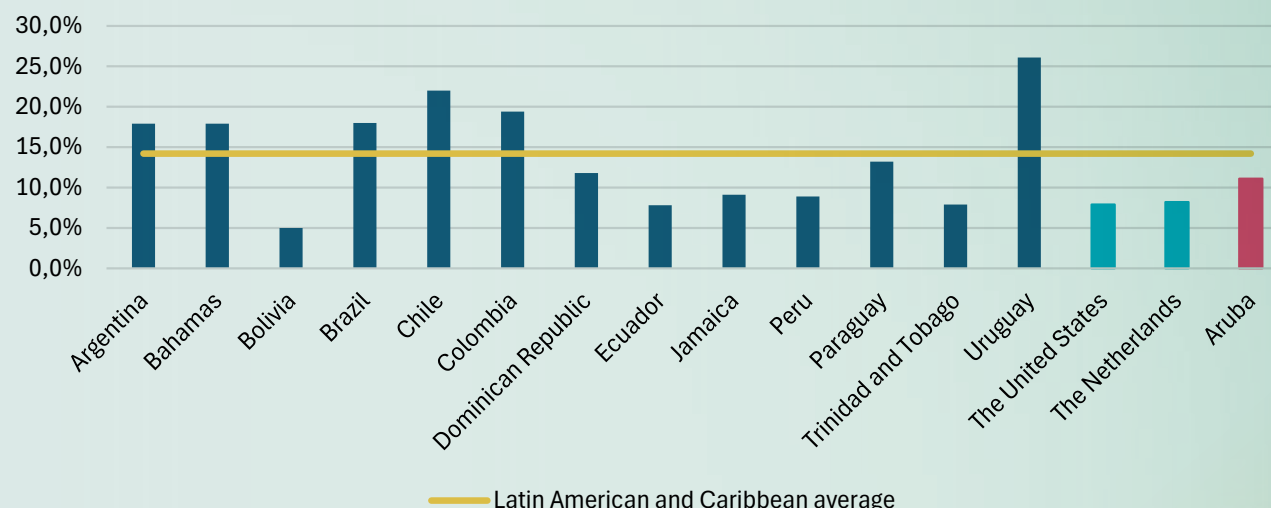
Source: IMF World Economic Outlook Database (October 2024)

4.3.3 Outcome assessment

Despite Aruba having a low youth unemployment rate for regional developing standards, 11.1 percent in 2023

(Figure 11) represents an increase compared to 2022, where it registered 9.9 percent. This increase in unemployment is explained by the surge in young unemployment (+30.2 percent) outweighing the jump in young employment (14.3 percent). More recent data from the Youth Labor Security Survey displays that the proportion of those seeking work in the youth active population recorded 31.1 percent. A caveat here is that this measure deviates from the unemployment rate in that it does not distinguish between those seeking paid versus unpaid work – a relevant distinction given the population under study.

Figure 11: The youth unemployment rate in 2023 for Aruba and selected countries



Source: ILO Labor Force Statistics (November 2024) and Aruba Labor Force Survey 2023 (2024). Joint venture by DAO, CBS, and CBA.

Box 4.1: Beyond the unemployment rate for labor market tightness

Labor market tightness is a critical indicator for understanding the balance between job supply and demand. Traditionally, the unemployment rate has been the most widely used measure of labor market tightness. Yet, it has notable limitations, i.e., it focuses solely on job seekers (labor supply), not minding the valuable information about vacancies (labor demand).

Against this background, the vacancy-to-unemployment ratio offers a more nuanced view of labor market tightness than the unemployment ratio by linking labor demand (vacancies) to labor

supply (unemployed workers). However, Aruba currently does not have a measure of that. Therefore, Box 4.1 approximates the youth vacancy-to-unemployment ratio for Aruba and compares the results with the Netherlands and the United States. In that process, the data and method will be discussed.

Data & method

- a. The first step involved scraping data from several websites on December 16, 2023; three from government entities, ten from recruitment companies, one from LinkedIn, three from private companies, and one from a business union (see Appendix 2). Websites were chosen based on the number of posted

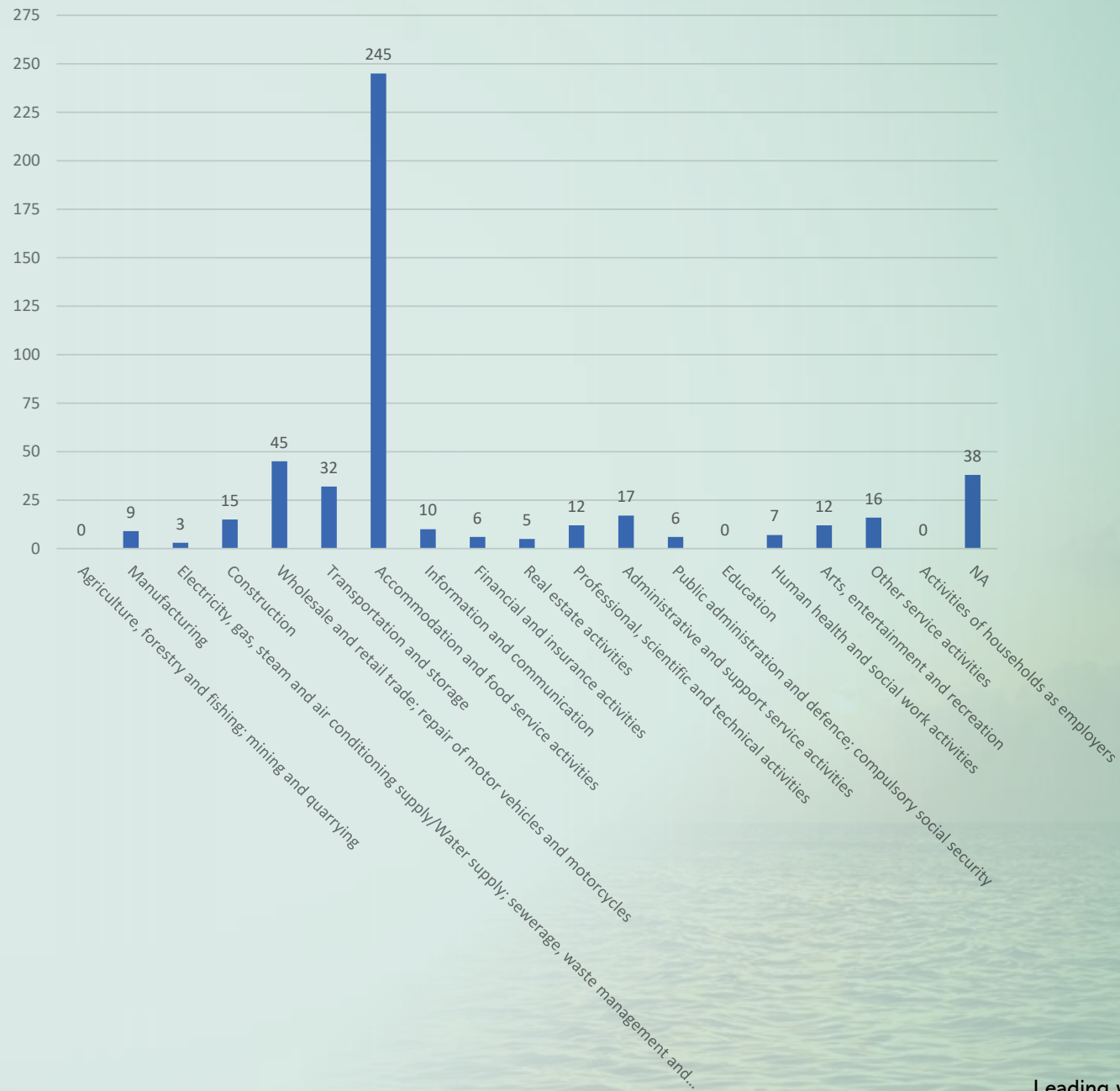
- vacancies and to capture a broad range of sectors.
- b. Some government websites, such as the DPL, post vacancies as images with text. Accordingly, the second step utilized optical character recognition tools to detect and extract text from images.
 - c. Considering that some websites post vacancies in English, while others do so in Papiamentu, the third step required standardizing the languages. To this end, the author resorted to a natural language processing (NLP) tools such as ChatGPT.
 - d. In the fourth step, natural language processing tools were equally important, as junior positions needed to be filtered from senior positions to capture vacancies that are fillable by those between 15 and 24 years (although one suboptimally assumes that every junior position is attainable to the youth). Adequate prompting is key in this step since NLP tools tend to classify, “officer”, “expert”, “consultant”, “technicians”, “coordinator” and “engineer” as senior positions. However, “nail technicians”, “activities coordinator” and “shift engineer” are attainable jobs in the 15-24 age cohort.
 - e. The fifth step revolved around standardizing writing conventions. For example, “Jr” or “Jr.” were all converted to “Junior”. This step was crucial to removing duplicate vacancies.
 - f. In the sixth step, duplicate vacancies were removed. A vacancy was classified as a duplicate when it appeared twice in the same company. A company may of course have multiple vacancies for the same position, but this occurrence is presumed uncommon.
 - g. With the help of NLP tools, the last step involved classifying jobs into sectors according to the International Standard Industrial Classification (ISIC). In cases where the relationship between the company and the vacancy was unavailable, the

ISIC classification was generally omitted. Exceptions hereof include vacancies clearly related to the hotel, construction, manufacturing, or other services sector.

Results

The scraping exercise suggests 478 vacancies for young people in Aruba per December 16, 2023 (Figure 12). Of the 478 vacancies, roughly half describe accommodation and food service activities. This finding is not surprising considering that Aruba largely relies on the tourism sector. Other sectors also produce vacancies related to tourism, such as transportation and storage. After all, airport-related jobs, tour operators, and car rentals fall under transportation and storage.

Figure 12: Vacancies attainable for those aged 15-24 years in Aruba, by ISIC



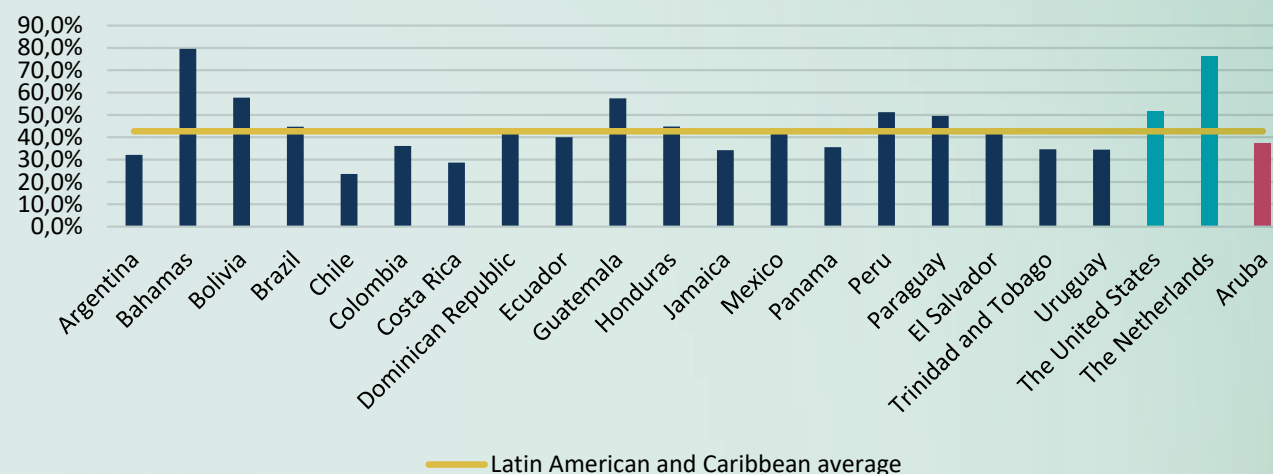
Given 478 vacancies and 535 unemployed young people according to the Aruban Labor Force Survey of November 2023, the estimated vacancy-to-unemployment ratio stood at 0.89. That is, labor supply exceeded labor demand. However, during the GDP consultation mission of the CBA in April 2024, various stakeholders reported difficulties in filling vacancies. This contrast between what the scraping data suggests and what stakeholders perceive is reconcilable. **While quantitative data suggest an oversupply of labor, stakeholders may perceive a labor supply shortage due to skill mismatches, disinterest in certain sectors, and misalignment between company demands and worker preferences (such as work from home possibilities, non-standard working hours).** Perhaps if the structurally unemployed persons are removed from total unemployment, the new vacancy-to-unemployment ratio would provide a much tighter labor market. Alternatively, the inclusion of more websites in the scraping exercise would have revealed a tighter labor market.

In the United States and the Netherlands, the ratio between entry-level vacancies and young unemployment is unavailable. Nevertheless, the overall vacancy-to-unemployment ratio is available, which was 1.14 for the Netherlands (CBS NL, 2024), and 1.40 in the US (BLS, 2024) in the fourth quarter of 2023. For Aruba, the scraping exercise for the overall labor market implied 593 vacancies for 2248 unemployed, bringing the ratio to 0.26. Thus, based on available data and preliminary exercises, the labor market in Aruba is less tight than in the Netherlands and the United States.

Besides the shortcoming already explained in Box 4.1, the unemployment rate can also drop when discouraged people stop looking for work. Meanwhile, employment as a share of

the working-age population is less prone to this drawback. Accordingly, the latter can complement the unemployment rate in measuring labor market security. For this chapter's specific purpose, youth employment as a share of the youth population reached 35.7 percent in 2023. **However, even for regional standards, youth employment is low in Aruba, let alone for advanced economy standards (Figure 13).** A possible explanation is that the Aruban youth are less inclined to take part-time jobs than the Dutch youth, for example. Anecdotal evidence would suggest that this difference is partly due to many young adults in Aruba still living with their parents, saving on rent and food expenses, and lessening their need for work.

Figure 13: Youth employment as a share of the youth population in 2023 for Aruba and selected territories



Source: World Bank national accounts data, and OECD National Accounts data files. Scope: General government

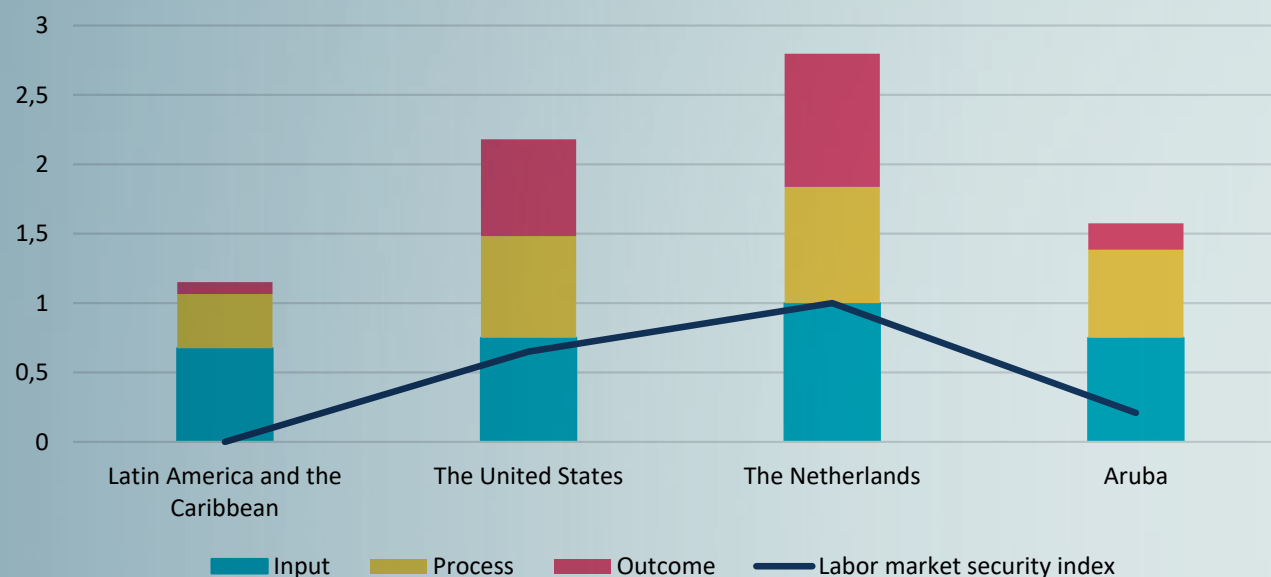
Another indicator relevant for labor security is the wage share in GDP. **As previously mentioned in Section 3.1.3, Aruba's wage share of GDP is at a level of advanced economies.** A high wage share may indicate that the economy relies on labor-intensive production rather than capital-intensive processes. This reliance on labor often translates to more job opportunities, as businesses need more workers to sustain productivity and growth. Alternatively, this finding might also signal low productivity and little innovation – issues that fall outside the scope of this chapter.

4.3.4 Youth labor marker security index

Given the inputs, the processes, and the outcome of income

security, Figure 14 presents the labor market security index. **The key takeaway is that Aruba outperforms Latin America and the Caribbean in youth labor market security. This Aruban advantage is mainly occasioned by more resources towards labor market security (e.g., higher public consumption) and better processes that stimulate labor market security (as evidenced by the stronger average GDP growth).** Nevertheless, Aruba has significantly worse outcome indicators than advanced economies, and, to a lesser extent, process indicators. Examples of poorer outcome indicators in Aruba are the higher unemployment rate and the lower employment share in working age population. The section on policy recommendations will present solutions to bridge this gap.

Figure 14: The labor market security index of Aruba and selected territories using 2023 data or earlier.

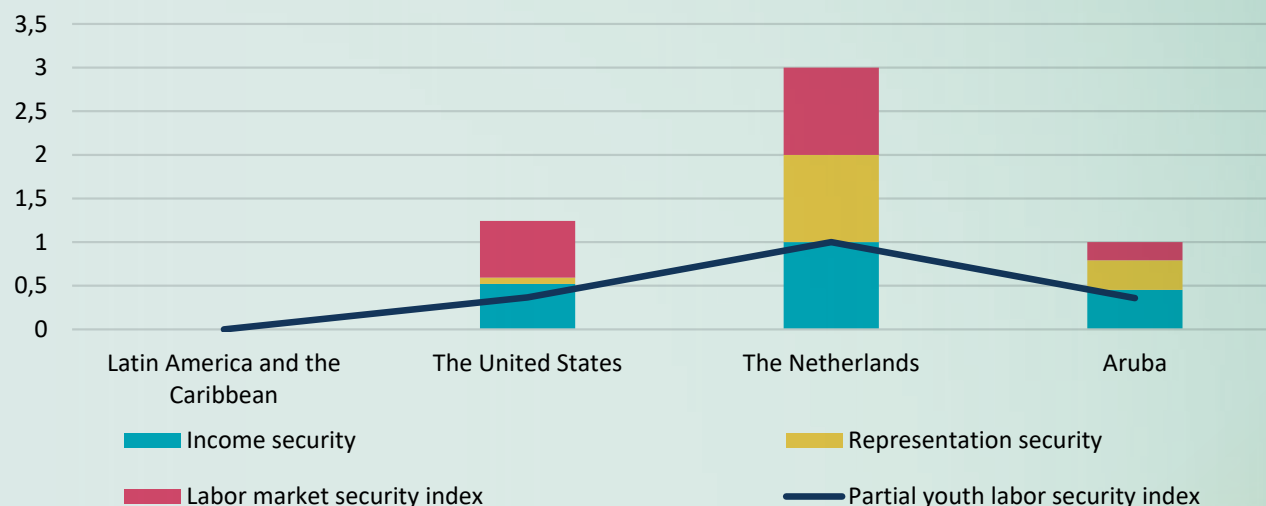


4.4 Partial youth labor market security

The partial youth labor security (PYLS) index indicates a country's **relative** economic security. A high PYLS score indicates that a country is providing more security than one with a low score. Nonetheless, a high (or low) score does not necessarily imply that the country is providing a very strong (or weak) environment of PYLS. In this case, a PYLS of zero for Latin America and the Caribbean means it ranks last among the four surveyed countries, not that there is no PYLS. **Specifically, Aruba beats its regional developing peers in all three aspects of PYLS.** That Aruba performs better in income, representation and labor market security was expected given Aruba's higher standard of living.

Compared to more advanced economies, Aruba trails behind the United States in PYLS, principally due to lower labor market security. The latter was expected, given the more diverse U.S. economy and, thus, job-providing potential. Nevertheless, Aruba tops the United States in representation security. This finding was anticipated given the pro-business policies in the United States that often come at the expense of unions (McGinley, 2021). **Relative to the Netherlands, Aruba falls behind PYLS in all three aspects.** This result aligns with expectations given that the Netherlands has one of the highest levels of GDP per capita in the world, combined with it being a welfare state (Wiepking & Bekkers, 2015). Given Aruba's PYLS comparison with advanced economies, policy recommendations are warranted to strengthen the PYLS of Aruba.

Figure 15: Partial youth labor security of Aruba and selected territories



5. Policy recommendations

Even though Aruba has several input indicators in place to secure youth income -- such as national laws and international conventions -- the previous section identified several deficiencies. For example, some laws excluded social security protection for teenage workers. These deficiencies may partially explain Aruba trailing the Netherlands in outcome indicators. Furthermore, process indicators, like social security spending, were adequate. Yet, process sufficiency did not translate to outcome levels similar to advanced economies. Once more, certain deficiencies, such as low compliance with laws or poor implementation of policies, may explain Aruba lagging in outcome. Against this background, this chapter provides the following policy recommendations for income, voice representation, and labor market security.

5.1 Youth income security

5.1.1 Legislative inputs

As the previous section emphasized, the current minimum wage laws exclude workers younger than 18.

- i. Therefore, the revised minimum wage law must include all legal age workers. Such an adjustment can ultimately help reduce youth income inequality; an issue highlighted in the previous section.

5.1.2 Process and resources

Improve pension coverage and adequacy

Young workers retire in the future, but the previous section stressed that old age insurance benefits (AOV) are below the subsistence level. This limitation can potentially explain

the inferior outcomes in youth income security compared to advanced economies.

- i. Hence, the government should slowly increase the AOV payout, and consider a higher “reparatatie toeslag” specific for old people with low means, instead of a universal one. A gradual rise in pension benefits that keeps pace with inflation can help future pensioners (who are currently young workers) to maintain a living closer to the subsistence level.
- ii. Currently, under the general pension ordinance (LAP), only local pension funds and life insurance companies can provide pension plans. As such, the GOA could expand on the LAP to include pension plan provisions by commercial banks (Tromp, 2022) and the SVB. This policy can increase competition and stimulate higher pension payouts.
- iii. Improve compliance with pension contributions: Under the general pension ordinance (LAP), employers must generally set up or participate in a pension scheme for their employees supplementary to the AOV old age insurance. However, in practice some companies fail to do so (SER, 2017). A solution for this shortcoming is twofold.
 - a) The government should assign a supervising organ for enforcement. This organ can, for instance, be the Department of Labor and Research (DAO).
 - b) Launch a public campaign targeted at (young) workers to verify if their employers are placing withheld funds at pension companies.

Strengthen social security sustainability

The previous section stated that social security spending in Aruba is high by regional standards. Nevertheless, this finding raises concerns around financial sustainability and

supporting youth income security in the future. The following recommendations may prove useful here.

- i. Reform social security contributions: Consider switching the AZV and SVB premiums from an employee-employer contribution system to an earmarked value-added tax system (VAT), akin to the BAZV. This action will tackle the informal economy and increase the collection base.
- ii. Enhance efficiency: Streamline the administration of social security programs to reduce costs and ensure funds are allocated effectively. An example is to integrate the sickness and accident insurance of the SVB into a single insurance (van Heel et al., 2022).
- iii. Extend the days employers pay when an employee is sick (van Heel et al., 2022). This situation can create a win-win situation where the SVB reduces its outlays on sickness and accident insurance, and employers pay less premiums because SVB bears fewer risk. Additionally, this measure encourages employers to invest in the health and safety of their employees, curbing sickness leave, and reducing SVB payouts.
- iv. Monitor impact: Regularly evaluate the outcomes of social security expenditures to identify areas of improvement and ensure funds achieve desired results.

Enhance unemployment benefits

In contrast to a few of its regional developing peers, Aruba has an unemployment benefits scheme. However, the previous section underlined some design deficiencies specifically for the youth. These shortcomings can explain why outcomes of youth income security in Aruba are not up to advanced-economy levels. Against this background, the government can consider the following options.

- i. Reform “cessantia” benefits: Adjust the formula for severance pay to better account for the unique challenges faced by younger workers, such as lower starting wages and shorter service durations. A minimum amount should be considered such that it protects young workers but also maintains the incentive for companies to hire young workers.
- ii. Introduce regular payments: Transition from one-time severance pay to a more structured unemployment benefit system with regular payouts to provide income security for laid-off workers. Given the (compliance) expertise of SVB, this entity can be in charge of the new unemployment benefit system.

5.1.3 Outcomes

Address youth income inequality

The previous section highlighted that youth income inequality -- one indicator of income security -- is probably an issue in Aruba, more so than in the two advanced economies examined. There are a range of remedies for this issue, to be discussed below.

- i. Introduce targeted programs: Implement social programs aimed at reducing income inequality among the youth. Typical efforts include education grants, vocational training, and entrepreneurship support.
 - a) All three already take place in Aruba, but particularly the latter can be boosted by linking entrepreneurial education at school with the Youth Entrepreneurship Program of “Iniciativa pa Desaroyo di Empresa Arubano”, a unit within the Department of Economic Affairs.
- ii. Promote progressive taxation: Explore progressive tax reforms that reduce the tax burden on lower-income groups.
 - a) Instill an Aruban whistleblowing program such as the Internal Revenue Service Whistleblower Program in the

United States where whistleblowers can report tax fraud through an online submission and receive a financial reward if their information leads to the collection of additional taxes, penalties, or fines. Generated funds hereof can be used to lower the tax burden of low-income households.

- b) In Aruba, a minimum wage earner does not necessarily mean belonging to the low-income group. After all, the Labor Force Survey of November 2023 reports that several people earned Afl. 4001 or more in tips in the surveyed month. Accordingly, the tax burden can be partially moved from those earning minimum wage without tips to tip earners.
- c) Transition from a turnover tax to a differentiated value-added tax on essential versus non-essential products to make essential products more affordable to the youth and reduce income inequality.
- d) Expand affordable housing: High income inequality can be alleviated by introducing renting subsidies to low-income workers, shrinking their largest expense category.

Promote economic diversification

- i. Reduce tourism dependency: As the previous section highlighted, a high government debt burden in tandem with a one-sided economy can be detrimental to youth income security. Therefore, the government should encourage investment in sectors beyond tourism, such as artificial intelligence, fintech, and renewable energy to create diverse employment opportunities for youth.
 - a) Aruba’s investment agency should approach small multinationals in these sectors. The government should offer tax exemptions to these small multinationals that slowly become less generous over time and conditional on

- a local hiring percentage.
 - i. The local hiring requirement can attract the Aruban diaspora, reducing the brain drain and knowledge leakage.
 - ii. A mapping of the education attainment of the local population and Aruban diaspora is necessary to assess which sectors should be eligible for tax exemptions.
- ii. Support startups and SMEs: Provide grants or act as guarantor for youth-led business loans, fostering entrepreneurship and reducing the reliance on tourism.
 - a) Using parameters from “Fondo Nacional di Garantia pa Vivienda”, Qredits⁷ and the European Investment Fund, a default probability of 10 percent, an own contribution of 10 percent by the loan applicant, a loss-given-default of 90 percent, a USD 10 million guarantee fund, a guarantee premium of 1 percent, and an administration cost fee of 0.5 percent, the estimated fiscal cost aggregates to USD 765,000 per year.

Tackle high public debt

As previously mentioned, a high public debt and a one-sided economy reduce the government’s ability to guarantee income security to its citizens during crisis. Given this risk, without going too much in detail of debt reduction, this chapter highlights some expenditure curbing measures and tax collection improvements.

A starting point to rationalize expenditures are the studies “Kerntakenanalyse 2024” by PricewaterhouseCoopers and CBA’s Fiscal Outlook 2024-2028: Projections and Policy Implications, with the latter, for example, recommending to structurally decrease overtime payments.

- a) Expenditures on interest can also be lowered by accelerating debt repayment, if possible.
- b) To improve tax collection, the proposed VAT also needs to embed a reverse charge mechanism for international service providers. Currently, when local companies provide services like IT, accounting, consulting, or legal advice, they are required to charge turnover taxes on their invoices to clients. However, international companies offering similar services are not required to charge turnover taxes. This situation creates unfair competition and suboptimal tax collection. The reverse charge mechanism shifts the responsibility of paying turnover taxes (BBO, BAVP and BAZV) from the service provider to the client.
- c) Such a reverse charge mechanism can also broaden the tax collection in the hotel and banking sector which pay sizeable management fees.

Encourage informal workers to formalize

According to the previous section, Aruba has a potentially smaller informal sector than its regional developing peers. Nevertheless, the government should incentivize businesses to formalize their employment relationships. In this scenario, more (young) local workers enjoy social security and other benefits, thereby raising their income security closer to advanced-economy standards.

- i. Accordingly, the government should continue its efforts to simplify employee registration processes.
 - a) Crucial aspects hereof are a one-stop shop consisting of cross-functional government departments that permit online document submission and payment.
- ii. Furthermore, the government can improve compliance by

■ ⁷ <https://s3.eu-central-1.amazonaws.com/webstores-qredits-nl/07/qredits-verslag-van-uitgeoefende-activiteiten-en-financiele-verantwoording-2023.pdf>

targeted audits, whistleblowing rewards, and stricter penalties.

- a) In particular, Spain's tax authority uses data analysis for targeted audits, which for Aruba, would require the government allocating funds to data science vacancies.

Monitor and evaluate progress

- i. Develop comprehensive Indicators: Create and regularly update poverty and income inequality time series to track progress and identify emerging issues.
- ii. Expand surveys: Conduct surveys to calculate a globally comparable multidimensional poverty index (MPI) for Aruba, enabling better benchmarking and policy design.

5.2 Youth representation security

5.2.1 Legislative inputs

The previous section revealed that Aruba has not ratified ILO Convention No. 98 on the Right to Organize and Collective Bargaining. This inaction may explain Aruba trailing behind the Netherlands in youth representation security.

- i. The recommendation is to then ratify Convention No. 98, which, in principle, will force national laws to be compliant with the convention's requirements. A significant benefit of this convention is that it safeguards unions from interference from employers or external entities during collective bargaining.

Another shortcoming identified in the previous section was that striking is legal only after 30 days of dispute.

- ii. That amount of days can decrease labor rights momentum and should therefore be shortened to international standards of 14 days or shorter.

In addition, the labor dispute decree does not require the reinstatement of workers illegally fired for union activities. This deficiency might lead to workers being less likely to join or engage in union activities, repressing representation security.

- iii. Accordingly, the revised labor dispute decree must prohibit firing workers for union activities and require reinstatement.

5.2.2 Process and resources

Fortify the collective bargaining coverage

The previous section established that the percentage of (young) workers covered by collective bargaining in Aruba is potentially lower than the regional developing average, and far lower than the Dutch standard. Accordingly, there is space to strengthen youth representation security and youth income security.

- i. Both employers and employees need to recognize the benefits of collective bargaining. One route is to collaborate with unions, NGOs, and educational institutions to launch awareness campaigns and workshops for sectors that have poor collective bargaining coverage. According to SER (2001) data, these are the sectors unrelated to the "horeca" and retail sector.
- ii. Introduce incentives for employers who voluntarily engage in collective bargaining: Governments can embed corporate social responsibility and robust labor practices into public procurement criteria. For example, employers with healthy collective agreements can score higher in bidding processes for government contracts.
- iii. Create minimum collective bargaining standards since SER (2001) data reveal that some positions in a company are excluded from the collective bargaining agreement or miss out on some benefits.

Monitor and evaluate progress

Up-to-date data on collective bargaining coverage are lacking, which makes policy making and evaluation more difficult.

- i. The recommendation is to strengthen the capacity of the Central Bureau of Statistics (CBS) and the DAO with, among others, cross-departmental data scientists.

5.2.3 Outcomes

As shown in the previous section, youth unionization rate in Aruba is up to par with advanced economies. Nevertheless, just as in collective labor agreements, the accommodation and food service sector seem to be overrepresented. Accordingly, the awareness recommendations set out for collective labor agreements also apply to unions.

5.3 Youth representation security

5.3.1 Legislative inputs

Formalize a commitment to full employment

The previous section discussed that Aruba lacks a formal commitment to full employment, an input to realizing labor market security according to ILO (2004).

- i. A policy recommendation is to then establish a national commitment to full employment laid down in law, akin to the European Union and the United States. A tripartite council could advise on realizing full employment, consisting of the DAO and DPL as public representatives, with each institution choosing an advisory or executionary role. Complementing the tripartite, the public representatives are joined by labor unions and employers' associations for their input.

5.3.2 Process and resources

Promote economic diversification

The previous section confirmed Aruba's sharp GDP volatility relative to developing regional peers and advanced economies. This volatility stems from Aruba's one-sided economy. Such over-reliance on one economic sector not only threatens youth income security, but also undermines youth labor market security by exposing a large chunk of young workers to unemployment during economic downturns.

- i. Thus, a policy recommendation is to diversify the Aruban economy. This action can decrease GDP volatility, increase resilience to external shocks, and create more stable and varied job opportunities. Potential steps to economic diversification were already discussed in Section 4.1.3. In addition to those previously mentioned, the government can consider innovation grants to eligible start-ups in the green and technological space.
 - a) In the United States for example, the Small Business Technology Transfer grant requires a partnership with a research institution, technical feasibility, and clear plan for transitioning the innovation into market-ready products. Such a program in Aruba would then prominently feature the University of Aruba.

5.3.3 Outcomes

Enhance youth employment opportunities

The previous section argued that one outcome of youth labor market security, i.e., youth employment rate, is subpar in Aruba compared to surveyed economies. This lag in youth employment is potentially caused by cultural norms and skill mismatches.

- i. Hence, the government should develop programs to promote youth employment, such as internships, apprenticeships, and

tax incentives for sectors that experience labor shortages, subject to certain criteria, e.g., company size.

- a) For instance, the Netherlands has the “Beroepsbegeleidende Leerweg” (BBL). BBL students spend 1 to 2 days per week in a vocational school (MBO) and the remaining days working at a company. They earn a salary and gain on-the-job experience under the guidance of experienced professionals. Employers that hire BBL apprentices can receive government subsidies or tax benefits (e.g., “Subsidie Praktijkleren”) to cover training costs. This encourages companies to take on young people and invest in their development.
- ii. Align curriculum with labor market needs to address skill mismatches: In vocational school, employers’ associations, and workforce agencies, including DPL, also need to have an input in the curriculum.
- iii. Cultural norms around the youth living with parents potentially contribute to low youth employment in Aruba. Accordingly, incentivizing part-time work can engage the youth without disrupting their education.
 - a) One way is to stimulate businesses to go looking for potential youth employees. A means to achieve this is to introduce tax incentives or stipends for businesses hiring youth in part-time roles.
 - b) Another option is to encourage young people to enter the labor market. A helpful tool would be awareness campaigns that promote the benefits of early work experience for young people, especially for higher educated young people.

Working as an employee is not the only path to employment; advancing youth entrepreneurship is another avenue to expand youth employment.

- i. Accordingly, the government should continue playing a role in supporting startups through microloans, mentorship, and innovation hubs.

Monitor and evaluate progress

The current data gap on labor market tightness undermines the ability to develop informed policies. The DPL should expand their database with online vacancies, just as Box 1 of this chapter did. Furthermore, it can collaborate with other recruitment agencies to report job vacancies systematically. The CBA would also benefit from such an open platform given the theoretical relationship between labor market tightness and wage inflation.

6. Conclusion

This chapter reveals that three aspects of labor youth security in Aruba are generally higher than its regional peers but below the surveyed advanced economies. **First, Aruba outperforms Latin America and the Caribbean in resources towards income security (e.g., social security expenditure as a share of GDP) and outcomes of income security (e.g., real GDP per capita and income equality).** However, compared to more advanced economies such as the Netherlands and the United States, Aruba underperforms. Consequently, the policy recommendations are expanding the minimum wage law to young workers, improve pension coverage and adequacy, strengthen social security sustainability, enhance unemployment benefits, address youth income inequality, promote economic diversification, tackle high public debt, and encourage informal workers to formalize. In particular, one way to guarantee social security sustainability is to consider switching the AZV and SVB premiums from an employee-employer contribution system to an earmarked value-added tax system (VAT), akin to the BAZV. This action will tackle the informal economy and increase the collection base.

Second, in terms of youth voice representation security, Aruba has better outcomes (e.g., voice and accountability index and unionization rate) than its Latin American and Caribbean peers. Yet, the Netherlands has greater resources and processes (due to factors such as a higher collective bargaining coverage rate). Accordingly, the policy outline includes ratifying Convention No. 98, obligate the reinstatement of workers illegally fired for union activities under the labor dispute decree, shorten the legally required notice period for strikes to 14 days, and fortify the collective bargaining coverage. For the latter, one of the actions mentioned was governments embedding corporate social responsibility and robust labor practices into public procurement criteria.

Third, Aruba diverts more resources towards youth labor market security (e.g., higher public consumption) and has better processes that stimulate labor market security (as evidenced by the stronger average GDP growth) than its regional peers. Nevertheless, Aruba has significantly worse outcome indicators than the advanced economies examined. Examples of poorer outcome indicators in Aruba are the higher youth unemployment rate and the lower employment share in working age population. Therefore, the policy principles comprise formalizing a commitment to full employment, promote economic diversification, and enhance youth employment opportunities, either as employees or entrepreneurs. One specific recommendation that stands out is a tripartite council that advises on and realizes full employment, consisting of the DAO, and DPL as public representatives, joined by labor unions and employers' associations.

While this chapter assessed Aruba's post-COVID position in youth security in income, representation and labor markets,

other securities also matter. In particular, future research can gauge Aruba's status in employment protection security, job content security, working conditions security, and skill reproduction security. Another ripe avenue for future research is the development of age-specific indicators to improve policy guiding. This chapter assumed that certain average indicators, such as household poverty, accurately reflect the youth's position – an assumption that may not hold.

Appendices

Appendix 1

The social security expenditure scope can be ambiguous and vary across countries. With this in mind, social security expenditure in Aruba consists of benefit payouts for the following:

- general old age insurance (AOV) plus “reparatietoeslag”;
- general widows and orphans insurance plus “reparatietoeslag”;
- accident insurance;
- sickness insurance;
- unemployment insurance or “cessantia”;
- general old age insurance of government employees;
- cost of living allowance for government pensioners or “duurtetoeslag pensioenen”;
- housing subsidies;
- “loonsubsidie” and “MKB-regeling”;
- and the general health insurance (AZV).

In addition, social security expenditure comprised of benefit payouts and operational costs related to:

- material social assistance or “onderstand” plus FASE⁸;
- immaterial social assistance, such as “Voogdijraad” and “Family Justice Center”;
- and housing subsidies.

Meanwhile, social security spending for the selected countries included:

- pensions, early retirement pensions, home-help, and residential services for the elderly;
- spending on in- and out-patient care, medical goods,

prevention;

- child allowances and credits, childcare support, income support during leave, sole parent payments;
- unemployment compensation, early retirement for labor market reasons;
- survivor-related benefits such as pensions and funeral payments;
- Incapacity-related benefits, for instance care services, disability benefits, benefits accruing from occupational injury and accident legislation, employee sickness payments;
- employment services, training, employment incentives, integration of the disabled, direct job creation, and start-up incentives;
- housing allowances and rent subsidies;
- and other social policy areas involving cash benefits to low-income households, as well as other support programs such as food subsidies.

Appendix 2

To gather job vacancies in Aruba, this chapter scraped data from the following websites:

- Government entities:
 - <https://dpl.aw/453-2/>
 - <https://hrportaal.drh.gov.aw/vacatures/>
 - <https://www.arubahuis.nl/vacatures/>
- Recruitment companies
 - <https://tempoaruba.com/jobs/>
 - <https://careers.depalmartours.com/jobs/>
 - <https://flexomanpowerservices.com/job-seekers/>

■ ⁸ The reports examined did not split FASE from material social assistance.

- <https://mikiertaha.com/>
- <https://www.aruba-works.com/>
- <https://www.caribbeanjobsonline.com/jobs/aruba>
- <https://www.careerportal.aruba.com/jobs/>
- <https://www.caribworkforce.com/aruba/>
- <https://advance-hrs.com/job-listing/>
- <https://u-sparkpeople.com/job-openings/>
- Employment-focused social media company
 - https://www.linkedin.com/jobs/search/?currentJobId=3774268817&f_WT=1%2C3&geold=105763200&location=Aruba&origin=JOB_SEARCH_PAGE_LOCATION_AUTOCOMPLETE&refresh=true
- Private companies
 - <https://aruba-en.qredits.com/about-qredits/job-opportunities-aruba/>
 - <https://www.itpinternational.com/jobs/>
 - <https://marriottemployment.dejobs.org/abw/jobs/#5>
- Business unions
 - <https://www.ahata.com/career-center?modal=1613>

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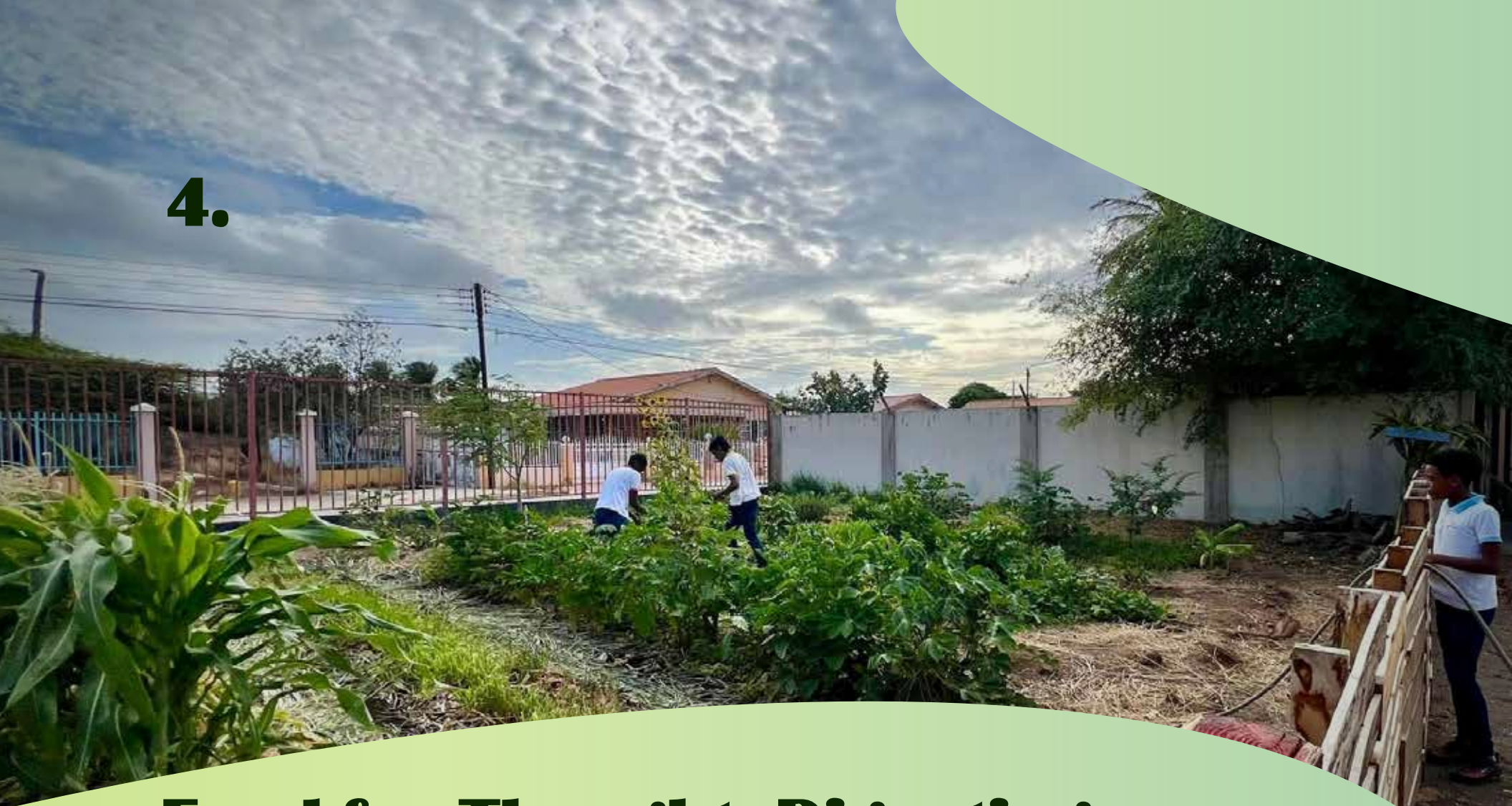
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4.



Food for Thought: Digesting the Dimensions of Food Security in Aruba

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Abstract

This chapter contributes to the discussion of food security, with a focus on the case of Aruba. It presents the definition of food security, and elaborates on its dimensions, importance, and links to the United Nations' (UN) Sustainable Development Goals (SDG). More importantly, the chapter provides insights into the state of food security in Aruba, exhibiting available data for the island along the lines of the four dimensions of food security: availability, access, utilization, and stability. Additionally, the chapter includes results from the Centrale Bank van Aruba's Food Security Survey 2024 (FSS 2024). The latter indicates that the proportion of people facing moderate or severe food security in Aruba is relatively low compared to the average proportion in the Caribbean, but that there is room for improvement as some islands in the region report substantially lower proportions. The potential for improvement is also reflected in the available data across the dimensions mentioned above. The data displays a blend of successes and challenges related to various aspects concerning food security. The chapter concludes by providing several recommendations that can be implemented to improve the state of food security in Aruba.

Key words: Food Security, Food Insecurity Experience Survey, Aruba

1. Introduction

Food security is an essential topic to include in a government policy study. It is a useful objective around which to organize public policy, as it does not only concern itself with economic growth but also gives weight to the distribution of the benefits of this growth (Hindle, 1990). This chapter contributes to the discussion of food security, particularly focusing on the case of Aruba. It starts by presenting the definition of food security and elaborating on its dimensions and importance. The chapter links food security to the United Nations' (UN) Sustainable Development Goals (SDG) and provides insights into the state of food security in Aruba. Additionally, the chapter explores how food security is experienced, by presenting results from the FSS 2024. The chapter concludes with recommendations that contribute to the improvement of food security for the community.

2. The definition of food security

Food security is a dynamic concept, which has evolved over the years. It originated in the 1970s, amid the Global Food Crisis of 1972 – 1975. Food security was initially defined at the World Food Conference of 1974 as *'Availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices'* (United Nations, 1975). This definition, with its heavy emphasis on the supply and price of food, reflects the concerns present at the time: low harvests and soaring prices (Horton, 2009). Indeed, at the time, it was thought that hunger principally arose due to a lack of sufficient food supplies at the global level, and due to international price instability (High Level Panel of Experts on Food Security and Nutrition, 2020). Almost ten years later, the Food and Agriculture Organization of the

United Nations (FAO) adapted the definition to not solely focus on the supply side of food security (Clay, 2002). The definition became *'Ensuring that all people at all times have both physical and economic access to the basic food that they need'* (FAO, 1983). Shortly thereafter, the World Bank (WB) published a report on poverty and hunger, in which it introduced the dimension of time to the concept of food security. The latter allowed for a distinction to be made between chronic food insecurity which results from structural poverty and low income, and transitory food insecurity which is the temporary product of events such as natural disasters, economic collapse, or conflict (Clay, 2002). The definition of food security that followed was *'Access of all people at all times to enough food for an active, healthy life'* (Reutlinger, 1986). With time, additional factors were considered, such as the level at which food security exists (ranging from the individual level to the global level), food safety, nutritional balance, and food preference (Clay, 2002). Consequently, at the 1996 World Food Summit, a broader definition of food security was adopted. According to the Rome Declaration on World Food Security, *'Food security, at the individual, household, national, regional and global levels is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life'* (FAO, 1996). In 2001, the FAO again enhanced the definition of food security, emphasizing consumption, the demand side, and the issues of vulnerable people's access to food (Clay, 2002). The new definition, published in The State of Food Insecurity in the World 2001 states that *'Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life'* (FAO, 2002). **This definition of food security is used in the remainder of this chapter.**

3. The dimensions of food security

The selected definition of food security enables the identification of four main dimensions of food security: (i) availability, (ii) access, (iii) utilization, and (iv) stability (FAO, 2008). These dimensions must be fulfilled simultaneously for food security.

The availability dimension alludes to the physical availability of food. This so-called supply side of food security is determined by the level and quality of food produced domestically or imported from abroad (FAO, 2006). In this regard, the emphasis is on having sufficient food of good quality, regardless of whether a country produces it or acquires it from abroad.

Food access, in turn, entails individuals' access to adequate resources that allow them to obtain appropriate foods for a nutritious diet. While no single definition of the term 'nutritious diet' is provided, the FAO and the World Health Organization (WHO) have issued a joint statement in which the principles of a healthy diet are presented. These principles include adequacy (a healthy diet provides enough essential nutrients to prevent deficiencies and promote health, without excess), balance (a healthy diet is balanced in energy intake and energy sources to promote healthy weight, growth, and disease prevention), moderation (a healthy diet is moderate in the consumption of foods, nutrients and other compounds associated with detrimental health effects), and diverse (a healthy diet includes a wide variety of nutritious foods within and across food groups to favor nutrient adequacy and consumption of other health promoting substances). Furthermore, a healthy diet consists of foods that are safe (i.e., foods that do not cause adverse health effects to consumers when they are prepared or eaten) (FAO & WHO, 2024).

In addition to physical access to food, which refers to the proximity of available food options, the food access dimension takes into account economic and social access (FAO, 2006). Economic access refers to the affordability of the foods that are available for purchase and consumption (Food Forward NDCs, 2024-a), while social access encompasses social and cultural norms, as well as political factors that have an impact on the ability of individuals to acquire foods (Pinerua, 2023).

The third dimension, food utilization, comprises how the body makes the most of various nutrients in food (FAO, 2008). This dimension underlines that it is not sufficient for food to be available and accessible. Individuals should also be able to take in enough energy and nutrients from the food that they eat. There are a range of factors that can affect the body's ability to extract and use nutrients from food. These include, among others, the composition of the diet, how food is stored, prepared, and cooked, hydration levels, environmental factors such as exposure to pollutants, lifestyle choices, and stress levels, as well as health conditions and the use of certain medications and supplements (Sterling, 2024). The food utilization dimension is fulfilled when food can be safely stored and prepared (e.g., proper cooking facilities are available and there is access to clean water), feeding practices are appropriate (i.e., the ingested food corresponds to individuals' nutritional needs, particularly those with special needs such as infants, young children, the elderly, the sick, as well as pregnant and lactating women), and the health status of individuals allows for efficient digestion and absorption of nutrients (Food Security Cluster, n.d.). Food utilization determines the nutritional status of individuals and highlights the importance of non-food items to food security.

Finally, there is the stability dimension. This dimension is different from the other three dimensions of food security. Food stability can be interpreted as the application of a time component to the availability, access, and utilization dimensions (Anderson, 2018). Therefore, the stability dimension highlights the fact that food availability, accessibility, and utilization can vary over time. The achievement of food stability requires the simultaneous fulfillment of the availability, access, and utilization dimensions over time.

More recently, however, it has been argued that capturing the full range of dimensions that matter for food security calls for the implementation of a six-dimensional framework, with agency and sustainability as two additional pillars (Clapp et al., 2022). In this regard, agency refers to the capacity of individuals or groups to make their own decisions about what foods to produce and eat, how their food is produced, processed, and distributed within food systems, as well as their ability to engage in processes that shape food system policies and governance (High Level Panel of Experts on Food Security and Nutrition, 2020). Sustainability, in turn, refers to the long-term ability of food systems to provide food security and nutrition in a way that does not compromise the economic, social, and environmental bases that generate food security and nutrition for future generations (High Level Panel of Experts on Food Security and Nutrition, 2020).

4. The importance of food security

The importance of food security can be highlighted by revealing the costs of food insecurity. On the individual level, food insecurity expresses itself through the deterioration of both physical and cognitive abilities, such as increased

vulnerability to disease and parasites, reduced strength for tasks requiring physical effort, as well as a general lack of vigor, alertness, and vitality. Consequently, gains from schooling and training programs are reduced, there is lower productivity, and there is decreased output and income (Reutlinger, 1986). The above-mentioned costs do not only affect individuals, but the economy as a whole. Businesses, for instance, are able to produce less and face increased costs for insurance, paid sick leave, and other payments. Governments, in turn, lose revenue due to decreased work productivity and business profits, and face higher health costs particularly related to non-communicable diseases (Wanjek, 2005). The latter reduces the government's ability to address any crisis at hand, and to secure future generations of healthy workers.

The importance of food security is furthermore reflected in the fact that the right to food is a legal obligation anchored in international law. The right to food was first recognized as a human right in Article 25 of the Universal Declaration of Human Rights in 1948 and was further ratified in Article 11 of the 1966 International Covenant on Economic, Social and Cultural Rights (Anthes & de Schutter, 2017). The right to food is also recognized in other international conventions and is considered crucial to the enjoyment of other rights, including, the right to health, life, water, adequate housing, and education (United Nations Office of the High Commissioner for Human Rights, 2010).

The prominence of food security is also revealed by the fact that food security is related to all the United Nations Sustainable Development Goals (SDGs) (Pérez-Escamilla, 2017). These 17 goals, part of the 2030 agenda

for sustainable development, constitute a plan of action for the benefit of people, planet, and prosperity, which recognizes that eradicating poverty in all its forms and dimensions, including extreme poverty, is the greatest global challenge and an indispensable requirement for sustainable development (United Nations, 2015). The dimensions of food security are particularly exhibited in SDG 1. No Poverty, SDG 2. Zero Hunger, SDG 3. Good Health and Well-being, SDG 6. Clean Water and Sanitation, and SDG 12 Responsible Consumption and Production.

5. Insights into the state of food security in Aruba

An indirect yet widely used indicator that provides insights into the state of food security in a country is the Prevalence of Undernourishment (PoU). This indicator reflects the probability that a randomly selected individual from the reference population is found to consume less than his/her calorie requirement for an active and healthy life (Wanner et al., 2014). The estimation of the PoU requires national level data regarding food supply and food consumption, as well as energy needs of the population. Given data constraints and the fact that departures from food security can involve many different situations, a more complete description of the state of food security in a country calls for supplementing the PoU indicator with a broader set of indicators related to the various dimensions of food security (FAO, 2012). The PoU indicator is currently not available for Aruba. Nonetheless, this section presents insights into the state of food security in Aruba along the lines of the food security dimensions mentioned earlier.

5.1 Availability

Food availability comprises the availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (FAO, 2006). For the case of Aruba, where domestic food production is minimal – i.e., between 0.01 – 0.03 percent of nominal Gross Domestic Product during the period 2000 - 2019¹ – most food products are imported. Reliance on food imports, however, stresses the importance of a couple of factors. Firstly, the import capacity of the island, which refers to its ability to produce and trade other goods and services for the foreign exchange needed to finance food imports, and secondly, the reliability of the world market as a source of affordable food supplies (FAO, 2000).

First of all, food availability hinges on the country's ability to pay for food imports. One way to assess a country's ability to pay for imports is to look at its current account coverage ratio. The latter is a measure of the number of months that the country's foreign exchange reserves can sustain current account payments, including imports, with the benchmark set at three months of coverage. Aruba's international reserves, which comprise the official reserves of the Central Bank of Aruba as well as foreign exchange reserves held by the local commercial banks trended upward during 2000 – 2023 (Graph. 5.1.1). Likewise, the current account coverage ratio also expanded during this period, despite dipping below the 3-month benchmark between 2005 and August 2007.

■ ¹ GDP data series 2000 – 2019 – Central Bureau of Statistics (cbs.aw)

Graph. 5.1.1 International reserves & current account payments: Aruba 2000 - 2023



Source: Centrale Bank van Aruba

Similar to the developments in international reserves and current account payments, the share of food import expenditure in total import expenditure also followed an upward trend during 2000 – 2023 (Graph. 5.1.2). The aforementioned share peaked at 14.4 percent in 2021, following the COVID-19 crisis in 2020, and declined afterwards, remaining

unchanged in 2023 compared to 2022. While the developments in the post-COVID-19 years suggest an improved capacity to finance food imports in the most recent years, Aruba has not yet managed to spend equal to or less on food products relative to total imports compared to pre-pandemic 2019.

Graph. 5.1.2 Share of food import expenditure in total merchandise import

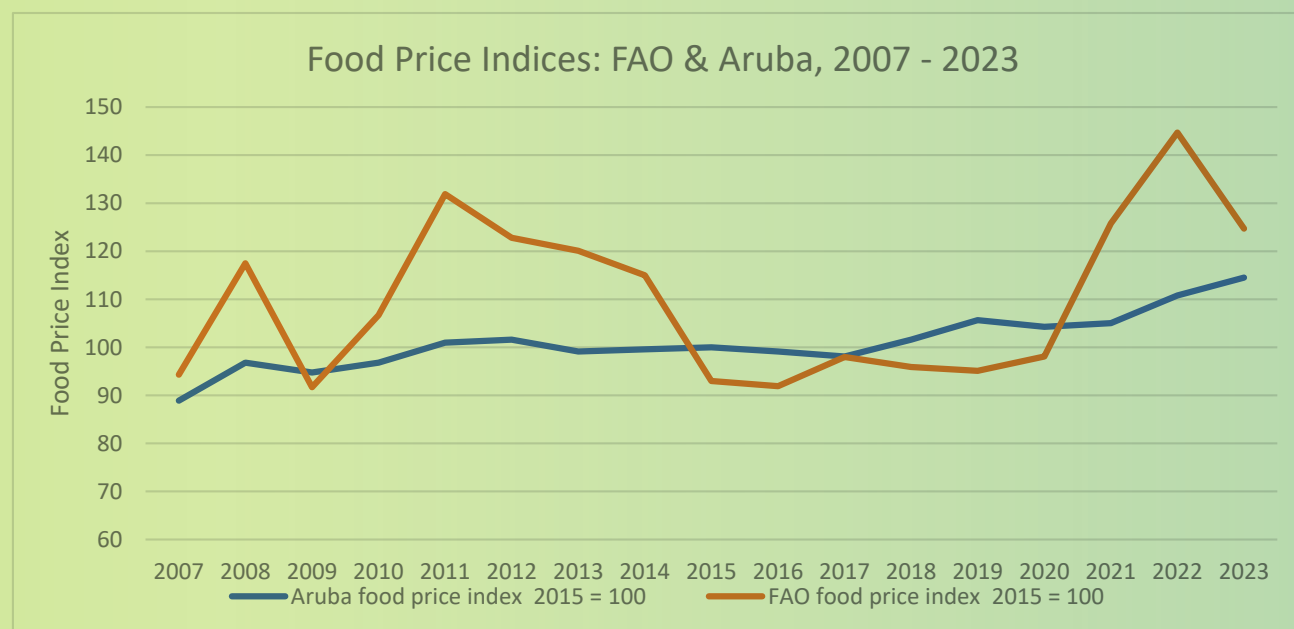


Source: Central Bureau of Statistics Aruba

To assess the reliability of the world market as a source of affordable food supplies, developments in global food prices and global food supply need to be considered. The FAO's Food Price Index (FFPI) over the period 2007 – 2023, shows an increasing trend over the period 2007 – 2023. During this period, there were various shocks to global food prices. There was the 2007 – 2008 Global Food Crisis, the 2010 – 2011 Food Price Spike, as well as the COVID-19 pandemic-induced supply chain disruptions, which were further amplified by Russia's invasion of Ukraine in 2022 (Rother et al., 2023). However, the observed increase in the FFPI (+32.2 percent) appears to be steeper than the rise in the Aruban food price index (+28.9 percent) during the

period under review. This suggests a relatively weak transmission of global food prices to domestic markets, which can be the result of numerous factors, including the structure of the markets and of the distribution chains, transport and transaction costs, exchange rates, and policy interventions (Cachia, 2014). Aruba benefits from a fixed exchange rate to the United States Dollar. Consequently, price increases related to depreciation of the Aruban Florin are eluded. In addition, the Government of Aruba regulates wholesale and retail prices for basic products, eggs, and white bread, effectively constraining price increases for these products (Department of Economic Affairs, Commerce, and Industry of Aruba (DEACI), n.d.).

Graph. 5.1.3 Food Price Indices: FAO & Aruba, 2007 - 2023



Source: FAO & Central Bureau of Statistics Aruba

Regarding global food supply, more than enough food is produced to feed everyone in the world (World Food Program USA, n.d.). Despite sufficient production, food waste and trade disruptions undermine food security. Food waste results in the loss of more than US \$ 1 trillion worth of food every year (United Nations Environment Programme, 2024). Furthermore, export restrictions, which can take the form of taxes, quotas, and bans on

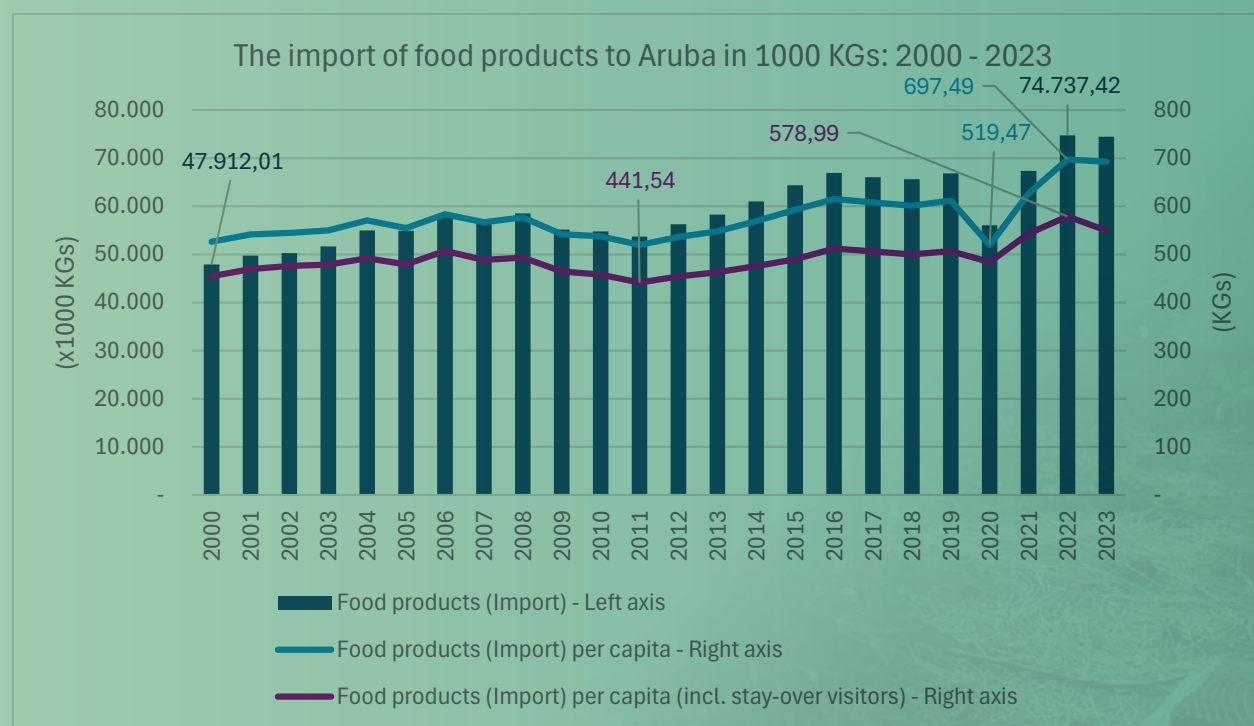
exports, reduce the global food supply and drive up international prices. These factors have the potential to negatively affect the availability of food on the island.

During the period 2000 – 2023, the import of food products by weight followed an upward trend, with Aruba importing on average 59.2 million kilograms of food products annually.

During the period under review, Aruba registered the lowest level of import by weight in 2000 (47.9 million kilograms), and the highest in 2022 (74.7 million kilograms). Per capita food import followed a similar trend between 2000 and 2023. The yearly per capita food import during the aforementioned period averaged 576.4 kilograms. At its lowest (2020), per capita food import registered 519.5 kilograms while at its highest (2022), it recorded

697.5 kilograms. However, it should be noted that the food imported is not only consumed by the Aruban population. Aruba's economy relies heavily on the tourism sector, with an average of 876,732 stay-over visitors per year during the period 2000 – 2023. Taking into account the number of stay-over visitors as well as their average length of stay, annual per capita food imports averaged 490.3 kilograms per year during the period under review.

Graph. 5.1.4 The import of food products to Aruba: 2000 - 2023



Source: Central Bureau of Statistics Aruba

With regard to the quality of food products, DEACI (2022) states that all foods destined for human consumption must be wholesome and fit for human consumption. As such, there are various import requirements in place (DEACI, 2022)²:

1. Government regulation states that all agencies that receive, store, and sell imported products must be registered with the Chamber of Commerce.
2. Foods that are imported into Aruba must always originate from hygienic and safe sources.
3. Products that are imported must have proper labeling, containing the name of the product, the list of ingredients, the quantity of the products, the expiration date, storage instruction, importer information, place of origin, and batch number.
4. Perishable foods must always be kept and maintained outside the temperature danger zone which is between 5°C and 60°C.
5. When importing frozen foods, they must always be kept frozen at -18°C or below.
6. When importing perishable food items in a non-frozen state, information on the method of transportation and storage of the products must be provided.
7. Products that are termed fresh imply that the food is unprocessed, in its raw state, without being frozen or subject to any form of thermal processing or preservation.
8. Meat and poultry may only be imported from USDA and EU approved slaughterhouses.
9. First-time shipments of canned meats must be inspected by the Veterinary Service, while first-time shipments of perishables need to be accompanied by a sanitary certificate

from the country of origin. In both cases, the aforementioned requirements are waived as long as subsequent shipments originate from the same supplier.

10. An import license from the DEACI is required for various food products (see Department of Economic Affairs, Commerce, and Industry of Aruba, 2022).
11. The import of chicken eggs is restricted, however, given that the domestic supply of chicken eggs is insufficient to meet demand, the restriction is usually waived.

It should be noted, however, that while all pesticides must be registered with the Bureau of Pharmaceutical Affairs of the Department of Public Health, Aruba has no regulations regarding pesticides and other contaminants in food products.

5.2 Access

5.2.1 Physical access

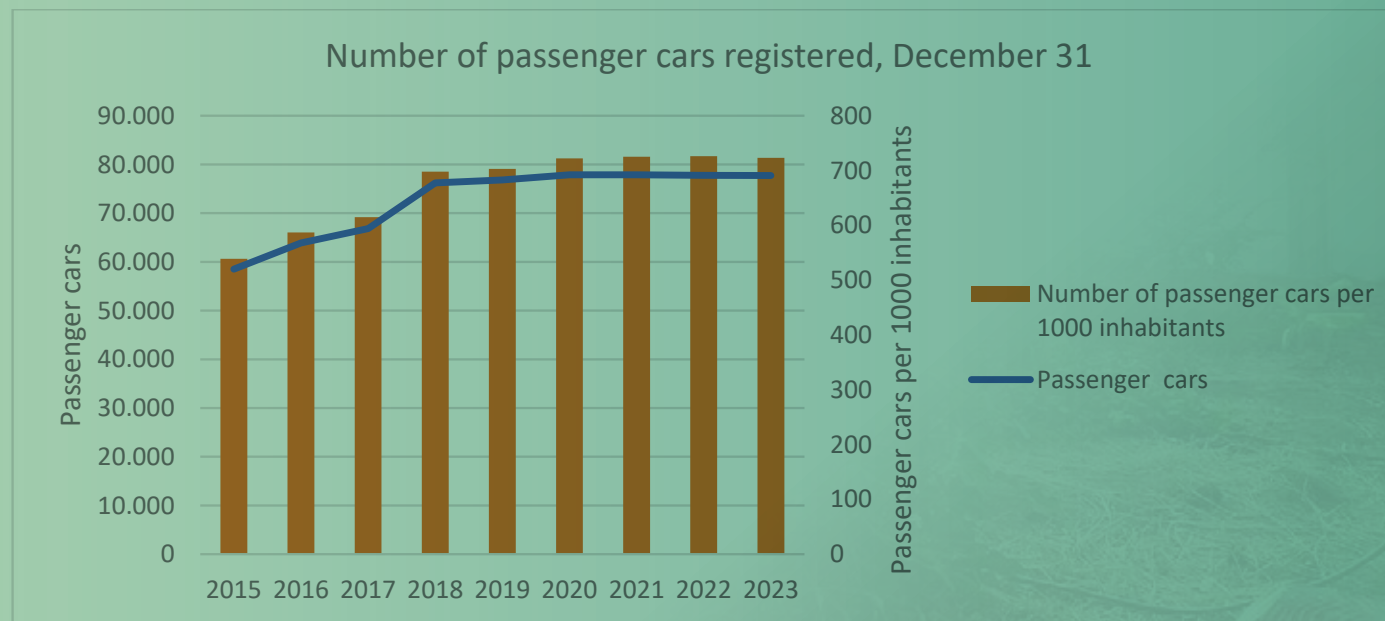
Food access entails, among others, that food is physically accessible to all households (Sharma, 1992). Proximity, availability, and density of food outlets are all indicators of physical food accessibility. In 2024, the number of available supermarkets, minimarkets, and specialty stores in Aruba amounted to 747 (Aruba Fair Trade Authority, 2024). The latter results in a food outlet density of 6.7 outlets per 1000 inhabitants. However, other factors may also influence the physical accessibility of food. For instance, residents who do not own or have access to a vehicle may be at higher risk for food insecurity either due to limited access to full-service grocery stores or higher food prices at smaller stores in their neighborhood. The lack of access may furthermore contribute to poorer diet if those who lack access to full-service stores are more reliant on local

■ ² IMPORT-2022.pdf (deaci.aw)

convenience stores or fast-food restaurants (Fitzpatrick & Ver Ploeg, 2010). In this regard, Coveney & O'Dwyer (2009) found that lack of private transport to food outlets affects food access more than household distance to food outlets does. They furthermore highlight the role of social and welfare networks in enabling access to private transport and consequently to food access. The aforementioned studies suggest that vehicle ownership may positively contribute to food security on the island.

Data on the number of passenger cars registered in Aruba on December 31 shows an increase during the period 2015 – 2023, with the number of cars per 1000 inhabitants growing from 539 cars in 2015 to 723 cars in 2023. The latter suggests an improved capacity to obtain food on the island. To put the aforementioned figure in perspective, the average number of passenger cars per 1000 inhabitants in the European Union was 560 in 2022 (Eurostat, 2024).

Graph. 5.2.1 Number of passenger cars in Aruba: 2015 - 2023



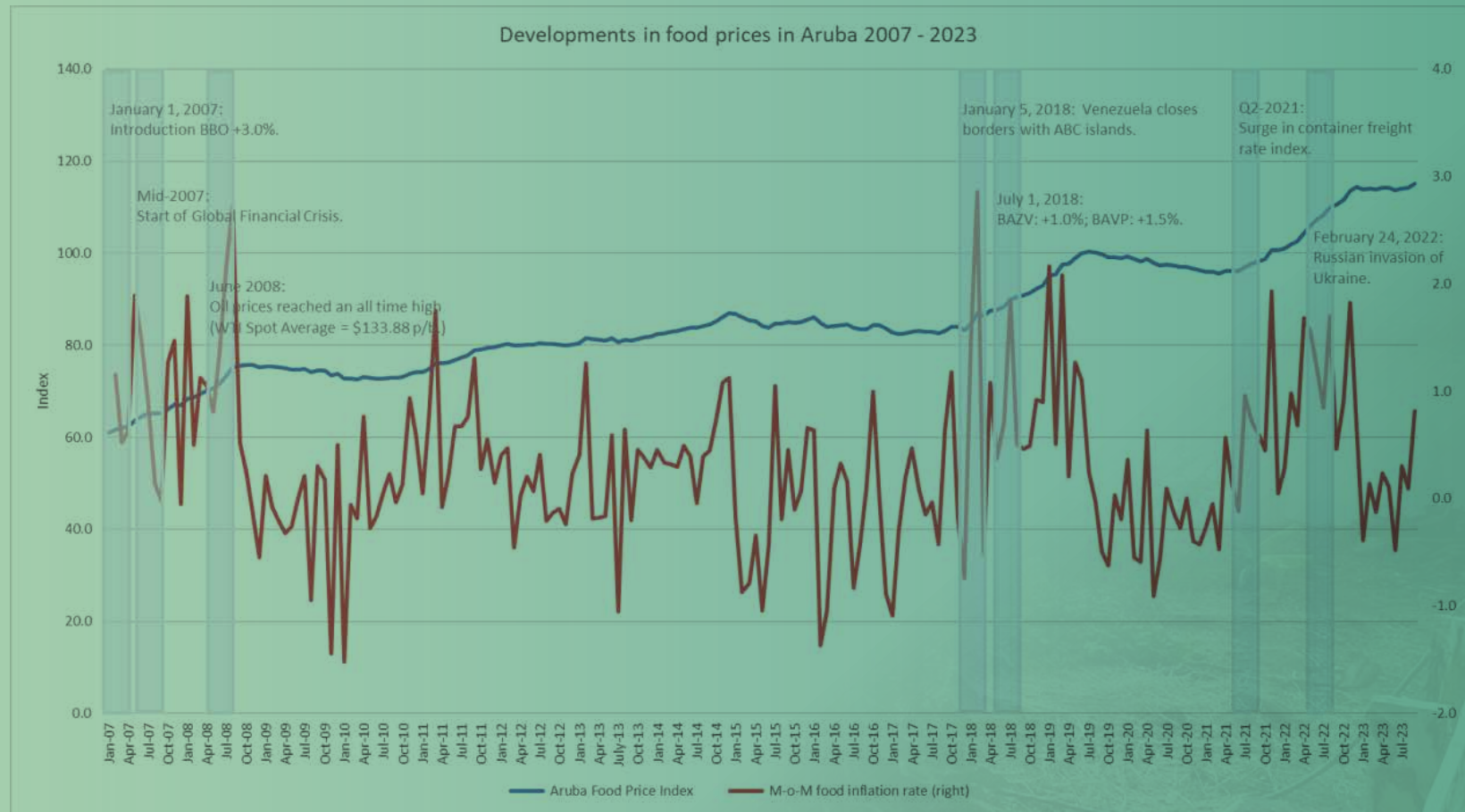
Source: Central Bureau of Statistics Aruba

5.2.2 Economic access

Economic access to food refers to the ability to buy food. Whether and how much food can be bought depend on numerous factors, including the income level of individuals, and the prices of food on the island.

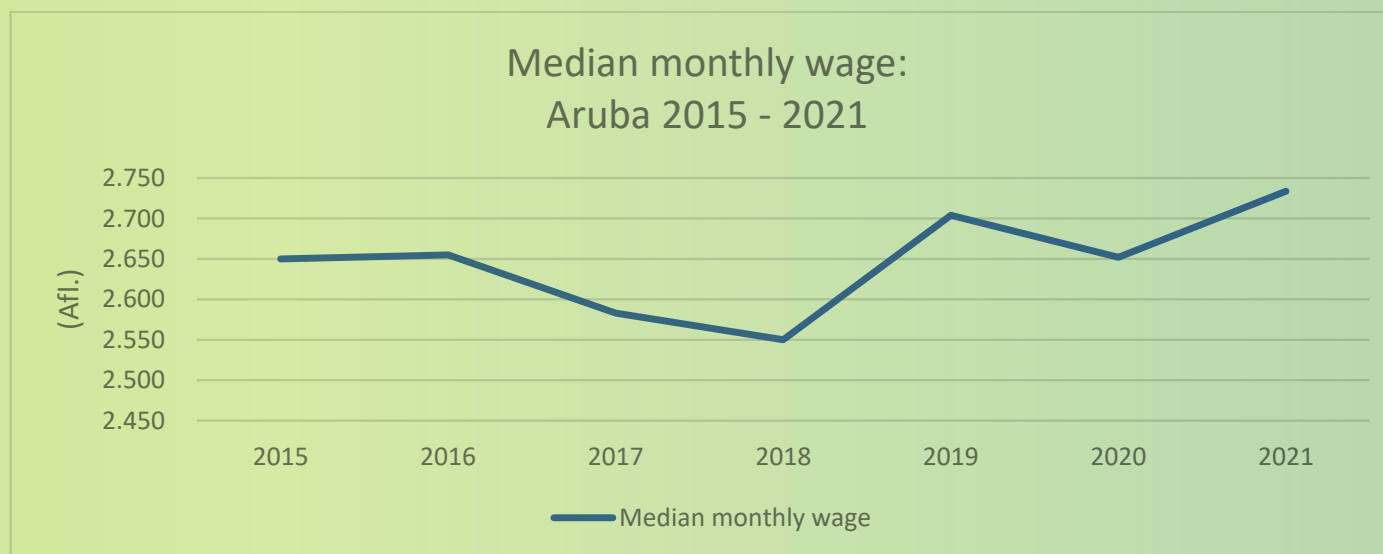
Looking at the monthly food price index from January 2007 to September 2023, an upward trend in food prices is observed. Furthermore, three periods of sustained upward momentum in prices are seen (Graph. 5.2.2, blue line). These were mainly affected by the Global Financial Crisis (January 2007 – July 2008; End-of-period inflation (EOP): +16.0 percent, 12-month average inflation (12M): +11.0 percent), the border closure with Venezuela (January 2018 – July 2019; EOP: +7.7 percent, 12M: +5.9 percent), as well as COVID-19 and the Russian-Ukraine war (July 2021 – December 2022; EOP: +8.0 percent, 12M: +6.6 percent). Notably large volatility in monthly food prices could be observed (Graph. 5.2.2, red line), as a result of heightened oil prices (August 2008: +1.8 percent) and the border closure with Venezuela (February 2018: +1.1 percent). However, during the period under review, monthly food price changes amounted to at most 2.9 percent. Regarding the income level of individuals, median monthly wages during the period 2015 – 2021 followed a rising trend, despite contracting in 2017, 2018, and 2020. Furthermore, the 12-month average inflation rate and the changes in the median wage have moved in tandem during the period with the exception of 2016 and 2018. In general, the developments in the median wage point to an improved capacity to purchase.

Graph. 5.2.2 Developments in food prices in Aruba 2007 - 2023



Source: CBS

Graph 5.2.3. Developments in the median monthly wage in Aruba 2015 – 2021



Source: SVB

5.3 Utilization

For the human body to take in sufficient energy and nutrients, it should be subject to diligent care and feeding practices. Food should be well-prepared, the diet should be diverse, and there should be a proper intra-household distribution of food. In addition to an adequate diet, food utilization requires non-food items such as clean water, sanitation, and health care, to reach a state of nutritional well-being in which all the physiological needs of an individual are met.

5.3.1 Access to clean water

Water- en Energiebedrijf Aruba N.V. (WEB) is responsible for the production of water in Aruba. The total installed capacity of WEB, consisting of Seawater Reverse Osmosis Plants (SWRO) and Ion Exchange Plants amounts to 51,000 cubic meters per day. Average water production averages 35,600 cubic meters per day, while average water consumption in Aruba reaches 33,000 cubic meters per day³. Based on the total installed capacity of WEB as well as the average production and

■ ³ WEB Aruba N.V. | Water- en Energiebedrijf Aruba N.V.: Technologies used.

consumption registered, water supply is regarded as sufficient to accommodate local and tourism-driven demand in Aruba.

Regarding the quality of the water produced, WEB complies with WHO's 2004 guidelines for drinking-water quality⁴. To do so, WEB follows various procedures. These include an annual audit of its water production and distribution system by the U.S. National Testing Laboratories Ltd., a monthly review of the drinking water by the Landslaboratorium Aruba, as well as daily chemical tests. Consequently, the quality of the water produced is deemed to meet the required standards.

5.3.2. Sanitation

Basic sanitation entails the disposal of human excreta to prevent disease and safeguard privacy and dignity (Evans, et al. 2009). Aruba provides basic sanitation services through a sewage system that consists of four wastewater treatment plants (WWTP), a sewage network, and an incinerator⁵. The first WWTP (Bubali) became operational in 1972 (van Halewijn et al., 1992), with a daily capacity of 4500 m³. The island's total wastewater treatment capacity was further expanded by 1500 m³ in 2007 (WWTP Parkietenbos), and by 5000 m³ in 2008 (WWTP Zeewijk). In addition, there is the Tierra del Sol WWTP. While the wastewater treatment capacities at the Parkietenbos and Zeewijk plants are not fully utilized, the development of the tourism industry over the years, particularly in the Eagle Beach and Palm Beach areas, have led to a daily supply of 8500 m³ - 12000 m³ wastewater to the Bubali WWTP (Ministerie van Transport, Integriteit, Natuur en Ouderenzaken, 2022). Consequently,

there is odor and mosquito nuisance (Recht.nl, 2022), as well as degradation of seawater quality and environmental damage (Vermeij et al., 2019). During the COVID-19 shutdown, when there were no tourists on the island, it became evident that 65% of the wastewater processed by WWTP Bubali was caused by the accommodation of tourists, particularly in and around Eagle Beach and Palm Beach (Aruba.nu, 2021). The absence of tourism activities during the COVID-19 international border closure led to an improvement in the situation at Bubali Plas. The resumption of tourism activities after the international border reopened has again led to a deterioration of the condition at Bubali Plas and a continuation of related nuisance and damage. Based on the daily capacity of the Bubali WWTP, as well as the daily supply of wastewater to the Bubali WWTP, it can be stated that the sewage treatment facilities in Aruba are not adequate to accommodate local and tourism-driven demand, to provide basic sanitation on the island. Indeed, the latter is confirmed by a verdict from May 2024, in which a judge ruled that hotel permits issued by the government led to the WWTP-Bubali problem, and that the capacity of the Bubali WWTP must increase to at least 12,000 m³ (Recht.nl, 2024).

5.3.3. Health care

Since the introduction of the National Ordinance General Health Insurance (AZV) in 2001, all Aruban residents or valid residency permit holders in Aruba are insured for curative medical care⁶. The latter entails care by general practitioners, midwives, physiotherapists, specialist care, hospital care, limited

⁴ WEB Aruba N.V. | Water- en Energiebedrijf Aruba N.V.: Our water quality.

⁵ About Us - Aruba Wastewater Sustainable Solutions (awss.aw)

⁶ Register and prolongation - Algemene Ziektekosten Verzekering (AZV) Algemene Ziektekosten Verzekering (AZV)

dental care, medicine, auxiliary medical devices, and medical treatment abroad. As a result of the broad coverage provided, out-of-pocket healthcare payments account for only 3.5% of total healthcare spending in Aruba (Department of Public Health Aruba, 2019). In contrast, the world average out-of-pocket healthcare expenditure as a share of current health expenditure ranged between 18.0% and 19.5% during 2000 – 2019 (WHO, n.d.-a). Having relatively low out-of-pocket healthcare payments contributes to food security, as there is growing evidence of households being pushed into poverty or forced into deeper poverty when they are faced with substantial medical expenses (McIntyre et al., 2005).

5.3.4 Nutritional status of individuals

To determine the nutritional status of an individual or population group as influenced by the intake and utilization of nutrients, a nutritional assessment is required (Gibson, 2005). Nutritional assessment methods are based on dietary, laboratory-biochemical, anthropometric, and clinical observations (Gurinović, 2016).

The most recently published health statistics for Aruba (Ministry of Tourism and Public Health of Aruba et al., 2024) include anthropometric data which suggest that 79% of the Aruban population is overweight or obese, with a higher prevalence of obesity reported among women compared to men. Furthermore, Directie Volksgezondheid (2018) presents a rising trend in the average Body Mass Index (BMI) among the adult population of Aruba over the period 2001 – 2016. The latter provides cause for concern, particularly as the average BMI of 28.9 observed in 2001 pertains to the overweight category, while the average BMI of 30.1 registered in 2016 indicates obesity. Studies show that food insecurity is significantly associated with

overweight and obesity in adults, particularly among women (Maitra, 2018). One of the various channels through which food insecurity is associated with being overweight or obese is the consumption of a low-quality diet. Specifically, food-insecure individuals tend to consume cheap and energy-dense foods which are high in added sugar and fat. Overconsuming the latter may cause weight gain (Drewnowski & Darmon, 2005).

5.4 Stability

Food security requires food availability, food access, and food utilization to remain stable over time, despite variations in weather conditions, changes in the price of food, and civil conflicts (Ashby et al., 2016). Aruba has abundant sunshine and limited rainfall. Aruba is furthermore located on the Southern peripheral of the hurricane belt. Due to its convenient location, flooding and hurricane risks have been relatively low, mitigating the likelihood of transitory food insecurity as a result of natural disasters. Nonetheless, analysis indicates that the time interval between extreme weather events such as hurricanes and major tropical storms has shortened (Peterson, 2019). While Aruba benefits from a location that does not put it in the direct path of the aforementioned storms, the associated precipitation makes flooding a more pressing issue. Regarding the weather conditions on the island, the lack of rainfall makes agriculture challenging. This is further exacerbated by rising temperatures, which negatively affect crops (e.g., reduced photosynthesis, accelerated ripening) livestock (e.g., heat stress, dehydration), and the labor productivity of agricultural workers (e.g., physical fatigue, health risks, and equipment efficiency). Regarding controllable factors affecting the stability dimension, the island has a high World Bank Governance Indicators ranking, reflecting its long track record of stable and peaceful political transitions, well established rights for participation in the political process,

strong institutional capacity, effective rule of law, and a low level of corruption (Fitch, 2024). Despite the challenges related to weather conditions, Aruba's performance with regard to the World Bank Governance Indicators positively contributes to the stability dimension. However, domestic food production on the island is minimal. Consequently, the domestic food stability dimension is largely affected by foreign factors.

6. How is food security experienced in Aruba?

Contrary to observable variables such as height and weight, food security is an unobservable or latent trait. As it cannot be measured directly, its observable manifestations need to be studied to learn about it.

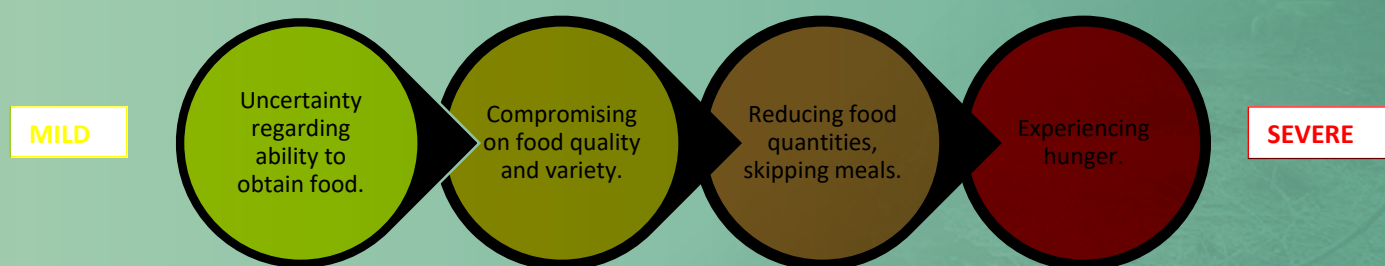
This section explores data on the prevalence of moderate and severe food insecurity in Aruba based on the Food Insecurity Experience Scale (FIES). The FIES is a tool that provides estimates of the proportion of the population facing

difficulties in obtaining food of sufficient quality and quantity (FAO, 2017). The prevalence of severe food insecurity resulting from the FIES and the PoU in a population is expected to be similar, since both are indicators of serious food deprivation.

The FIES is based on a survey containing eight questions⁷ to which respondents can answer “Yes” or “No”. The questions aim to reveal the underlying continuum of severity along which food insecurity exists (Graph. 6.1), by gauging the experiences of respondents related to their ability to obtain food.

The FIES yields reliable estimates of food insecurity, even in relatively wealthy countries where rates of food insecurity may be exceptionally low. It can be used to identify vulnerable population groups most affected by food insecurity (when applied in large-scale surveys designed to be representative of subnational population groups) and provides actionable information that policymakers can use to guide policy interventions.

Graph 6.1: Continuum of food insecurity severity



Source: FAO

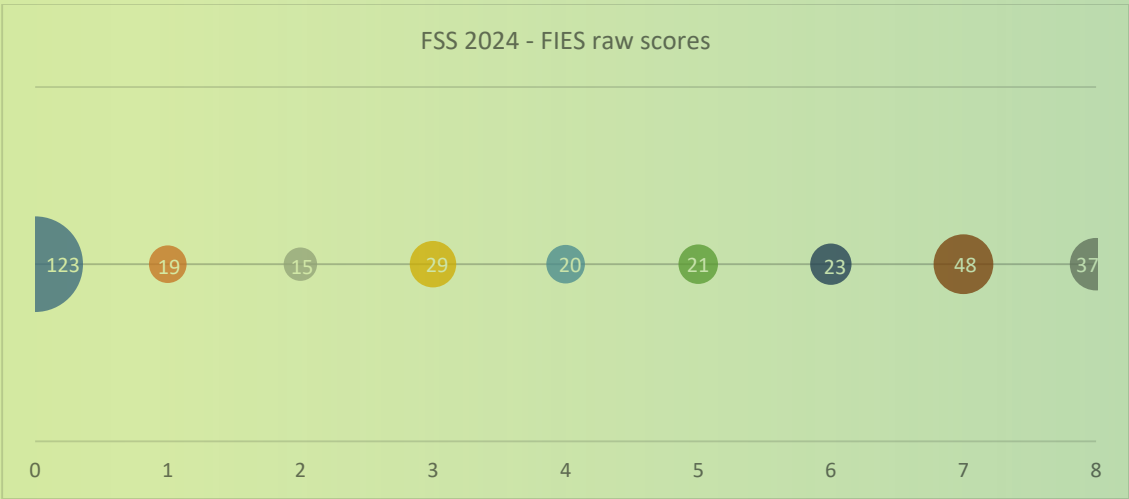
■ ⁷ The questions of the FIES Survey Module are included in Annex. 1

From August 16, 2024 – September 18, 2024, the Centrale Bank van Aruba (CBA) conducted a food security survey, including the FAO’s eight questions on the Food Insecurity Experience Scale Survey Module (FIES SM). The survey was targeted at Aruban residents older than 18 years, and was available in three languages (Papiamentu, English, and Spanish). Dissemination took place via the CBA’s website and social media channels, the media, QR code posters, and via e-mail to various relevant stakeholders. A total of 335 complete

responses to the FIES SM were received, of which 175 were used for data validation, as data validation is only carried out on complete non-extreme responses⁸.

A first glance at the data shows a notable number of respondents with a raw score of 0 (Graph. 6.2). The raw score indicates the number of questions of the FIES SM to which respondents answered “Yes”. The higher the raw score (up to the maximum of 8), the more food insecure a respondent is.

Graph. 6.2 FSS 2024 – FIES raw scores



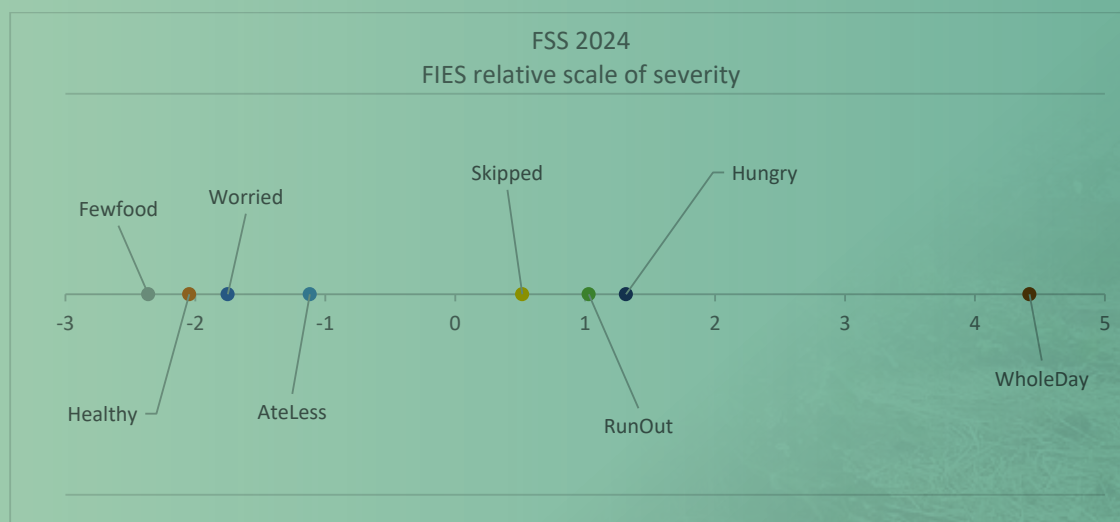
Source: CBA.

⁸ Complete non-extreme responses are FIES SM survey responses of which all 8 questions to the survey have been answered and that did not result in a raw score of 0 (completely food secure respondent) or a raw score of 8 (completely food insecure respondent).

Based on the responses collected from the FIES SM, it is possible to construct a relative scale of severity pertaining to food insecurity under the respondents. This allows for a more precise evaluation of the relative differences in food insecurity severity between the respondents with each raw score. The less severe experience a question represents, the smaller its parameter value will be. Alternatively, the more severe experience a question represents, the larger parameter value it will have. From Graph. 6.3, it is evident that the order of some items on the scale resulting from the FSS 2024 diverges from the order in which the FIES SM was administered⁹. This is a fundamental feature of the FIES and can be explained by cultural or country

differences in response to food insecurity. In our sample of respondents, eating only a few kinds of foods is considered the least severe experience with food insecurity (Graph. 6.3). The aforementioned experience is also regarded to be relatively close to experiences such as the inability to eat healthy and nutritious food, as well as being worried about not having enough food to eat. The severity of eating less than one thinks one should eat is located a bit further along the severity scale. At quite a distance from the latter, the next severity cluster can be found, related to the experiences of skipping a meal, running out of food in the household, and feeling hungry. The most extreme experience related to food insecurity is going an entire day without eating.

Graph. 6.3 FSS 2024 – FIES relative scale of severity



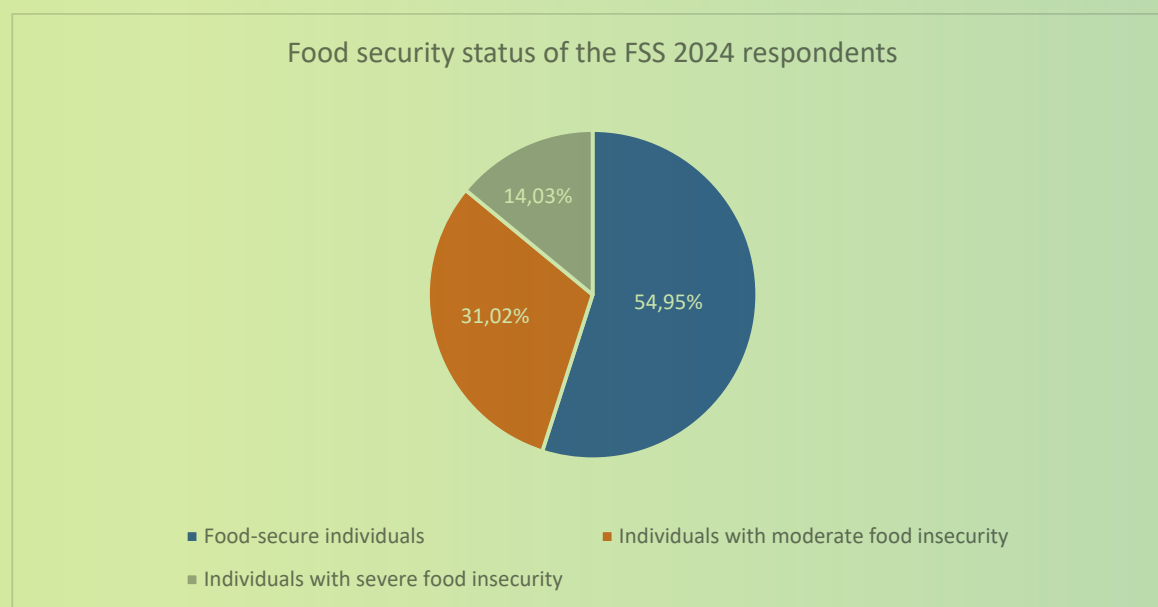
Source: CBA.

■ ⁹ Annex 1. presents the FIES SM questions in the order in which they were administered.

Of the respondents that completed the survey, 45.05% are considered to be moderately or severely food insecure (Graph. 6.4). This proportion is relatively lower compared to the proportion (58.8%) of people that faced moderate or severe food insecurity in the Caribbean in 2023 (FAO et al., 2025). The prevalence rate from the FSS 2024, is particularly in line with the 2021 – 2023 average of the Dominican Republic (46.1%). In contrast, Haiti (82.8%) registered a relatively higher prevalence rate during 2021 – 2023, while Bahamas (17.2%) and Grenada (19.9%) reported substantially lower prevalence rates (FAO et al., 2025). Comparing

the food insecurity status of the FSS 2024 respondents by gender suggests that the female respondents (moderately or severely food insecure: 51.16%) are more food insecure than the male ones (moderately or severely food insecure: 27.63%). This finding is in line with expectations, as globally, women have a higher probability of being food insecure than men (Broussard, 2019; FAO et al., 2025). However, the suggested gender gap (23.53 percentage points) under the respondents of the FSS 2024 is considerably higher compared to the Caribbean (3.9 percentage points) and the global gender gap (1.3 percentage points).

Graph. 6.4 Food security status of the FSS 2024 respondents

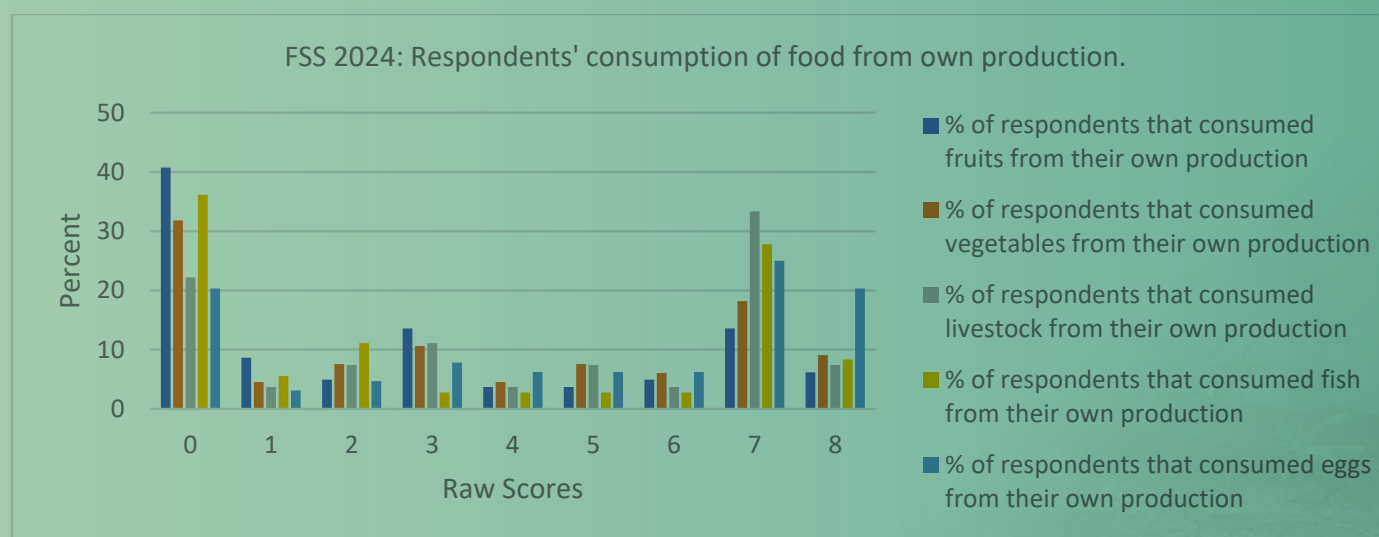


Source: CBA.

The CBA FSS 2024 included additional questions related to the behavior of the respondents. Of the 335 complete FIES SM responses, 134 respondents indicated that they consumed food from their own production during the last 12 months prior to the

survey. It is notable that respondents with extreme raw scores (0 = completely food secure and 7 = severely food insecure) were those that mostly consumed food from their own production.

Graph. 6.5 FSS 2024: Respondents' consumption of food from own production

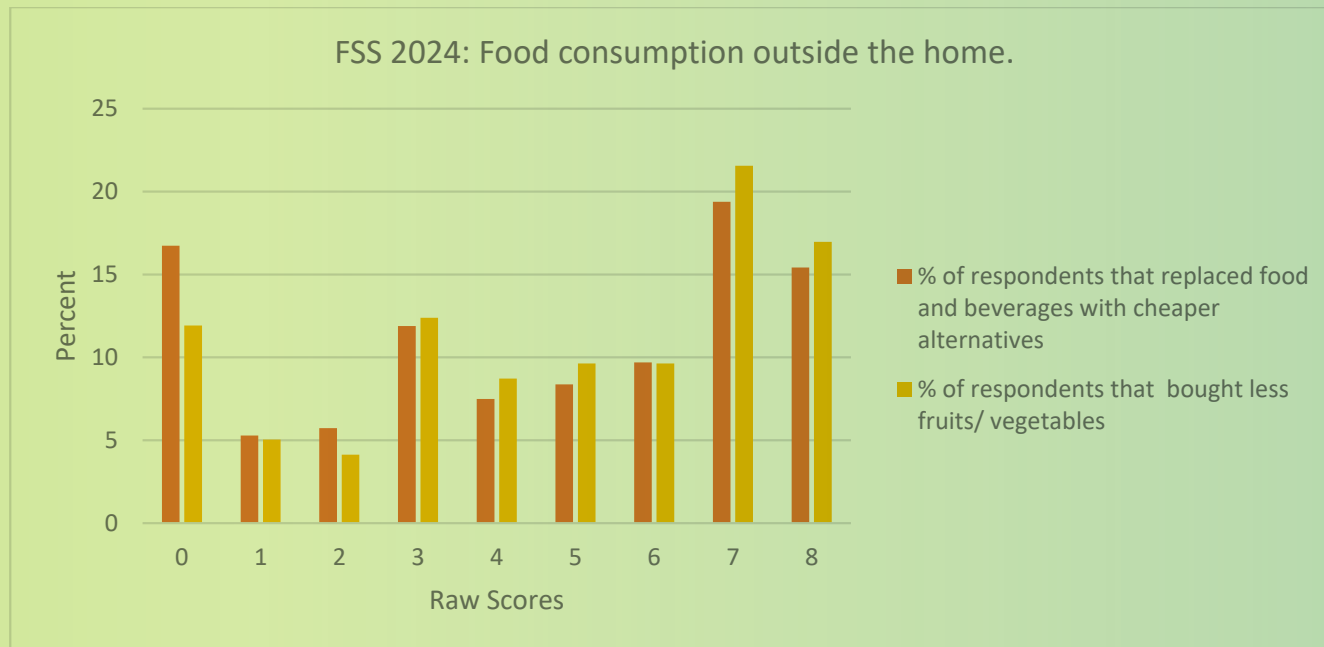


Source: CBA.

Regarding food bought at a store, again it was mostly respondents with extreme raw scores that displayed elevated rates of replacing food and beverages with cheaper alternatives. The same respondents were also more likely to buy

less fruits and vegetables. Especially respondents with a raw score of 7 (severely food insecure) stood out when it came to this trade-off.

Graph. 6.6 FSS 2024: Respondents' trade-offs.

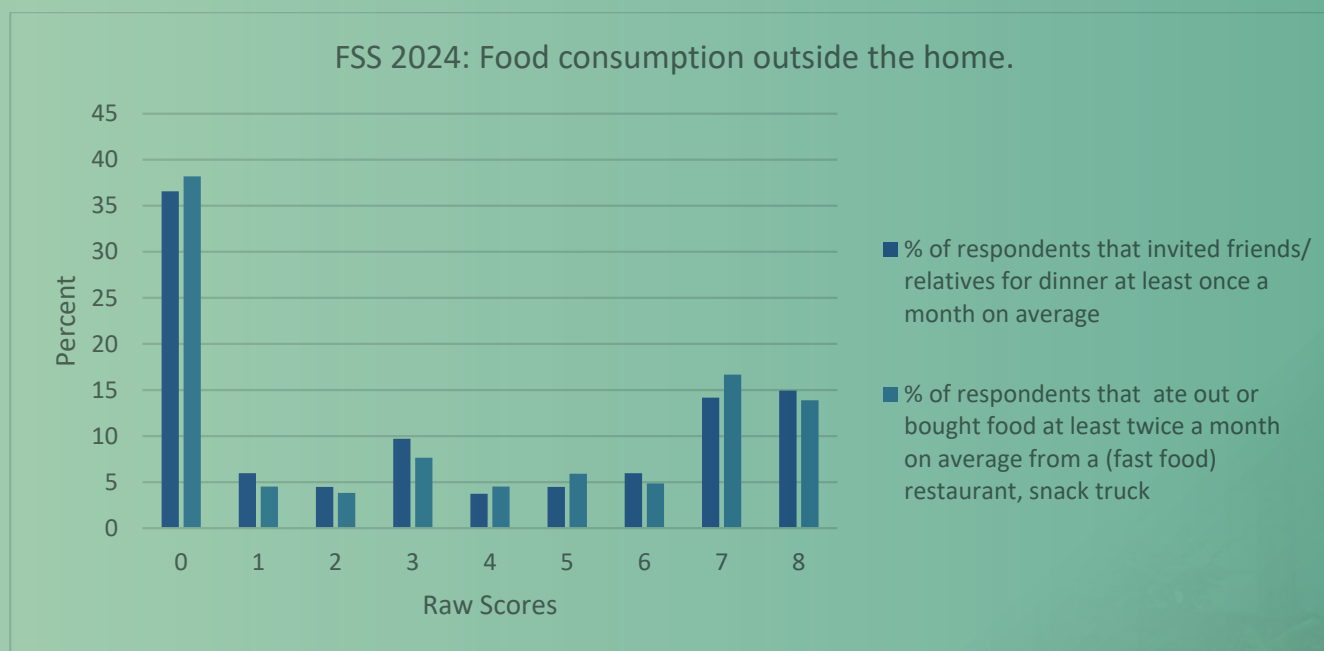


Source: CBA.

On the topic of food consumption outside the home, completely food secure respondents were the respondents reporting higher rates of eating at least twice a month on average from a (fast food) restaurant or snack truck. Food secure respondents were also more likely to invite friends and relatives for dinner at least once a month. The latter highlights

the possibility that food insecurity may not only be detrimental to physical health, but also to the social relationships of individuals. Indeed, Park & Berkowitz (2024) found that food insecurity is associated with worsened social and mental well-being. They suggest that food insecurity interventions should be designed in a holistic way that goes beyond only focusing on nutrition.

Graph. 6.7 FSS 2024: Food consumption outside the home



Source: CBA.

7. Discussion

The achievement of food security hinges on addressing a multitude of factors concurrently. Based on available data related to the four main dimensions of food security, this chapter discusses the successes and challenges in dealing with food security in Aruba.

Regarding the availability of food in Aruba, this study highlights a heavy reliance on imports, resulting from minimal food production domestically. Such a reliance, in turn, leans on Aruba's ability to produce and trade other goods and services to generate foreign exchange to acquire food from other countries. Aruba put its eggs in the basket of tourism, which turned out to be successful. The economic activity

became the main pillar of the economy. However, economic shocks, such as the one resulting from the COVID-19 pandemic, exposed Aruba's vulnerability related to its ability to generate foreign exchange. The latter calls for diversification of tourism in Aruba (which is mainly supported by stay-over visitors from the United States), as well as of the economy. To this end, the Government of Aruba identified six sectors as promising sectors for economic diversification: creative industries, circular economy, agriculture, logistics, knowledge economy, and niche tourism. The strengthening of these sectors enables Aruba to build greater resilience against future economic shocks. A heavy reliance on imports also makes a country dependent on the world market as a source of affordable food supplies. While global food production is deemed sufficient, the world market cannot always be considered a source of affordable food supplies, particularly in times of crisis such as wars and pandemics, when considerations such as food security concerns or political pressures tend to result in export restrictions. There is an array of strategies that Aruba can consider to shield itself from the negative effects of export restrictions, among others, the promotion of domestic agriculture, building and maintaining food reserves, as well as the diversification of import sources. Moreover, regional cooperation regarding food security may also prove to be beneficial.

Regarding food accessibility, available indicators on the physical accessibility of food suggest a high density of food outlets, and ample access to private transport, which enhance access to food. What is less clear is the type of food outlets that are available to consumers, and their proximity to residential areas, as well as schools and workplaces, where people spend a substantial amount of time. These insights are valuable, given that the type of food to which consumers are

exposed plays a role in shaping their dietary habits. Economic access indicators, in turn, display promising trends, with the median monthly wage following an upward trend over the past years, and inflation returning to moderate levels following upturns related to post-COVID-19 supply chain disruptions. These factors point to improvements in the purchasing ability of consumers, positively affecting the food access dimension.

Utilization indicators paint a mixed picture of food security in Aruba. While the water supply is deemed sufficient and of good quality, and general health insurance alleviates the strain of out-of-pocket medical expenses on household income, there is still work to be done with regards to sanitation. Furthermore, available data on the nutritional status of individuals provides cause for concern given the considerable share of the population that is overweight or obese, and following the increasing trend in the average BMI of the population, which shifted from the overweight to the obese category. Dietary habits contribute to overweight and obesity. Consequently, food security should be considered in the design of any plan of action to combat overweight and obesity in Aruba. The importance of tackling overweight and obesity is evident from the health consequences as well as the economic strains they bring to individuals and society.

Aruba faces stability challenges due to weather conditions, which are progressively recurring over time. This calls for resilience-building policies aimed at reducing vulnerability and strengthening adaptive capacity related to extreme weather events, such as flooding and heat. Strategies to improve flood resilience include, among others, flood mapping and improved drainage systems, as well as the promotion of raised bed farming. Heat resilience strategies for the island, in turn, could include the usage of heat-tolerant crop varieties,

effective irrigation systems, implementing agroforestry systems, introducing flexible work hours scheduling, and establishing heat safety guidelines. Regarding factors concerning civil unrest, which contribute negatively to the stability dimension, it is important for the Government of Aruba to continue upholding principles of good governance, and to promote these principles across all institutions in the economy.

This study finds a lower proportion of people facing moderate or severe food insecurity in Aruba compared to the Caribbean region. While this is positive news, factors contributing to the performance of Caribbean islands registering considerably lower food insecurity should be examined. Additionally, opportunities for cooperation with these countries on food security matters should be explored. An alarming observation entails the wide gap in the food security status of females compared to males in Aruba. The substantial gender gap should be brought under the loop. Should subsequent surveys also find such a pronounced gender gap, it would substantiate the findings of this study and call for increased priority to be put on gender equality in Aruba.

Considering the aforementioned insights, future research on food security should consider the incorporation of additional types of data to paint a more comprehensive picture of food security in Aruba. In this regard, tools like the Global Food Security Index can be considered; however, they require the availability of a broader range of data. The latter emphasizes the importance of investing in (food security) data. Furthermore, conducting the FSS and constructing the FIES for Aruba on a regular basis provides useful insights into how food security is experienced over time and enables the implementation of needed policies.

Further avenues for research include the economic burden of food insecurity in Aruba, which can focus on the direct healthcare costs, as well as the indirect costs linked to diet-related diseases on the island. Research should also investigate potential gender differences in food security on the island, particularly following the observed gender gap in the FIES.

8. Recommendations to improve food security in Aruba

Food security is an outcome that policymakers can achieve by implementing effective food security strategies. The implementation starts by identifying vulnerable members of the population to enable the prioritization of interventions (Hindle, 1990). To achieve improved food security outcomes in Aruba, the following actions are recommended:

8.1 Policies

1. **Include the right to food as a concrete goal to achieve through policies, laws, and strategies related to food security and nutrition (FAO, 2019-a).** More than thirty countries in the world have the right to food explicitly included in their constitution. The latter grants the right to food the highest level of protection and sends a strong message of commitment, as it obliges countries to develop or amend legislation to implement the right to food. The introduction of appropriate framework or sectoral laws further strengthens the implementation of the right to food in practice. Finally, shaping the country's national development strategy and related policies around the progressive realization of the right to food contributes to the effective realization of this right (FAO, 2024).
2. **Enact laws and regulations that mandate the integration of food accessibility into community design processes**

and consider food accessibility in other policy domains (Food Forward NDCs, 2024-a). Zoning laws that require community gardens to be included in new developments can prevent the emergence of food deserts, which are areas where residents do not have access to an affordable and healthy diet. Furthermore, regulating the location and density of fast-food restaurants in neighborhoods and near schools reduces exposure to ultra-processed foods. The creation of environments that offer ample opportunities to acquire healthy foods and that limit exposure to unhealthy foods can be considered a potential strategy to address food security, as evidence suggests that increased exposure to unhealthy food outlets increases the intake of unhealthy foods, whereas being exposed to a larger number of healthy food outlets is associated with an increase in the consumption of healthy foods, including fruits and vegetables (Bivoltsis et al., 2020).

- 3. Implement national food procurement policies that discourage the consumption of unhealthy, unsustainable foods (Food Forwards NDCs, 2024).** Public food procurement, which refers to the purchase of food for public institutions such as schools, hospitals, prisons, universities, as well as cafeterias in public buildings and other public social programs can be considered as a tool to instill healthy and sustainable eating habits. Governments can set standards that align with healthy diet recommendations for food served or sold in public settings, and for food purchased with government funds. By expanding the exposure of people to healthy meals and snacks by making sure they are available at the places where they spend a substantial amount of time, such as work, and school, the government is able to shape the eating habits of its citizens (WHO,

n.d.-b). Furthermore, public food procurement policies can also be used to foster agricultural development by directing government food demand to domestic suppliers, particularly smallholder farmers (FAO, 2018).

8.2 Standards

- 1. Collect better, regular, detailed, and disaggregated data to design effective interventions, to monitor progress, and to ensure accountability (Development Initiatives, 2017).** Resources should be devoted to the regular collection of data that enables the production of indicators that can be monitored over time. This is vital to address gaps and to adjust actions toward the achievement of the food security goals set forth in policies, laws, and governance processes (FAO, 2019-b). The nutritional status of the population can be monitored with the use of anthropometric measures such as the Body Mass Index (BMI) and the Waist-to-Hip Ratio, as well as biochemical markers such as blood glucose and cholesterol levels. Furthermore, incorporating the FIES SM in a survey conducted regularly on a representative sample¹⁰ of the Aruban population allows for inferences to be drawn related to the food insecurity experience of the population over time. In this regard, the FAO recommends its inclusion within a well-established, ongoing, government-administered survey. Related to the collection of data, it should be noted that on the 24th of March 2025, the Department of Public Health of Aruba launched the survey “Kico Nos ta Come”, which is a Total Diet Study (TDS). A TDS measures levels of nutrients and contaminants in foods eaten by the population. It is the first time since 1993 that the TDS is carried out in Aruba.

■ ¹⁰ Annex 2. presents the characteristics of the respondents of the FSS 2024 vs. those of the population.

2. **Develop and strengthen governance and policy dialogue mechanisms and prioritize participation and engagement from stakeholders in crucial decisions related to nutrition and food security (FAO, 2019-a).** The Committee on World Food Security (CWFS) promotes a multi-stakeholder approach in the creation of an enabling environment for policy formulation and implementation. In addition to member countries, the CWFS includes various categories of stakeholders in policy dialogue, such as UN agencies and bodies, civil society and non-governmental organizations, agricultural research systems, financial institutions, private sector associations, and philanthropic foundations (FAO, n.d.). Such a global constellation could also be mirrored domestically. Stakeholder ownership, which results from having a voice in the policy process, is crucial to policy implementation, as the latter may be directly dependent on stakeholder participation (Rajan et al., 2015). In this regard, effective policy dialogue mechanisms contribute to a shared understanding of synergies and trade-offs that exist between various stakeholders, and make it possible to negotiate, implement, and evaluate collective priorities. The implementation of a policy dialogue mechanism, such as a Food Policy Council, can be led by the Ministry of Agriculture.

8.3 Procedures

1. **Raise awareness of consumers about their basic right to feed themselves with adequate and nutritious foods (FAO, 2019-a).** Increased awareness about human rights in general and the right to adequate food, in particular, gives citizens knowledge about their rights and motivates them to act upon them. In addition to building citizens' confidence to claim their rights, increased awareness strengthens

the knowledge of the government and public institutions regarding their obligations engrained in these rights. As a result, improved awareness can influence decisions and actions, and support advocacy and mobilization efforts (Pepino, 2014). Various stakeholders can contribute in diverse ways to raise consumer awareness about the right to food. Governments, for example, can incorporate food rights in public policy and campaigns. Educational institutions together with the Ministry of Education can integrate food rights in the curriculum offered at schools. Media outlets can also play a vital role by highlighting issues like malnutrition and food waste, and by explaining the concepts of food security and food rights.

2. **Promote environmentally friendly kitchen gardens (Food Forward NDCs, 2024-a).** Kitchen gardens, also called home gardens, or homestead gardens, are small portions of land around the household or within walking distance from the family home, where vegetables, fruits or herbs are grown (Galhena et al., 2013). These gardens can contribute to food security by serving as a supplementary source of food and income. Furthermore, they can lead to improvements in the nutritional status of the community. In this regard, evidence shows that the implementation of kitchen gardens at schools can shift the nutritional habits of students towards fresher, healthier foods, encourage them to be more adventurous eaters, and teach them about the environment and how to act and live sustainably (Meltzer, 2014).
3. **Implement high quality waste management practices and markets through a circular economy approach (Food Forward NDCs, 2024-a).** Even though hunger affects an estimated 783 million people each year, more than US \$1 trillion worth of food is thrown away annually (United Nations Environment Programme, 2024). While food losses occur

before reaching the consumption stage, waste also arises in the latter (Alexander et al., 2013). Based on estimates from the United Nations Environment Programme (2024), the yearly global average food waste per capita amounted to 132 kilograms in 2022, with the largest share (79 kilograms per capita) wasted in households. Furthermore, various studies carried out in Latin America and the Caribbean over the period 2003 – 2023 estimate food waste in the region to be between 34 kilograms per capita per year (Belize: 2011, Ecuador: 2023) and 207 kilograms per capita per year (The Dominican Republic: 2018), with household food waste generation in the region estimated at 95 kilograms per capita per year (United Nations Environment Programme, 2024). Reducing food waste by managing it effectively can therefore lead to improved food security. In this regard, in 2022 the Latin American and Caribbean Parliament (Parlatino), of which Aruba is a member, set out a regulatory framework for public and private actions to prevent and reduce food loss and food waste (FAO, 2024). The duties of the state, as described in the regulatory framework include, among others, adopting a national policy and strategy aimed at preventing and reducing food losses and waste, generating and systematically publishing periodic data and information on food losses and waste in the country, designing and implementing education and awareness campaigns on the topic of food loss and waste prevention, promoting fair and inclusive production models, developing policies, programs, and actions that contribute to closing the gender gaps in food systems, and encouraging research and innovation that supports the achievement of the law's objectives (Parlamento Latinoamericano y Caribeño, 2022).

4. Introduce healthy, sustainable, and climate-positive eating guidelines (Food Forward NDCs, 2024-a). Dietary

guidelines are a key policy tool for the promotion of healthy eating habits. When they are aligned with reputable, science-based sources such as the FAO, the WHO, and the European Food Safety Authority (EFSA), they provide evidence-based recommendations that can form the basis of public dietary education. Furthermore, dietary guidelines can serve as a guide to inform policies across the entire food system, including policies related to agriculture, trade, and taxation. In this way, these guidelines do not only promote healthy diets but can also contribute to the achievement of sustainability and climate goals (Food Forward NDCs, 2024-b). Depending on the goals to be achieved, the responsibility for the national dietary guidelines can be shared by different Ministries, such as those of Health, the Environment, and the Primary Sector.

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Annex

Annex 1. The FIES Survey Module questionnaire

During the last 12 months, was there a time when, because of lack of money or other resources:

1. You were worried you would not have enough food to eat?
2. You were unable to eat healthy and nutritious food?
3. You ate only a few kinds of foods?
4. You had to skip a meal?
5. You ate less than you thought you should?
6. Your household ran out of food?
7. You were hungry but did not eat?
8. You went without eating for a whole day?

Annex 2. Demographic Characteristics of CBA's Food Security Survey vs. Population

		CBA Food Security Survey 2024	Population
Gender	Female	67.5%	52.8%
	Male	32.5%	47.2%
Region	Noord/ Tanki Leendert	25.4%	22.4%
	Oranjestad	27.2%	26.5%
	Paradera	13.4%	12.8%
	Santa Cruz	13.1%	14.1%
	Savaneta	10.1%	11.1%
	San Nicolas	10.1%	13.1%
Country of Birth	Aruba	59.7%	63.0%
	Curaçao	3.0%	1.8%
	St. Maarten	0.6%	N.A.
	Netherlands	8.7%	4.2%
	Colombia	6.9%	9.5%
	Dominican Republic	0.3%	4.5%
	Suriname	0.3%	1.1%
	USA	0.6%	0.5%
	Venezuela	17.0%	6.6%
	Other	3.0%	93.4%
Education	Less than primary education	0.3%	N.A.
	Primary education	2.4%	N.A.
	EPB / LTS	7.5%	N.A.
	MAVO / MULO / MAO / MTS / EPI	21.5%	N.A.
	HAVO	7.5%	N.A.
	VWO	1.2%	N.A.
	HBO	25.1%	N.A.
	WO	24.8%	N.A.
Income	PHD	9.3%	N.A.
	10th percentile	Afl. 1,893 or less	Afl. 1,310
	20th percentile	Afl. 1,893 or less	Afl. 1,763
	30th percentile	Afl. 1,894 - 2,500	Afl. 1,920
	40th percentile	Afl. 3,001 - 4,000	Afl. 2,157
	50th percentile	Afl. 3,001 - 4,000	Afl. 2,499
	60th percentile	Afl. 4,001 - 5,000	Afl. 2,857
	70th percentile	Afl. 5,001 - 7,000	Afl. 3,441
	80th percentile	Afl. 7,001 - 9,000	Afl. 4,462
	90th percentile	Afl. 9,001 - 12,000	Afl. 6,219

Source: CBS, SVB.

5.



Measuring Student Financial Literacy in Aruba: Insights from the OECD/INFE Framework

Elmelynn Croes

Abstract

This study assesses the reliability and validity of an adapted measure of financial literacy among students enrolled in Aruba's public higher education institutions, addressing the need for localized, data-informed insights into youth financial literacy. Guided by the OECD/INFE framework, which conceptualizes financial literacy across Financial Attitude, Financial Behavior, and Financial Knowledge, the study explores whether a locally adapted instrument can meaningfully assess these dimensions to inform financial education strategy and policy design. A survey was administered to all registered students at the University of Aruba and the Instituto Pedagógico Arubano, of which 145 complete cases were retained for analysis from 262 responses. Descriptive results showed that students held positive attitudes toward saving and self-control and demonstrated strong knowledge of basic concepts such as interest and inflation. However, financial behavior was more varied: while 86% reported tracking expenses and 81% saved money, only 56% reported making informed financial decisions, and just 25% consulted independent information sources. Internal consistency was moderate for Financial Attitude and lower for Behavior and Knowledge, consistent with their item structure and diversity. More robust reliability estimates (e.g., MacDonald's omega) provided stronger support for internal consistency. Factor analysis identified two behavioral sub-dimensions: Financial Planning and Financial Caution. Regression results showed that financial knowledge increased with age, while gender differences were associated with both knowledge and attitude scores. No significant correlation was found between Financial Knowledge and Behavior, suggesting that knowledge may not translate into action without supportive attitudes or contextual enablers. Findings indicate students demonstrate caution in their financial

practices but are less engaged in strategic planning behaviors. The study supports the OECD/INFE framework's relevance in small-island contexts and offers a practical approach to financial literacy measurement. Recommendations include integrating practical financial education into tertiary curricula, co-developing applied tools through cross-sector partnerships, and promoting culturally relevant, student-centered financial literacy through civic engagement and peer initiatives.

Keywords: financial literacy, higher education, Aruba, OECD/INFE, exploratory analysis

1. Introduction

Financial literacy is a critical skill for students in higher education, who increasingly face complex financial decisions involving tuition, housing, credit, and day-to-day budgeting (Artavanis & Karra, 2020; Miller et al., 2015). However, evidence shows that young adults often lack the financial knowledge and behavioral skills needed to make informed decisions. For example, Lusardi et al. (2010) found that only 27% of young adults had knowledge of basic financial concepts. Similarly, Chen and Volpe (1998) reported that college students answered only about 53% of questions correctly on a personal finance survey, even though the items were relatively basic. This can contribute to increased financial stress and long-term vulnerability among them. To date, there are no known studies assessing financial literacy among students in Aruba's public higher education system. No standardized instruments have been formally used to collect data on students' financial knowledge, attitudes, or behaviors, and no baseline data have been published by academic institutions or government entities. This study addresses this important gap by providing one of the first localized, psychometrically-informed datasets, designed to support institutional and policy decision-making.

In contrast, many countries, particularly within the OECD, have introduced financial education initiatives aimed at young people, primarily through school-based programs (OECD, 2014). However, far less is known about the scope or impact of financial education at the tertiary level. While comprehensive global data is lacking, some universities — such as Harvard, Stanford, and Florida International University — have implemented financial literacy initiatives through online tools, workshops, and formal coursework. These examples

suggest that financial capability efforts at the tertiary level are taking shape in a variety of formats. However, such efforts are still under-documented in global evaluations, as most large-scale studies continue to focus on school-age populations or adults (Miller et al., 2015). This pattern holds true in Aruba, where the absence of reliable and valid measurement instruments in the Aruban context limits the ability to design, evaluate, and improve such initiatives.

This study addresses this gap by piloting a comprehensive financial literacy measurement instrument tailored to the characteristics and needs of Aruba's higher education student population. The instrument is designed to assess students' knowledge, attitudes, and behaviors related to personal finance, offering a multidimensional perspective on financial literacy. It is informed by the OECD/INFE framework, which conceptualizes financial literacy across three core dimensions: financial knowledge, financial attitude, and financial behavior (OECD, 2022). The research also responds to the growing national interest in building financial resilience through education, as reflected in the 2023 draft proposal for the establishment of a National Financial inclusion/Education Council submitted to the Council of Ministers. By offering localized, data-driven insights on financial literacy, this exploratory study offers an initial evidence base to inform the design of financial education programs and broader youth policy strategies. It contributes both a practical tool for future monitoring and a foundation for further validation and curriculum development.

The research questions addressed in this study are: 1) What are the key dimensions of financial literacy among students in Aruba's public higher education institutions, as conceptualized by the OECD/INFE framework? 2) To

what extent does a tailored financial literacy measurement instrument reliably and validly assess these dimensions?

3) What insights do the instrument's results offer regarding students' financial attitudes, behaviors, and knowledge, and how might these inform targeted education policy?

The remainder of this paper is structured as follows: First, a review of the literature on financial literacy measurement is presented, drawing insights from existing research. Second, the methodology used to develop the financial literacy measurement instrument is described, including the instrument's structure, content, and modifications made for contextual and cultural relevance. Third, a descriptive analysis of the participant demographics and item-level responses is presented, followed by a discussion of the results of the reliability and validity analyses for Aruban higher education students. Finally, the implications of the findings and directions for future research are discussed.

2. Theoretical Background and Research Design

2.1. Concepts and Definitions

This study adopts the OECD/INFE (2022) definition of financial literacy as “a combination of financial awareness, knowledge, skills, attitudes, and behaviors necessary to make sound financial decisions and ultimately achieve individual financial well-being.” Financial literacy is conceptualized as a multidimensional construct comprising three interrelated domains:

- I. Financial knowledge refers to the understanding of fundamental financial concepts such as interest, inflation, risk and return, and diversification. It is measured through

multiple-choice questions that assess the ability to apply this knowledge in everyday financial decision-making.

- II. Financial attitude captures an individual's orientation toward saving and long-term planning. It is operationalized through agreement with statements that reflect preferences for short-term gratification versus long-term financial discipline, such as *“I find it more satisfying to spend money than to save it for the long term.”*
- III. Financial behavior encompasses everyday money management actions, including budgeting, saving, making considered purchases, and meeting financial obligations. It is assessed through self-reported behaviors that reflect financial control, planning, and responsibility.

These three dimensions collectively reflect an individual's capacity to make informed financial decisions and manage financial resources effectively.

The OECD/INFE framework is conceptually aligned with broader theories of behavior and capability. Notably, the Theory of Planned Behavior (Ajzen, 1991) emphasizes the role of attitudes and perceived behavioral control in shaping intentions and actions, offering a psychological basis for linking financial attitude to behavior. Similarly, the financial capability framework (Atkinson & Kempson, 2008) views financial capability not merely as knowledge acquisition, but as the ability to apply that knowledge in managing financial resources, aligning with this study's emphasis on behavior and the identification of two latent subdimensions: Financial Planning and Financial Caution. These frameworks provide a theoretical foundation for understanding the relationships among financial literacy domains and support the multidimensional structure adopted in this study.

2.2. Review of Previous Studies

Financial literacy has gained increasing global attention as a foundational life skill, linked to better financial decisions, greater economic resilience, and improved well-being (OECD, 2022; Lusardi & Mitchell, 2014). While definitions vary across the literature, many frameworks conceptualize financial literacy as a combination of knowledge, attitudes, and behaviors (Remund, 2010; Huston, 2010). Yet, despite widespread application, the instruments used to assess these constructs vary considerably and are not always subjected to formal validation across contexts. The OECD/INFE framework, in particular, has informed large-scale surveys and national strategies, offering a three-part structure that captures both cognitive and behavioral dimensions of financial capability. However, the OECD/INFE instrument was primarily designed for comparative and policy use and has not undergone formal psychometric validation as a unified measurement scale. This study contributes to closing this gap by exploring the internal consistency and factor structure of a localized adaptation of the OECD/INFE framework.

Although early research on financial literacy focused largely on working-age adults and retirees, recent attention has shifted toward university students and young adults, who face increasingly complex financial decisions. This growing body of research emphasizes their heightened financial exposure and underscores the importance of building capability early in life (Miller et al., 2015; Artavanis & Karra, 2020). Despite this shift, few studies apply multidimensional frameworks, like OECD/INFE or Potrich et al.'s (2016) structural model, to student populations, particularly in small-island or developing economies. Moreover, the emotional and psychosocial aspects of financial behavior — such as stress, anxiety, or financial distress — remain under-explored, despite increasing recognition of their impact on young

adults' financial well-being in recent research (Norvilitis et al., 2006; Serido et al., 2013; Heckman et al., 2014).

The following subsections explore each of the three dimensions in greater detail, drawing on empirical literature to contextualize their relevance for youth and higher education populations. For each domain—financial knowledge, attitude, and behavior—the review summarizes key definitions, measurement approaches, and evidence linking the construct to financial outcomes.

Financial Knowledge (FK)

Financial knowledge involves understanding fundamental financial concepts such as interest, inflation, and risk diversification. Research consistently finds that young adults lack proficiency in these areas, often struggling with numeracy-based questions or misconceptions about credit (Chen & Volpe, 1998; Lusardi et al., 2010). Lusardi and Mitchell (2011, 2014) have demonstrated strong associations between financial knowledge and outcomes such as retirement planning, saving, and debt avoidance.

Disparities in financial knowledge are well-documented.

Studies show that males, students from higher-income households, and those whose parents discuss money matters tend to score higher on financial knowledge assessments (Mändmaa, 2019; Jorgensen & Savla, 2010). However, knowledge alone may not be sufficient. Fernandes et al. (2014), in a large meta-analysis, found that financial education programs focused solely on increasing knowledge produced only modest effects on long-term financial behavior, particularly in low-income populations. While financial knowledge lays the foundation for informed decisions, its practical utility often depends on attitudinal dispositions and behavioral execution.

Financial Attitude (FA)

Financial attitude reflects an individual's orientation toward long-term thinking (OECD, 2022), although some broader definitions also include predispositions toward saving and planning (Potrich et al., 2016). These attitudes influence how knowledge is translated into action and are shaped by personal values, cultural norms, and early life experiences. Parental financial socialization, in particular, has been shown to impact students' attitudes toward money and budgeting (Jorgensen & Savla, 2010; Shim et al., 2009).

Several studies have found that positive financial attitudes — such as delayed gratification, self-discipline, and future-oriented thinking —are associated with improved financial behaviors. The latter includes budgeting, saving regularly, avoiding impulse purchases, and paying debts on time (Jorgensen et al, 2017; Potrich et al., 2016). Lusardi and Mitchell (2014) note that psychological traits, such as attitudes toward planning and self-control, may moderate the relationship between financial knowledge and behavior. However, the measurement of financial attitudes remains challenging due to their subjective and abstract nature.

Unlike behaviors, which are observable, or knowledge, which can be tested objectively, attitudes are latent constructs that rely on self-report and may be influenced by context or social desirability bias. Measuring financial attitudes is particularly challenging, as they represent latent psychological constructs that are difficult to observe directly and are vulnerable to contextual or social desirability biases (Huston, 2010; Xiao & O'Neill, 2016; Potrich et al., 2016). In their model development work, Potrich et al. (2016) found that several attitude items had to be excluded to achieve model fit, despite

attitude being a statistically significant predictor of financial behavior.

Financial Behavior (FB)

Financial behavior encompasses practical actions related to money management, such as budgeting, saving, avoiding late payments, and responsible credit use (OECD, 2022; Xiao & Dew, 2011; Huston, 2010). Numerous studies have demonstrated that positive financial behaviors in young adulthood are predictive of long-term financial stability and reduced debt burdens (Lusardi & Tufano, 2009; Hilgert et al., 2003).

Among university students, suboptimal financial behaviors—such as low savings, impulsive spending, and inadequate planning for unexpected expenses—are commonly observed (Annisa et al., 2023; Ninan & Kurian, 2021). Increasingly, research is acknowledging the emotional dimension of behavior—such as financial stress or avoidance tendencies—that may undermine even well-intentioned efforts (Perry, 2023).

In the present study, exploratory factor analysis reveals two distinct sub-dimensions within Financial Behavior: Financial Caution and Financial Planning. The planning dimension captures forward-looking, proactive behaviors such as budgeting, saving, and making informed purchases. The caution dimension reflects prudent day-to-day management, including tracking expenses, setting long-term financial goals, and paying bills on time. While this structure emerged from the current dataset, it aligns conceptually with the multidimensional nature of financial behavior highlighted in the OECD/INFE framework (OECD, 2022) and in prior research (Xiao et al., 2011; Lusardi et al.,

2010). These findings offer new insights into the differentiated ways in which students engage with their finances and reinforce the value of using multidimensional models when assessing financial capability among youth.

Empirical Models and Framework Application

Potrich et al. (2016) offer one of the few model-based studies specifically focused on university students. Their work, conducted in Brazil, used structural equation modeling to examine the interrelationships between knowledge, attitude, and behavior. The best-fitting model showed that knowledge and attitude predicted financial behavior, supporting a conceptual structure that aligns with OECD/INFE. However, the authors acknowledge the exploratory nature of their modeling and the need for further validation in diverse contexts. Their study also required refinement of scale items to improve fit, illustrating the complexity of measuring financial literacy reliably in young adult populations.

This study builds on that approach by adapting an international framework to the Aruban context and exploring the internal structure of behavioral dimensions. In doing so, it contributes to the small but growing body of research using multidimensional constructs to assess student financial literacy in developing or small-island settings.

2.3. Research Model and Indicators

The research model draws on the three core dimensions of financial literacy defined by the OECD/INFE framework:

- I. **Financial Attitude (FA):** Captures long-term thinking and self-control in financial decision-making, measured using two Likert scale items from the OECD/INFE instrument. Responses were recorded on a 5-point Likert scale, with

higher scores indicating stronger financial attitudes.

- II. **Financial Behavior (FB):** Reflects day-to-day financial management, including budgeting, saving, paying bills on time, and avoiding impulsive spending. The score was computed as a count of financially savvy behaviors, based on the OECD/INFE 2022 methodology. Composite variables were created for key domains: budgeting, active saving, making ends meet, and informed product choice, while individual items captured financial monitoring, goal setting, considered purchases, and timely bill payment. The total score ranged from 0 to 8.
- III. **Financial Knowledge (FK):** Assesses understanding of essential financial concepts such as simple and compound interest, inflation, and risk diversification, measured through multiple-choice questions scored as correct or incorrect.

The study selected and adapted indicators for contextual relevance while maintaining alignment with the OECD/INFE methodology. Adaptation involved harmonizing local survey language, incorporating culturally appropriate examples where needed, and removing non-applicable items. Alignment with the OECD/INFE was safeguarded by strictly applying the scoring criteria defined in the 2022 Toolkit, using only items that directly map to core indicators for financial knowledge, attitude, and behavior. This ensures international comparability while preserving local relevance. However, due to the narrower target population (higher education students), results are not directly comparable to OECD adult population benchmarks. Each construct was scored independently to allow for disaggregated and composite analyses.

2.4. Research Methodology

The target population for this study comprised all students

enrolled in the 2024/2025 academic year at two public higher education institutions in Aruba: The University of Aruba and the Instituto Pedagógico Arubano (IPA). At the time of the survey, 845 students were registered across both institutions. The survey was distributed to the full population via institutional email, constituting a census-based approach. Participation was voluntary and anonymous. To encourage full completion, students could opt for a random prize drawn upon submitting their responses, with three incentives awarded.

A total of 262 students responded, yielding a 31% response rate. Based on the total student population (N = 845), a minimum of 264 responses would be required to achieve a 95% confidence level with a 5% margin of error. Respondents represented a range of academic programs and demographic backgrounds. The final analytic sample consisted of 145 students with complete data across the three financial literacy constructs — behavior, attitude, and knowledge.

Missing data patterns were examined using both variable-level and case-level summaries, along with visual diagnostics. Several auxiliary variables — such as open-ended “Other” response fields like QD5UAO and QD8ao (QD5UAO = UA faculty - other; QD8ao = Participated in financial education programs, courses, or workshops - other) — had extremely high missingness (up to 100%) due to their inapplicability to most respondents. Overall, more than half of the respondents (56.1%) were missing between four and six variables. However, most respondents (55.3%) still had valid financial literacy scores.

Although a formal non-response bias analysis was not conducted, the distribution of scores among incomplete cases indicates a low risk of substantial bias in the financial

literacy outcomes. Nonetheless, the possibility of subtle differences between included and excluded respondents cannot be entirely ruled out.

The instrument builds on the OECD/INFE 2022 questionnaire and is structured to measure three dimensions of financial literacy: Financial Attitude (FA), Financial Behavior (FB), and Financial Knowledge (FK). Items were adapted for local relevance while maintaining comparability with international benchmarks.

Likert-scale responses were numerically coded, and multiple-choice knowledge questions were scored as correct/incorrect. Scores were calculated using aggregation or averaging, depending on the scale format. Likert-scale items (Financial Attitude) used 5-point format with higher values reflecting stronger future-oriented attitudes. Knowledge items were scored 1 = correct, 0 = incorrect. The Attitude score (0–4) was the average of two items, rescaled from a 1–5 scale. The Knowledge score (0–7) summed up correct responses to seven items.

For Financial Behavior, the analysis calculated a score using the method defined by the OECD/INFE, based on a subset of survey items aligned with their core behavioral indicators. The Behavior score (0–8) followed OECD/INFE 2022 criteria. It combined four composite binary indicators — budgeting, active saving, making ends meet, and informed product choice — with four Likert-based items that were binarized (1 point for financially responsible responses, 0 otherwise). Higher total scores reflected more financially responsible behaviors. This approach ensures full alignment with international measurement standards and supports cross-country comparability. To capture

responsible behavior in the face of financial shortfalls, the 'QF_makeendsmeet' item was coded based on responses to QF11¹ and QF12². Respondents who reported experiencing a shortfall in the past 10 months (QF11 = 1) were further evaluated based on the strategies they used to cope (QF12_1 to QF12_7). Following OECD-INFE guidance, individuals were scored as 1 (responsible behavior) if they used non-credit coping strategies such as spending less, using savings, working extra hours, or seeking help without borrowing (QF12_1 or QF12_2 = 1). Those who relied on credit — either formal or informal — such as borrowing from friends, using credit cards, or missing payments (QF12_3 to QF12_7 = 1) were scored as 0. Respondents who reported no shortfall (QF11 = 0) were also scored as 1, reflecting sound financial management.

To assess internal validity, the study applied two complementary psychometric validation strategies:

Cronbach's alpha and McDonald's omega. Cronbach's alpha was calculated using the item-level scores in their original format (binary or Likert-type), consistent with standard applications and OECD benchmarks. While $\alpha > 0.70$ is often cited as a threshold for acceptable reliability, this criterion can be overly conservative for short scales or heterogeneous constructs. Given the mixed item formats and moderate non-normality observed in the data distributions, a more robust reliability estimate, McDonald's omega, was also computed for the Financial Behavior and Financial Knowledge constructs. Omega was estimated using polychoric correlation matrices, which model the underlying continuous traits behind ordinal and binary responses and are

robust to violations of tau-equivalence. The Financial Attitude construct, composed of only two Likert items, was evaluated using alpha only, as omega requires a minimum of three items to yield stable estimates.

All reliability estimates were calculated using the analytic sample (n = 145), which exceeded minimum sample size thresholds of n=140 for psychometric analysis for all constructs, supporting the use of these metrics despite the observed non-normality. Together, these complementary approaches provide a reliable assessment of internal consistency for the composite scores.

Exploratory factor analysis (EFA) was conducted on the Financial Behavior (FB) construct using principal axis factoring with Oblimin rotation, which allows for correlation between factors. This rotation was selected based on the theoretical expectation that dimensions of financial behavior, such as saving, budgeting, and financial control, are interrelated rather than orthogonal. Post-EFA inspection confirmed that the extracted factors were indeed moderately correlated, supporting the use of an Oblimin rotation method over Varimax.

EFA was limited to FB because it included the largest and most heterogeneous item pool. In contrast, the Financial Attitude (FA) construct comprised only two items — making EFA inapplicable — and the Financial Knowledge (FK) construct was designed as a factual index, not a latent trait scale. Additionally, several FK items exhibited no variance and were excluded from

¹ QF11 = Sometimes people find that their income does not quite cover their living expenses. In the last 10 months, has this happened to you, personally?

² QF12 = What did you do to make ends meet the last time this happened? Check all that apply.

psychometric analysis. Conducting EFA across all constructs was not conceptually appropriate, as FA, FB, and FK were designed to capture theoretically distinct dimensions in line with the OECD/INFE framework.

Two factors were retained based on parallel analysis, corresponding to ‘Financial Planning’ and ‘Financial Caution’. This factor structure provided insight into the multidimensional nature of financial behavior among students, distinguishing between strategic planning activities (e.g., budgeting, saving, informed spending) and cautious habits (e.g., paying bills on time, monitoring finances, setting goals). While this structure informed the interpretation of results, the original Financial Behavior score was retained for consistency, as the sample size was insufficient for revising and validating new subscale scores.

To explore potential demographic predictors of financial literacy, the analysis estimated a set of exploratory linear regression models using the analytic sample (n = 145). The models included gender and age as core predictors, both widely cited in the literature. Where coverage permitted, the analysis also explored other variables such as household income and financial education exposure. However, these additional variables did not significantly improve model fit or show consistent predictive value across constructs. Due to the highly uneven distribution of institutional affiliation, 85.9% of respondents were enrolled at the University of Aruba (UA) compared to 14.1% at IPA, inter-institutional comparisons were not pursued. Faculty-level comparisons were similarly excluded due to small subgroup sizes, particularly among IPA students. Separate regression models were estimated for each construct — FA, FB, FK, and the composite FinLit score — to examine the

effects of gender, age, and, where applicable, other variables such as income and financial education.

While the outcome variables exhibited moderate non-normality, they were treated as continuous composite scores, and linear regression was retained given its robustness at this sample size. Non-parametric alternatives (e.g., Mann–Whitney U or Chi-square tests) were considered but were not suitable for the multivariate framework or for models with continuous outcomes and multiple covariates. Given the limited sample size, findings should be interpreted with caution and serve primarily to guide future hypothesis-driven research, such as evaluating the influence of demographic and contextual factors on financial literacy dimensions in larger and more diverse samples.

Potential sources of bias include non-response, self-selection, and social desirability, particularly regarding behavior items. The 31% response rate, use of a self-report instrument, and prize-based incentives may have further contributed to selection effects. These limitations are acknowledged, and the results are presented as exploratory and not generalizable to a larger population.

3. Results

This section presents the results of the descriptive analysis, internal consistency testing, exploratory factor analysis, inter-construct correlations, and regression modeling. The final analytic sample included 145 respondents with complete data on all financial literacy dimensions.

3.1 Descriptive Statistics

Table A1 (Appendix) presents the demographic

characteristics of the analytic sample (n = 145), which includes only respondents with complete data for the three financial literacy constructs: Financial Attitude (FA), Financial Behavior (FB), and Financial Knowledge (FK).

The table reports distributions for gender, age categories, region, academic institution, and faculty, as well as whether the respondent believes that financial education is important for higher education students, level of parental education, their employment status, and (net monthly) household income.

Among these 145 students, 72.1% identified as female and 26.4% as male. Region of residence was reported by nearly all, with representation across all six geographic areas — most commonly Noord (24.3%), Oranjestad (18.6%), and Santa Cruz (16.4%). Age was collected as an open-ended numeric response, and subsequently, recoded into five brackets for analysis. Among the analytic sample (n = 145), 48.6% of respondents were aged 18–22, 19.0% were 23–26, and 32.4% were 27 or older. Age data was missing for 2.1% of respondents.

Most respondents were enrolled at the University of Aruba (85.9%), while a smaller group attended IPA (14.1%). Faculty-level representation included Arts & Science (31.5%), Hospitality & Tourism (20.0%), Accounting, Finance & Marketing (18.5%), Law (14.6%), and Teacher Education (14.6%). All faculty respondents from IPA were enrolled in teacher education programs, except for one student in another area. The remaining faculties were affiliated with the University of Aruba, reflecting a broad academic cross-section.

Reported household income spanned six ordinal categories. For interpretability, these were grouped into three categories:

over half of the sample (53.2%) reported low-income levels ($\leq$ Afl. 3,000/month), 40.3% fell within the middle-income range (Afl. 3,001–9,000), and only 6.5% reported high-income levels ($\geq$ Afl. 9,001). This distribution highlights that most respondents came from lower- to middle-income households, with only a small share reporting higher income levels.

To contextualize the composite scores, the study provides item-level descriptive statistics for all individual items contributing to each financial literacy construct. Tables A2 to A4 (Appendix) display the frequency distributions, means, medians, and standard deviations for the Financial Behavior, Financial Attitude, and Financial Knowledge items, respectively. Given the small sample size and a mix of binary and ordinal formats, both mean and median values are reported to support transparent reporting and facilitate interpretation.

The Financial Behavior construct showed high engagement with core responsible behaviors: 85.5% reported using a budget, 84.1% reported saving, and 80.0% demonstrated responsible coping strategies when facing financial shortfalls. Likert-type behavior items (e.g., tracking expenses, goal setting) showed that students largely agreed with statements reflecting responsible financial practices, indicating a general tendency toward prudent day-to-day money management. However, fewer students reported proactive financial engagement: only 56% attempted to inform financial decisions, and just 25% used independent advice or information sources. In addition, only 68% considered affordability before making purchases, and 20% reported borrowing to make ends meet. These patterns suggest a strong foundation of financial caution, with opportunities to strengthen strategic behaviors that support long-term financial resilience.

For Financial Attitude, responses reflected strong future-oriented views. Almost half of the respondents (49.7%) disagreed or completely disagreed that it is more satisfying to spend money than to save it for the long-term, while about two-thirds (69.6%) of respondents disagreed with the notion of living only for today without considering the future. These patterns suggest that most students endorsed prudent attitudes toward saving and planning, reflecting moderate levels of future-oriented financial attitude.

Financial Knowledge results were more varied. Students performed well on foundational concepts — such as interest on loan (97% correct), cost of living (96%), and simple interest (92%) — and inflation (80%). However, items

assessing compound interest (52%), return on risk (61%), and diversification (42%) had lower correctness rates. These results suggest that while most students grasp basic financial concepts, many struggle with applying that knowledge in contexts involving uncertainty or compound reasoning.

Table 1 (below) presents descriptive statistics for the three core financial literacy constructs. The Financial Attitude score ranges from 0 to 4, the Financial Behavior score from 0 to 8, and the Financial Knowledge score from 0 to 7. Each score reflects increasing levels of literacy, with higher scores representing stronger attitudes, more responsible behaviors, and greater knowledge, respectively.

Table 1: Descriptive Statistics for Financial Literacy Constructs (n=145)

Summary Statistics of Financial Literacy Constructs (Analytic Sample, n = 145)				
Construct	Mean	SD	Min	Max
Financial Attitude	2.69	0.92	0	4
Financial Behavior	6.43	1.52	2	8
Financial Knowledge	5.02	1.39	2	7

3.2 Internal Consistency Reliability

To assess the internal consistency of each construct, Cronbach's alpha and McDonald's omega were calculated for each construct using the analytic sample (n=145). The Financial Attitude scale (2 Likert items) demonstrated moderate internal consistency ($\alpha = 0.59$), which is acceptable given its short format, especially given the limitations of Cronbach's alpha for short measures as discussed in Section 2.4. Omega was not

computed for this construct, as it requires a minimum of three items.

The Financial Knowledge construct, composed of seven binary-scored multiple-choice items, yielded low internal consistency using Cronbach's alpha ($\alpha = 0.36$). While this would typically raise concerns, this level of internal consistency is typical for knowledge tests that assess diverse content areas.

Item-level diagnostics indicated that items QK5, QK6, and QK7_3 contributed more meaningfully to the overall scale, while QK3 and QK7_2 showed weaker or negative correlations with the total score. However, removing any single item did not substantially improve internal consistency. Importantly, McDonald's omega total was substantially higher ($\omega = 0.77$), indicating that the scale holds acceptable reliability once multidimensionality and binary item format are accounted for. Given the conceptual breadth of the construct and the desire for comprehensive content coverage, all items were retained in further analysis despite the low alpha. This approach prioritizes content validity while acknowledging the limitations of alpha in this context.

The Financial Behavior construct, based on eight binary indicators, produced $\alpha = 0.53$ and a much stronger $\omega = 0.86$. This divergence reflects the expected heterogeneity of the

behaviors assessed - ranging from practical actions like budgeting and saving to indicators of financial distress - capturing a wide spectrum of financial behavior among students. The variation is consistent with the OECD/INFE framework, which conceptualizes financial behavior as a multidimensional construct. Table A5 (Appendix) presents the reliability estimates for all constructs.

Figure 1 displays the distribution of Financial Attitude, Behavior, and Knowledge scores across the analytic sample ($n = 145$). All three constructs exhibited left (negative) skewness, particularly Financial Behavior (skew = -1.06) and Financial Attitude (skew = -0.73). Shapiro-Wilk tests confirmed statistically significant departures from normality for each construct ($p < 0.01$), consistent with the observed skewness in the distributions. This non-normality should be taken into account when interpreting results and conducting subsequent parametric analyses.

*Figure 1:
Distribution of financial
literacy constructs*



3.3 Exploratory Factor Analysis (EFA)

The study conducted Exploratory Factor Analysis (EFA) on the binary-scored Financial Behavior items to explore their underlying structure. A one-factor solution using principal axis factoring explained 17.3% of the variance. While six of the eight items loaded above 0.3, only three exceeded the commonly accepted 0.5 threshold for strong factor loadings. This pattern indicates partial coherence but limited unidimensionality. The relatively weak factor loadings are consistent with the construct's modest internal consistency ($\alpha = 0.53$) and suggest that the items likely capture related but distinct aspects of financial behavior. This outcome reflects the design of the FB construct, developed to capture a broad spectrum of financial actions as defined by the OECD/INFE, rather than a single latent trait.

Follow-up Confirmatory Factor Analysis (CFA) supported a two-factor model with improved fit (CFI = 0.954, RMSEA = 0.047), revealing two interpretable dimensions consistent with Financial Planning and Financial Caution. Descriptive statistics for the two CFA-based sub-dimensions indicate relatively high mean engagement across both domains—Planning ($M = 0.83$, $SD = 0.22$) and Caution ($M = 0.78$, $SD = 0.24$)—as shown in Appendix Table A6. These findings align with the multidimensional conceptualization of financial behavior (OECD, 2022) and reflect the structural complexity commonly observed in behavioral constructs. Although the explained variance was modest, this is not unusual for EFA on binary indicators and aligns with patterns reported in applied psychometric research (Watkins, 2018). In this context, the composite FB score serves as a policy-relevant index of behavioral engagement, with its interpretation informed by the underlying multidimensional structure.

The Financial Knowledge (FK) construct was assessed using seven binary-scored multiple-choice items drawn from established financial literacy measures, covering key domains such as interest, inflation, and risk diversification. As discussed in Section 3.2, these items were developed to reflect distinct learning objectives, which limits internal consistency ($\alpha = 0.36$) but is consistent with the construct's multidimensional nature. Exploratory Factor Analysis (EFA) was not conducted, as it would be conceptually inappropriate to impose a reflective latent structure on a construct intended to capture broad factual knowledge. The FK score is best interpreted as a formative index of financial knowledge breadth—providing an integrated snapshot of competencies rather than representing a unidimensional trait.

3.4 Correlations Among Constructs

To assess associations among the three core financial literacy constructs, both Pearson and Spearman correlations were computed using the complete-case analytic sample ($n = 145$). These analyses explored the extent to which Financial Attitude (FA), Financial Behavior (FB), and Financial Knowledge (FK) scores are interrelated.

Using Pearson correlations, Financial Attitude and Financial Behavior showed a weak but statistically significant positive association ($r = 0.21$, $p = 0.029$), while Financial Knowledge and Financial Attitude were weakly negatively correlated ($r = -0.13$, $p = 0.12$). The correlation between Financial Knowledge and Financial Behavior was also negative and non-significant ($r = -0.10$, $p = 0.774$).

Given the non-normality of all three constructs (as evidenced by significant Shapiro–Wilk tests), Spearman's

rank-order correlations were also calculated as a non-parametric alternative. The results were directionally consistent: FA and FB ($p = 0.19$, $p = 0.063$), FK and FA ($p = -0.09$, $p = .265$), and FK and FB ($p = 0.04$, $p = 0.671$). Again, no statistically significant relationships were observed.

These weak and non-significant inter-construct correlations suggest that the three dimensions of financial literacy — attitude, behavior, and knowledge — capture distinct aspects of financial literacy in this student population. The modest positive correlation between Financial Attitude and Financial Behavior is consistent with expectations, as favorable attitudes may support — but do not ensure — sound behavioral choices. The weak inverse correlation between Financial Knowledge and Financial Attitude may partly reflect the reverse-framed nature of the attitude items, which could lead to different response patterns among more knowledgeable students. Lastly, the minimal correlation between Knowledge and Behavior aligns with prior research showing that factual knowledge alone does not consistently predict behavior without additional motivational or contextual factors (OECD, 2022; Fernandes et al., 2014; Atkinson & Messy, 2012).

3.5 Exploratory Regression Analysis

To examine potential demographic determinants of financial literacy outcomes, a series of linear regression models were estimated using complete-case data ($n = 142$). Each core construct — Financial Attitude (FA), Financial Behavior (FB), and Financial Knowledge (FK) — along with the composite Financial Literacy score, was regressed on gender (QD1) and age (QD3), two widely recognized predictors in financial literacy research (Lusardi & Mitchell, 2014; OECD, 2022).

As shown in Appendix Table A7, gender was a significant predictor of both FA and FK. Specifically, females scored lower on financial attitude ($\beta = -0.46$, $p = 0.008$), but higher on financial knowledge ($\beta = 0.88$, $p = 0.001$). Age was also a significant positive predictor of FK ($\beta = 0.178$, $p = 0.032$) and the composite Financial Literacy score ($\beta = 0.254$, $p = 0.070$), indicating that older students demonstrated broader financial understanding. No significant effects were observed for financial behavior or the composite Financial Literacy score.

Ordinary least squares (OLS) regression was used to ensure comparability across continuous outcomes, despite the presence of non-normality in some variables.

As a robustness check, non-parametric correlations were also computed (see Section 3.4). While OLS was deemed appropriate at the construct level, future studies may consider Mann–Whitney U tests or ordinal logistic models for item-level or ordinal outcomes.

Additional models included household income (QD11), perceived importance of financial education (QD7), and participation in financial education (QD8), but these variables did not consistently improve model fit or yield stable results—likely due to item-level missingness and multicollinearity (e.g., singularities in QD7). The final simplified models with gender and age are presented as the most parsimonious and interpretable specification.

Given the modest sample size and exploratory design, findings should be interpreted cautiously. Nonetheless, the results provide preliminary insights into demographic patterns in student financial literacy and can inform future studies with larger, more representative samples.

3.6 Discussion of Results

The descriptive results showed variability in Financial Attitude, Behavior, and Knowledge among respondents.

These patterns suggest that while students grasp factual knowledge, they may struggle with applying that knowledge in complex or uncertain contexts, highlighting the importance of instruction that supports conceptual reasoning and real-world application.

While students demonstrated relatively strong financial attitudes and cautionary behaviors, the findings reveal important gaps in strategic financial engagement. For example, although a large majority tracked expenses, saved regularly, and paid bills on time — indicating high levels of short-term financial control — only a fraction sought independent information or advice before making financial decisions. This divergence suggests that while students are capable of managing day-to-day finances, many may lack the knowledge, confidence, or habits needed for longer-term planning and financial resilience.

The low rates of information-seeking behavior and affordability check before purchases may reflect limited exposure to financial education or low perceived relevance of proactive strategies at this life stage. These behavioral gaps, if left unaddressed, could hinder their ability to make informed choices about credit, investments, or major life expenses. In particular, the finding that one in five students resorted to borrowing to make ends meet underscores the need to differentiate between financial caution (e.g., avoiding debt) and financial constraint (e.g., limited access to coping mechanisms).

This profile — strong in control, moderate in planning, and weak in strategic engagement — is consistent with

prior research on emerging adults, who often possess foundational skills but face structural and motivational barriers to long-term financial planning (Xiao et al., 2011; Lusardi et al., 2010). It also aligns with the multidimensional structure of the Financial Behavior scale, where factor analysis revealed distinct dimensions of Caution and Planning. This reinforces the value of tailored interventions that not only promote awareness but also equip students with concrete tools and confidence to plan ahead.

Although none of the constructs reached the conventional 0.70 threshold for Cronbach's alpha, this does not necessarily indicate poor reliability. Rather, it reflects the structural properties of the constructs and item formats used, particularly their brevity and multidimensionality, as supported by substantially higher omega values. Internal consistency was moderate for the Financial Attitude construct ($\alpha = 0.59$), which is acceptable given its two-item structure. The Financial Knowledge ($\alpha = 0.36$) and Financial Behavior ($\alpha = 0.53$) constructs showed lower reliability, consistent with their design as a factual knowledge test and a policy-oriented composite index, respectively. In this context, internal consistency (as measured by Cronbach's alpha) reflects how closely related the items within each construct are. While higher alpha values are expected in unidimensional psychometric scales, lower values are common in constructs that encompass diverse item content, such as knowledge questions targeting different facts or behaviors spanning multiple domains (Streiner, 2003).

Alpha is known to underestimate reliability for short scales (e.g., Financial Attitude) and multidimensional constructs composed of binary items (e.g., Financial Knowledge and Behavior). More robust estimates using McDonald's omega

showed substantially stronger internal consistency, particularly for Financial Behavior ($\omega = 0.86$) and Financial Knowledge ($\omega = 0.77$). These results suggest that alpha alone is insufficient to judge the scale reliability in this context. Nonetheless, the divergence between alpha and omega underscores the importance of carefully evaluating measurement quality, especially in adapted instruments, and signals the need for further validation studies with larger and more diverse samples.

Exploratory and confirmatory factor analyses revealed a two-dimensional structure within the Financial Behavior construct. Rather than forming a unidimensional scale, the items grouped into two latent domains: Financial Planning (e.g., budgeting, saving, making informed purchases) and Financial Caution (e.g., monitoring one's financial affairs, setting long-term financial goals, and paying bills on time). These factors reflect proactive versus preventive behavioral tendencies. The CFA-supported model showed good fit (CFI = 0.954, RMSEA = 0.047), and descriptive statistics indicate relatively high mean engagement across both subdimensions—Planning ($M = 0.83$, $SD = 0.22$) and Caution ($M = 0.78$, $SD = 0.24$)—as shown in Appendix Table A6. This multidimensionality aligns with the OECD/INFE framework (OECD, 2022) and reinforces the need for behavioral indicators that capture both forward-looking financial habits and cautious financial management. This two-factor structure suggests that Aruban students demonstrate both forward-looking and cautionary financial tendencies, but these behaviors may stem from distinct underlying motivations and should be supported through differentiated educational approaches.

The results from the correlation analysis revealed distinct relationships among the three dimensions of financial literacy. Financial Attitude (FA) showed a positive association

with Financial Behavior (FB), supporting the theoretical expectation that stronger attitudes toward planning and saving are linked to more capable financial practices. However, Financial Knowledge (FK) did not exhibit a significant correlation with FB or FA. These findings underscore the multidimensional nature of financial literacy. While FA and FB appear modestly connected, FK may operate more independently—especially among youth, where knowledge may not yet be fully internalized into attitudes or activated behaviorally. The lack of association between FK and FB is consistent with previous research showing that knowledge alone often does not translate into action without supportive attitudes, habits, or contextual enablers (OECD, 2022; Fernandes et al., 2014; Atkinson & Messy, 2012).

Exploratory regression analyses revealed some trends that warrant further investigation. For instance, Financial Knowledge tended to increase slightly with age ($\beta = 0.178$, $p = 0.032$), and there were indications of gender-based differences in Financial Attitude ($\beta = -0.46$, $p = 0.008$) and Financial Knowledge ($\beta = 0.88$, $p = 0.001$). However, due to the small sample size and limited statistical power, these findings are preliminary and should be interpreted with caution.

The study faced several limitations that affect generalizability and statistical robustness. First, the reliance on voluntary survey participation may have introduced self-selection bias, while the exclusion of incomplete cases limits the diversity of the final sample. Second, while the internal consistency of the constructs was supported, the small sample restricted the use of more complex analyses such as full structural equation modeling. Third, the incentive offered may have contributed to response bias, and all measures relied on self-report, potentially increasing social desirability effects. Despite anonymity, social desirability

bias may still influence self-reported behaviors—particularly for items related to borrowing, bill payment, or saving—due to perceived social norms or internalized expectations about financial responsibility (Fisher, 1993).

An important advantage of using the OECD/INFE framework is the ability to structure local assessments in alignment with international benchmarks. Although this study applied adaptations for cultural appropriateness, the core indicators and scoring criteria were preserved, allowing for analytical comparability. However, direct score-level comparisons should be interpreted with caution, as the target population in this study, higher education students, differs substantially from the general adult populations typically surveyed in OECD/INFE studies. Such demographic and contextual differences limit the feasibility of robust cross-country benchmarking. Nevertheless, this alignment supports future participation in international assessments, informs regional policy dialogues, and demonstrates that, with cautious adaptation, it is possible to uphold global measurement standards in smaller-scale national studies. Further validation in larger, more diverse samples would strengthen the foundation for meaningful international comparisons.

Despite these constraints, the findings contribute valuable initial insights into financial literacy among higher education students in Aruba — representing, to the best of available knowledge, the first systematic assessment in this population — and demonstrate the applicability of the OECD/INFE framework in this context. More importantly, the study provides a replicable and adaptable measurement approach — informed by established constructs, supported by initial psychometric testing, and using practical scoring methods — that can be refined and scaled in other small-sample

educational environments where large-scale data collection is not feasible.

4. Conclusion

This study examined the financial literacy of students enrolled in Aruba’s two public higher education institutions, applying the OECD/INFE framework to assess financial attitudes, behaviors, and knowledge. The findings provide exploratory evidence of moderately strong financial attitudes, solid day-to-day behavioral control, and foundational financial knowledge, while also highlighting specific areas for improvement. Most students reported behaviors such as tracking expenses, saving regularly, and paying bills on time, reflecting financial caution. However, fewer demonstrated proactive or strategic behaviors such as seeking advice or evaluating affordability before purchases. Similarly, while students performed well on core knowledge items (e.g., interest and inflation), their understanding of more complex concepts like compound interest and diversification was more limited. These patterns suggest that while students have a solid base, there is room to strengthen strategic financial capabilities that promote long-term resilience.

Internal consistency analysis provided preliminary evidence of the reliability of the adapted constructs. Financial Attitude demonstrated moderate internal consistency, while the Financial Knowledge and Financial Behavior constructs showed lower but theoretically justifiable values, given their factual and policy-oriented design. The internal consistency findings highlight the methodological complexity of measuring financial literacy using mixed-format items. While omega values suggest acceptable reliability, the low alpha scores call for cautious interpretation

and point to the need for continued psychometric refinement of adapted instruments in small-sample contexts.

Exploratory and confirmatory factor analyses revealed a two-factor structure within the Financial Behavior construct — Financial Planning and Financial Caution — capturing proactive and preventive behavioral tendencies. The Planning dimension included behaviors like budgeting, saving, and making informed purchases, while the Caution dimension encompassed paying bills on time, monitoring financial affairs, and setting long-term goals. This multidimensional structure aligns with the OECD/ INFE framework and underscores the importance of addressing both strategic and cautious behaviors when designing financial education interventions. It also reflects the structural complexity of real-world financial decision-making among youth.

Correlational analyses revealed a nuanced pattern of relationships among the three dimensions of financial literacy. Financial Attitude showed a weak but statistically significant positive association with Financial Behavior, supporting the theoretical link between mindset and action. However, Financial Knowledge was not significantly correlated with either Behavior or Attitude. These findings reinforce the multidimensional nature of financial literacy and suggest that, in this student population, knowledge may operate independently of attitudes and behaviors—especially when knowledge has not yet been internalized or behaviorally activated. This dissociation highlights the need for integrative approaches that bridge factual understanding with motivational and contextual support.

These findings address the study’s research questions by (1) showing that financial literacy among Aruban students can be initially conceptualized using the OECD/

INFE framework; (2) demonstrating that a locally adapted instrument can capture these dimensions with exploratory evidence of reliability and construct validity, marking an initial step toward formal validation, based on internal consistency estimates and factor analysis; and (3) providing new insights that can inform the design of more responsive and inclusive financial education efforts in Aruba’s higher education system. For this population, the results suggest that tailored interventions may be more effective than generalized programs, particularly those that address students’ emotional financial burdens and diverse knowledge levels.

While exploratory in nature, the study offers a methodological foundation for future research on student financial literacy in small-sample contexts. By adapting a validated framework and applying psychometric methods in a novel setting, it highlights both the potential and the challenges of measuring financial capability in under-researched populations. These insights can support further validation studies, instrument refinement, and more targeted education interventions.

Future research should aim to scale the study to a broader and more diverse student population, including students from private universities, vocational schools, and non-traditional educational pathways. To address current methodological limitations—such as self-selection bias, reliance on complete-case analysis, and modest sample size—future studies should prioritize random or stratified sampling, oversampling of underrepresented groups, and the use of imputation techniques where appropriate. Statistically, larger samples will enable the application of more robust modeling techniques, such as full structural equation modeling, measurement invariance testing, and multi-group comparisons.

Building on the exploratory regressions and factor analyses, future research could evaluate the initial hypothesis that Financial Knowledge and Financial Attitude are positively related to Financial Behavior. With the two distinct subdimensions now identified — Financial Planning and Financial Caution — research can also explore whether knowledge and attitude relate differently to each type of behavior. For example, attitudes may play a stronger role in motivating planning behaviors like budgeting and saving, while knowledge may support cautious habits such as paying bills on time. These follow-up studies could help clarify how different aspects of financial literacy interact and guide more targeted interventions.

For the public sector, the findings highlight specific behavioral gaps — such as limited use of independent financial information and a subset of students borrowing to make ends meet — that signal the need for targeted support within higher education. Integrating practical financial education into the curriculum, aligned with OECD/INFE indicators, could help strengthen both planning and caution-related behaviors. Since this study applied and validated components of the OECD/INFE framework in a local context, it provides a foundation for national benchmarking using standardized indicators. Such benchmarking would enable longitudinal tracking of student outcomes and help identify at-risk groups over time. Moreover, aligning local data with international standards allows for comparative analysis, offering insight into Aruba's position relative to global trends and supporting evidence-based policy development.

For the private sector, the study's finding that only 25% of students reported using independent information to make financial decisions points to an opportunity for innovation in

how financial knowledge is delivered. Collaborations between universities and private institutions could support experiential learning programs, mobile budgeting apps, or peer mentorship models that foster more active and informed decision-making.

For civil society, the observed variation in financial knowledge and behavior — along with the emotional strain reported by a subset of students — highlights the need for culturally relevant engagement. Youth-focused NGOs could play a key role in co-developing materials and campaigns that reflect students' lived realities, especially in addressing stigma around financial hardship and promoting proactive help-seeking.

In summary, this study highlights both the promise and the urgency of strengthening financial literacy among young adults in Aruba. By adapting an internationally recognized measurement framework to a small-island context, it offers the first systematic assessment of financial literacy in this population and provides a methodologically grounded, locally relevant contribution to the global discourse. The identification of distinct sub-dimensions within financial behavior — Financial Planning and Financial Caution — adds nuance to existing frameworks and supports more targeted educational interventions. Together, the findings and recommendations underscore the value of context-sensitive, data-informed strategies to enhance financial resilience and empower Aruba's youth with the skills they need for a financially secure future.

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Appendix

Table A1: Demographic characteristics of the analytic sample

Table A1. Demographic Characteristics of the Analytic Sample (n = 145)			
Category	n	%	
QD1			
Female	105	73.9	
Male	37	26.1	
Missing	3	2.1	
QD2			
Noord	34	23.9	
Oranjestad	29	20.4	
Santa Cruz	24	16.9	
San Nicolas	20	14.1	
Paradera	18	12.7	
Savaneta	17	12.0	
Missing	3	2.1	
QD3_label			
18–22	69	48.6	
23–26	27	19.0	
31–40	22	15.5	
27–30	14	9.9	
41+	10	7.0	
Missing	3	2.1	
QD4			
University of Aruba (UA)	122	85.9	
IPA	20	14.1	
Missing	3	2.1	
faculty_label			
Arts & Science	41	31.5	
Hospitality & Tourism	26	20.0	
Accounting, Finance & Marketing	24	18.5	
Faculty of Law	19	14.6	
Teacher Primary Education	19	14.6	
IPA - Other	1	0.8	
Missing	15	10.3	
QD7			
Yes	139	100.0	
Missing	6	4.1	
QD10			
Paid employment	64	46.0	
Not working, not looking	21	15.1	
Self-employed	16	11.5	
Apprentice	13	9.4	
9	13	9.4	
Unemployed	10	7.2	
Home duties	2	1.4	
Missing	6	4.1	
QD11			
≤ Afl. 1,893	51	36.7	
Afl. 3,001 – 6,000	37	26.6	
Afl. 1,894 – 3,000	23	16.5	
Afl. 6,001 – 9,000	19	13.7	
Afl. 9,001 – 12,000	6	4.3	
≥ Afl. 12,001	3	2.2	
Missing	6	4.1	

Table A2: Financial behavior items

Table A2. Item-Level Descriptive Statistics for Financial Behavior (n = 145)					
Response	n	%	Mean	Median	SD
QF_budget					
Summary	NA	NA	0.9	1.0	0.3
0	21	14.5	NA	NA	NA
1	124	85.5	NA	NA	NA
QF_saving					
Summary	NA	NA	0.8	1.0	0.4
0	23	15.9	NA	NA	NA
1	122	84.1	NA	NA	NA
QF_makeendsmeet					
Summary	NA	NA	0.8	1.0	0.4
0	29	20.0	NA	NA	NA
1	116	80.0	NA	NA	NA
Qb7_new					
Summary	NA	NA	1.1	1.0	0.7
0	28	19.3	NA	NA	NA
1	81	55.9	NA	NA	NA
2	36	24.8	NA	NA	NA
QS1_5					
Summary	NA	NA	2.0	2.0	0.8
1	36	24.8	NA	NA	NA
2	82	56.6	NA	NA	NA
3	20	13.8	NA	NA	NA
4	5	3.4	NA	NA	NA
5	2	1.4	NA	NA	NA

QS1_8

Summary	NA	NA	2.2	2.0	0.9
1	27	18.6	NA	NA	NA
2	75	51.7	NA	NA	NA
3	26	17.9	NA	NA	NA
4	15	10.3	NA	NA	NA
5	2	1.4	NA	NA	NA

QS2_3

Summary	NA	NA	2.1	2.0	0.9
1	48	33.1	NA	NA	NA
2	51	35.2	NA	NA	NA
3	36	24.8	NA	NA	NA
4	9	6.2	NA	NA	NA
5	1	0.7	NA	NA	NA

QS2_5

Summary	NA	NA	1.6	1.0	0.8
1	81	55.9	NA	NA	NA
2	54	37.2	NA	NA	NA
3	5	3.4	NA	NA	NA
4	2	1.4	NA	NA	NA
5	3	2.1	NA	NA	NA

Table A3: Financial attitude items

Table A3. Item-Level Descriptive Statistics for Financial Attitude (n = 145)					
Response	n	%	Mean	Median	SD
QS1_1					
Summary	NA	NA	3.4	3.0	1.1
1	8	5.5	NA	NA	NA
2	22	15.2	NA	NA	NA
3	43	29.7	NA	NA	NA
4	52	35.9	NA	NA	NA
5	20	13.8	NA	NA	NA
QS3_11					
Summary	NA	NA	4.0	4.0	1.1
1	6	4.1	NA	NA	NA
2	7	4.8	NA	NA	NA
3	31	21.4	NA	NA	NA
4	37	25.5	NA	NA	NA
5	64	44.1	NA	NA	NA

Table A4: Financial knowledge items

Table A4. Item-Level Descriptive Statistics for Financial Knowledge (n = 145)					
Response	n	%	Mean	Median	SD
QK3_score					
Summary	NA	NA	0.8	1.0	0.4
0	28	19.3	NA	NA	NA
1	114	78.6	NA	NA	NA
NA	3	2.1	NA	NA	NA
QK4_score					
Summary	NA	NA	1.0	1.0	0.2
0	5	3.4	NA	NA	NA
1	137	94.5	NA	NA	NA
NA	3	2.1	NA	NA	NA
QK5_score					
Summary	NA	NA	0.9	1.0	0.3
0	11	7.6	NA	NA	NA
1	120	82.8	NA	NA	NA
NA	14	9.7	NA	NA	NA
QK6_score					
Summary	NA	NA	0.5	1.0	0.5
0	63	43.4	NA	NA	NA
1	68	46.9	NA	NA	NA
NA	14	9.7	NA	NA	NA
QK7_1_score					
Summary	NA	NA	0.6	1.0	0.5
0	56	38.6	NA	NA	NA
1	89	61.4	NA	NA	NA
QK7_2_score					
Summary	NA	NA	1.0	1.0	0.2
0	6	4.1	NA	NA	NA
1	139	95.9	NA	NA	NA
QK7_3_score					
Summary	NA	NA	0.4	0.0	0.5
0	84	57.9	NA	NA	NA
1	61	42.1	NA	NA	NA

Table A5: Reliability analysis

Reliability Estimates for Financial Literacy Constructs			
Construct	Cronbach's Alpha	McDonald's Omega	N (complete cases)
Financial Attitude (FA)	0.59	Not applicable	145
Financial Knowledge (FK)	0.36	0.77	145
Financial Behavior (FB)	0.53	0.86	145

Table A6: Financial behavior sub-dimensions

Mean and Standard Deviation for CFA-Based Financial Behavior Subdimensions		
Subdimension	Mean (M)	Standard Deviation (SD)
Planning	0.83	0.22
Caution	0.78	0.24

Figure A1: Factor analysis

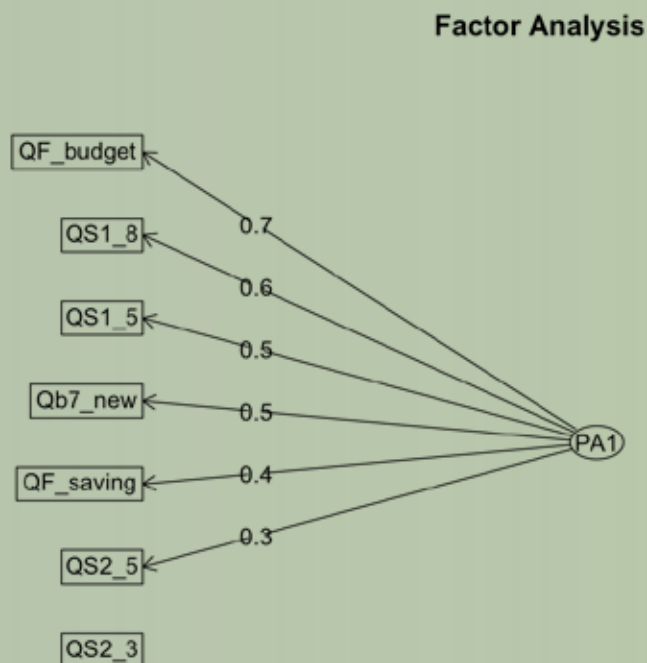


Table A7: Regression model output

Outcome	Predictor	Coefficient	Std. Error	p-value
Financial Attitude	Gender	-0.46	0.17	0.008
Financial Attitude	Age	0.02	0.06	0.684
Financial Behavior	Gender	-0.39	0.29	0.184
Financial Behavior	Age	0.05	0.09	0.573
Financial Knowledge	Gender	0.87	0.25	0.001
Financial Knowledge	Age	0.18	0.08	0.032
Composite FinLit	Gender	0.03	0.43	0.940
Composite FinLit	Age	0.25	0.14	0.070

6.

Securing energy during the energy transition: A study on the emerging risks to energy security during the energy transition in Aruba

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Abstract

Energy security is a key element of a successful energy transition. In the long run, the energy transition should improve energy security. However, the transition to a low-carbon economy will expose a number of new risks to energy security that are fundamentally different from the traditional risks around supply, demand, and system stability. These risks are specifically associated with the use of renewable energy and can occur in the areas of geopolitics, decentralization of energy production, digitalization, physical climate events, and critical minerals supply. Unsurprisingly, the risks to energy security faced by the rest of the world apply to Aruba as well. In particular, Aruba faces energy security risks across the dimensions of supply security, system stability, and system security. The recommendations presented in this chapter focus on, inter alia, the governance of energy security through a dedicated energy agency, managing supply security by expanding the share of renewable energy in the energy mix, enhancing system stability through investment in technology and energy storage capacity, and improving system security by implementing effective risk management and developing emergency response strategies.

Keywords: energy security, energy transition, renewable energy, small island economies.

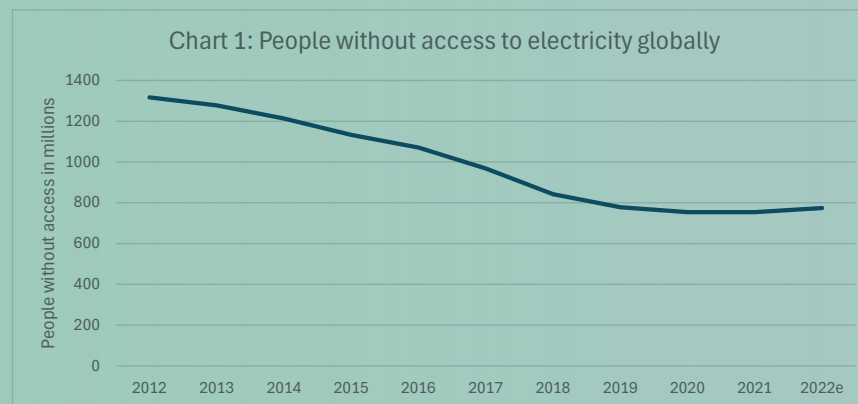
1. Introduction

There is broad international consensus that climate change is leaving us no choice but to transition to a low-carbon energy system. To avoid disastrous and irreversible climate change, we must lower carbon emissions and limit global warming to 2°C or preferably 1.5°C. In addition, Russia's war in Ukraine and the resulting energy crisis have highlighted the need for countries to reduce their energy dependency and increase the share of renewables in their energy mix. However, while the energy transition enhances energy security through reducing dependency on energy imports, it does bring its own set of challenges to energy security.

The International Energy Agency (IEA) defines energy security as having uninterrupted access to energy and securing energy supplies at affordable prices. This definition comprises the three dimensions often considered the core pillars of energy security, namely, accessibility, reliability, and affordability (Holley and Lecavalier, 2017). The precise meaning of these dimensions varies within policy and the literature (IEA,

2014). Holley and Lecavalier (2017) associate accessibility with geopolitical elements related to energy generation, safety, energy independence, and diversification of energy fuels and services. They relate affordability to the basic cost and price of energy, but it can also include equitable access of energy services. Finally, they define reliability as the ability to supply the quantity and quality of energy desired by the customer when it is needed under normal operating conditions, but also in response to unexpected disruptions.

The abundance of relatively cheap oil and gas over the past decade or so, driven by the shale revolution in the United States, has lured the world into a false sense of security when it comes to energy. Energy market volatility and geopolitical events over the past three years have exposed vulnerabilities in the world's energy mix, raising doubts on energy security, affordability, and the resilience of the global energy supply. These doubts were strengthened when 2022 became the first year in decades in which the number of people without access to electricity increased (a rise of about 20 million).



Source: IEA, 2022.

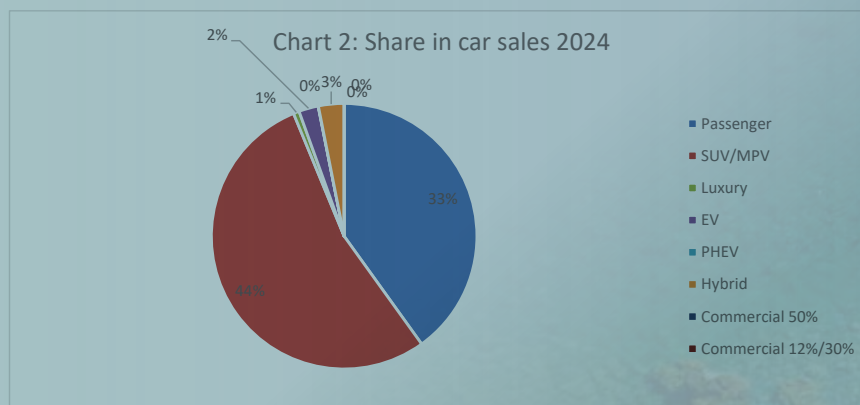
In light of the mentioned risks and the energy crisis sparked by the war in Ukraine, it is clear that energy security is a key element of a successful energy transition. In the long run, the energy transition should improve energy security. However, the transition to a low-carbon economy exposes a number of new risks to energy security that are fundamentally different from the traditional risks around supply, demand, and system stability. These new risks are specifically associated with the use of renewable energy and can occur in the areas of geopolitics, decentralization of energy production, digitalization, physical climate events, and critical minerals supply. These risk areas are captured in the energy security dimensions that are discussed in the next section.

Energy security consists of several dimensions. With regard to the energy transition, these dimensions are (WEF (2023), Securing the Energy Transition):

- a. Supply security.
- b. Demand management.

- c. Market and regulatory measures.
- d. Global and regional trust.
- e. System stability.
- f. System security.

Unsurprisingly, the risks to energy security faced by the rest of the world apply to Aruba as well. Aruba is currently increasing the share of renewable energy in its energy mix and aims to have 50 percent of its energy needs produced through renewable sources by 2030 (Government of Aruba (March 2021), Resolutions Energy Summit III). In addition, it aims at raising the adoption of electrical vehicles to at least 15 percent of total vehicles by 2030. In 2024, the car sales of electric vehicles reported by the Aruba Car Dealers Association (ACDA) amounted to 2 percent of total sales (Chart 2). It should be noted that there are several car dealerships in Aruba that specialize in electrical vehicles, which are not included ACDA's numbers. Aruba will, thus, be escalating its reliance on electricity and renewables to produce it. Consequently, it also must effectively manage the risks to energy security associated with this transition.



Source: Aruba Car Dealers Association.

The question that this chapter answers is two-fold: The first question is: what are the energy security risks emerging from the energy transition that apply to Aruba? The study aims to answer this question by probing the WEF's six-dimension energy security framework and determining which dimensions are at play in Aruba. After establishing the relevant dimensions, the study turns to the second question: **what should the government do to mitigate the energy security risks associated with the energy transition?** The study bases its recommendations on international best practices, while taking into account the small-island context of Aruba.

The remainder of this chapter focuses on the various dimensions of energy security related to the energy transition. Next, the chapter lists energy security risks during the energy transition for Aruba and provides recommendations on effectively managing and/or mitigating these risks. The chapter concludes with a summary of the main findings and recommendations, as well as suggestions for future research and closing remarks.

2. New dimensions of energy security

The energy crisis that resulted from global disruptions in energy markets and the war in Ukraine has intensified the push for renewable energy and the shift to net-zero carbon emissions. The global consensus around the energy transition is now even stronger. However, it has also become clear that energy security has returned as a concern for many countries and poses a serious challenge to the transition. Some experts believe that a near-term focus on energy security will accelerate the drive to net zero over the medium- and longer term (Ashraf et al., 2022). This is because companies rethinking their energy

security strategies will quickly realize that future energy security depends on a more diversified mix of energy sources. Originally, energy security awareness in western countries was triggered in the 1970's by the oil embargo. Since then, countries have become concerned about the potential for OPEC to use its market power to disrupt oil supplies, and energy security has been centered primarily around ensuring adequate and reliable supply of energy at reasonable prices. The focus has traditionally been on threats caused by sudden interruptions, the collapse of existing energy supply agreements, and large price fluctuations due to manipulation, as well as geopolitical risks.

However, as the world changes, so does the global energy landscape as well as the supply and demand dynamics of the global energy market. These changes significantly impact energy security. For instance, Ang et al. (2015) find that the definition of energy security is contextual and dynamic in nature. They find also that the scope of energy security has expanded, with a growing emphasis on dimensions such as environmental sustainability and energy efficiency. Some changes that have significantly influenced energy security include geopolitical changes, globalization, technological advances, and climate change. Geopolitical changes, such as the collapse of the Soviet Union in the 1990's, alter the supply and demand dynamics of the global energy market.

Globalization has promoted the interdependency between suppliers and consumers and has intensified the energy competition between consuming countries. Meanwhile, technological advances, among other things, have made it possible to diversify energy supplies and reduce countries' dependence on imported energy. Climate change has also become an aspect of energy security as countries seek to ensure

access to reliable and affordable renewable energy sources as they transition to a clean energy economy. In addition to the environmental damage caused by fossil fuels and their role in greenhouse gas emission, the desire to shift toward renewable

sources was further triggered by the non-renewable nature of fossil energy and the ensuing worries about resource depletion. Table 1 gives an overview of how several factors and risks shape the energy transition and risks to energy security.

Table 1: Factors impacting energy transition and energy security

Scope of energy transition	Traditional risks to energy security	New Risks/Factors impacting scope of energy security
Diversify energy supply/reduce dependence on imported energy	Sudden interruptions	Geopolitical changes
Environmental / access to reliable and affordable renewable energy sources	Collapse of existing energy supply agreements	Globalization
Resource depletion / non-renewable nature of fossil energy	Price manipulation	Technological advances
Energy efficiency	Geopolitical risks	Climate change

Energy security has always been a strategic priority. However, an era of supply abundance has caused the need for energy security to largely fade over the past decade or so. The recent energy shock, coupled with the ensuing economic slowdown, surging energy prices, and geopolitical

conflicts have led many countries to reassess their energy strategies. This reassessment reflects the realization that energy security, meaning adequate and reasonably priced supplies, is a precondition for a successful energy transition. It recognizes that energy security is needed to ensure public support and

avoid severe economic dislocations, with dangerous political consequences that can follow (Yergin (2022), Bumps in the energy transition).

The period of supply abundance may have contributed to concealing long-term structural vulnerabilities (WEF 2023).

These vulnerabilities include:

- I. Vulnerability from limited import partner diversification: countries experiencing energy security challenges have often failed to diversify either their domestic energy mix or their energy import partners or both. Consequently, these countries are more exposed to supply disruptions from adverse climatic, geopolitical, and supply chain events.
- II. Inadequate penetration of renewable and low-carbon energy sources to compensate for the drop in fossil fuel supplies: investment amounts in energy transitions fall well short of what is needed to trigger a peak and decline in fossil fuel demand, and to support the creation of a clean, sustainable energy system. Consequently, a strong dependence on fossil fuels remains.
- III. Slow progress on energy efficiency: investments in energy efficiency and demand-side responses have lagged. This has compromised the flexibility of the energy system. In addition, the shortfall in investments in energy efficiency resulted in higher energy demand.
- IV. Reduced investment in upstream oil and gas: the need for energy security and affordability requires further investment in fossil fuel projects while energy production transitions from fossil sources to renewable sources. Insufficient investments in recent years have led to tight energy markets. Unplanned or premature retirement of fossil fuel infrastructure also can have negative consequences for energy security.

- V. Phasing out of nuclear energy: after the Fukushima disaster in 2011, many countries announced phasing out nuclear electricity production, reducing the potential of nuclear energy to serve as an alternative source of energy production. Concerns around nuclear waste and fuel storage also withheld countries from raising investments.

In addition to the aforementioned vulnerabilities, the energy transition to a low-carbon economy is exposing new risks to energy security as energy systems are becoming more decentralized, electrified, digitalized, and decarbonized.

These risks differ in essence from the traditional risks that centered around supply, demand, and system stability – even though these traditional risks remain. These emerging energy security risks can be grouped in the following categories (Table 2) (WEF 2023):

- 1) Geopolitics
 - a) Realigning energy trade flows of renewable energy technologies and components;
 - b) Rising protectionism;
 - c) Intellectual property barriers.
- 2) Decentralization
 - a) Risks to system stability and reliability due to a wide range of power generation and management assets;
 - b) Lack of economies of scale;
 - c) Likelihood of more stranded legacy assets.
- 3) Digitalization
 - a) Exposure to more cyber risks with increasingly connected systems;
 - b) Digital assets more prone to critical system failures and lack stability to handle fluctuations.
- 4) Physical climate events

- a) Unpredictable weather and extreme events (e.g., droughts, floods, wildfires) impact operation of renewables, with implications for energy system stability and planning.
- b) Critical minerals supply
 - i. Concentration of minerals in specific locations brings challenges in supply, accessibility, and affordability.
 - ii. Aggravated by policy push towards diversification.

These new risks that emerge during energy transition bring new dimensions to energy security. Traditionally, energy security has been understood in terms of supply

security, reliability, and resilience. However, there are additional dimensions that have to be considered to secure the energy transition. The WEF has identified the following dimensions (WEF) 2023:

- I. Supply security;
- II. Demand management;
- III. Market and regulatory measures;
- IV. Global and regional trust;
- V. System stability;
- VI. System security.

Table 2: Emerging energy security risk categories

Geopolitics	Decentralization	Digitalization	Physical climate events
Realigning energy trade flows of renewable energy technologies and components.	Risks to system stability and reliability.	More cyber risk exposure.	Risks to energy system stability and planning due to impacts of unpredictable weather on operation of renewables.
Rising protectionism.	Lack of economies of scale.	Digital assets more prone to system failures and lack stability to handle fluctuations.	Critical minerals supply Concentration of minerals in specific locations. Aggravated by policy push towards diversification.
Intellectual property barriers.	Likelihood of more stranded legacy assets.		

I. Supply security

Supply security is not only about becoming more self-sufficient, but also about reaching an optimal combination of energy trade and diversification to keep overall costs under control. Supply security consists of diversifying supply by increasing the domestic low-carbon energy mix, diversifying imports to reduce trade exposure, and securing supply of critical minerals.

a. Diversify supply by increasing the domestic low-carbon energy mix.

The transition to net-zero will require substantial growth in output from low-emission sources. Consequently, diversification of domestic energy supplies will shift reliance on fossil fuels to alternative energy sources with lower emissions. The use of fossil fuels will not be completely eliminated in the medium-term, but a diversified approach will mitigate the impact of fossil fuels on the transition. However, there are also voices in the literature that question the addition of natural gas infrastructure on the grounds that this puts the energy transition at risk due to carbon lock-in and stranded assets (Kemfert et al., 2022).

Countries should be cautious of transitioning away from fossil-fuel-based energy too rapidly. The latter could lead to a reduction in the supply of energy if there are insufficient renewable energy sources available to supplement the reduction in fossil-based supply. This could result in an upward shock in energy prices with a detrimental impact on the economy. The years following the pandemic, i.e., 2020-2022, illustrated this risk, as investments in the oil and gas sector were significantly below pre-pandemic levels (IEA, 2022) and contributed to tight

energy markets. According to the WEF's Energy Transition Index (ETI), countries with a well-diversified energy mix improve their chances of a successful energy transition, while also scoring higher on energy security. If a country is able to diversify across its renewable energy sources, it can further reduce its risk of being dependent on any single clean energy source and, thus, enhance its energy security.

b. Diversify imports to reduce trade exposure.

When a country depends on just one or two trade partners for the lion's share of its energy imports it becomes more vulnerable to supply disruptions, which could also become a national security concern. To enhance the security around imports, countries should diversify the network of fuel and electricity import partners. In this way, exposure to concentrated supply shocks can be reduced. The WEF considers countries with over 70 percent of their energy imports from their top three trade partners more exposed to supply disruptions than those with a more diversified import partner mix. In addition to importing from different countries, countries can further reduce their exposure by also diversifying the import regions.

c. Secure supply of critical minerals

As the economy's shift to low-carbon energy sources gains traction, there will be a substantial boost in the demand for critical minerals needed for clean energy. The International Energy Agency (IEA) estimates that its net zero emissions (NZE) by 2050 scenario will entail a quadrupling of demand for critical minerals by 2030 compared to the current level. The regional concentration of these minerals in a relatively small number of countries means that regulatory changes, trade

restrictions or even political instability in a small number of countries can quickly affect supply chains and is a cause for concern with regard to price volatility, resource availability, and security of supplies. In addition to this concentration, the lead time to expand supply is long. The geopolitics of these minerals constitute a risk of higher prices for solar panels, wind turbines, EV batteries, and grid lines, thus, a higher cost of transition. Consequently, the supply security of these critical minerals becomes an important dimension to consider.

II. Demand management

Demand side management (DSM) is a crucial aspect of energy security and should be a long-term proactive strategy, rather than a short-term reactive measure. DSM is geared towards monitoring and altering the energy demand of end-users. It is achieved by efficiency improvement on the customer's end and ultimately results in reduced fossil fuel consumption. DSM is particularly relevant for small islands as it is considered to be the least costly option to reduce oil import dependency for small islands (Raghoo et al., 2018). Energy efficiency, materials efficiency, and behavioral change can lead to significant energy savings and emission reductions. Demand management includes the following elements: prioritize energy efficiency, accelerate the materials transition, and scale up demand response and advocate for consumer behavioral change.

Energy efficiency

The EIA refers to energy efficiency as the “first fuel”, since the cleanest, cheapest, and most reliable source of energy is the energy that countries can save or do not

have to consume, while still providing full energy services for citizens (EIA, 2022). Energy efficiency measures can be both short term and long term. Short-term measures include emergency conservation measures and active participation of end-consumers in demand management to reduce demand during disruptions. Long-term efficiency measures refer to large-scale retrofit programs, the adoption of high-efficiency appliances, and the integration of industrial processes conducive to benefits such as waste-heat recovery and improving energy intensities. Lowering the energy intensity is important for economies in the transition to clean energy as it helps avoid substantial amounts of emissions. Moving forward, investments in energy technology are required to enable more efficient use of energy and materials, to allow substitution, and to unlock new supplies. Targeted investment in energy efficiency and electrification will be of particular importance. In addition, the EIA contends that energy efficiency can reduce fuel import dependence, lessen exposure to energy price volatility, and make systems and societies more resilient (EIA, 2022).

Accelerate the materials transition

Almulla et al. (2022) describe the materials transition as the aim of evolving the current materials landscape by enhancing materials-induced efficiency, reducing emission-intensive materials through material substitution, and expanding upon direct and indirect material reuse and circularity. A faster materials transition can be achieved by industries seeking greater efficiencies, substituting emissions-intensive materials, and enhancing circularity. This includes the replacement of conventional materials with substitutes that are superior in terms of performance and can extend a product's life and optimize its energy consumption. If energy efficiency is

enhanced throughout product lifecycles and emissions-intensive materials are substituted, the materials transitions can contribute to a stronger energy supply.

Demand response and consumer behavioral change

One way to change patterns of consumers behavior is through demand response mechanisms. The U.S. Department of energy describes demand response as systems that provide consumers with an opportunity to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods (www.energy.gov). These mechanisms are either price-based (encouraging consumers to reduce demand at peak hours) or incentive-based (rewarding consumers who modify their consumption with direct payments). Measures such as these help balance electricity supply and demand and reduce the risk of power outages and damage to devices connected to the grid. In addition to balancing demand and supply, influencing consumer behavior is also essential in curbing total energy demand and carbon emissions. Changing consumer behavior requires raising consumers' awareness of the impact of climate change, carbon footprints, and the individual actions that can be taken to support national energy security and sustainability ambitions, such as reducing wasteful energy use, switching to less energy-intensive modes of transportation, increasing digitalization, and becoming a prosumer.

III. Market and regulatory measures

This dimension of energy security consists of rationalizing capital funding and allocation, adapting to re-designed energy market structures, and managing policy mechanisms.

Rationalize capital funding and allocation

This aspect is about channeling new energy investment to low-emission sources and technologies, while balancing investments in fallback (fossil) fuels, which are still necessary to manage energy supply disruptions. Finding this balance is tricky. This is because these fossil fuel power plants typically have a lifespan of 30-50 years and investing in these plants to meet short-term needs represents a risk of emissions lock-in and significant stranded assets, as policy measures to mitigate emissions become increasingly stringent. On the other hand, a mismatch between energy supply and demand could lead to a drop in investment in new oil and/or gas fields combined with a shortfall in renewable energy investment. Such a development could trigger higher and more volatile prices and eventually an energy crisis. A crisis like that could, in turn, cause uncertainty, major economic problems, and undermine public support for the energy transition. To avoid these risks from materializing, it is important to combine flexible short-cycle investments in abating hydrocarbons with step-change towards clean, renewable power investment.

The WEF (2023) identifies the following key considerations for rationalizing capital funding and allocation for a secure energy transition:

- 1) Tackle stranded assets and repurpose infrastructure:
 - a) Consider low-cost and long-term financing to fund the required investment and retrofit
 - b) Repurpose existing infrastructure to support the low-carbon supply chain and create a new revenue stream for existing assets
 - c) Rationalize investments to minimize the wasted capital from unplanned and pre-mature stranded assets.
- 2) Allocate capital to align with long-term goals:
 - a) Aggregate energy projects into portfolios that can be

- securitized, enabling investors to finance small-scale assets, while spreading risks and lowering financing costs
 - b) Address the risks of cashflow uncertainty and financing costs stemming from new business models
 - c) Ensure coordination among investors, companies, and governments
 - d) Use good data and analysis to support decision-making for scaling investible opportunities consistent with long-term goals.
- 3) Accelerate commercialization of clean technologies and solutions:
- a) Accelerate the deployment of solutions such as wind, solar, hydrogen, biofuels, and carbon capture utilization and storage (CCUS), as well as solutions that improve energy efficiency and circularity
 - b) Substantially increase investments in energy efficiency solutions, low-carbon fuels, and CCUS in the coming years
 - c) Develop more full-scale demonstration projects to accelerate the commercial readiness of low-emission technologies and reduce costs.
- 4) Make targeted investments in the renewables value chain:
- a) Targeted investment can spur adoption and scale the benefits of abated fossil fuel and renewable technologies.
 - b) Hydrogen, sustainable fuels, and carbon capture offer potential for reduced dependence on solar and wind alone, while supplying clean power for energy uses that cannot be electrified.

Adapt to redesigned energy market structures

A well-designed energy market structure can hedge the

system against extreme price volatility and in such a way that reduces dependence on a single fuel type as the sole driver of energy prices. Other types of market reform, such as splitting the wholesale market into a market for clean power and a fossil power market for conventional power generation leading to a price that is a weighted average of the two markets, could also make it possible for consumers to access cost savings of renewables, while still allowing clean technologies to compete with fossil fuels in the production of electricity in the spot market. In this way, the discrepancy between average and marginal costs of electricity production can be mitigated.

Manage policy mechanisms

Governments can influence energy demand through their policies. These policy mechanisms can take the form of subsidies, tax benefits or waivers, capital grants, energy efficiency mandates, and more. These mechanisms can be used for several purposes, such as the adoption of green solutions, the de-risking of markets to unlock private financing, and scaling up low-emission production technology. One of the strongest policy instruments available to incentivize low-emission technology is carbon-pricing. The latter has the potential to change the behavior of consumers, businesses, and investors, while spurring technological innovation and generating revenues that can be invested in a cleaner energy mix enhancing supply security and sustainability requirements.

IV. Global and regional trust

This dimension of energy security consists of strengthening collaboration for energy security and building trusted interconnections.

Strengthen collaboration for energy security

Improved trust and coordination are essential. Across regions and countries, but also within countries and sectors and among stakeholders. Collaboration between public and private sectors is important to attract the diversified sources of capital needed for multi-year investments in energy systems, develop large infrastructure projects, and scale-up technologies such as clean hydrogen and CCUS applications. From a government perspective, there are several advantages of public-private collaboration (World Bank, 2022), including the ability to:

1. Enhance the constrained public sector resources to address growing requirements for infrastructure development.
2. Integrate private sector expertise, innovation, and operational efficiency.
3. Complete projects on time and within budget through robust performance-based contractual arrangements and financing structures.
4. Achieve long-term value by transferring risk to the private sector throughout the project's lifecycle, from design and construction to operations and maintenance.
5. Facilitate skill transfer between the private sector and state-owned enterprises and government, increasing the competitiveness of national entities and improving service delivery for the end-user.

In addition to the benefits, the government also faces some key risks and challenges when entering into collaboration with the private sector. These include the following:

1. Despite lower costs in a competitive bidding environment,

projects can incur higher capital costs, due to private investors' limited access to low-cost financing and risk mitigation instruments.

2. Private sector involvement requires a return on investment. Consequently, costs must be covered either by end-customers or through government guarantees.
3. Information asymmetry between the private sector and the government partner owing to the greater expertise of the former. To mitigate this imbalance, the enforcement of clear and comprehensive reporting obligations on the private operator are crucial.
4. Certain projects may be more difficult to execute through public-private collaboration, in particular when there is resistance from public sector employees to private sector involvement, substantial tariff hikes for project viability, or complex land and resettlement issues.

Moreover, an accelerated energy transition requires trust between countries. Considering regional distributions in technology development, manufacturing of renewable energy components, and availability of critical minerals, international trade will increasingly determine the ability of countries to support mutual energy transition. Protectionist policies that restrict trade in low-carbon materials and technologies are likely to trigger similar reactions from other countries.

In addition, trust in institutions is critical for implementing successful demand-management programs, as these demand broad societal acceptance and participation. Social adaptation behavior can be achieved in the short-term through a high degree of transparency, adherence to scientific evidence, and consistent information sharing.

Build trusted interconnections

Grid interconnections are likely to play a significant role in the energy transition. They will help achieve the underlying infrastructure needed to integrate new wind and solar capacities, serve new demand, and provide flexibility. The impacts of these interconnections can be rather complex and may vary for different dimensions of energy security. An interconnected grid may, for example, improve energy supplies, but increase reliance on imports. A positive impact of interconnected grids is that they can help smooth fluctuations in the supply of weather-dependent renewables within and between countries and regions. In addition, they can connect additional providers to the system.

Countries can increase trade in low-carbon power, reduce emissions, improve energy security, and enhance system flexibility, while expanding opportunities for energy imports diversification by creating new cross-border super grids. Neighboring economies that are linked through these interconnections can improve energy security through diversification and by building cross-border trusted mechanisms that foster bilateral co-operation, which is necessary given the current uncertain geopolitical environment.

V. System stability

The share of electricity in total energy consumption will likely increase in the coming years if the transition to net-zero is to be achieved. This means that system stability will become pivotal in electricity security to enable systems to withstand and respond to disturbances such as generator or grid outages from load changes or extreme weather events. The addition of more renewables to the grid presents a challenge to

system operators to maintain stability. It requires them to address the variability of renewable energy supply, the role of storage, changes in demand patterns, and the impact of transmission outages. Weather proofing the energy infrastructure is another aspect of a strategy to enhance the stability and resilience of the system. The system stability dimension of energy security consists of three elements:

- a) building a reliable system with adequate dispatchable generation, demand response, and network capacity;
- b) integrating system resilience to survive and quickly recover from extreme and unexpected disruptions;
- c) Program grid expansion and modernization.

Build a reliable system with adequate dispatchable generation, demand response, and network capacity

Electricity reliability is particularly important to consumers and virtually every sector depends on electricity. Loss of generation, loss of transmission, and loss of consumer demand traditionally form the threats to reliability. Operational reliability is the ability of the power system to balance supply and demand in real time by managing variability and flexible loads. The intermittent nature of renewable energy sources can cause sudden changes to generation patterns on a daily or weekly basis. The increase of their use in the energy mix requires more flexibility as well as a stronger focus on grid stability and reliability. It is therefore important to have market structures that appropriately price and incentivize reliability of services related to both supply and demand. A reliable system should be able to reduce or shift energy demand to meet supply (demand response), provide information about electricity production and use, and access or store renewable energy for use when it is needed.

Integrate system resilience to survive and quickly recover from extreme and unexpected disruptions

Diversifying into renewables such as wind and solar can help enhance grid resilience. This is because small-scale generators, like distributed wind and solar PV, have the potential to facilitate recovery from large-scale power disruptions, while large thermal power plants take longer to restart after a blackout.

On the other hand, enhanced renewable energy penetration can make the power grid less reliable due to the intermittent nature of renewable energy sources. This results in increased risk of blackouts, which can have a detrimental effect on energy security and the economy. Therefore, energy storage becomes another important aspect of system resilience. Storage is crucial to meet the need for flexibility in a decarbonized and distributed electricity system. It is the key to solving the intermittency problem faced by clean energy sources and thereby bringing their reliability and consistency on par with fossil fuels. Storage plays a role in integrating renewables, supporting smart grids, creating more dynamic electricity markets, providing ancillary services, and improving self-sufficiency and stability. Storage technologies in use include pumped hydro, currently the largest source of electricity storage, and the use of excess renewable energy capacity to produce hydrogen. The latter serves as a solution to store seasonal peaks of renewable electricity, while mitigating the intermittent nature of supply from renewable sources.

Program grid expansion and modernization

As renewable energy capacity is added to the energy mix, expansion of grid infrastructure and enhanced grid flexibility are necessary to avoid grid congestion and

ensure a successful transition to clean energy. Therefore, grid modernization is gaining importance among policy makers seeking to promote the energy transition, while also maintaining energy security. The challenge for grid upgrades is the cost pressures they face along with tight markets for critical minerals. However, smart grids are essential to any modernization strategy in helping improve performance and uptime as well as overall stability and resilience.

VI. System security

The impact of energy disruptions is felt throughout the entire economy and wider society. Therefore, physical and cybersecurity in the energy sector merit special attention. System security contains two elements: developing risk management capabilities and strengthening cyber security and physical security of energy infrastructure.

Development of risk management capabilities

Risk management is important for enabling informed decision-making with regard to technology, policies, and operating models. It is also critical for maintaining the stability of the electricity system. Moreover, effective risk management can strengthen a country's disaster preparedness and ensure energy security in a crisis. Through effective risk management, countries can evaluate system vulnerabilities and formulate targeted mitigation and contingency plans. Monitoring tools and data analytics can help identify threats across the industry and region. The development of robust energy system risk management capabilities and strategies can be achieved through partnerships, information-exchange programs, and research initiatives across the electricity sector and beyond.

Strengthen cyber security and physical security of energy infrastructure

Energy security requires not only physical protection of critical infrastructure against threats but also protection against cyber threats. Increased digitalization has not only made the energy system smarter; it has also heightened exposure to cyber threats, which can put energy supply and consumer data privacy at risk.

The growing frequency and intensity of extreme weather events and their impact on physical energy infrastructure pose major risks to the security of energy supplies. Physical infrastructure is critical for maintaining the integrity of sensitive locations, like data centers and transmission, and distribution sites. At the same time, these systems are also essential in responding to a cyber-attack. Despite the growing cybersecurity threat, many attacks are not reported or may even go unnoticed. It is therefore important for policy makers to raise awareness and work with stakeholders to identify, manage, and communicate emerging vulnerabilities and risks. To this end, it is important to promote the exchange of lessons learned from challenging experiences as well as from success stories. This can be achieved through the implementation of knowledge sharing platforms and benchmarking groups. Awareness and knowledge can also be enhanced through the introduction of mandatory reporting requirements for cyber incidents by the government. In addition, policy makers can engage stakeholders in cybersecurity-focused partnerships with the aim of accelerating solutions to pressing challenges and risks.

3. Transition risks to energy security in Aruba

The Aruban government intends to reduce Aruba's CO₂ emissions by at least 45 percent from 2010 levels by

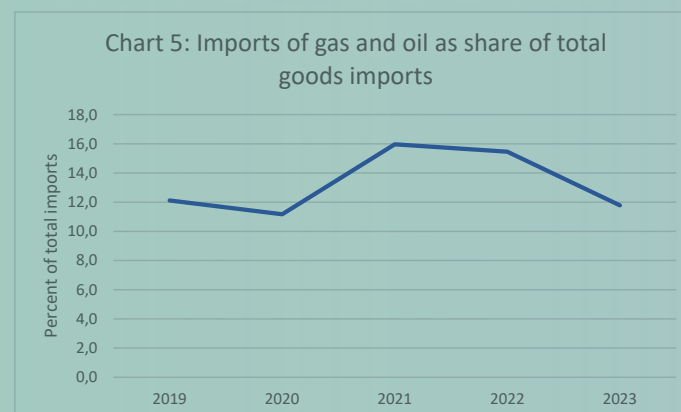
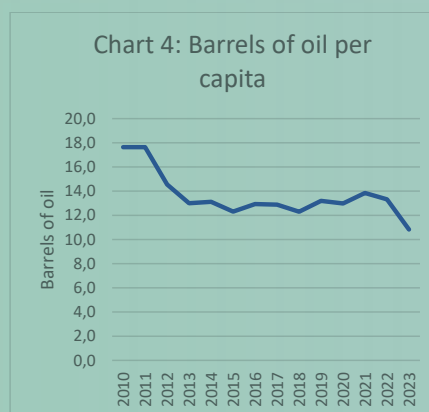
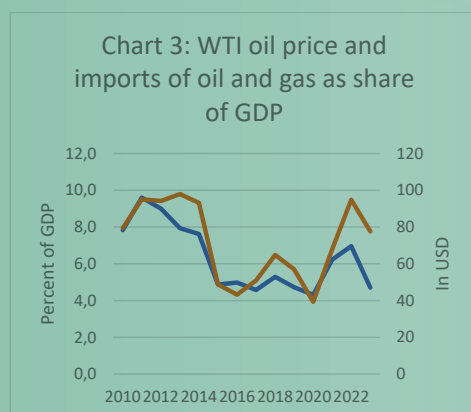
2030 and to reach net zero emissions no later than 2050

(Government of Aruba, 2021). While the reduction in emissions is part of Aruba's contribution to the mitigation of climate change, the transition away from fossil fuels is also a way to become less vulnerable to the price fluctuations on the international oil markets and to ultimately make energy more affordable for the Aruban people. It is undeniable that moving on from fossil fuels has energy security benefits. However, the previous section has also shown that the energy transition brings new challenges to energy security. This section will elaborate on the risks to energy security brought on by the energy transition that are particularly relevant for Aruba.

Despite having wind and solar parks and an abundance of sun and wind, Aruba currently still depends primarily on fossil fuels to meet its energy demands. Fossil fuels are the energy source for about 80 percent of total electricity production in addition to fueling the vast majority of vehicles on Aruban roads. Total installed capacity of Renewable Energy is about 30 percent of electricity production, but actual production is around 20 percent of the total. The discrepancy between installed capacity and actual output is due to the intermittent nature of renewable energy, whereby output fluctuates based on weather conditions. Moreover, grid limitations, maintenance, and outages may also cause deviations in actual output from installed capacity. In 2023, Aruba imported Afl. 293.5 million (4.4% of GDP) of crude oil (excluding jet fuel) and gas to meet its energy demand. This is consistent with studies that indicate that import dependency is the most important dimension of energy security in Small Island Developing States (SIDS) (Raghoo et al., 2018). While fuel imports as a percentage of GDP and barrels of fuel oil per capita have come down over the last decade (see Charts 3 and 4), Aruba still has a significant dependency on oil imports, which is also

reflected by the share of oil and gas imports in total imports of goods (see Chart 5). This large oil dependency exposes Aruba to the direct risk of supply disruption. In addition, oil stocks in Aruba average about 30-60 days of daily oil usage (source: Water and Energy Company (WEB)), which is below the IEA's recommended minimum of 90 days needed to respond to severe supply disruptions (IEA, 2022). The smaller stock of oil supply in Aruba may be due to cost constraints, as maintaining a larger oil reserve

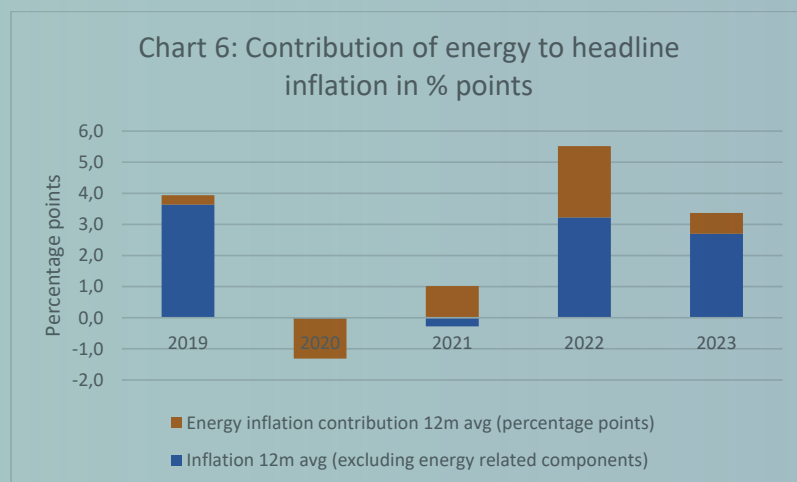
requires more capital. Moreover, Aruba purchases its oil from a small number of trading partners, suggesting that it has a large concentration of its oil suppliers, which further exacerbates the risk of supply disruption. It is worth noting that the Refineria di Aruba (RDA) emits a request for proposal every 18 months to ensure that it is buying at the best possible price. However, expanding or diversifying the group of suppliers presents challenges related to the reliability of potential counter parties.



Apart from the physical availability of oil, the price is also a factor that could impact energy security in many small island economies dependent on oil imports. Due to the small size of an island like Aruba and its negligible demand on the international market, it has no control over the price of its imports and is a 'price-taker' rather than a 'price-setter' (Briguglio, 1995). Geopolitical events, supply and demand shocks, and economic developments could all affect the price of oil. A higher oil price means that a larger part of Aruba's

foreign exchange reserves would flow out to pay for its energy needs, potentially putting pressure on reserve adequacy. Chart 3 shows the oil price development and the outflow related to oil and gas imports for Aruba over the period 2010-2023 as a share of GDP. We can see that on average import payments for oil and gas amounted to 5.4 percent of GDP during this period. A positive development is that this share shrunk significantly compared to a decade earlier (2010-2014) when the share was on average 8.4 percent (Chart 3).

Another consequence of higher oil prices is the impact on inflation. Throughout the years, price movements in international oil markets have been important contributors to inflation in Aruba through price hikes in utilities, gasoline, and indirectly in overall prices (Chart 6). Higher prices for utilities and gasoline directly impact the affordability component of energy security and may have a disproportionate effect on lower income households, which on average spend a larger portion of their income on utilities (CBS, Income and expenditure survey, 2016).



Higher oil prices could be the result of the transition itself if there is globally a rapid transition away from away from fossil-fuel-based energy, combined with insufficient investment in renewable energy. Such a mismatch between energy supply and demand could cause an upward shock to energy prices and eventually an energy crisis with detrimental effects on the economy. Aruba could also trigger

economic disruption through its own policies if it sets net carbon emission targets too aggressively or if it retires fossil fuel infrastructure prematurely. These scenarios could also undermine public support for the transition. In this regard, it is worth noting that WEB is still investing in its fossil fuel infrastructure to meet the expected increase in peak demand in the coming years.

The aforementioned risks are considered the traditional risks to energy security or long-term pre-existing vulnerabilities (WEF, 2023). The focus in this chapter is on the risks to energy security that are related to the energy transition, i.e., the emerging energy security risks.

One of these emerging energy security risks applicable to Aruba is the risk posed to energy infrastructure due to the growing frequency and intensity of extreme weather events that put at risk the security of energy supplies. Energy infrastructure is not only the power plant and power grid on-island, but it includes all components of the energy supply chain. These components entail transport by sea, disembarkation of oil, storage tanks, conversion to electricity, and the distribution thereof. For islands like Aruba, port infrastructure is critical to oil supply. Damage to the port could hinder the import and export of goods and forms a direct threat to Aruba's energy security. This means that port authorities need to perform regular maintenance to ensure that the port functions properly and storage tanks are sufficiently robust to resist natural disasters. Given the expected increase in frequency and intensity of extreme weather events, damages are more likely to occur, requiring more upfront investments to bolster resilience and probably higher repair costs. In addition to the port and oil storage tanks, the risks to energy security

also lie in the robustness of the power plants and the electricity grid. Extreme weather will also put these under more pressure and potentially cause interruptions to electricity transmission and distribution. Therefore, climate resilience of the energy infrastructure is critical. In this view, it is encouraging that WEB's business continuity plan addresses damage from extreme weather to all its assets.

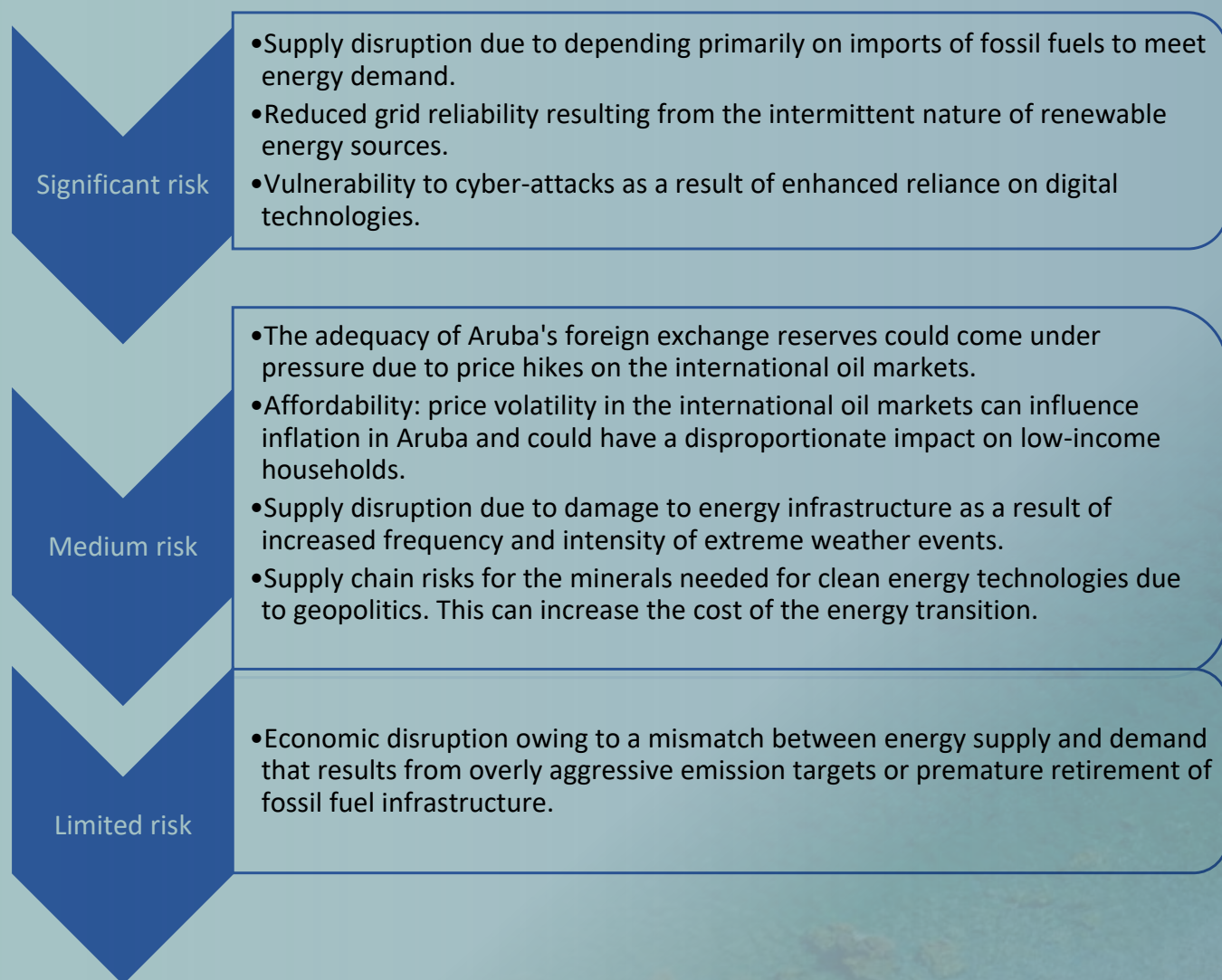
Another threat to energy security that has emerged along with the energy transition is the geopolitics of minerals needed for clean energy technologies. Overall mineral requirements for clean energy technologies will almost triple by 2050, but current supply and investment plans do not keep up with projected demand. Consequently, there is a risk of higher prices for solar panels, wind turbines, EV batteries and grid lines (up to 5-15 percent higher), thus, a higher cost of transition (IEA, 2021). Moreover, these minerals are distributed across a small concentration of source countries. This concentration introduces risk to supply chains. These supply chains could be quickly affected by regulatory changes, trade restrictions, or even political instability in a small number of countries. Geo-fragmentation can make it even more difficult to secure energy supply chains for the minerals needed. As a small island, Aruba is even more susceptible to this supply chain risk, due to its relatively small consumption and inability to offer competitive prices.

The increase foreseen in renewable energy penetration can make the power grid less reliable, due to the intermittent nature of renewable energy sources. This can cause sudden changes to generation patterns on a daily or weekly basis, leading to increased risk of blackouts which can have a detrimental effect on energy security and the economy. A

grid relying to a large extent on renewable sources requires more flexibility, i.e., battery storage and demand-side response become more important. In view of the significant amount of additional hotel rooms being constructed in the coming years, it is likely that energy demand and peak loads will increase correspondingly and put more demands on the electricity grid. Failure to meet this demand, reflected in a higher frequency of power outages, could result in dissatisfaction of tourists, and eventually negatively impact the livelihoods of those working in the tourism sector. Hence, reliable electricity supply is key for Aruba's tourism industry. If supply is not ensured, Aruba's primary economic pillar could suffer. Moreover, grid-related risks are especially relevant for islands since island grids are more fragile than relatively larger countries with grid interconnectivity. The heightened fragility of islands is due to them being completely isolated from other back-up systems (Croes, 2022).

The energy transition makes the energy infrastructure more vulnerable to cyber-attacks. This is also the case in Aruba where the utility companies rely increasingly on digital technologies like smart grids, digital controls for renewable energy sources, and interconnected communication networks. This enhanced digitalization presents greater opportunities for cyber criminals to disrupt operations, steal data, or manipulate energy flows. Cyber-attacks can lead to power outages disrupting essential services and causing economic damage, manipulation of energy supplies leading to shortages, and ultimately loss of public trust in the energy grid.

Figure 1: Summary of energy security risks in Aruba due to the energy transition.



4. Recommendations for managing risks to energy security in Aruba

This section puts forward recommendations to the government on how to mitigate risks to energy security triggered or enhanced by the energy transition. Before diving into the specific recommendations with regard to the dimensions of energy security, it is important to first provide recommendations on the governance aspects of energy security. While the utility companies are important players in Aruba's energy sector, the strategic decisions and implementation of policies regarding energy security should, first and foremost, be tasks of the government and government institutions.

Energy security governance

To effectively organize the governance of energy security, the government should develop a comprehensive and long-term national energy policy that outlines clear objectives for energy security. Also, it should introduce legislation to re-establish a dedicated energy ministry or agency to oversee the implementation of policy. Examples of countries with such legislation include the Netherlands and Singapore. The Dutch Energy Act was adopted in 2024 to merge the old electricity Act and the Gas act and replace them. The primary objective of this law is to lay a solid foundation for the energy transition and for a safe, reliable, and affordable energy supply. The act encapsulates three main themes: (1) reinforcing the position of consumers, (2) future-oriented system management, and (3) data exchange (www.kvdl.com, 2025). Singapore adopted the Electricity Act and Energy Market Authority (EMA) Act in 2001. The Electricity Act was enacted to create a competitive market framework for the electricity industry, to make provision for the

safety, technical and economic regulation of the generation, transmission, supply, and use of electricity, and for other matters connected therewith (Singapore Electricity Act 2001). This act grants authority to the EMA to exercise the functions and duties under this act.

In addition to an energy ministry, strong coordination is needed between different government agencies and departments involved in energy-related matters. Another requirement is a robust regulatory framework to ensure, fairness, consumer protection, and environmental sustainability in the energy sector. Meanwhile, **the decision-making processes should be transparent to promote accountability and public trust.** These recommendations are in line with actionable priorities suggested by the UNDP in relation to energy governance (UNDP, 2022). These priorities include:

- I. Inclusive and effective institutions that are responsive, accountable, trustworthy, and transparent, and able to act in a more coordinated way across the whole of government to address intersecting challenges or opportunities in society.
- II. A legal and regulatory framework that creates a conducive enabling environment to promote renewable energy, encourage private investments, support new clean energy innovations, and foster innovative business models for the energy sector.
- III. Civic engagement and empowerment to stimulate the participation of citizens and communities in problem diagnosis and co-creation of energy solutions, ultimately enhancing innovation.
- IV. Appropriate oversight, including through Parliament and its committees, and independent agencies, ombudspersons, human rights commissions, anticorruption agencies,

investigation and judiciary bodies, and consumer commissions which play a vital role in energy governance by ensuring compliance with fundamental rights and standards. In the case of Aruba, these entities are mostly already in place. The priority would be the establishment of an independent energy agency to oversee policy implementation, as well as a strong coordination between the aforementioned entities.

While the following recommendations are intended for the government, it should be noted that energy security is a collective responsibility and not solely a task for the government. Some recommendations may have implications for utility companies such as WEB and Elmar, which are crucial players in Aruba's energy sector. The recommendations are presented in line with the six dimensions of the secure energy transition framework by the WEF (WEF, 2023).

Rationalize capital funding and allocation

The government should continue and enhance policies that promote investment in low-emission energy sources and technologies. At the same time, in so far that investments in fossil fuels are needed to meet energy demand, it should ensure to avoid lock-in of these fuels, which could hamper the longer-term goal of a transition to low-carbon energy production. Examples of investment policies that can attract private sector investors include fiscal incentives, financial incentives, and other tools (United Nations, 2023). The fiscal incentives can be in the form of reduced tax rates, accelerated depreciation, exemption, or reduction of value added tax on capital material, and production-based tax credits. Financial incentives could be through grants or subsidies, subsidized loans, guarantee

schemes, and business facilitation. Other tools comprise policies such as offering feed-in tariffs --long-term contracts with guaranteed above-market price tariff-- to renewable energy producers or to stimulate investment through an auction: a government call for tenders to install a given capacity of renewable energy with the best bidder winning a long-term power purchasing agreement.

Managing supply security

As mentioned in the previous section, Aruba has a significant dependency on oil imports to meet its energy needs. This import dependency makes Aruba vulnerable to supply disruptions. To reduce the risk of supply disruption through the inability to import fossil fuels, Aruba should increase the proportion of renewable energy sources in its energy mix. The share of renewable energy in electricity production currently stands at 18 percent. In its energy policy, the government has voiced its intention to increase this share to 50 percent by 2030, and this is also the target that WEB is pursuing. We encourage the government to pursue this objective and to broaden it beyond the electricity sector. It should aim also to expand the share of renewable energy sources in one of the most energy intensive sectors, i.e., transportation. Besides growing the share of renewable energy, utility companies should explore the possibility to diversify across renewable energy sources beyond wind and solar. While the latter are proven technologies, other technologies (biomass, geothermal, ocean energy) could be tested on a small scale to determine feasibility.

Furthermore, the RDA should strive to reduce its supplier risk by diversifying the network of fuel import partners. The

aim should be to lower the share of fuel imported from the top three trading partners below 70 percent (WEF, 2023). If possible, the diversification should also be across regions. Doing so reduces the exposure to concentrated (regional) supply shocks. This is a challenging proposition, however, due to the difficulty in finding reliable and feasible suppliers.

Also related to supply risk, the deployment of clean energy technologies during the energy transition will increase the demand for critical minerals fourfold from current levels by 2030. In addition to the challenge of boosting supply to meet this demand, these minerals are regionally concentrated. The latter largely drives concerns about price volatility, resource availability, and security of supplies. **It is therefore important that Aruba secures the supply chain for these critical minerals.** This may be easier said than done, given that Aruba may have to compete with larger countries. It may, therefore, be beneficial to lessen the need for critical minerals. To achieve this, the government is encouraged to implement a critical minerals strategy that incorporates recycling, reuse of electrical vehicle batteries, and end-user efficiency measures, i.e., circular economy principles. Examples of countries and regions that have adopted critical minerals strategies focusing on circular economy principles include the United Kingdom, the European Union, the United States, and Australia.

Demand management

To reduce energy demand, the government should implement policies that incentivize DSM, which can also be cost-effective methods for managing the energy security risks related to oil price hikes. Incentives to reduce energy demand are crucial, since there are several factors

that will increase this demand in the coming years, such as increasing electrification of buildings (e.g., in the hotel sector) and the upcoming requirement for every port to have terminals that provide power to cruise ships when they are docked. The government should seek to boost energy efficiency by implementing and incentivizing energy efficiency measures for industries, transport, and buildings (see Table 3). For industries that rely on oil as an energy source, fuel input can be lowered through regular maintenance, and the integration of industrial processes to drive benefits such as waste-heat recovery and improving energy intensities. Moreover, companies can realize greater efficiencies by replacing conventional materials with substitutes that are superior in terms of performance and durability and thereby optimize energy consumption. For buildings, energy efficiency can be achieved by large-scale retrofit programs and by applying efficient techniques during construction. There are several countries where (local) governments have partnered up with their citizens by supporting effective renovation programs through tax incentives and “one-stop” renovation offices. Examples include Spain, Ireland, Mexico, and France. In addition, the government could provide free audits for homes and buildings to identify efficiency measures and digital solutions that can be swiftly implemented. In the transportation sector, proper road planning in the form of street layouts, pavement improvements, and other infrastructural measures can cut fuel consumption in vehicles. Given the expected growth in the share of electricity in final energy demand, targeted investments in energy efficiency and electrification will be of particular importance.

Table 3: Policies that incentivize demand side management

	Industries	Transport	Buildings
Energy efficiency measures	- Regular maintenance; - Integration of industrial processes; - Substitution of conventional materials with materials superior in terms of performance and durability.	- Proper road planning and other infrastructural measures to cut fuel consumption in vehicles, e.g., street layouts and pavement improvement.	- Large scale retrofit programs; - Application of energy efficient techniques during construction; - Effective renovation programs, e.g., tax incentives and “one-stop” renovation offices; - Free energy-efficiency audits for homes and buildings.

We welcome the plans of the utility companies to promote demand-response mechanisms as these can play a significant role in providing flexibility to the emerging power system. Flexibility is necessary, given the intermittent nature of renewables and the loss of flexibility due to the phasing out of unabated fossil fuels. To stimulate demand-response, utility companies should introduce policy frameworks that reward end-users and industrial consumers with greater flexibility in electricity, capacity, and ancillary service markets. The success of demand-response mechanisms requires a change in consumers' behavior. Changing this behavior begins with raising consumer awareness of climate change, carbon footprint, and the impact of individual actions on national energy security and sustainability ambitions. In this respect, utility companies have already taken action to some extent through their online and social media channels. Actions consumer can take to reduce energy demand include reduce wasteful energy use, increase temperature on cooling thermostat, switch transportation mode to more sustainable or less energy intensive methods, increase digitalization through the use of smart appliances, and engage and act as a prosumer. A simple, yet effective action the government can take to help consumers reduce energy usage is to require sellers of air conditioning to set a higher default temperature on all new devices they sell. In India, the government has implemented a similar regulation, which has been successful in helping consumers save energy.

By applying such efficiency measures and demand-response, energy demand can be reduced, thereby reducing dependency on oil imports as well as relieving some of the pressure on the energy infrastructure in terms of the required energy. By reducing the dependency on oil

imports, Aruba will become less sensitive to price fluctuations on the international oil market, whereby inflation in Aruba will be less impacted and the affordability component of energy security will be enhanced. In addition, Aruba's balance of payments position and reserve adequacy will be less vulnerable to price hikes in fossil fuels.

Manage policy mechanisms

We recommend the government to explore the possibility of introducing a carbon tax. The WEF and the IMF continuously mention carbon pricing as one of the strongest policy instruments available to help incentivize the scaling-up of low-emission production technology. Through the introduction of a carbon tax, the government could drive change in the behavior of consumers, businesses, and investors, while triggering technological innovation and generating revenues that can be invested in a cleaner energy mix that favors supply security and sustainability objectives. For an estimation of the potential revenue of a carbon tax scheme, the reader is referred to "Achieving an Inclusive Energy Transition in Aruba" in "Governing from the future, leading with inclusion: Policies, prospects and pathways for Aruba 2040" (CBA, 2024).

Collaboration

The government should seek partnerships with the private sector. This can be achieved through collaboration in the form of risk-sharing to attract diversified sources of capital needed for multi-year investments in energy systems. Examples of such partnerships include the financing and operating of energy infrastructure, such as solar and wind farms. The Vader Piet wind park is a local example of such an arrangement.

In addition, the energy authorities are advised to exercise a high degree of transparency, adhere to scientific evidence, and share information consistently to enhance trust in institutions and achieve adaptation of social behavior. Trust in institutions is crucial in implementing successful demand-management programs, as these require broader societal acceptance and participation.

System stability

To bolster energy system stability and reliability the electricity provider should invest in technologies that enhance system stability, such as smart grids, distributed and dispatchable energy generation, demand response, energy efficiency, distribution system planning, and energy storage capacity. The ability of the power system to balance supply and demand in real time by managing variability and flexible loads determines the operational reliability of the power system.

Moreover, we welcome the intention of the WEB to ramp up energy storage capacity through the use of batteries in the coming years as this is critical to flexibility in a decarbonized and distributed electricity system. Energy storage also solves the intermittency issues of renewable energy sources, making them as reliable and consistent as fossil fuels.

It is recommended that the utility companies explore the possibility of using excess renewable energy capacity to produce hydrogen, which is emerging as a solution to store excess production of renewable electricity, while at the same time solving the intermittency issue of renewables. In addition to investment in power storage, energy

storage should also include enhancement of storage of fuel products.

The utility companies should make the necessary estimations and allocations for grid modernization plans in their budgets. As renewable capacity expands, enhancement of grid capacity and flexibility is essential to avoid grid congestion and ensure the success of clean energy transitions. Grid modernization and upgrades should be key priorities for policymakers in addressing both energy security and energy transition. However, grid upgrades are costly and tight markets for critical minerals could push costs up even further.

System security

The energy authorities should ensure that effective risk management is in place, enabling an examination of system vulnerabilities and targeted mitigation and contingency plans. Risk management should include the use of monitoring tools and data analytics, which can provide a comprehensive and forward-looking view of threats across the industry and region, including technical vulnerabilities and other factors (e.g., geopolitical) that shape the threat landscape. Contingency plans should also be a feature of a risk management strategy. These plans help the government and energy authorities prepare for different supply disruption scenarios and ought to be formulated well in advance. Ultimately, the risk management strategy should allow the government and energy authorities to develop emergency response strategies and improve response capabilities.

Moreover, energy authorities should strive to raise awareness and work with stakeholders to identify, manage

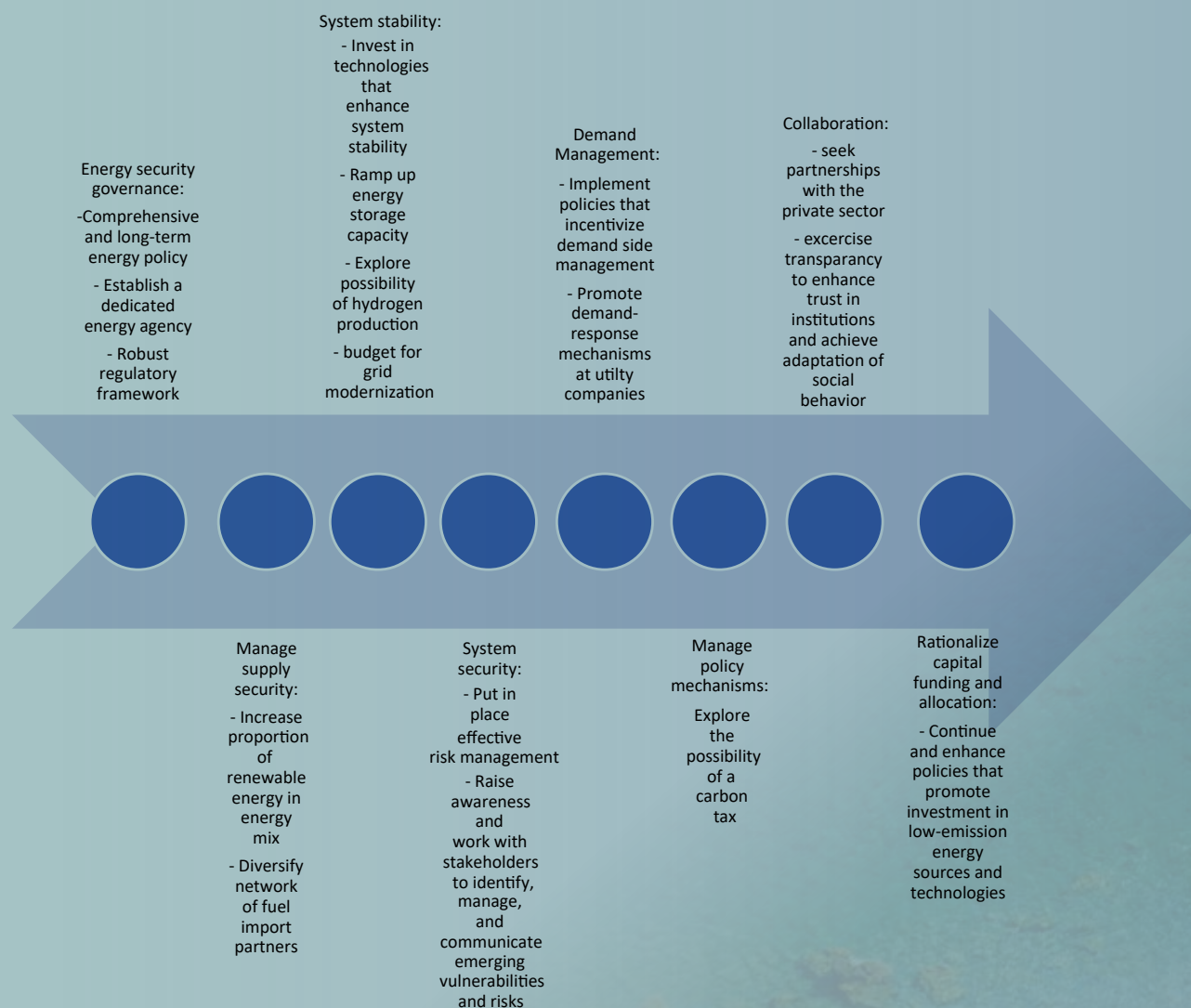
and communicate emerging vulnerabilities and risks regarding physical infrastructure and cybersecurity.

We welcome the efforts already underway at the utility companies to bolster infrastructure and cybersecurity. To further strengthen physical and cyber security the energy authorities should undertake the following actions:

- a) Develop emergency response strategies and improve response capabilities;
- b) Improve/introduce mandatory reporting requirement for cyber incidents;
- c) Collaborate within the energy sector as well as with government agencies and the government to develop response strategies to cyber intrusions;
- d) Establish state-level task forces with the purpose of studying incidents and providing recommendations to policymakers;
- e) Utility companies should ensure that new systems are designed for cyber resilience and upgrade existing systems to be in line with state-of-the art cyber protection;
- f) Learn the lessons from historical incidents and engage with (international) information-sharing and analysis centers (ISACs) or knowledge-sharing platforms.

Figure 2 provides a suggested implementation sequence for the recommendations put forward in this section, based on priority. The development of a comprehensive and long-term national energy policy, including a dedicated energy ministry or agency is put first in this sequence. This is because such an agency would be responsible for overseeing the implementation of the other recommendations. The degree of exposure to energy security risks in Aruba (see Figure 1) determines the order of priority for the other recommendations.

Figure 2: Suggested implementation sequence of recommendations



5. Main findings and conclusions

After a decade or so of relatively cheap prices for gas and oil, energy security concerns have roared back to the forefront of the global policy agenda following energy market volatility and geopolitical events over the past three years. The renewed focus on energy security has coincided with calls globally to transition the energy sector from fossil fuels to renewable energy sources. While the energy transition offers solutions to some of the energy vulnerabilities, it also poses its own specific challenges to energy security. Consequently, energy security in the age of energy transition requires a comprehensive strategy that takes into account the traditional energy security risks, as well as the risks to energy security that are spurred by the transition.

In this chapter, we reviewed energy security risks for Aruba through the lens of the WEF’s framework of six energy security dimensions. For Aruba, we found energy security risks across three of these dimensions, i.e., supply security, system stability, and system security (Table 4). While this study does provide figures reflecting Aruba’s import dependency on fossil fuels, the findings of this study are based primarily on qualitative analysis of best practices and policies. Future research could focus on expanding the quantitative analysis of energy security indicators with the aim of constructing and calculating an energy security index for Aruba. Based on the framework used in this study, we provided recommendations to the government on how to manage the identified risks and enhance energy security.

Table 4: Energy security risk in Aruba by dimension

Supply security	System stability	System security
- Increased frequency and intensity of extreme weather. - Securing supply chain of minerals needed for clean energy technology due to geopolitics.	- Higher renewable energy penetration can make power grid less reliable. Therefore, more grid flexibility is required.	- Enhanced digitalization raises risks of cyber-attacks.

For Aruba, one of the main vulnerabilities in terms of energy security is the still significant dependence on fossil fuel imports to meet its energy demands. This dependency remains despite fuel imports as a share of GDP and per capita decreasing over the past decade. In terms of import dependency on fossil fuels, Aruba is similar to other small islands. This oil dependency exposes it to the direct risk of supply disruption and oil price volatility. Fluctuations in oil prices can have a significant impact on its foreign exchange reserves, which are crucial in maintaining monetary stability. Moreover, international oil prices can also severely impact inflation in Aruba as it had in the past.

In terms of the emerging energy security risks, Aruba is vulnerable to the risk posed to energy infrastructure due to the growing frequency and intensity of extreme weather events that put the security of energy supplies at risk. Energy infrastructure is not only the power plant and power grid on-island, but it includes all components of the energy supply chain. Given the expected increase in frequency and intensity of extreme weather events, damages are more likely to occur and potentially cause interruptions to electricity transmission and distribution. Therefore, climate resilience of the energy infrastructure is critical. Future research could focus on stress test scenarios for Aruba related to extreme weather and the value at risk in terms of the energy infrastructure.

Another threat to energy security that has emerged along with the energy transition is the geopolitics of minerals needed for clean energy technologies. Overall mineral requirements for clean energy technologies, based on current estimates, will by far outpace supply and investment plans by 2050. Consequently, there is a risk of a higher cost of transition. Moreover, these minerals are distributed across a small concentration of source countries. This concentration introduces risk to supply chains. Geo-fragmentation can make it even

more difficult to secure energy supply chains for the minerals needed. As a small island, Aruba is even more susceptible to this risk, due to its relatively small consumption and inability to offer competitive prices.

The increase foreseen in renewable energy penetration in Aruba can make the power grid less reliable, due to the intermittent nature of renewable energy sources. This can cause sudden changes to generation patterns on a daily or weekly basis leading to increased risk of blackouts which can have a detrimental effect on energy security and the economy. Moreover, grid-related risks are especially relevant for islands since island grids are more fragile in comparison to larger countries with grid interconnectivity.

Finally, the energy transition makes the energy infrastructure more vulnerable to cyber-attacks. The increased reliance of the utility companies on digital technologies like smart grids, digital controls for renewable energy sources, and interconnected communication networks present greater opportunities for cyber criminals to disrupt operations, steal data, or manipulate energy flows. Cyber-attacks can lead to power outages disrupting essential services and causing economic damage, manipulation of energy supplies leading to shortages, and ultimately loss of public trust in the energy grid.

The energy transition undoubtedly brings benefits for Aruba, and if executed well, the gains will outweigh the costs.

However, as we have seen, the energy transition also sets forth its own set of risks to energy security on top of the traditional energy security risks. If not handled properly, these threats could cause severe disruptions to energy services in Aruba and, subsequently, derail the energy transition. In this chapter, we presented the following recommendations to mitigate risks to energy security in Aruba, triggered or enhanced by the energy transition.

Table 5: Recommendations to manage energy security risks in Aruba

1.	Energy security governance - Implement legislation to re-establish a dedicated energy ministry or agency to oversee the implementation of policy, with strong coordination between different government agencies and departments involved in energy-related matters; - Develop a comprehensive and long-term national energy policy that outlines clear objectives for energy security; - Implement a robust regulatory framework to ensure, fairness, consumer protection and environmental sustainability in the energy sector; - Ensure transparent decision-making processes to promote accountability and public trust.
2.	Rationalize capital funding and allocation - Introduce policies that promote investment in low-emission energy sources and technologies. At the same time, avoid lock-in of fossil fuels. Examples of investment policies that can attract private sector investors include fiscal incentives, financial incentives, and other tools such as feed-in tariffs (United Nations, 2023).
3.	Managing supply security - Increase the proportion of renewable energy sources in the energy mix; - Aim also to expand the share of renewable energy sources in the transportation sector; - Lower the share of fuel imported from the top three trading partners below 70 percent (WEF, 2023). If possible, also diversify across regions; - Secure the supply chain for critical minerals. - Implement a critical minerals strategy that incorporates recycling, reuse of electrical vehicle batteries, and end-user efficiency measures to lessen the need for critical minerals.

4.	Demand management - Boost energy efficiency by implementing and incentivizing energy efficiency measures for industries, transport, and buildings; - Promote demand-response mechanisms as these can play an important role in providing flexibility to the emerging power system; - Utility companies should introduce policy frameworks that reward end-users and industrial consumers with greater flexibility in electricity, capacity, and ancillary service markets; - Raise consumer awareness of climate change, carbon footprint, and the impact of individual actions on national energy security and sustainability ambitions to change consumer behavior and achieve successful demand-response mechanisms.
5.	Manage policy mechanisms - Explore the possibility of introducing a carbon tax to drive change in the behavior of consumers, businesses, and investors, while triggering technological innovation and generating revenues that can be invested in a cleaner energy mix that favors supply security and sustainability objectives.
6.	Collaboration - Seek partnerships with the private sector through collaboration in the form of risk-sharing to attract the diversified sources of capital needed for multi-year investments in energy systems; - Exercise a high degree of transparency, adhere to scientific evidence, and share information consistently to enhance trust in institutions and achieve adaptation of social behavior.

7.	System stability - Invest in technologies that enhance system stability, such as smart grids, distributed and dispatchable energy generation, demand response, energy efficiency, distribution system planning, and energy storage capacity; - Ramp up energy storage capacity as this is critical to flexibility in a decarbonized and distributed electricity system. Energy storage also solves the intermittency issues of renewable energy sources, making them as reliable and consistent as fossil fuels; - Explore the possibility of using excess renewable energy capacity to produce hydrogen, which is emerging as a solution to store excess production of renewable electricity, while at the same time solving the intermittency issue of renewables; - Make the necessary estimations and allocations for grid modernization plans in the government and utility budgets. Grid modernization and upgrades should be key priorities for policymakers in addressing both energy security and energy transition. However, grid upgrades are costly and tight markets for critical minerals could push costs up even further.
8.	System security - Ensure that effective risk management is in place, enabling an examination of system vulnerabilities and targeted mitigation and contingency plans. Contingency plans should also be a feature of a risk management strategy. Ultimately, the risk management strategy should allow the government and energy authorities to develop emergency response strategies and improve response capabilities; - Raise awareness and work with stakeholders to identify, manage, and communicate emerging vulnerabilities and risks regarding physical infrastructure and cybersecurity.

Finally, it is of utmost importance that the government apply a whole-of-government response, which is essential to align the intergovernmental response and eliminate barriers. The

success of energy security policies relies on the actions not just of ministries responsible for energy, but also housing, industry, transport, finance, and more.

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Safeguarding Workforce Wellbeing Amid Extreme Heat: Strategies for Strengthening Occupational Heat Resilience

Ryan R. Peterson

Abstract

This chapter investigates the escalating impact of climate change and rising temperatures on labor within Caribbean Small Island Tourism Economies (SITEs); more specifically, on the detrimental effects of extreme heat on workforce wellbeing and productivity in Aruba. Aruba is exceptionally vulnerable to extreme heat and heat stress, particularly in outdoor and semi-outdoor occupations. This challenge is further exacerbated by the urban heat island (UHI) effect, where urbanized (commercial and residential) centers experience significantly higher temperatures. The UHI phenomenon amplifies heat exposure for a large segment of the workforce concentrated in these centers. Moreover, there are several socioeconomic stressors – an aging population and workforce, high-density urbanization, and wide-spread public health risks – that amplify and aggravate occupational heat stress. For Aruba, heavily dependent on nature-based, labor-intensive tourism services, the implications for occupational wellbeing and economic productivity are severe.

However, the existing institutional framework of occupational (heat) safety and health regulations, as well as urban planning is inadequate, underscoring an urgent need for strengthening occupational heat resilience (OHR). OHR necessitates proactive policies and occupational health and safety strategies to adapt work environments to ensure worker health and productivity under future climate scenarios. In addition, and in complementary fashion, nature-inclusive urban planning and development are imperative for safeguarding workforce as well as community wellbeing amid extreme heat.

This chapter concludes by presenting a mix of policy recommendations for strengthening OHR in Aruba. These include (i) establishing a comprehensive national heat governance system; (ii) revising, harmonizing, and enforcing OHS regulations to explicitly address occupational heat stress; and (iii) advancing nature-based urban development to mitigate and adapt to extreme heat.

1. Introduction

It is a truism that extreme heat is a significant and increasing threat to lives and livelihoods across the world (ILO, 2024; WHO, 2024; EUROGIP, 2023; EU-ADAPT HEAT, 2024) Whether in the form of rising long-term average temperatures, or punctuated by more frequent, intensive, and extended heat periods, extreme heat is readily recognized as the single largest existential threat to humanity. According to the IPCC WGI AR6 assessment (IPCC, 2022), warming will continue in the 21st century for all global warming levels and future emissions scenarios, thereby further increasing heat extremes and exacerbating heat stress, especially in (tropical) small island states. Since the turn of the century, several international institutions and regional agencies have elevated heat to code red. According to the International Labor Organization (ILO), climate change is already having serious impacts on the safety and health of workers (ILO, 2024). Higher average temperatures, and more frequent and severe heatwaves, are now affecting workers in all regions of the world (ILO, 2024; WHO, 2024; EUROGIP, 2023; EU-ADAPT HEAT, 2024). It is well acknowledged that physically demanding occupations and outdoor workers are among those most exposed to temperature extremes (ILO, 2024; WHO, 2024; EUROGIP, 2023; EU-ADAPT HEAT, 2024), which are determined by both climate and non-climate factors (See Box 1).

In steadfast mode, heat stress is a chronic killer. The ILO (2024) reports that at least 2.41 billion workers – 71% of the working population – are exposed to excessive heat, resulting in +22 million injuries and close to 19,000 deaths annually. Heat impacts workers by leading to acute and chronic illnesses – such as heat exhaustion, heatstroke, and even death –, as already

experienced in and reported by many regions of the world over the past two decades. In the long run, workers develop serious and debilitating chronic diseases, impacting cardiovascular and respiratory systems, as well as the kidneys. Furthermore, heat-related occupational injuries are also acknowledged, as well as the numerous accidents occurring due to reduced cognitive performance, heated surfaces, and unsuitable personal protective equipment (PPE).

Box 1. Stylized example of differences between temperature and heat under climate and non-climate conditions.

Whereas temperature is measured by the air surface temperature, the measurement of *heat* incorporates the effect of relative humidity levels. The latter is often referred to as the ‘experienced’ or ‘feels like’ temperature and adds (+4°C on average) to the air temperature. If the air temperature is, e.g., 28°C, this results in a heat index temperature of 32°C. However, the heat index excludes direct solar radiation (i.e., radiant heat) and wind speed, which are usually common in outdoor occupational settings.

When measuring outdoor temperatures and under direct sun exposure, the solar temperature can increase by +5°C (on average). In combination with a 75% relative humidity level, the former situation results in a temperature of 46°C, which is well above the *thermal work limit* (TWL) temperature of 38°C. The TWL is defined as the limiting (or maximum) sustainable metabolic rate that well-hydrated, acclimatized individuals can maintain in a specific work environment, within a safe deep body core temperature (< 38°C) and sweat rate (< 1.2 kg per hour).

The combined measurement of air temperature, humidity levels, and solar radiation (as well as wind speed) is known as the *Wet Bulb Global Temperature* (WBGT). Whereas the heat index measures temperature and humidity in shaded environments, the WBGT measures outdoor heat. As an example, under varying (air) temperatures, constant average relative humidity (75%), and an average wind speed (7 m/s), the heat index and the WBGT record different temperatures with associated occupational heat risks, warnings, and precautions.

Air temperature (°C)	Humidity (%)	Heat index (°C Shaded)	WBGT (°C Outdoor)	Heat alert level	Occupational heat stress and outdoor work precaution
28	75	32	27.2	Heat caution	Thermal heat stress after 45 minutes- 15 minutes of breaks each hour
29	75	34	28.1	Heat caution	Thermal heat stress after 45 minutes- 15 minutes of breaks each hour
30	75	36	29.1	Extreme heat caution	Thermal heat stress after 30 minutes- 30 minutes of breaks each hour
31	75	39	30.1	Extreme heat caution	Thermal heat stress after 30 minutes- 30 minutes of breaks each hour
32	75	42	31	Heat danger	Thermal heat stress after 20 minutes- 40 minutes of breaks each hour
33	75	46	32	Heat danger	Thermal heat stress after 15 minutes- 45 minutes of breaks each hour
34	75	49	32.9	Extreme heat danger	Thermal heat stress after 15 minutes- No outdoor work

An additional non-climate factor is the built environment and the degree of urbanization. The latter is also known as an ‘urban heat island’ (UHI) effect in which the physical infrastructure can exacerbate the effect of heat. In the case of, for example, outdoor construction activities in a highly urbanized (build-up) area, extreme heat is elevated (+10°C) due to several compounding factors, including, direct sun exposure, thermal work limits, and an additional urban heat island effect (+3°C).

Occupational heat stress is concentrated in key sectors of the economy. The ILO notes that while workers in all sectors are adversely affected, some face unique exposure situations placing them at higher risk, including, older workers, informal workers, pregnant women, those working outdoors in physically demanding roles, and indoor workers in unventilated environments. Overall, the human capacity to handle heat stress diminishes with age (Larose et al., 2013). This thermal impairment begins as early as 45 years old and by 60 years of age escalates thereby increasing the risk of hyperthermia when engaging in physical activities (Larose et al., 2013; Stapleton et al., 2015; Kenny et al., 2016). Outdoor and physical occupations (i.e., manual labor) are most at risk from heat stress. From an occupational perspective, research indicates that there is a high incidence of heat-related illnesses and accidents in outdoor workers, i.e., in occupations that involve work in the sun (especially during the hottest hours of the day), such as in agriculture, construction, transportation, and manufacturing, as well as trade, tourism, and (outdoor) recreation and sport-related professions (Devi 2014; Xiang et al., 2015; Harari Arjona et al., 2016; Beck et al., 2018; Flouris et al., 2019; Ioannou et al., 2021a; Nag et al., 2009).

The intensification of excessive heat not only jeopardizes the safety and health of workers but also undermines the resilience of economies and the potential for decent work. Research confirms that working under conditions of heat stress can significantly impair an individual's health and productivity, with broader implications for national economies and sustainable development (Nybo et al., 2017; Flouris et al., 2018b; Kjellstrom et al., 2018 ; Flouris et al., 2022). The ILO reports that occupational heat stress is projected – under a conservative scenario of +1.5°C global temperature rise – to reduce productivity worldwide by 2.2% – a loss equivalent to 80 million full-time jobs – and global GDP contraction by \$2,400

billion in 2030 (ILO, 2024). Furthermore, the profound effects of (occupational) heat stress makes it significantly harder to attain the United Nations Sustainable Development Goals (SDGs), including those related to poverty (UNSDG 1), health (UNSDG 3), and decent work (UNSDG 8). Thus, the need and urgency to safeguard occupational heat resilience (OHR) is clear and present. For the purposes of this study and consistent with previous studies, *OHR is defined as the capacity of the (national) occupational system and the workforce to cope with, as well as anticipate and adapt to acute and chronic heat stress.*

In addition to increasing international calls of action to advance OHR, previous empirical studies underscore the imperative for strengthening OHR. Empirical studies consistently show that heat and heat stress negatively affect labor productivity, worker health, and economic output (See Annex A for a list of reviewed empirical studies). A review of previous studies indicates that:

- a) **Heat stress is a global concern:** The studies cover a wide range of regions, including Iran, Italy, Nepal, Southern India, Europe, the United States, and Canada, with a strong focus on low- and middle-income countries and hot climates. However, the economic and social costs of heat stress are not evenly distributed. Low-income countries, particularly those in tropical and subtropical latitudes, are disproportionately affected. These regions often have a substantial proportion of their workforce employed in outdoor, physically demanding jobs like agriculture, construction, and tourism, and they also have lower rates of social protection and a higher share of informal workers. While wealthier regions like Europe and the U.S. also experience productivity losses during heatwaves, their advanced economies and better adaptive capacities can partially offset the damage.

b) The socioeconomic losses of heat stress are substantial.

Globally, labor productivity losses due to heat stress are projected to be equivalent to 80 million full-time jobs by 2030, with an estimated 2.2% of total working hours lost. Some estimates suggest that cumulative losses from extreme heat between 1992 and 2013 were between \$16 trillion and \$50 trillion globally. A study on Europe projected that annual economic losses could reach 563 billion euros by the 2080s in a worst-case scenario. Economic productivity can drop by 2–3% for every degree above 25°C. In some cases, individual productivity in moderately physical jobs can drop by as much as 50% at temperatures above 33–34°C. The effects are often non-linear, with sharp declines in productivity beyond certain temperature thresholds.

c) Heat stress differentiates between specific sectors and occupations. The most vulnerable sectors are those with a high reliance on outdoor or strenuous physical labor. The agricultural, construction, and tourism and recreation sectors are consistently identified as the worst affected, accounting for a significant portion of the working hours lost to heat stress. However, the impact is not limited to outdoor work. Furthermore, migrant and informal (unregistered) workers are often more vulnerable, as they may have less control over their working conditions and less access to social protection or health care. In addition, heat stress also affects indoor workers in unventilated or non-air-conditioned environments, such as manufacturing and utility companies. The effects extend to cognitive performance as well, leading to impaired judgment and an increase in work-related injuries and accidents.

d) The impact of heat stress is multifaceted: Heat stress directly affects workers through a combination of physiological and behavioral responses. Physiologically, elevated temperatures can cause heat-related illnesses such as dehydration, heat

exhaustion, and heatstroke, which can be fatal. It can also lead to long-term chronic conditions, particularly kidney disease. Behaviorally, workers instinctively slow down, take more frequent breaks, or reduce their work hours to cope with the heat, directly leading to lost work capacity and output.

e) Heat stress poses a significant threat to workers' health.

Excessive and extreme heat can overwhelm the body's thermoregulation, leading to heat-related illnesses such as heat rash, heat cramps, heat exhaustion, and heatstroke. In extreme cases, heatstroke can cause multi-organ failure and death without prompt treatment. Moreover, long-term exposure to heat stress is linked to chronic health problems, including chronic kidney disease. Both acute and chronic heat stress impair physical and cognitive abilities, subsequently leading to an increase in work-related injuries and accidents. Previous studies also note that heat stress can lead to increased irritation and interpersonal issues among workers.

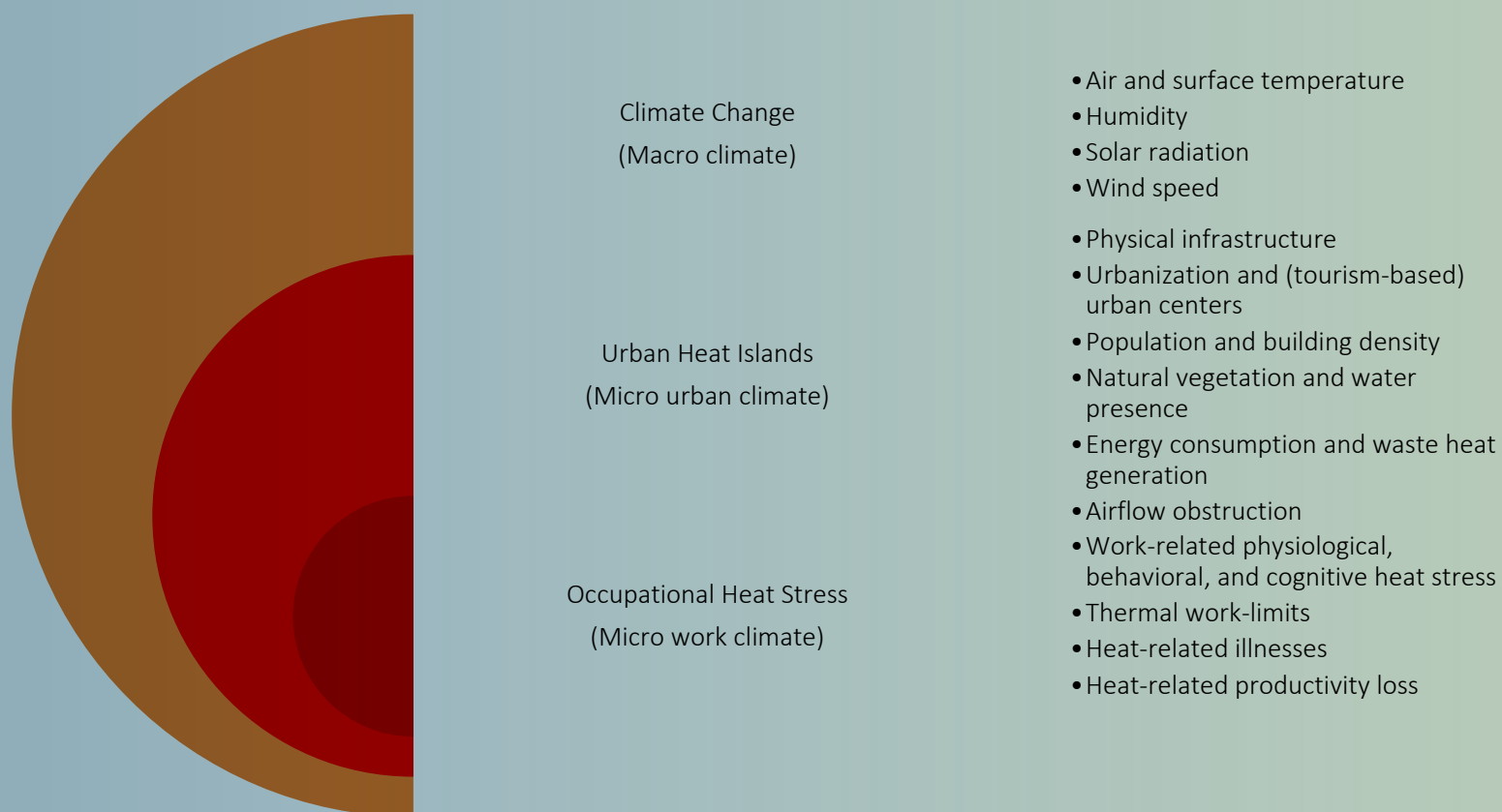
Considering the systemic and adverse impact of heat and heat stress, the main purpose of this study is threefold:

- (i) To conduct a situational analysis of (occupational) heat stress and associated socioeconomic risks in Aruba. The situational analysis is based on an exploratory analysis of socioeconomic and occupational developments, as well as public perceptions of heat stress in Aruba (See Section 2).
- (ii) To benchmark Aruba's current occupational heat legislation, regulation, and policies against international standards. The benchmark analysis is based on an analysis and synthesis of international and national regulation and policy on OHR, as well as a review of previous empirical studies (See Section 3).

(iii) To provide policy recommendations for strengthening occupational heat resilience. Recognizing the embeddedness of labor and work within natural and built environments (See

Figure 1), this chapter addresses the importance of advancing both workforce-directed as well as urbanization-enabled heat resilience (See Section 4).

Figure 1. Embedded occupational heat stress and enabling conditions and consequences.



The remainder of this chapter is structured as follows. In Section 2, a situational analysis of Aruba is conducted. The state of heat and occupational health in Aruba are described, and several climate conditions, socioeconomic developments, and occupational vulnerabilities are exposed. The main findings of the benchmark and scoping review of international legislation and regulation on OHR are discussed in Section 3. Based on a global analysis of various countries and regions, evidence of leading policies for safeguarding OHR is discussed. A synopsis of the existing occupational (heat) legislation and regulation in Aruba is presented, and a number of limitations and opportunities are identified. Based on the findings of the situational analysis and the institutional deficiencies in the existing occupational legislation and regulation in Aruba, policy recommendations are presented for safeguarding workforce wellbeing and strengthening OHR (Section 4).

2. The State of Heat: A Situational Snapshot

Awareness of climate change and extreme heat are gradually evolving in Aruba. The general alertness of increasing temperatures and intensifying heat, as well as of the detrimental impact of extreme heat on the health and wellbeing of vulnerable groups (e.g., young children, elderly, heat-exposed occupations, lower-income groups, and chronically-ill people) are slowly gaining momentum. In recent years, government agencies have alerted on the rise, impact, and prevention of extreme heat and heat waves (See Figure 2).

Figure 2. Heat alerts in recent years by the public sector (Government of Aruba, Ministry of Transportation, Integrity, and Elderly Affairs, Crisis Management Office, Department of Public Health).

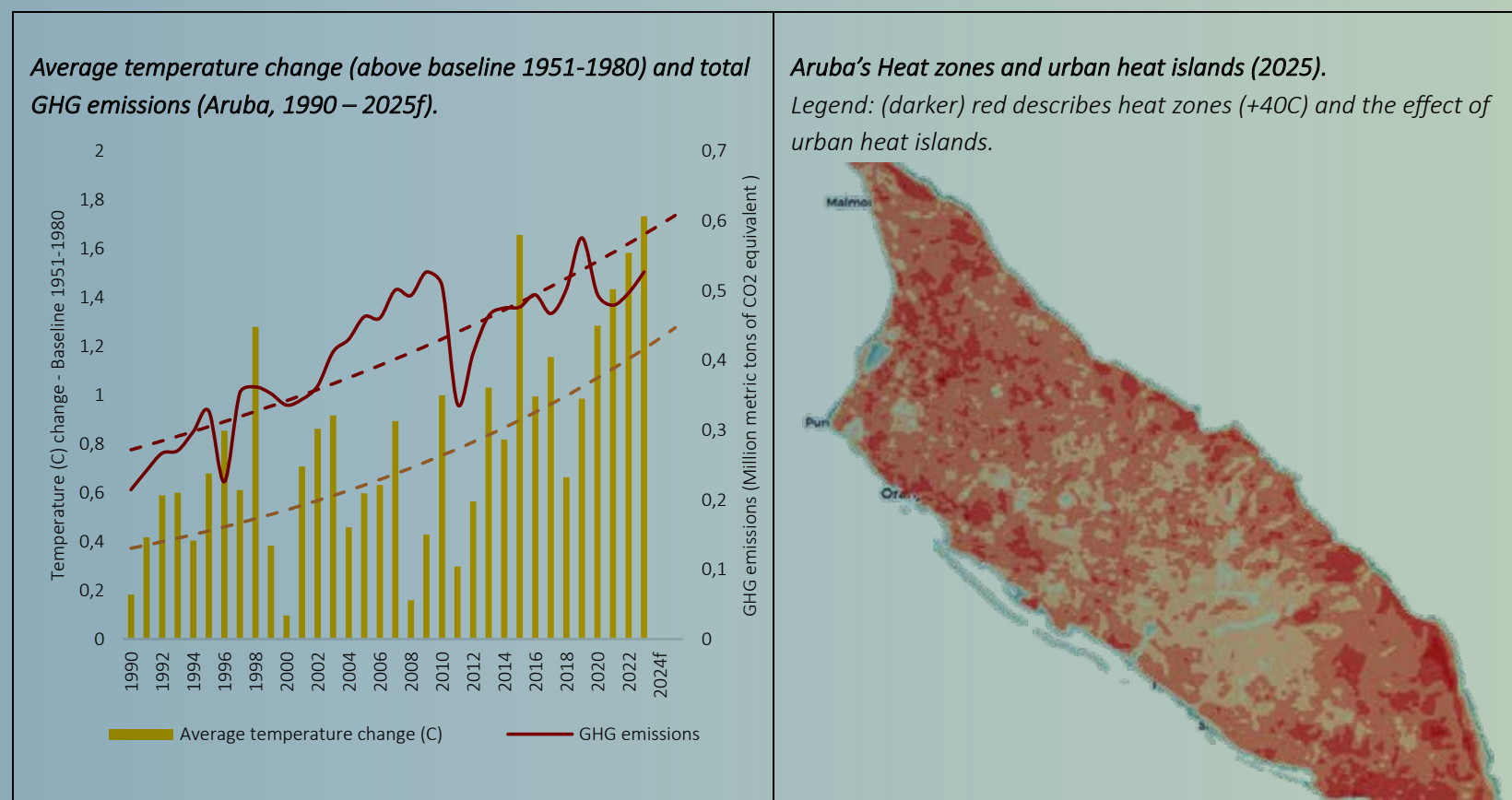


In this section, a situational analysis of Aruba is conducted to contextualize and frame occupational heat stress and vulnerabilities. The recent developments in temperature rise, the state of heat, and occupational health risks in Aruba are presented, and several climate conditions and socioeconomic developments are highlighted.

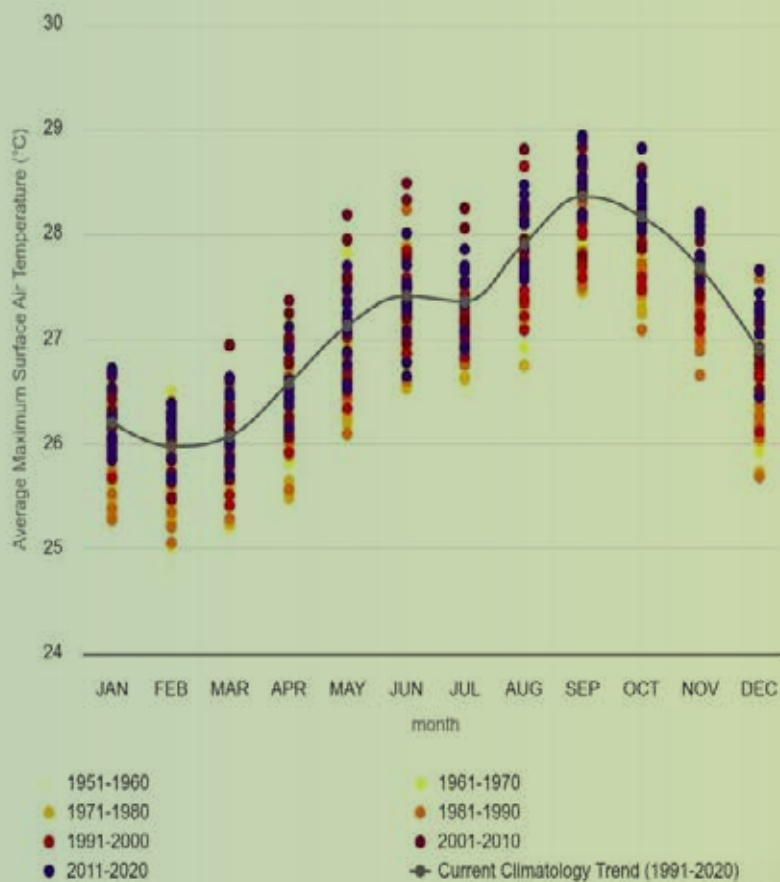
2.1. The Heat is On

Records indicate that Aruba has experienced accelerating temperature rise and intensifying heat since the early 1990's with profound socioeconomic implications (see Figure 3). In fact, recent years have been the hottest on record, with record high max temperatures recorded in 2023 and 2024 (MDA, 2024). Since 1990, the average air temperature has risen by at least 1.5°C, and together with the increase in relative humidity (+75%), have amplified heat exposure and heat-related risks. Extreme and extended heat events are expected to intensify in the decades to come. Consistent with the IPCC assessments (IPCC, 2023), climate projections by the World Bank report that both average and above-average temperatures in Aruba are expected to rise by at least 3°C (relative to 1995-2014 baseline) in the coming decades. In addition, extreme heat events – heat index of +40°C – are likely to endure over a relatively longer time during the year, spanning from May to November, thereby extending the traditional heat season in Aruba (i.e., August to October) (World Bank Climate Change Indicators, 2024).

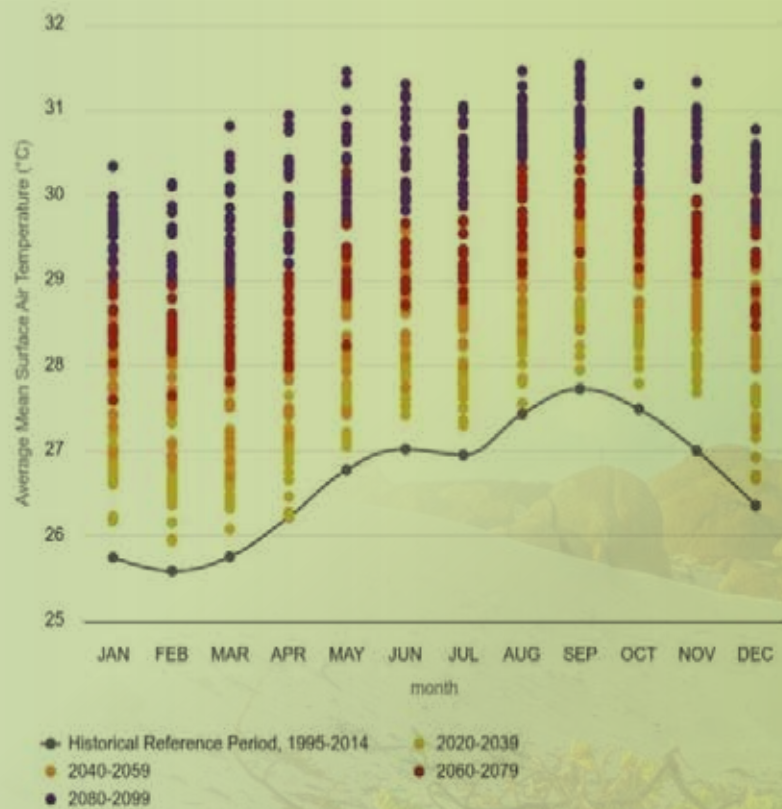
Figure 3. Trends and projections in temperature rise and heat intensification in Aruba (MDA, 2024; IMF, 2024; WB, 2024; NCRC Climate Impact Atlas (2025).



Past trends in average temperature (Aruba, 1951-2020).



Projected trends in average temperature (Aruba, 2020 - 2099).



The (occupational) health risks of enduring heat exposure are significant, especially considering several longstanding socioeconomic stressors as well as (island-) specific socioeconomic sensitivities. It is important to note that occupational heat vulnerability is a function of both occupational exposure and occupational sensitivity to heat, as well as the capacity to cope with and adapt to heat. Within the context of small island states, the IPCC (2023) confirms – with a significant degree of confidence and robustness – that the (high) level of heat vulnerability of small islands is caused by multiple stressors, both climate and non-climate.

Whereas *climate factors* describe the rise in gradual temperatures and humidity, as well as extreme and extended heat events, non-climate factors refer to multiple (island-specific) contextual stressors, including (pre-existing) socioeconomic and environmental conditions that co-determine the magnitude of heat impacts. Socioeconomic stressors include long-standing island vulnerabilities, e.g., population growth and aging, poverty and income inequality, coastal urbanization, as well as occupational and health conditions. Ultimately, the heat resilience of islands is shaped by the relative degree of climate and socioeconomic stressors, as well as policy interventions and the institutional capability to reduce socioeconomic vulnerabilities and strengthen heat adaptation capacity.

2.2. Occupational Heat Vulnerability in Aruba

Occupational heat vulnerability is on the ascent. In addition to gradual temperature rise since the early 1990's, as well as extreme and extended heat events in recent years, various

demographic, economic, social, and infrastructural developments have (collectively) aggravated occupational health risks of (extreme) heat (See Figure 4). These main socioeconomic stressors include:

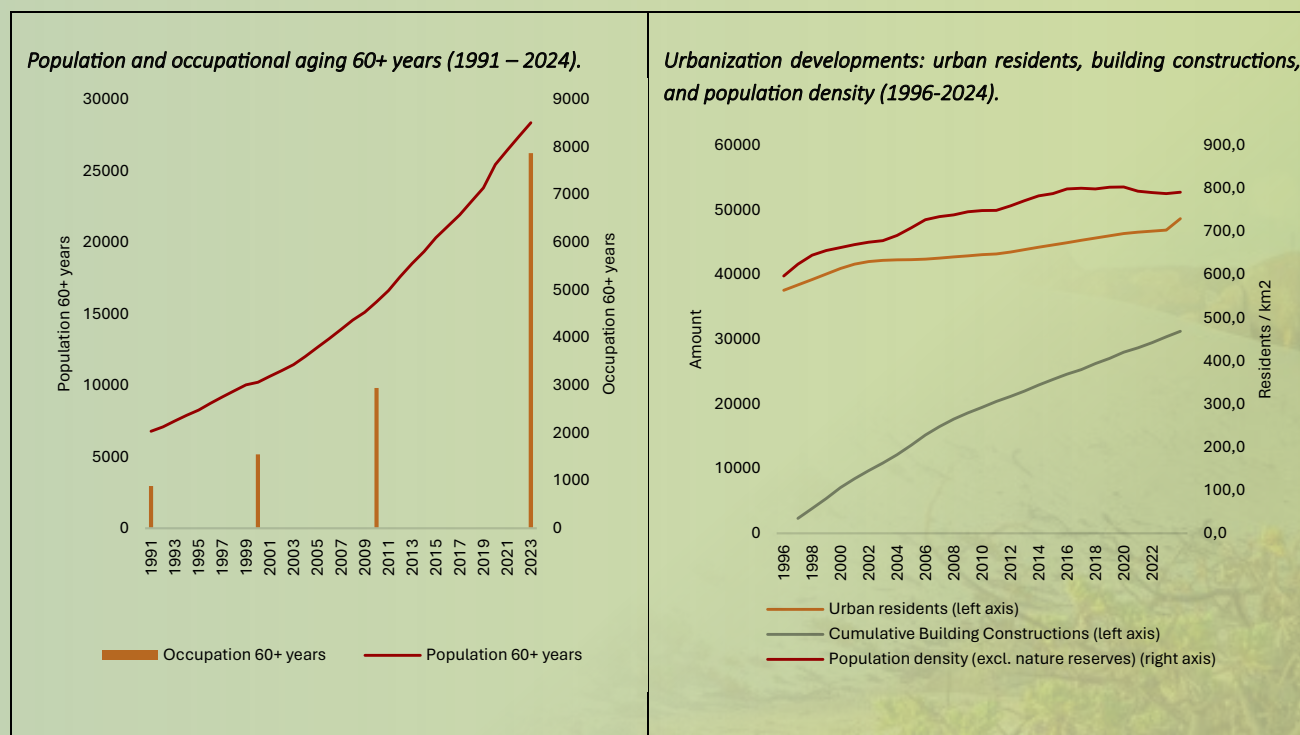
- A. **Aging.** Demographically, Aruba has experienced significant population and occupational aging over the past 30 years. Currently, an estimated 27% of the population is over the age of 60 years, and close to 15% of the working population is over the age of 60 years. These developments in population and occupational aging are expected to continue and accelerate in the coming decades. With increasing aging population and extreme heat, fatality risks increase (WHO, 2023; ILO, 2024). Based on fatality records between 1992 and 2023 (CBS, 2023), initial analysis indicates that at least 30% of the increase in total mortality (amongst 50+ years) can be (indirectly) attributed to increasing cases of extreme heat. However, it is not only the current generation of 60+ years that is exposed to rising heat levels, but especially the current workforce of 40-45+ years. This cohort is likely to experience rising temperatures and more extreme heat in the next 25 years. Recent labor force surveys indicate that an estimated 27,625 economically actives are over the age of 45 years, i.e., 51.7% of the total employed population (CBS, 2023). Employing an average annual real GDP per workforce capita of an estimated Afl. 108,000¹, the potential (future) labor productivity at risk could amount to Afl. 3 billion by 2050 (39% of nominal GDP 2024).
- B. **Urbanization.** Largely driven by (tourism-based) economic growth, population density and the rate of urbanization

■ ¹ Based on CBA (2025) nominal GDP estimates for 2024 and LFS (2024).

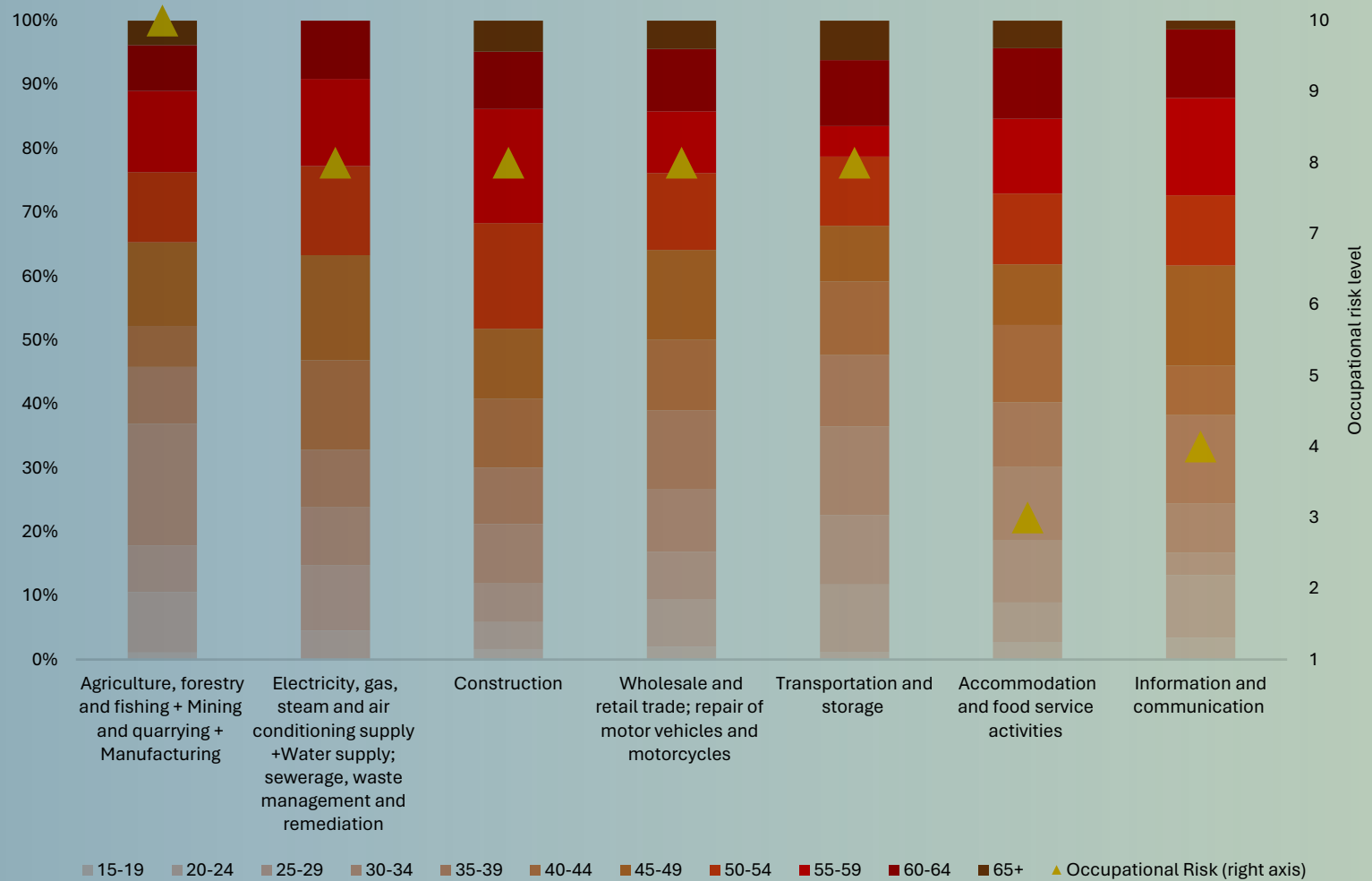
have expanded considerably over the past three decades. Currently, an estimated 48,648 residents (45.5%) live in urban areas, where resident density levels surpass 750 residents/km² (CBS, 2023). Since the late 1990's, well over 30,000 commercial and residential construction projects were executed (CBA, 2024). Subsequently, (artificial) land coverage surged from 72km² (40% of total land surface in 1990) to well over 150km² (83% of total land surface in 2022)

(World Bank, 2024), thereby also causing a significant loss and decay of nature and natural habitats (and commensurate natural CO₂ sequestration). Likewise, increased residential and commercial urbanization demand more energy, thereby increasing energy production and consumption, potentially fueling the energy financial burden on households and business. Over the past three decades, energy consumption expanded by close to 65% in Aruba.

Figure 4. Socioeconomic stressors and vulnerabilities (CBS, 2023; SVB, 2023; LFS, 2023; CBA, 2024).



Occupational risk sectors and age distribution (2024).



These highly urbanized and dense areas experience (+5°C) higher average temperatures due to the effects of 'urban heat islands' (UHI) in which relatively more heat is created and captured due to multiple compounding factors and conditions, e.g., increased energy from buildings, housing, building materials, roads, transportation, machinery, and people, as well as weaker wind speeds, and lower air quality. These conditions exacerbate heat stress at work and at home, thereby adversely affecting livelihoods and lives.

- C. **Occupational risks.** Increasing levels of urbanization and continued construction of commercial and residential areas suggest that *numerous sectors are prominent in the economy*, including tourism, transportation, trade, construction, and utilities. In total, an estimated 30,412 workers are officially employed across these key sectors, representing 55.8% of the total employed population. Of these economically active, 15,100 employees (49.7%) are over the age of 45 years. With the exception of tourism and information and communication sectors, these sectors are also most *prone to occupational risks and hazards* and physically-demanding work, as reported by the Social Security Bank (SVB, 2023) in accordance with the Incident Insurance Ordinance that ranks industry activities in different injury risk categories.²

Despite the void in empirical studies and evidence on the relationship between occupational heat stress and heat-

related illnesses and injuries in Aruba, and notwithstanding other relevant (occupational, health, demographic) factors, annual accounts and records of the Social Security Bank on illness and injury severance payments suggest that at least 25% of the growth in registered total illness days (between 2014-2022) can be (indirectly) attributed to temperature rise and excessive heat as of 2010.

- D. **Outdoor exposure.** With the inclusion of agriculture, these prominent sectors (tourism, transportation, trade, construction, and utilities) are likely to employ more outdoor workers – thereby increasing their heat exposure –, as well as employ relatively older workers, hence intensifying their sensitivity to age-related heat risks in the coming decades. Although there are no official records – yet considering a conservative 75% outdoor work ratio across these sectors –, preliminary analysis indicates that at least 22,800 workers (41.8% of the total workforce) are likely exposed to various degrees of outdoor heat and heat stress. Employing an average annual real GDP per workforce capita of Afl. 108,000³, the potential outdoor labor productivity impact amounts to an estimated Afl. 2,4 billion by 2050 (32% of 2024 nominal GDP).
- E. **Heat stress experiences and perceptions.** Analysis of heat stress perceptions by the community indicates that at least 70% of residents report that they are personally affected by high temperatures (See Figure 5), especially during the second half of the year (i.e., July to December). Whereas an estimated 45%

² The injury risk categories range from 1 (lowest risk) to 10 (highest risk). Although not explicitly mentioned, the categories also suggest more physically-demanding work at higher levels of injury risk.

³ Based on CBA (2025) nominal GDP estimates for 2024 and LFS (2024).

experience heat stress at work, more than 70% experience heat stress at home, mainly by lower to middle-income households (gross monthly income less than Afl. 5,000). More than 50% of survey respondents indicate that they experience heat stress often to very often, with 80% reporting that heat stress affected their general wellbeing and personal health.

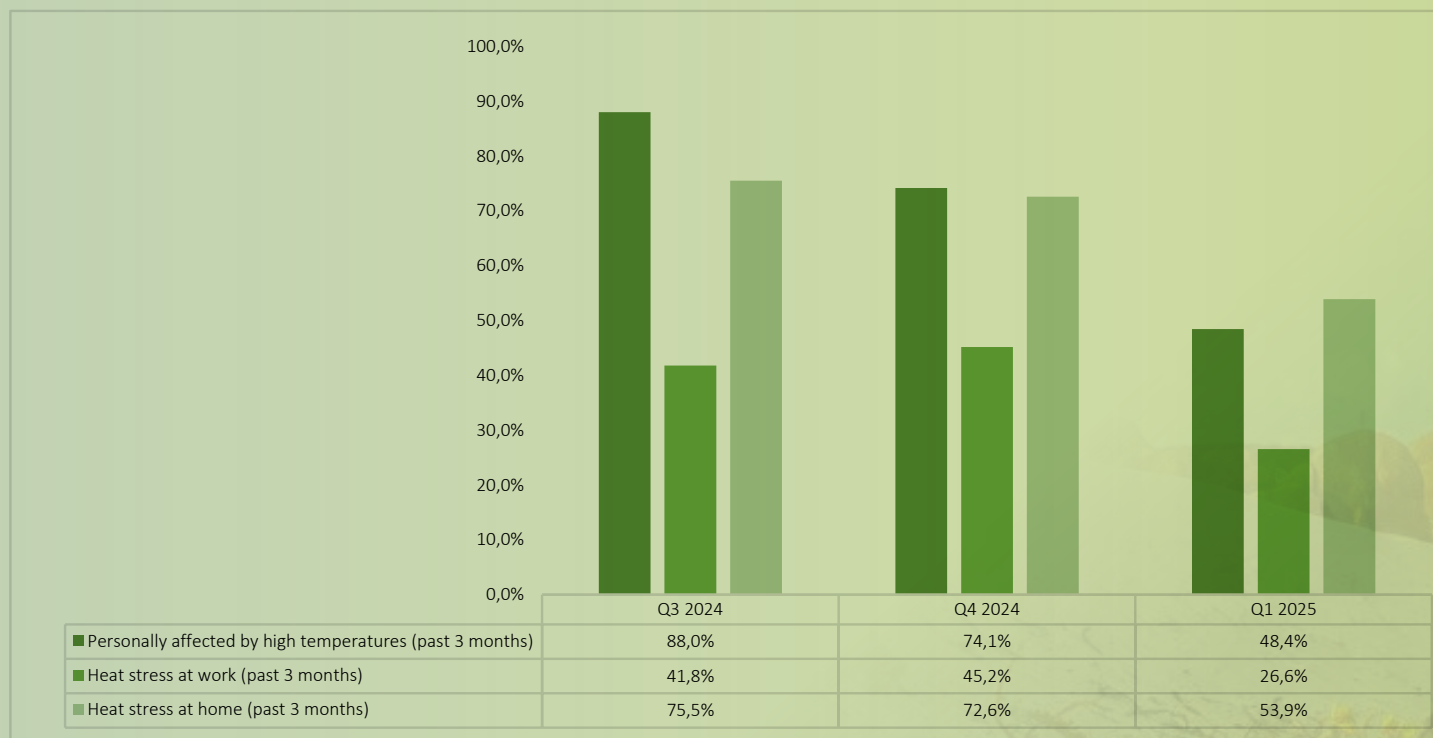
The findings indicate that heat stress is largely concentrated

(more than 50% of respondents) in the following occupational sectors: agriculture, manufacturing, utilities, construction, transportation, accommodation and food services. During the second half of the year, at least 60% of respondents indicate that their work (activities and productivity) was adversely affected by heat and heat stress. Reflective of Aruba’s heat seasonality, perceived heat stress drops by almost 20 percentage points during the first quarter of the year.

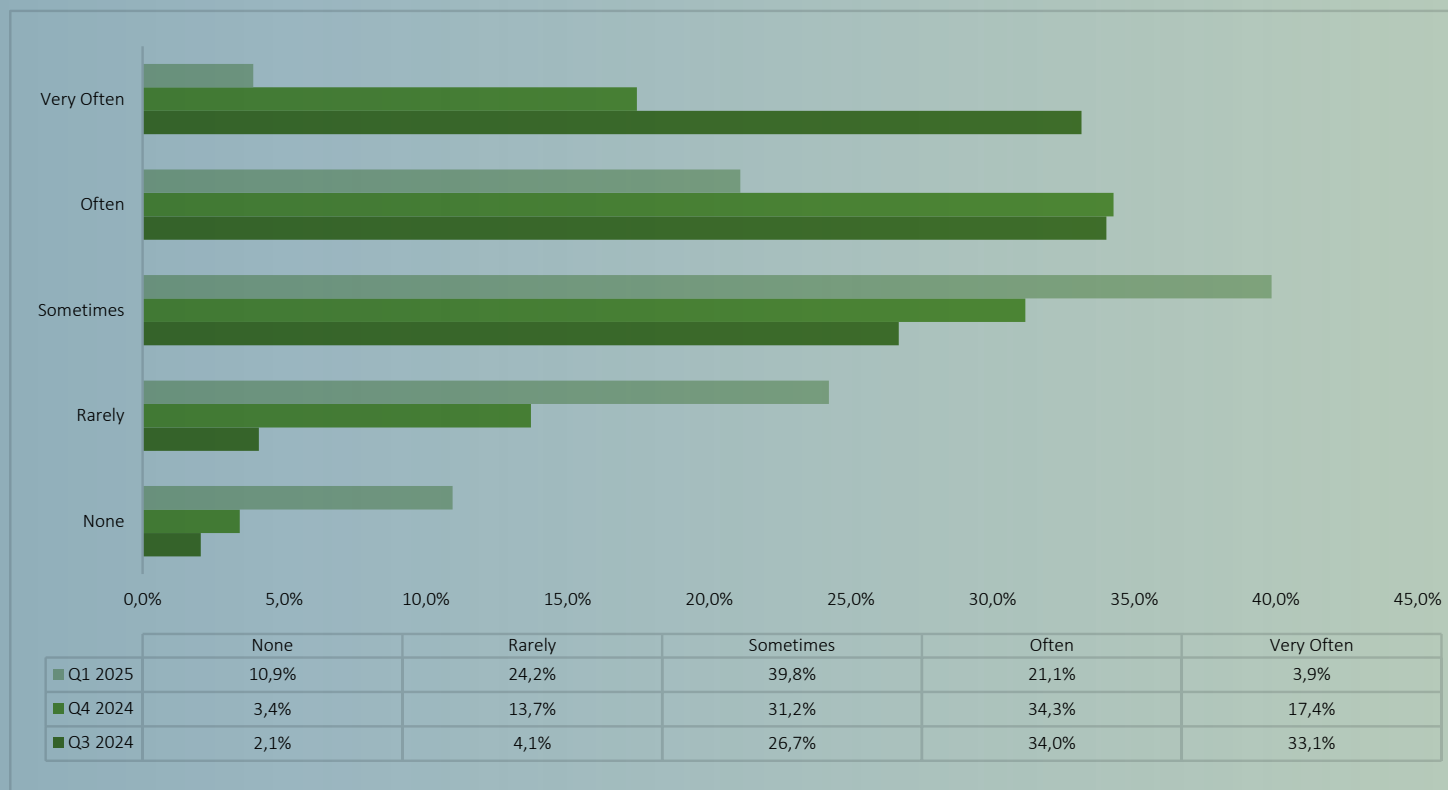
Figure 5. Heat stress experiences and perceptions in Aruba (CBA, 2025).



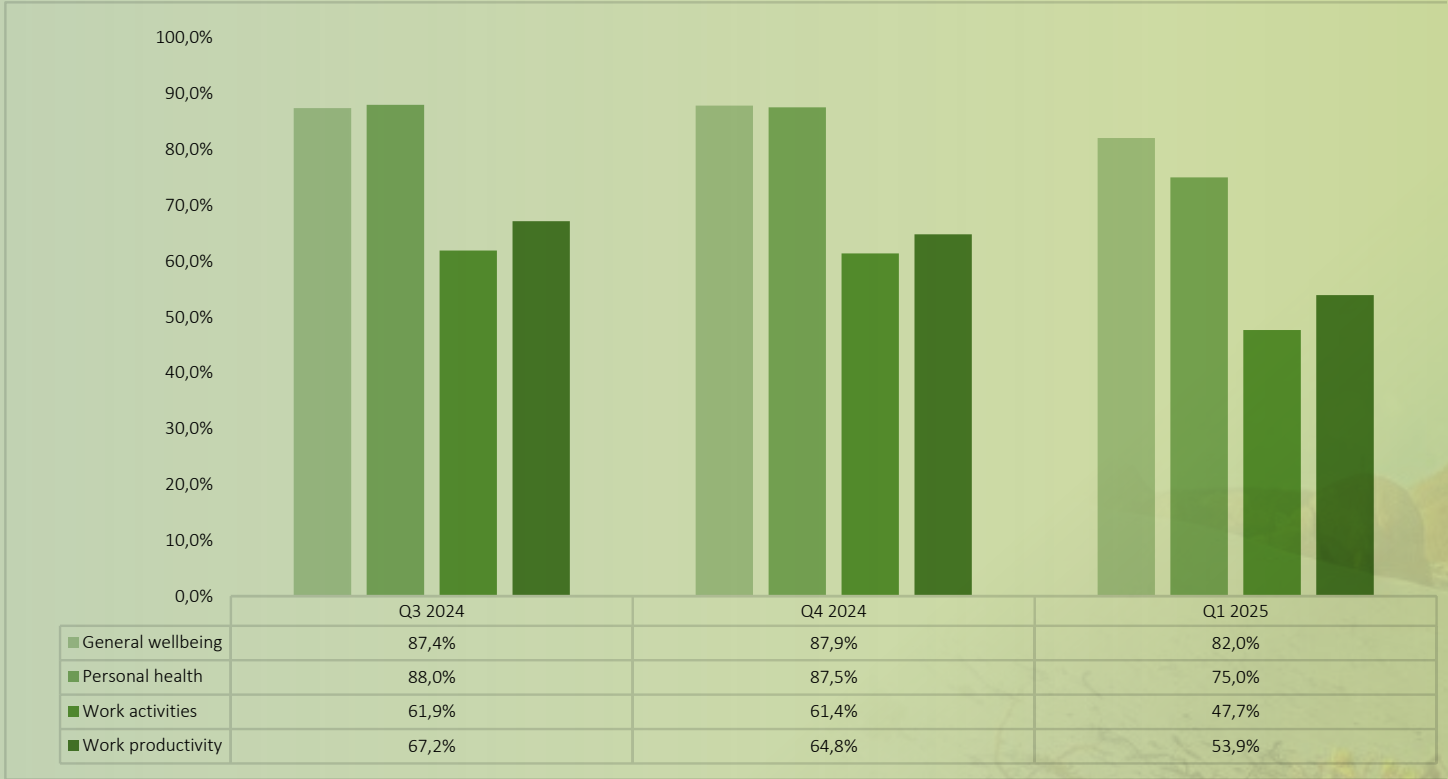
High temperatures and perceived heat stress at work and home (Aruba, Q3/2024 – Q1/2025)



Frequency of feeling heat stress in the last three months



Effects of heat stress on wellbeing and work.



F. Health conditions. In addition to an aging and heat-exposed workforce, occupational heat risks are also heightened due to deteriorating health conditions. Health records indicate that the generation between 45 and 69 years is highly susceptible to various (NCD) health conditions and risks (STEPS, 2024). At least 50% of individuals aged between 45 and 69 years suffer from one or more health conditions, with men enjoying relatively less healthy conditions in comparison to females (between 45 and 69 years).

G. Systemic risks and impacts. The compounding impact of the aforementioned climate and socioeconomic stressors underscore the systemic risks associated with increasing heat and intensifying heat stress in Aruba. More specifically, the analysis of sectoral heat exposure and sensitivity indicates that

industry output is adversely affected by heat (See Table 1). In line with previous estimates, at least 35% of Aruba's economic output is at risk of extreme heat and excessive heat stress in the medium to long term. Based on estimates of total and sectoral gross value added in 2024 (CBA, 2025), and assuming a conservative sectoral heat exposure of 30% annually, in addition to sectoral heat sensitivity levels – ranging between 25% and 75% of the workforce –, industry productivity drops by at least 2.8% (in the most conservative scenario). This amounts to an estimated annual industry output loss of at least Afl. 215 mln. With the expected increase of extreme temperatures and heat stress in the coming decades, industry productivity is projected to decline by 5.6% (Afl. 433 mln. in 2024 nominal GDP). Under a business-as-usual scenario, economic losses could amount to 8.5% (of nominal GDP) by 2050.

Table 1. Stylized sectoral heat exposure and heat sensitivity impacts on select industry output.

	2024e	Average Sectoral Heat Exposure (%) 30	Sectoral Heat Sensitivity (%; workforce)		
			25	50	75
Total gross value added of select sectors (Afl. Mln)	7,694.0	2,308.2	577.1	1,154.1	1,731.2
Agriculture	1.0	0.3	0.1	0.2	0.2
Manufacturing	224.0	67.2	16.8	33.6	50.4
Utilities	321.0	96.3	24.1	48.2	72.2
Construction	433.0	129.9	32.5	65.0	97.4
Transportation	417.3	125.2	31.3	62.6	93.9
Accommodation and food services	1,493.7	448.1	112.0	224.1	336.1
Total	2,890.0	867.0	216.8	433.5	650.3
Relative (% of total gross value added)	37.6	11.3	2.8	5.6	8.5

2.3. Discussion

In review of the situational analysis, the findings indicate that Aruba faces significant occupational heat vulnerabilities due to the cascading and compounding effect of multiple climate and socioeconomic stressors (See Figure 6). In terms of temperature and extreme heat, Aruba is experiencing a continued rise in temperature and intensifying periods of extreme heat. Initial projections suggest that extreme heat will intensify and expand over longer periods of the year. Occupational heat vulnerability

is further exacerbated by multiple socioeconomic developments, including an (i) aging workforce that is (ii) exposed to outdoor heat (iii) under physically-demanding work conditions in (iv) densely-built environments, and (v) experiencing substantial health risks. The mix of these stressors results in high and escalating occupational heat vulnerabilities, thus underscoring the importance – and urgency – of designing and executing an appropriate mix of occupational and urbanization policy measures for strengthening and safeguarding current and future OHR in Aruba.

Figure 6. Compounding and cascading conditions driving occupational heat vulnerabilities in Aruba.



3. Scoping National Legislation & Policies for Strengthening Occupational & Urban Heat Resilience

3.1. Introduction

Over the past decade, and with the mounting events and evidence of extreme heat, several countries have taken concerted legislative and policy actions to strengthening occupational safety and health (OSH) against extreme heat, as well as introduce policies for strengthening urban heat resilience. Regional and country-specific extreme heat events and subsequent occupational heat impacts, including heat-related illnesses and fatalities, have prompted multiple countries to advance and strengthen their OSH laws and regulations with the explicit inclusion and expansion of occupational heat standards and controls (EUROGIP, 2023). Likewise, previous studies show that countries are investing heavily in green-blue infrastructures for mitigating and adapting to urban heat island effects. In this section, the main findings of the scoping review and benchmark analysis on international legislation and national policies for occupational and urban heat resilience are presented.

3.2. OHR in International and National Perspective

Internationally, the ILO's fundamental conventions on OSH 1981 (Convention No. 155) and the Promotional Framework for Occupational Safety and Health Convention, 2006 (Convention No. 187) and their accompanying recommendations No. 164 and No. 197, include provisions for the development of national OSH policies, systems, and programs (ILO, 2023). The OSH recommendation, 1981 (No. 164), specifically mentions that measures should be taken regarding the temperature, humidity, and movement of air in the workplace (Article 3(c)). All ILO Member States, regardless of

ratification status, are expected to respect, promote, and realize the principles of these fundamental conventions, i.e., a safe and healthy working environment is recognized as a fundamental principle and right at work.

Box 2. Historical developments and importance of main provisions of the OSH Fundamental Conventions (ILO, 2023).

The Occupational Safety and Health Convention, 1981 (No. 155) represents an important milestone for promoting a holistic approach to national governance of OSH, one that is policy oriented and focused on prevention. It introduced the principles of a national policy in relation to OSH, emphasizing the need to consider OSH as a matter of national concern. Twenty-five years later, the Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187) was adopted, aiming at promoting a national preventative safety and health culture and progressively achieving a safe and healthy working environment. Convention No. 187 calls for the establishment of a national framework for continuous improvement in the field of OSH, emphasizing the interdependence and interactive nature of its different components (i.e., national OSH policy, a national OSH system, and a national OSH program). Convention No. 187 was the first OSH Convention to apply a new integrated approach to ILO standards-related activities to increase their coherence, relevance, and impact. The principle of prevention is at the core of OSH, which is well reflected in both the fundamental Conventions No's 155 and 187. Convention No. 155 states that the aim of the national policy shall be to prevent accidents and injury to health, by minimizing the causes of hazards inherent in the working environment. Convention No. 187 requires Members to promote continuous improvement of occupational safety and health to prevent occupational injuries, diseases, and deaths, by the development, in consultation with the most representative organizations of employers and workers, of a national policy, a national system, and a national program. Both fundamental Conventions describe a framework with complementary roles of governments, employers, and workers in improving safety and health at work. They emphasize the importance of participation of employers and workers, through express provisions on consultation and cooperation in decision-making and implementation processes.

Nonetheless, to date, less than half of ILO Member States have ratified C155 and C187. ILO records indicate that out of the 187 countries that have ratified ILO’s fundamental conventions 82 countries (44%) have ratified C155 (44%), whereas 67 countries (36%) have ratified C187 (ILO, 2024). In terms of ratification year, most ILO Member States ratified C155 by 2004, whereas C187 was largely ratified a decade later in 2015 by most ILO Member States. There are, however, significant inter-regional differences (See Figure 7). Europe has the highest relative ratification rates of C155 and C187 (respectively, 65% and 59%), whereas the Arab States have the lowest relative ratification rates. In the Americas, less than one third of ILO Member States have ratified either C155 or C187. A small number of countries

(18%) have ratified both C155 and C187, including, Antigua & Barbuda, Argentina, Belgium, Cuba, Cyprus, Denmark, Finland, Iceland, Italy, Norway, Spain, and Sweden. It is noteworthy, that although the Netherlands ratified C155 in 1991, it is yet to ratify C187. Earlier this year, a proposal was submitted to the Senate and House of Representatives to consider the ratification of C187, which was previously rejected in 2012. More specifically, the ratification would also apply to the Dutch Caribbean, including Bonaire, St. Eustatius, and Saba (BES). Records indicate that, thus far, Curacao, Aruba, and St. Maarten have reclused themselves from the ratification (Promotional Framework for Occupational Safety and Health Convention in the Kingdom of the Netherlands, Staten-Generaal, 2024).

Figure 7. Regional ratification rate of ILO C155 and C187 amongst ILO Member States (ILO, 2024).



Regionally, Europe remains at the forefront of OSH legislation and regulation. The protection of workers' health and safety, enshrined in the Treaties and the Charter of Fundamental Rights (Charter of Fundamental Rights of the European Union, OJ C 326), is one of the key elements of an EU economy. The right to a healthy and safe workplace is reflected in principle 10 of the European Pillar of Social Rights, and is fundamental for reaching the United Nations' sustainable development goals (UN, 2020). The new EU 2021-2027 OSH framework, announced in the European Pillar of Social Rights action plan (European Commission, 2019) defines the key priorities and actions for improving workers' health and safety, addressing rapid changes in the economy, demography and work patterns. The Strategic Framework takes a tripartite approach — involving EU institutions, Member States, social partners and other stakeholders — and focuses on three key priorities: (1) anticipating and managing change in the context of green, digital, and demographic transitions; (2) improving the prevention of work-related accidents

and diseases, and striving towards a Vision Zero approach to work-related deaths; (3) increasing preparedness to respond to current and future health crises.

Similar to the current (Federal) OSH Administration in the United States of America (See Box 3), the new EU OSH framework omits OHR standards. Although the EU Directive 89/391/EEC (Council of the European Union 1989) mandates the protection of workers' health and safety from all risks, including emerging ones. Nevertheless, the European Union (EU) currently lacks binding legislation specifically safeguarding workers from heat stress. Consequently, various EU Member States have independently formulated plans to protect their workforce from excessive heat exposure by providing maximum temperature limits, yet there is considerable variation in the strategies used across states and sectors. In general, the thresholds are determined through a mix of statutory laws, collective bargaining or both.

Box 3. New Proposed Occupational Heat Directive by the US OSH Administration (U.S Department of Labor's Occupational Safety and Health Administration, 2024)

In July, 2024, On July 2, 2024, the Occupational Safety and Health Administration (OSHA) released a proposed rule on “Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings.” The rule would apply to all employers and be triggered when employees are exposed to temperatures of 80°F (“initial heat trigger”) for more than fifteen minutes in any given sixty-minute period. The proposal includes additional provisions, e.g., more breaks, an observation/buddy system to monitor workers for signs of heat illness, and training- that would apply at the “high heat trigger” of a heat index of 90°F. Employers would be required to monitor temperatures to determine when the high heat trigger is met. OSHA's new heat safety rules are a major step towards mitigating heat stress health risks and, if enforced, would be the first federal heat stress standard to ensure that workers are better protected against the dangers of rising temperatures and heat illness.

Even though climate change is acknowledged as one of the change drivers that affects workers' safety and health, no further OHR provisions are mentioned in the new EU 2021-2027 OSH framework. This omission has been strongly criticized across the EU and many have called for specific EU directives on occupational heat standards and measures (ADAPT HEAT, 2024). Critics contend that the new strategic framework does not include new protections for workers from exposure to high temperatures or concrete proposals for active labor market policies to prevent heat-related illnesses and occupational injuries in the most affected sectors (EUROGIP, 2023).

Opponents of a specific EU directive contend that the diversity and disparity between countries is too complex for an all-encompassing occupational heat standard and threshold (EUROGIP, 2023). Moreover, consistent with the principle of prevention at the core of OSH, which states that the aim of the national policy is to prevent accidents and injury to health, by minimizing the causes of hazards inherent in the working environment, in most EU countries occupational heat risk assessments are required to prevent the risks associated with excessive exposure to heat, particularly for outdoor work (EUROGIP, 2023). Likewise, in the absence of specific OHR standards enshrined in law, collective agreements are often applied in EU countries with reference to specific sectors. However, research indicates that collective agreements and social dialogue fall short (ADAPT HEAT, 2024).

More specifically, in the majority of (EU) OSH collective labor agreements, there is no clear standard to determine when it is too hot to work, i.e., excessive occupational heat stress). In addition to legal ambiguity, inequality, and uncertainty,

when OHR standards and heat threshold values are mentioned, they differ across sectors and collective agreements, in which the onus usually falls on the workers' personal responsibility, without duly considering other organizational, technical, and administrative controls. Additionally, few collective agreements describe how occupational heat stress should be measured, despite clear scientific consensus and guidelines (ADAPT HEAT, 2024).

In summary, occupational heat resilience and working in extreme heat are rarely regulated at the regional level, either in Europe or across other regions. This creates a wide variety of national and state-wide legislation and policies. The ILO concludes that in most countries, provisions referring to excessive heat in existing OSH laws are often (too) general and do not adequately address the intensifying climate and heat-related dangers many contemporary workers face daily (ILO, 2024). Furthermore, according to the ILO, despite the presence of laws and regulations aimed at safeguarding workers from heat stress, many of these provisions were established in the past, often with basic requirements that fail to address the acceleration of climate change and contemporary (extreme) heat stress in today's working environments.

Notwithstanding national differences in legislation, regulation, and systems for OHR, the scoping review reveals that there is an emerging understanding and evolving concurrence across different regions and countries on leading policies for advancing OHR. Countries that are at the fore of advancing OHR legislation and policies – including, but not limited to, Canada, Costa Rica, Chile, Cyprus, Greece, The Netherlands, Qatar, Saudi Arabia, Singapore,

Spain, and the United States of America – recognize the urgency of protecting workers and workplaces against rising occupational heat risks and heat casualties (See Annex B). These leading countries include heat-related risks and OHR as key priorities in national OSH policies and strategies, define concerted and collaborative policy actions and initiatives, and have created or adapted regulations and guidelines to strengthen OHR.

From a systems ('whole-of-country') perspective, leading policies for advancing OHR are based on a scaffold of basic design components. This general framework is largely in line with the recommendations of the ILO for the adoption of a strategic approach for systemic national governance of OHR (ILO, 2023). The general OHR framework is organized as 'tree-tier architecture' consisting of three levels or layers, including legislation, regulation, and policies and (sectoral and/or organizational) programs.

In general, the OHR framework describes three fundamental principles for safeguarding and strengthening national OHR:

I. To legally anchor OHR in national legislation and regulation based upon the ratification of ILO Fundamental Convention C155 and C187, in addition to international and regional OSH legislative frameworks. All OHR-advanced countries have enshrined OHR in their respective laws and legislative frameworks, either by means of National Acts (Ordinances and/or decrees), Ministerial Decrees, and/or Ministerial guidelines (Codes of Practice). However, the scoping review indicates that (currently) countries do differ on four (4) basic legislative anchoring dimensions:

- a) National/federal vs. state/province level OHR legislation (e.g., North America and EU)
- b) Specific OHR legislation vs. general OHR legal frameworks (e.g., EU: Cyprus vs. the Netherlands)
- c) Normative (max. heat stress exposure threshold) vs. preventive (min. heat stress trigger levels) OHR legislation (e.g., Chile, Cyprus, Qatar vs. USA, the Netherlands)
- d) The extent and comprehensiveness of OHR-inclusive collective (sectoral) agreements and social dialogue (e.g., Spain, The Netherlands).

Notwithstanding national differences, legal OHR anchoring provides the foundation for executing subsequent regulations, directives, and guidelines in a just and transparent manner, in consultation between government, social partners, and representative organizations of employers and employees. Likewise, anchoring OHR includes *assigning and authorizing a designated body (or authorities) responsible for OSH in general*, and ensuring compliance of OHR in particular. In accordance with ILO C187, systems of OHR inspection are key in advanced countries, and in some case include sanctions for violations (e.g., the Netherlands, Qatar, Saudi Arabia).

II. To foster evidence-based OHR policy development based upon legally-established OHR standards (threshold values) and comprehensive OHR risk assessments for anticipating, minimizing, and preventing occupational heat hazards and risks ('trigger values'), and developing a national OHR plan, as well as promoting a culture that includes information, consultation, and training on OHR. OHR-advanced countries – with the exception of Canada,

USA, and the Netherlands⁴ – set and use a standardized occupational heat exposure limit based on WBGT heat stress index (ISO7243;17), including specifications of work intensity or work risk level (e.g., Canada, Costa Rica, Chile, Cyprus, Greece, Qatar, Singapore, USA). In addition, some countries rely on the Heat Index (e.g., Spain, Saudi Arabia). Heat risk assessments and national (or state-level) heat plans – including heat early warning systems (HEWS) – are standard and mandatory practices in countries at the forefront of OHR (e.g., Costa Rica, Chile, Cyprus, Greece, Saudi Arabia, Singapore, The Netherlands, USA).

III. To develop and improve the (institutional) adaptive capacity for safeguarding OHR by means of a system of general preventive and protective measures for optimizing (organizational and workplace) OHR (See Box 4). These OHR measures form a hierarchy (high to low) of control, i.e., from substitution and technical measures to organizational and personal (STOP) measures (ADAPT HEAT, 2024).

⁴ According to ADAPT HEAT (2024): “Dutch OHS legislation does not contain a threshold value or occupational exposure limit relating to work in heat. The Dutch legislation is characterized by very general stipulations. In article 6.1 of the Working Conditions Decree, it is stated that “Taking into account the nature of the activities carried out by the employees and the physical load resulting from them, the temperature at the workplace should not cause damage to the health of the employees”. Until 2013, reference was made to ISO7243;17 for occupational heat stress, but the ‘policy rule’ was abolished in 2012. Since then, employers and trade unions have to negotiate a threshold value in either an OHS catalogue or a collective labor agreement. Only a limited number of collective labor agreements mention some sort of threshold value, but these are based on air temperature only. All relevant labor agreements use different threshold values, which is not in line with the notion of equal protection. Furthermore, the thresholds are rather high (>35°C) and do not take into consideration the physical exertion of the work”.

Box 4. Preventive occupational heat-stress measures following the hierarchy of control (ADAPTHEAT, 2024).

Substitution measures

- Stop/don't start work when occupational heat stress and heat exposure are above the Occupational Exposure Limit (OEL).
- Minimize (and stop) work during (extended) periods of (extreme) heat.
- Arrange financial compensation schemes for employers/employees in case of 'unworkable' heat, including the right for workers to interrupt work without repercussions.

Technical measures

- Climate-resilient design of workplace and rest areas.
- Air conditioning/climate system.
- Ventilation.
- Workplace adaptability and use of shading for outdoor work environments.
- Measure local workplace (on-site) heat stress (by means of WBGT)

Organizational measures

- Monitor weather forecasts (3 to 5 day weather forecasts)
- Adaptation of work schedule, including work-rest schedules.
- Job rotation (considering work intensity)
- Extra (drinking) breaks in a cool environment.
- Use of monitoring devices (in visible places) so workers can monitor their own exposure to ambient heat.
- Buddy systems.
- Medical surveillance by occupational physicians.
- First-aid measures and emergency plans.

Personal protection

- Sunblock (cream).
- Protective clothing, using clear-cut, evidence-based specifications.
- Use of hats or caps (with or without neck flaps).
- Supply of drinks or other forms of rehydration.
- Wristbands to monitor heat strain and receive early warning if either heat is above the OEL or there are symptoms that may indicate the onset of heat-related problems.

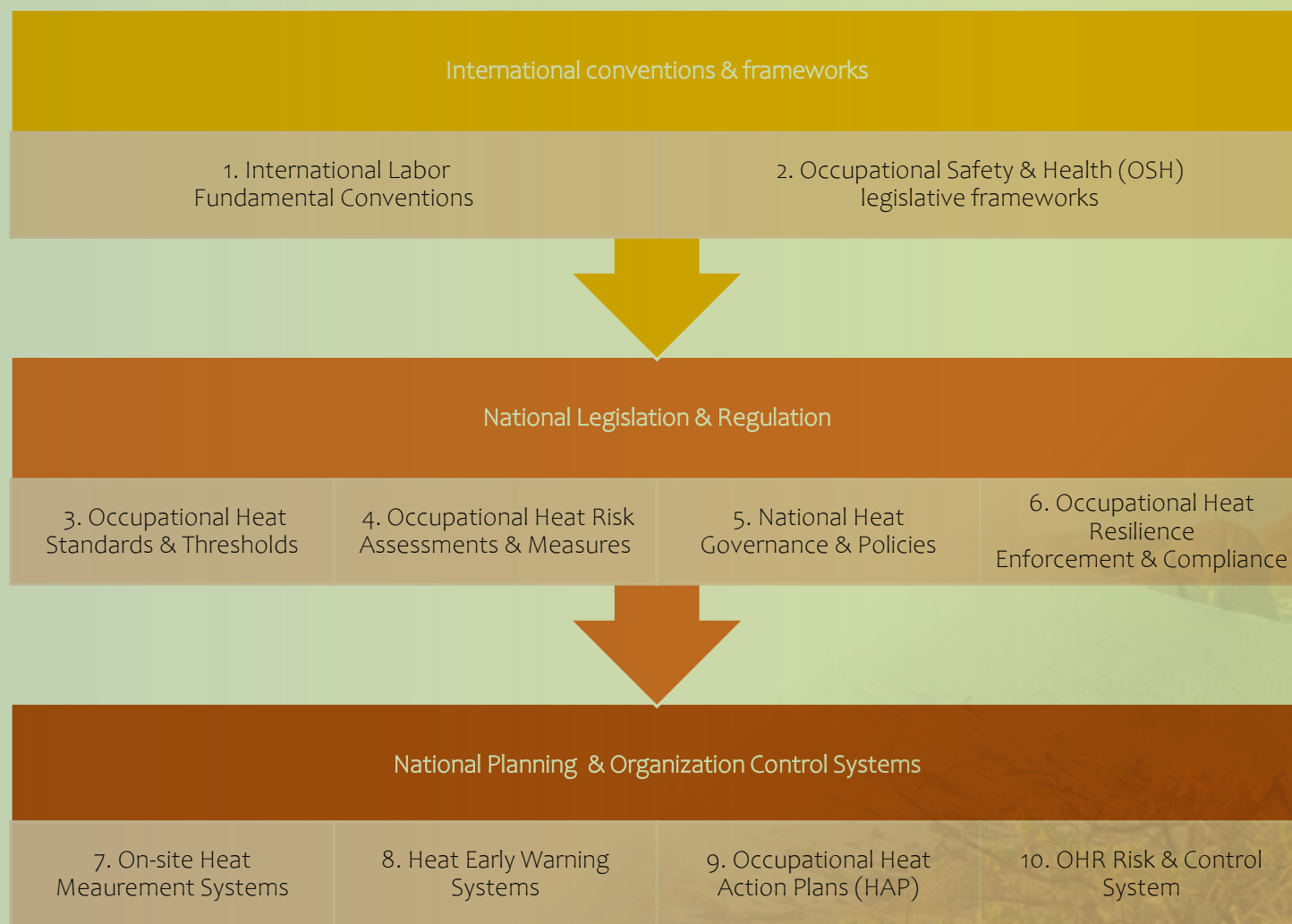
The adaptation of (preventive) control measures resonates strongly across OHR-advanced countries. Moreover, the continuous improvement and agility of organizational systems is enhanced by several (sector and/or organizational) 'best OHR practices', including:

- a. *Developing, implementing, and managing a (year-round) heat action plan* – supported and agreed upon between employers and employees – to determine at any given time whether environmental conditions increase heat stress levels, with specific OHS protective measures activated automatically when certain 'threshold levels' are reached (based on national and/or state-level HEWS).
- b. *Measuring and monitoring the level of (site-specific) occupational heat exposure and heat stress according to standard and validated heat stress methodologies.* Advanced countries concur in the usage of the WBGT as an occupational heat stress indicator to assess the level of heat exposure, with varying safety thresholds based on work intensity. Maximum WBGT thresholds vary according to work intensity and are typically (WBGT) 29-30°C for high-intensity work, 30-31°C for moderate-intensity work, and 31.5-32.5°C for low-intensity work. Many countries measure and monitor (air) temperature, relative humidity, and heat indices as well, yet recognize the significant limitations of temperature and heat index in physically-demanding outdoor occupations. Advanced countries also have an integrated digital GIS system for measuring, monitoring, and mapping (site-specific) occupational heat risks and hazards, oftentimes coordinated with HEWS.

- c. *Establish and authorize (organizational) responsibilities* for compliance with the heat action plan, informing and training workers of occupational heat risk levels and appropriate STOP measures, as well as organizing first-aid and emergency response procedures. In addition, acclimatization processes must be established for new employees. Special attention should be paid to pregnant workers and people who are particularly sensitive due to their physical and health conditions.

Across advanced countries, the aforementioned principles and leading policies for *anchoring, authorizing, assessing, anticipating, and adapting*, are applied for safeguarding OHR. Considering climate change acceleration and heat wave intensification, many advanced countries have adapted and continue to update their OHR legislative and (risk-based) control systems. These principles and policies form a general OHR framework consisting of ten (10) basic design components for advancing OHR at the national level (See Figure 8).

Figure 8. Systemic OHR framework: Key design characteristics for safeguarding and advancing OHR.



The OHR scaffold emphasizes the importance of multiple building blocks for strengthening OHR. Previous empirical studies underscore the importance of these basic design components and confirm that although each building block is necessary, no single design component is sufficient for safeguarding OHR. Hence, the need for and importance of pursuing and implementing a systemic framework for advancing OHR, in which all the design components are allocated, aligned, and acculturated. Furthermore, at the national (and state) level, OHR is fostered by the consistency and alignment between the different design components, emphasizing the need for an integrated and coordinated to advance OHR. Finally, although there are guiding principles, there is no 'single best model' for safeguarding OHR, especially considering the (regional, national, and sectoral) diversity of occupational heat exposure, heat stress, and heat-health vulnerabilities. Hence, the governance of OHR needs to be contextualized and calibrated to the local context and specificity of the socioeconomic environment.

3.3. State of Occupational Heat Resilience Legislation and Regulation in Aruba

In terms of OHR legislation, Aruba does not have comprehensive labor legislation that addresses and incorporates (contemporary) working conditions, occupational health and safety, nor occupational heat stress (SER, 2014; EBA, 2022) The ILO Fundamental Conventions C155 and C187 are not ratified. Currently, there is no comprehensive working conditions act nor decree that explicitly considers and incorporates safeguarding occupational safety, health, and wellbeing²⁵. The Labor Ordinance (Arbeidsverordening, 2013) does not make any reference to occupational temperatures, occupational heat stress, nor the effect of rising temperatures and heat at work.

Although the Safety Ordinance (Veiligheidsverordening, 1990) and the Safety Decree (Veiligheidsbesluit, 1991) include several general provisions for (technical) occupational safety (see, e.g., Art. 15.1, Art. 23, Art. 39, Art. 40, Art. 41, Art. 42, Art. 43, Art. 44), albeit from an indoor perspective, as well as the promotion of a bearable temperature (Art. 2h), **the Safety Ordinance does not address occupational heat stress and thermal work limits, nor does it provide any specific heat-related risk provisions.**

With regard to social security and insurance, the National Ordinance for Injury Insurance (Landsverordening Ongevallenverzekering, 1996) references several occupational injury categories and organizational activity risk levels. Nevertheless, occupational and workload intensity are not mentioned nor differentiated. However, while the National Decree on Occupational Illnesses (Landsbesluit Beroepsziekten, 1996) does explicitly recognize heat stress and heat-related illnesses (see Art. 2b, 2c, 2d, 2e), however, **no specific heat stress provisions and/or occupational heat resilience measures are included.**

In similar fashion, the Calamity Ordinance (Calamiteitenverordening, 2014). references disruption of safety and security with severe consequences for lives and health of the population (Art. 1), including measures for the prevention of disasters (Art. 2a), **yet no explicit or formal legal provision is made for extreme heat events** (e.g., heat waves) as national disasters and corresponding preventive and response measures. It should be noted, however, that the Calamity Ordinance by means of Article 4 could allow for the identification and designation of extreme heat events as national disasters by means of a National Decree. Furthermore, it is recognized that the Crisis Management Office (CMO) in Aruba is developing and advancing its Multi-Hazard Early Warning System (MHEWS), including a comprehensive Heat EWS (CMO, 2023).

Table 2. The State of Occupational Safety and Health Legislation in Aruba.

	LABOR & WORK	OCCUPATIONAL SAFETY & HEALTH	SOCIAL SECURITY & INSURANCE	DISASTERS & CALAMITIES
National ordinance (NO) [last amendment]	Arbeidsverordening (inwtr. 2013 90) [2022]	Veiligheidsverordening AB 1990 no. GT 31 [2014]	Landsverordening ongevallenverzekering (Pos. 508) [2010]	Calamiteitenverordening AB. 1989, no. 51 [2014]
National decree (ND)		Veiligheidsbesluit I ((AB 1990 no. GT 31)	Landsbesluit beroepsziekten (uitv. art. 1) (Pos. 509)	
			Landbesluit Gevarenklassenbesluit ongevallenverzekering AB 1997 no. GT 6 [1997]	
Ministerial regulations (MR)		MR. for ND Art. 38 Hazardous workspaces defined when occupational temperature exceeds outdoor (air) temperature by 5C		
International treaty and/or agreements	ILO ILO conventions for occupational safety and health (C155 and C187) not ratified	OSHA NO OSH legislation and/or working conditions regulation		DRR Framework Multi-Hazard Early Warning System
AUTHORITY	Department of Labor	Department of Technical Inspections	Social Security Bank	Crisis Management Office

	LABOR & WORK	OCCUPATIONAL SAFETY & HEALTH	SOCIAL SECURITY & INSURANCE	DISASTERS & CALAMITIES
COVERAGE	NO: Total work hours (Art. 8) NO: Work hours (Art. 10; 26) NO: Rest time (Art. 12)	NO: Accident prevention (Art. 2a)	NO: Occupational danger levels of sectors (Art. 1)	NO: Disruption of safety and security with severe consequences for lives and health of population (Art. 1). Prevention of disasters (Art. 2).
TEMPERATURE (INDOOR)		NO: Promoting a bearable temperature (Art. 2h) ND: Heat exposure and sanitary facilities (Art. 15; 23); Warm air flow (Art. 40); Ventilation (Art. 44); Heat radiation (Art. 41); +5C (indoor vs. outdoor air) temperature exposure (Art. 42); Requirement to measure temperature contingent on weather conditions (Art 43).		
TEMPERATURE (OUTDOOR)		ND: Shading and weather protection (Art. 39); Hydration (Art. 56)		
HEAT			ND: Occupational illnesses include occupational physical accidents and injuries, including heat exhaustion, heat stroke, sun stroke, and blisters (Art. 2)	

3.4. Discussion

Aruba's approach to occupational heat stress is currently reactive and lacks specific regulatory mandates. While the public and private sector recognize the risks of extreme heat, a dedicated legislative and comprehensive policy framework to protect workers from (outdoor) occupational heat is not yet in place. The current OSH legislation often lacks clear, quantifiable triggers for when heat protection measures must be implemented. A revised legislative framework would mandate quantitative thresholds and establish specific heat triggers for action. For example, some jurisdictions have established initial heat triggers at a heat index of 35°C. In addition, the occupational heat legislation does not require employers to conduct a site-specific heat hazard assessment. The current policy relies largely on public health advisories and private sector initiatives, rather than enforceable policies for employers. Unlike advanced countries with mature heat governance, Aruba does not have explicit laws or regulations that mandate specific protective measures against heat stress. There are no requirements for, e.g., mandatory rest breaks for outdoor workers during hot periods, provision of water or shade as a legal requirement, acclimatization protocols for new or returning employees, nor enforceable heat-related work/rest cycles. Likewise, the current regulation does not ensure that both employers and employees are prepared to recognize and respond to occupational heat stress and heat-related illnesses. Furthermore, the lack of specific regulations creates an unequal playing field. While some employers may voluntarily implement best practices (e.g., providing water or adjusting work schedules), others may not. Workers in vulnerable employment, such as those in the informal economy, are often the most exposed to heat risk with the least protection. Moreover, there is a lack of publicly available data on heat-related occupational

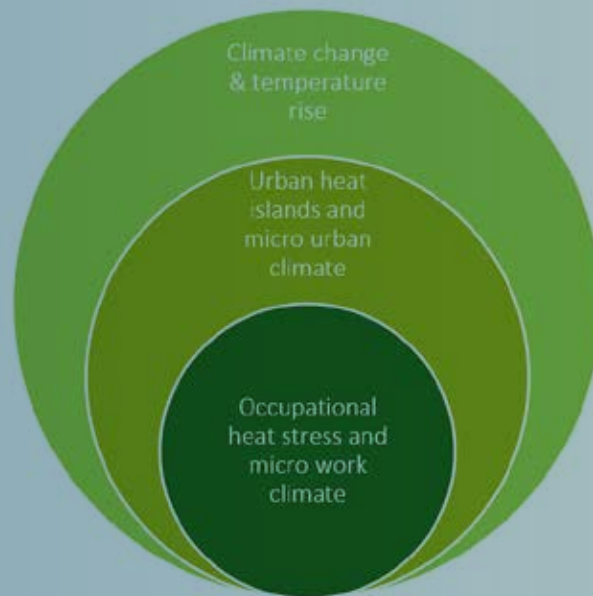
illnesses and injuries in Aruba. Without a robust system for monitoring and reporting, the true scope of heat stress and heat-related health illnesses and injuries are likely underestimated.

In summary, Aruba's OSH legal framework has a number of key limitations and weaknesses, particularly when it comes to addressing the specific risk and health hazard of occupational heat stress. The overall framework may be hindered by a lack of comprehensive, detailed, and enforceable standards. Aruba does not have a single, overarching Occupational Heat Safety and Health Act that provides a clear and cohesive framework for heat-related workplace safety, especially for outdoor work. Instead, regulations are fragmented scattered across various national ordinances and decrees, labor laws, and guidelines. This can lead to inconsistencies and difficulties in enforcement. The absence of a strong, preventive legal framework means the system is likely to be more reactive to occupation heat incidents rather than proactively preventing them. Much of the existing legislation relies on general duty clauses, which broadly require employers to provide a reasonably safe and healthy working environment. While this is a foundational principle, it lacks the specificity needed for effective enforcement and compliance, especially for a complex issue like occupational heat stress.

Aruba's institutional framework for heat governance is nascent and assets for comprehensive heat governance are limited. While Aruba has some basic occupational elements, a cohesive, integrated system for strengthening heat resilience is not yet in place. Although occupational safety and health policies are required to safeguard workforce wellbeing and productivity, these labor policies are insufficient for effectively mitigating and managing the adverse effects of occupational

heat stress in urban (residential and commercial) centers. Thus, while occupational heat resilience strategies are required, these are insufficient and must be complemented and integrated with (nature-based) strategies and policies for mitigating urban heat islands (UHI) and enabling urban heat resilience.

Figure 9. The embeddedness of occupational heat stress, urban heat islands, and climate change.



3.5. Mitigating Urban Heat Islands

The UHI effect (Li et al., 2024) significantly exacerbates occupational heat stress in Aruba, particularly in its most densely-populated areas and key (outdoor work) sectors (NCRC, 2024). While Aruba's tropical climate already poses a

baseline risk, the UHI effect creates localized 'hot spots' that elevate temperatures and intensify the risks for outdoor and even some indoor workers. In Aruba, the UHI effect is caused by several factors (NCRC, 2024):

- i. Heat-absorbing surfaces: buildings, asphalt roads, and concrete sidewalks absorb and store solar radiation during the day. Unlike natural landscapes with vegetation that cool through evapotranspiration, these surfaces release the stored heat slowly at night, keeping urban areas warmer around the clock.
- ii. Lack of vegetation and water retention: densely built urban centers have limited green spaces, which are essential for providing shade and natural cooling. This absence of trees and plants prevents the cooling effect of evapotranspiration, a process that releases water vapor from plants and cools the surrounding air. Likewise, water retention and harvesting are restrained in urban areas due to predominance of (non-water absorbing) concrete and asphalt.
- iii. Trapped heat: tall buildings and narrow streets of urban areas can create 'urban canyons' that restrict airflow, trapping heat and preventing it from dissipating. The UHI effect can worsen air quality by increasing ground-level ozone, which can lead to respiratory problems (Li et al., 2024). This combined with heat stress poses a dual health threat to workers, particularly those in outdoor jobs.

The UHI effect is a critical multiplier of occupational heat stress in Aruba, raising heat by at least 4°C. Addressing this requires not only general climate adaptation policies but also targeted urban planning strategies such as increasing green

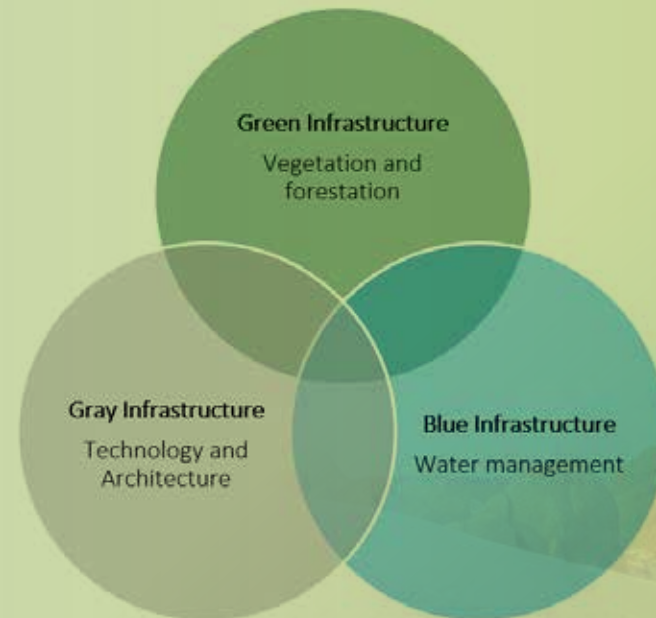
and blue infrastructure, using reflective materials, water-based cooling technologies, and improving building designs to protect the island's workforce (See Figure 10). More importantly, urban planning strategies need to be aligned with occupational heat resilience policies, thereby strengthening the synergistic effects of occupational and urban heat resilience.

To manage rising temperatures and extreme heat, green and blue (nature-based) infrastructures (GBI) need to be structurally, explicitly, and proactively incorporated in urban and spatial planning. GBI can be used to combat urban heat islands and occupational heat stress by creating cooler ($\Delta T = 5^{\circ}\text{C}$), more comfortable microclimates through a combination of natural systems (Fu et al., 2024; Kumar et al., 2024, Li et al., 2024). The core strategies involve increasing shade, promoting evaporative cooling, and using materials that absorb less heat. More specifically, green infrastructure uses (endemic) vegetation and forestation to provide shade and cool the air through evapotranspiration. Examples include:

- a) *Urban forests and street trees:* Planting trees along streets, in parks, and in public squares creates a large canopy that shades surfaces like pavement and buildings, preventing them from heating up. This directly reduces surface temperatures and lowers the ambient air temperature.
- b) *Green roofs and walls:* Installing vegetation on rooftops and building facades provides a layer of insulation that reduces the heat absorbed by buildings. This lowers the need for air conditioning, saves energy, and reduces the heat released from buildings into the urban environment.
- c) *Rain gardens and bioswales:* These landscaped depressions are designed to collect and filter

stormwater. The plants within them use the captured water for evapotranspiration, providing localized cooling.

Figure 10. Green-Blue-Gray infrastructure for mitigating urban and occupational heat.



In complementary fashion, blue infrastructure leverages water's cooling properties. Water bodies have a high thermal capacity, meaning they can absorb a lot of heat without a significant temperature increase. Additionally, the evaporation of water has a powerful cooling effect. Examples include:

- a) *Natural water bodies:* restoring natural water bodies, such as wetlands and natural water reservoirs, in urban

areas acts as a heat sink, absorbing excess heat from the surrounding environment. The evaporation from their surfaces provides a strong cooling effect, especially for nearby areas. Natural water bodies also enable water harvesting and retention, thereby providing co-benefits against storm floods and drought.

- b) *Blue-green roofs*: These are a hybrid of green and blue infrastructure. They combine vegetated roofs with the capacity to store stormwater on the roof itself, using it to sustain the plants and provide enhanced evaporative cooling.
- c) *Urban sponges*: Urban sponges are urban designs that use natural systems to manage stormwater and mitigate flooding. Residential and commercial areas are developed that can absorb, store, and purify rainwater like a sponge, reducing reliance on traditional drainage systems. This approach incorporates green and blue infrastructure like permeable pavements, green roofs, urban wetlands, and parks to manage rainfall and improve water quality.

While traditional (gray) infrastructure often contributes to the UHI effect, it can be adapted with strategies that reflect heat rather than absorbing it. Using materials that are more reflective and less absorptive of solar radiation for roads, sidewalks, and parking lots can significantly reduce surface temperatures (i.e., cool pavements). This includes lighter-colored asphalt or special coatings. Likewise, Painting rooftops with highly reflective, light-colored, or specialized coatings helps to reflect sunlight and reduces the amount of heat a building absorbs. Furthermore, architectural and urban planning designs that enhance air movement and ventilation corridors can help dissipate heat. This includes orienting buildings to maximize

shade and airflow and creating open spaces to allow for natural breezes.

Notwithstanding the costs and required investments in developing GBI in the long run, the cost of inaction largely outweighs the costs of action. Based on conservative estimates of GBI investments of Afl. 150 per square meter and considering an estimated 150 km² of land surface that would potentially require GBI adaptation in the next 25 years, the required GBI investments are projected to total Afl. 22 billion. Considering a discount rate of 4%, the estimated annual investment would amount to Afl. 528 million (6.8% of nominal GDP 2024), which is less than the costs of inaction under a business-as-usual scenario of Afl. 867 million (11.3% of nominal GDP 2024).

In terms of critical (utility) infrastructure, the dependencies on centralized – largely fossil fuel-based – utility systems are susceptible to extreme weather conditions and vulnerable to power outages during extreme heat events. In addition, the widespread use of air conditioning, while providing personal relief, contributes to increased energy consumption and the UHI effect. Moreover, the island's legacy of fast-paced urbanization and construction, as well as the lack of sound spatial planning and enforcement exacerbate heat stress in densely-populated commercial and residential areas. Although Aruba has a National Biodiversity Strategy and Action Plan (DNM, 2024) and recently presented a nature-inclusive vision of Aruba (ACF, 2025), both of which acknowledge the value of natural ecosystems, specific policies for conserving and restoring green and blue urban spaces to combat the urban heat island effect and strengthen urban heat resilience are not evident yet.

There are, however, no comprehensive regulations and coordinated policies for occupational safety and urban planning to manage and mitigate extreme and chronic heat. In fact, applying a maturity model for heat governance (National Integrated Heat Health Information System, 2024) and based on expert interviews across various policy domains and business areas⁵, the findings indicate that Aruba's current heat governance system remains largely embryonic, reactive, and fragmented. Experts concur that across all dimensions of heat governance – occupational heat legislation and regulation, institutional capability and coordination, as well as nature-based and infrastructural assets – Aruba scores relatively low. The latter describes a relatively low level of national heat governance maturity. Considering the present and projected state of extreme heat in Aruba, this calls for concerted and coordinated national heat legislation, policies, and governance.

4. Conclusions & Recommendations

4.1. Introduction

Extreme heat is an increasing global threat to lives and livelihoods, recognized as a significant existential risk.

Rising temperatures and more frequent heatwaves are affecting workers worldwide, with ILO reporting that at least 2.41 billion workers are exposed to excessive heat, leading to millions of injuries and nearly 19,000 deaths annually. Heat stress causes both acute illnesses like heatstroke and chronic diseases affecting the cardiovascular and respiratory systems. It also impairs cognitive performance, increasing workplace accidents and

reducing productivity. The most vulnerable are those in physically demanding or outdoor jobs, such as agriculture, construction, transportation, and tourism. The economic impact is substantial, with a projected 2.2% reduction in global productivity. The primary purpose of this study was to analyze occupational heat stress and its impacts in Aruba, benchmark its current occupational and urban policies against international standards, and provide recommendations for strengthening occupational heat resilience.

4.2. Lessons Learned

Aruba is facing escalating occupational heat vulnerabilities due to a combination of climate and socioeconomic factors.

Since the early 1990s, the island has experienced a significant rise in temperatures, with a 1.5°C increase in average air temperature and a rise in relative humidity. Projections indicate that average temperatures could increase by at least 3°C in the coming decades, with extreme heat events (heat index of +40°C) lasting longer, from May to November, which would extend the traditional heat season. This intensifying climate stress is compounded by long-standing socioeconomic vulnerabilities, including population aging, urbanization, and a high concentration of outdoor workers in physically demanding sectors. These combined stressors underscore the urgent need to address occupational heat resilience to protect workers and the economy.

A major socioeconomic stressor is the aging workforce and population. An estimated 27% of Aruba's population is over 60 years old, and nearly 15% of the working population falls into this age group. This demographic trend is expected to continue.

⁵ Between August and October 2024, a total of 11 interviews were conducted with stakeholders and local experts. The interviews used a semi-structured design based on the main dimensions of the heat governance maturity model.

The human capacity to handle heat stress diminishes with age, starting as early as 45 years old. For Aruba, this is particularly concerning as over half of the employed population is over the age of 45. The potential future labor productivity at risk from this aging workforce could amount to an estimated 39% of GDP (in nominal 2024 terms). Moreover, the elderly and senior residents are at an increased risk of fatality from extreme heat.

Urbanization is another critical factor exacerbating heat-related risks. Driven by economic growth, Aruba's population density and urbanization rate have increased considerably over the past three decades. This has led to a significant increase – more than doubling – in artificial land coverage, causing the loss and decay of natural habitats. These densely built urban areas experience temperatures at least 5°C higher than surrounding areas due to the urban heat island (UHI) effect. This phenomenon, caused by factors like increased energy from buildings, roads, and machinery, exacerbates heat stress for workers and residents alike, affecting livelihoods and lives.

Occupational risks are particularly high in sectors prominent in Aruba's economy. The tourism, transportation, trade, construction, and utilities sectors employ over half of the total workforce. Many of these jobs are physically demanding and involve outdoor work, significantly increasing heat exposure. Preliminary analysis suggests that at least 40% of the total workforce is exposed to various degrees of outdoor heat. Community perceptions of heat stress are high, with 70% of residents reporting being personally affected, and over 45% experiencing heat stress at work.

The compounding effects of these climate and socioeconomic stressors pose systemic risks to Aruba's economy. The analysis of sectoral heat exposure and sensitivity

indicates that at least 35% of the island's economic output is at risk from extreme heat. A conservative scenario projects that industry productivity could drop by at least 2.8. Under a business-as-usual scenario, economic losses could amount to 8.5% of nominal GDP by 2050. The findings of this situational analysis underscore the urgency of designing and implementing policy measures to strengthen current and safeguard future occupational and urban heat resilience in Aruba.

An important lesson from the international review and scoping is that while many countries are taking concerted action to address extreme heat through legislation and policy, Aruba's approach remains reactive and lacks a specific and comprehensive institutional framework. The country's strategy currently relies on public health advisories and voluntary private sector initiatives, rather than enforceable policies that mandate protective measures for workers. There are no explicit standards for heat thresholds and triggers. There is also no legislation requiring, e.g., mandatory rest breaks for outdoor workers, the provision of water or shade, or acclimatization protocols. Furthermore, vulnerable workers in the informal economy are most at risk with the least protection. A lack of publicly available data on heat-related occupational illnesses and injuries in Aruba makes it difficult to fully understand the true scope of the problem.

The findings highlight that Aruba's institutional framework for heat governance is in its early stages of development. While some key elements are present, a cohesive, integrated system for strengthening heat resilience is not yet in place. The current labor and (work) safety policies, which are necessary to protect workers, are insufficient on their own to effectively mitigate and manage the broader adverse effects of urban heat. Therefore, occupational

heat resilience strategies must be complemented and integrated with nature-based policies for urban heat resilience.

A key insight is the exacerbating effect of the urban heat island (UHI) phenomenon on occupational heat stress in Aruba.

Although the tropical climate already poses a baseline risk, the UHI effect creates localized ‘hot spots’ that elevate temperatures and intensify risks for (outdoor) workers. This effect is driven by several factors, including heat-absorbing surfaces like buildings, asphalt roads, and concrete sidewalks that retain solar radiation. The lack of vegetation and limited green spaces in densely built urban centers prevent natural cooling through evapotranspiration.

This requires a multi-pronged approach that goes beyond labor policies; it necessitates co-integrated and targeted urban (heat) resilience planning and development. These should focus on strengthening and restoring (nature-based) green and blue infrastructures, as well as using reflective materials, in addition to improving and retrofitting building designs to protect the workforce. To be effective, urban planning strategies must be aligned with occupational heat resilience policies to create synergistic effects. In conclusion, Aruba’s current heat governance system is reactive and fragmented, with no clear regulations for occupational safety or urban planning to mitigate and adapt to intensifying heat. The lessons learned underscore the need for a mature, proactive, and integrated approach that combines robust occupational heat safety policies with comprehensive urban planning strategies to build effective and lasting heat resilience.

4.3. Policy recommendations

In order to safeguard workforce wellbeing amid extreme and strengthening occupational heat resilience, a comprehensive national heat resilience policy framework

is required that is anchored in four strategic pillars that advance occupational heat resilience. Thereto, an integrated national heat governance system (NHGS) is foundational. A national heat governance system is a multi-sectoral and multi-level institutional framework designed to manage the risks of chronic and extreme heat. The NHGS moves beyond a reactive, emergency-response approach to long-term strategy that addresses heat as a chronic, systemic threat. The NHGS enables resilience against heat waves and UHI by protecting both public health and critical infrastructure, with a special focus on occupational heat resilience (for protecting workers) and urban heat resilience (protecting the community). The strategic pillars of the proposed Aruban NHGS are (See Figure 11):

- 1) **Occupational health and heat safety.** This strategic pillar focuses on protecting employees from the direct health and work-related impacts of heat, and includes:
 - a) *Occupational heat safety regulations:* To address occupational heat stress, the government should update, revise, and harmonize occupational safety legislation and regulations. This should include the specification of occupational heat stress and the requisite mandatory standards and measures. Subsequently, the government is urged to ratify the ILO Conventions 155 and 187.
 - b) *Mandatory occupational heat stress standards:* The government should establish clear, legally binding standards for employers to protect workers from heat exposure. These standards should specify heat thresholds, required work-rest cycles, access to shade and water, and emergency protocols. In addition, heat risk assessments should be mandated as well as training for employers and employees on recognizing the symptoms of heat-related

illnesses and administering first aid.

- c) *Heat Action Strategies and Plans (HASPs)*: This is a cornerstone of heat governance. HASPs outline specific, actionable steps for different heat thresholds, including public awareness campaigns, the opening of cooling centers, and protocols for emergency medical services. The government in collaboration with the private sector should develop national as well as sector-specific HASPs, especially for prominent sectors that are exposed and vulnerable to heat stress.
- d) *Early warning systems*: A robust system includes real-time monitoring and forecasting of heat events. This allows authorities to issue alerts and advisories to the public and to specific vulnerable groups, such as the elderly, outdoor workers, and the undocumented. The government in collaboration with the Crisis Management Office (CMO) should implement regionally distributed heat sensors as an integral part of the national Multi-Hazard Early Warning System (MHEWS).

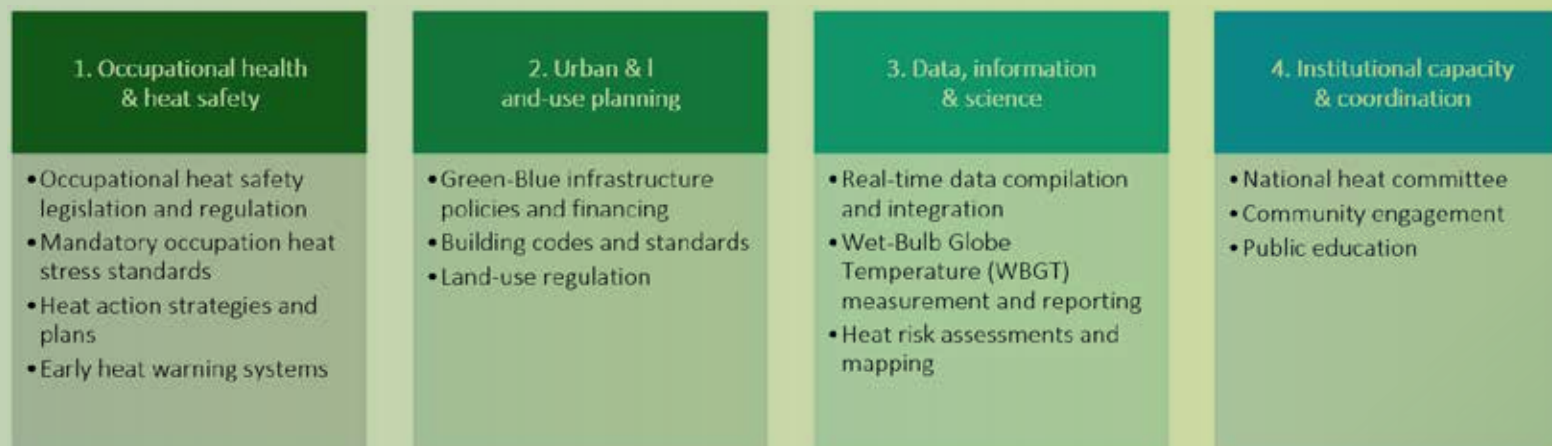
2) Urban and land-use planning. This strategic pillar focuses on the physical and natural environment to mitigate the UHI effect.

- a) *Green-Blue infrastructure policies and financing*: This includes policies that mandate or incentivize the use of nature-based solutions. Examples include ordinances for green roofs, permeable pavements, urban parks, and the restoration of natural water bodies. The government should develop a national GBI program in coordination with the (new) spatial planning ordinance and directives. Considering the long-term development and implementation of GBI, sustainable and dedicated funding and financing is quintessential. The government is advised

to access and mobilize multiple modalities of climate financing, including but not limited to the establishment of a Climate Resilience Fund, Public-Private partnerships, multi-lateral financing, as well as tapping into European climate finance and development funds in collaboration with the Kingdom of the Netherlands.

- b) *Building codes and standards*: The government should update building codes to require 'cool roofs' with high solar reflectance and to improve insulation standards to reduce heat absorption and the need for air conditioning. This also includes urban design guidelines that promote airflow and ventilation to disperse heat. Establish and enforce regulations for the use of materials with high thermal mass and low heat absorption in building facades and infrastructure. Furthermore, the government should encourage and promote the installation of solar panels to reduce the heat generated by electricity production. For building retrofits, the government should provide tax incentives for property owners to upgrade insulation, install cool roofs, and implement other heat-mitigation measures on existing structures.
- c) *Land-use regulations*: This involves zoning and development rules that preserve natural areas and mandate sufficient green space in new developments. It also includes spatial regulation and policies that limit urban sprawl and infilling. The government should mandate the inclusion of green spaces, parks, and tree-planting initiatives in new urban development projects. Moreover, this mandate should be included in the (new) spatial planning directives in 2026. Together with the community, the government should design and implement programs to promote residential tree-planting and the creation of residential gardens.

Figure 11. Strategic Pillars of the Aruban National Heat Governance System.



3) **Data, information, and science.** This strategic pillar ensures that all policies are evidence-based and informed by the latest (scientific) data.

- a) *Data integration and sharing:* The system relies on a central platform that integrates data from various sources, including meteorological services, health surveillance systems, and urban sensors. This allows policymakers to identify high-risk areas and populations. The government should strengthen the institutional capacity of the Meteorological Services department by expanding human, technical, and information resources.
- b) *Adopt, measure, and report the Wet Bulb Globe Temperature (WBGT) as a standard for occupational heat stress:* In addition to existing indicators (e.g., temperature, humidity, wind, and heat), and in order to measure and determine occupational heat stress

specifically, the WBGT should be adopted and reported. Consequently, this would facilitate the determination and calibration of multisite (multisector) occupational heat stress levels, heat thresholds, as well as assist in developing and validating occupational heat risk alerts and warnings.

- c) *Risk assessment and mapping:* This involves creating detailed geographic and demographic maps that overlay heat vulnerability data (e.g., demographics, tree cover, poverty levels) with heat exposure data (e.g., temperatures and heat measurement) to pinpoint 'heat deserts' and other vulnerable zones. The government is urged to conduct regular national heat risk assessments (e.g., annually) and expand the existing climate impact atlas of Aruba with detailed data and information on (local) urban temperatures and heat. This would facilitate targeted and location-specific interventions.

4) **Institutional capacity and coordination.** This strategic pillar focuses on the organizational relations and partnerships needed to make the system work effectively.

a) *National heat committee:* In order to plan, coordinate, and execute the HASPs, the government should establish a permanent inter-ministerial and cross-sectoral committee comprising representatives from public health, urban planning, labor, tourism, energy, and infrastructure sectors to develop and coordinate the HASPs, as well as monitor and evaluate their effectiveness. To this end, the governance is urged to acquire technical assistance and expertise (from e.g., the World Bank and/or the Netherlands) to develop and advance (inter-) institutional capacity.

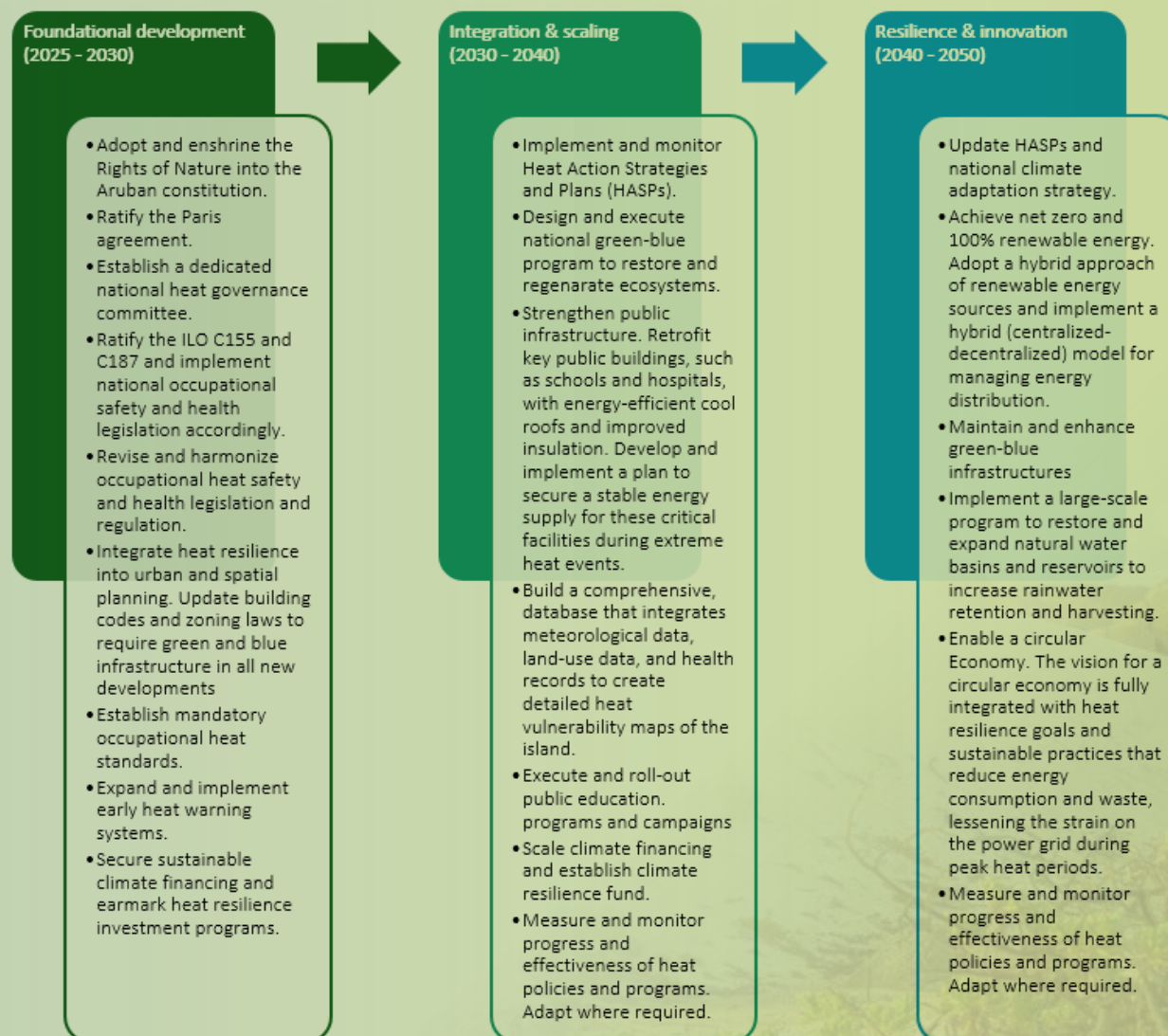
b) *Community engagement:* Considering the location-specific impact of UHI (micro urban spaces) and the sectoral effects of occupational heat stress, it is essential to involve local communities, non-governmental organizations, and businesses in the HASPs policy-making process to ensure that strategies and actions are context-specific and meet local, as well as sector-specific needs.

c) *Public education campaigns:* The government should launch nationally-coordinated campaigns to educate the general public on personal heat safety, including hydration, wearing appropriate clothing, and avoiding strenuous activity during peak heat hours. The campaigns should specifically target vulnerable populations, such as the elderly, children, and people with chronic illnesses. Likewise, the government is urged to structurally incorporate climate education – with an emphasis on the multiple climate impacts and climate adaptation solutions – in national curricula and school programs. Considering

the adverse business impact of occupational heat stress, national heat awareness campaigns should be organized in collaboration with the private sector and industry associations.

To strengthen Aruba's resilience against (current and future) extreme heat and the adverse socioeconomic impacts thereof, a strategic roadmap is required for strengthening heat resilience. This strategic heat resilience roadmap (SHRR) leverages the four strategic pillars and organizes the implementation of the national heat resilience policy framework in three distinct phases (See Figure 12): (i) foundational development, (ii) integration and scaling, and (iii) resilience and innovation.

Figure 12. Strategic Heat Resilience Roadmap.



Annex A. List of previous empirical studies reviewed.

Reference	Region	Heat measurement	Sample	Period	Analysis	Results
Amini et al. (2021)	Iran	Predicted mean vote (PMV) index	Agriculture workers	2016	Productivity loss due to heat at area level	A strong and significant ($p < 0.05$) relationship between temperature index and agriculture labor output.
Bonafede et al. (2022)	Italy	Perceived stress from heat and heat waves	345 workers in several occupational sectors indoor (with and without air conditioning) and outdoor	June–October 2022	Perceived labor productivity loss due to heat	73% of workers perceived heat completely or very much as an important contributor to productivity loss (mean score of 3.93 on a scale of 1 to 5).
Budhathoki & Zander (2019)	Nepal	Perceived stress from heat and heat waves	350 farmers	2012–2017	Perceived labor productivity loss due to heat	Farmers' perceived heat stress levels, and the number of associated illnesses or symptoms, significantly increase labor productivity loss during heat waves ($p < 0.05$).
Burke et al. (2015)	Global and regional level (rich and poor countries)	Annual mean temperature	Several occupational types	2050–2100 compared to 1960–2010 (two socioeconomic scenario consistent with RCP8.5)	Non-linear analysis between global and country economic production and temperature.	Overall economic productivity is non-linear in temperature for all countries, with productivity peaking at an annual average temperature of 13.6°C and declining strongly at higher temperatures. Climate change reduces projected global GDP by 23% in 2100 (best estimate, SSP5) relative to a world without climate change. Reductions are similar in rich and poor countries, while they are larger in countries becoming warmer.
Chavaillaz et al. (2019)	Global and regional level (high- and low-income countries)	Wet-bulb Globe Temperature (WBGT) index of heat stress	vulnerable industries to heat exposure (agriculture, mining and quarrying, manufacturing, and construction workers)	Different emission scenarios (1% CO ₂ , RCP4.5, and RCP8.5) compared to the pre-industrial period (1861–1880)	Estimation of the effect of heat exposure on working time loss per year (due to increasing resting times) based on WBGT safety threshold for different job intensities.	The relationship between productivity loss and CO ₂ emissions is robustly linear at global scale. For each trillion tons of carbon emitted, the annual productivity loss will globally increase by 1.84% (± 0.94 , 1 σ -intervals due to climate and inter-model variability), 2.96% (± 1.97) and 3.61% (± 1.77) of total GDP in the 1% CO ₂ , RCP4.5 and RCP8.5 scenarios, respectively.
DARA (2023)	Global and country level	Annual mean temperature	Several occupation types (both indoor and outdoor)	2030 scenario SRES A2 vs. 2010 (baseline)	Analysis of labor productivity losses from WBGT change exceedance of safety standards in acclimatized populations. The changing structure of the workforce over time, in particular, the industrial shift of developing countries away from outdoor agriculture was included.	These results projected a total global GDP loss of US\$2.5 trillion (PPP \$) per year for 2030 (1% loss of global GDP in 2030, 0.5% loss in 2010). As a percentage of the national GDP, losses varied markedly and were greatest in tropical low- or middle-income countries.

Reference	Region	Heat measurement	Sample	Period	Analysis	Results
Das (2015)	India	Heat wave days	150 low-income urban informal workers (mostly outdoor)	April–May 2013	Change in time allocation and worktime loss during heat wave compared to normal days (adjusting for workplace, family size and income, and worker's health)	The results show that workers work 1.19h less and spend 0.46h less at home, and they rest 1.65h longer on average on a heat wave day than on a normal summer day. Worktime loss is more for people doing manual work and having health problems
Dasgupta et al. (2021)	Global and regional level	Mean temperature and wet-bulb globe temperature (WBGT).	Low-exposure working conditions (labor outside in the shade or indoors—e.g., manufacturing) and high-exposure working conditions (outside with no shade—e.g., agriculture and construction)	1.5°C, 2.0°C, and 3.0°C of global warming compared with the historical baseline period (1986–2005)	The effect of climate change on labor productivity was assessed using five different exposure-response functions established in the literature. Warming levels were assessed over the observational period until the reference period 1986–2005 (0.6°C) and modeled warming for the individual climate models relative to the reference period.	Current climate conditions already negatively affect labor effectiveness, particularly in tropical countries. Future climate change will reduce global total labor in the low-exposure sectors by 18% and 24.8% in high-exposure sectors under 3°C global warming scenario. Higher impacts for labor outdoors in full sunlight. Europe is expected to have highest impact will be in Sub-Saharan Africa.
Davey et al. (2021)	UK	Perceived heat stress and heat-related illness	Healthcare workers	May and August 2020	Perceived cognitive and physical performance reductions due to heat stress and PPE	Heat stress impaired both cognitive and physical performance of workers. Respondents reported that PPE impaired their physical performance at work (76%) and made their job more difficult (92%).
De Lima et al. (2021)	Global and regional level	WBGT	Agriculture	1.5°C, 2.0°C, and 3.0°C of global warming compared with the 1986–2005 baseline	Labor capacity change is estimated for baseline and climate change scenarios accounting for impacts in crop yields change. Global economic model to predict impacts on yield and labor changes.	In sub-Saharan Africa and Southeast Asia heat stress with 3°C global warming could reduce labor capacity in agriculture by 30%–50%, increasing food prices and requiring much higher levels of employment in the farm sector.
Deloitte (2020)	Australia	Annual mean temperature	all work sectors	Global average warming of above 3°C by 2070 under RCP 8.5 compared to 2020 (baseline)	Climate change models for different emission scenarios are the basis for translating a given temperature increase into economic damage by sector, region, and over time. Damage functions include capital damage, sea level rise damages to and stock, heat stress damages on labor productivity, human health damages to labor productivity, agricultural damages from changes in crop yields, tourism damages to net inflow of foreign currency and damages to energy demand.	The economic losses to Australia from unmitigated climate change are 3.4 trillion USD (2020) or 6% of GDP by 2070. On average, over the 30 years to 2050, that is a loss of 135,000 jobs per year and 1.8% of GDP. The worst impacted industries are service sectors (both government and business), trade and tourism, manufacturing, and mining. Agriculture damages were evaluated based on variations in crop yields.

Reference	Region	Heat measurement	Sample	Period	Analysis	Results
Dunne et al. (2013)	Global level	Wet-bulb Globe Temperature (WBGT)	Outdoor workers	Reanalysis 1971–1980 and 2001–2010, projected 2091–2100 and 2191–2200 under high emissions (RCP 8.5) and mitigation (RCP 4.5) scenarios	Analysis focused on the loss of labor productivity as a function of WBGT levels during the hottest months in reference period and under scenarios.	Reductions in work capacity during the hottest months already occur at the global level (10% reduction). By 2050 under both scenarios, work capacity loss is 2-fold higher than in the historical period (20% reduction). By 2100, the reductions in the hottest month may reach 37% based on RCP8.5 and 20% based on RCP4.5. By 2200, very significant further changes in work capacity are projected for the hottest month based on RCP8.5 (61% reduction), and 12% of the population is exposed to work capacity losses.
Heal and Park (2014)	US and other countries at global level	annual mean temperature	all work sectors	1950–2005 no future climate change scenarios	Analysis based on statistical models of work output (or GDP) and thermal stress (controlling for institutions, capital stock, and education).	Extremely hot countries such as Thailand, India, and Nigeria suffer negative output shocks in the order of 3–4% per capita GDP per 1°C. Very cold countries such as the UK, Canada, Norway, and Sweden have significantly higher output in warmer years (and lower output in colder years).
Hsiang (2010)	Caribbean and Central America	annual mean temperature	different work sectors	1970–2006 by season	Empirical models of the relationship between the production of value in individual industries and interannual variations in climate. The production of goods and services is measured by per capita value added. Regression models of production with temperature, rainfall, and cyclones evaluated in non-linear models.	Heat impact on total production of -2.5% per 1°C increase. Wholesale, retail, restaurants and hotels (6.1% per 1°C increase), and other services (-2.2% per 1°C increase) exhibit significant production losses. Output losses occurring in non-agricultural production (-2.4% per 1°C increase) substantially exceed losses occurring in agricultural production (-0.1% per 1°C increase).
Kjellstorm et al. (2019)	global and regional level	Wet-bulb Globe Temperature (WBGT) index of heat stress	all work sectors (agriculture, construction, industry, services)	2030 compared to 1995 (1981–2010) under RCP6.0 (worst) vs. RCP2.6 (best)	Productivity loss due to heat estimated based on dose–response function between WBGT and work capacity in each grid cell and each region for moderate and heavy labor. Projections of future labor productivity losses estimated for workers in moderate-intensity jobs (MR = 300W).	By 2030 the share of total working hours lost will rise to 2.2%, a productivity loss equivalent to 80 million full-time jobs at global level. The loss in monetary terms is then expected to total US\$ 2,400 billion (PPP). Lower-middle- and low-income countries would be the worst affected, losing 4% and 1.5% of their GDP in 2030, respectively. Agricultural and construction workers will be the worst affected. The agricultural sector alone accounts for 83% and 60% of global working hours lost to heat stress in 1995 and 2030, respectively. Construction is expected to account for 19% of the total loss in 2030, up from 6% in 1995.

Reference	Region	Heat measurement	Sample	Period	Analysis	Results
Kjellstrom et al. (2009)	Global and regional level (21 geographical regions)	Wet-bulb Globe Temperature (WBGT)	All work sectors (service, industry, and agriculture) both indoor and outdoor	2020, 2050, and 2080 compared to 1961–1990 under climate scenarios SRES A2 (worst) and B2 (best)	Projections of future labor productivity losses (in terms of lost labor days) under climate scenarios compared to baseline climate applying dose–response function between WBGT and work capacity. Assuming the different work intensities for each sector, regional labor productivity change is estimated based on the weighted average of work activities across each sector.	By the 2080s, the greatest absolute losses of population-based labor work capacity (in the range 11% to 27%) are seen under the A2 scenario in Southeast Asia, Andean and Central America, and the Caribbean. Under B2 scenario smaller impacts in all regions (the greatest loss being 16% in Central America).
Kjellstrom et al. (2015)	Seven countries (USA, China, India, Cambodia, Philippines, Ethiopia, Costa Rica)	Wet-bulb Globe Temperature (WBGT) index of heat stress	all work sectors (service, industry, and agriculture) assuming agriculture is the hardest work (400W) and mostly occurs outdoors in the sun, industry at 300W is in the shade or indoors and servicing the easiest at 200W and in air-conditioned spaces	2011–2040, 2041–2070, and 2071–2099 vs. 1981–2010 under climate change scenarios of 1.5°C (RCP2.6) and 2.7°C warming (RCP6.0)	Productivity loss due to heat estimated based on dose–response function between WBGT and work capacity in each grid cell and each region. Projections of future labor productivity losses estimated for workers in moderate-intensity jobs (MR = 300W).	Under the more extreme climate change trend (RCP6.0; increase of 2.7 °C), as much as 12–16% of annual work hours will be lost in some areas. The impact is naturally mainly occurring in the hotter southern areas. Countries with large cool climate areas (such as USA) have limited work hour losses due to heat now (0.17%), but it may increase beyond 1.3% at the end of the century based on the current global climate policy pathway (RCP6.0).
Kjellstrom et al. (2016)	global and country level	Wet-bulb Globe Temperature (WBGT) index of heat stress	all work sectors (service, industry, and agriculture) both indoor and outdoor for a mixed workforce (average metabolic rate = 300W; in shade or indoor non-cooled work)	2085 (2070–2099) under global warming scenarios 4°C (RCP8.5) (worst) and 1.5°C (RCP 2.6) (best) compared to 1995 (1980–2009)	Projections of future labor productivity losses (in terms of lost labor days) compared to baseline climate, applying dose–response function between WBGT and work capacity estimated in literature for moderate labor	Productivity is already lost up to 10% of annual daylight hour in some regions. There is a 10-times or more increase of work hours lost from 2015 to 2085 for several countries under RCP8.5 scenario. The areas with the greatest risk in 2085 remain the same (Amazon region, West Africa, Arab Gulf area, Pakistan, North India, Indonesia, and parts of China), but substantial reductions in work capacity are apparent in the southeast United States, parts of Europe (South), Africa, and the rest of India and China. By the end of the century impact will increase in the hottest areas even if temperatures are held at 1.5°C (RCP2.6), but the increase is much higher for the business-as-usual scenario of 4°C (RCP8.5), reaching more than 30–40%.

Reference	Region	Heat measurement	Sample	Period	Analysis	Results
Kjellstrom et al. (2018)	21 global regions (high and low- and middle-income countries)	Wet-bulb Globe Temperature (WBGT) index of heat stress (calculated using Hothaps functions)	All work sectors (outdoor and indoor)	2030 and 2050 vs. 1960–1989	Lost work capacity calculated using exposure–response relationships from literature. The national loss estimates used the proportion of the work force in jobs with different physical demands and different heat exposure levels, based on a World Bank model. The losses, as percentage of daylight work hours, were multiplied with the estimated GDP for 2011 and 2030.	For Southeast Asia work capacity losses increase from 17% to 29% (of daylight work hours) from 1975 to 2050 for outdoor workers doing heavy labor. The losses for indoor workers doing heavy labor increase from 3% to 8%, and for outdoor workers doing moderate labor the estimates go from 7% to 15%. Low- and middle-income countries have losses of 6% of annual GDP, higher compared to high income countries.
Knittel et al. (2020)	All world regions (European and not European)	Wet Bulb Globe Temperature	heavy outdoor work (agriculture, construction) and medium intensity indoor work (manufacturing industry)	Shared Socioeconomic Pathways (SSP1, SSP2, and SSP3) and two Representative Concentration Pathways (RCP4.5 and RCP8.5) in 2036–2065 vs. 1981–2010	Impact of heat on production estimated based on heat-production function based on labor input, change in work ability based on dose–response function between WBGT and work capacity from literature. The study evaluated these impacts on Germany economy using a global CGE models.	Impacts on productivity higher for outdoor than indoor work. By 2050, within Europe, reductions are most pronounced for Italy and other Mediterranean countries (Cyprus, Greece, Malta, Portugal, Spain), while other countries are only marginally affected. Other world regions are severely impacted such as Southeast Asian countries, India, and oil exporting countries. In the Amazon region, heavy outdoor work (400W) is projected to decline by more than 50% under RCP8.5.
Kuhla et al. (2020)	global and regional level	daily mean temperature	agriculture, fishing, mining and quarrying, hotels and restaurants, wholesale trade, and others	2020–2039 vs. 2000–2019 (RCP2.6 and RCP6.0 scenarios)	Absolute and relative heat stress-induced direct output losses based on risk function between temperature and productivity from literature. Absolute output losses are then determined by multiplying the perturbed productivity with the baseline production of that region	Globally, between 2000 and 2039 direct output losses increase by 47% if no further adaptation measures are taken. Regional increase in direct losses in the billions USD (e.g., in India, Saudi Arabia, or Mexico) or nearly double the direct output losses (e.g., in Northern America or Europe) within the next decades.
Lee et al. (2018)	South Korea	Wet-bulb Globe Temperature (WBGT)	outdoor laborers in construction, agriculture, forestry, and fisheries (moderate, 234–407W and heavy intensity, 407–581W)	2011–2040, 2041–2070, 2071–2100 under RCP 8.5 (high emission) and 4.5 (moderate emission) compared to 1981–2005 (baseline) summer season (June to September)	Projections of future labor productivity losses (in terms of lost labor days) compared to baseline climate, applying dose–response function between WBGT and work capacity (work–rest ratio) estimated in literature for moderate and heavy labor.	Future productivity losses for moderate work of 4.8% and 15.8% by 2071–2100 under RCPs 4.5 and 8.5, respectively, compared to the baseline. Productivity losses for heavy work are 12% (RCP4.5) and 26.1% (RCP8.5) compared to the baseline. Areas with larger productivity losses are those with higher proportion of outdoor workers.

Reference	Region	Heat measurement	Sample	Period	Analysis	Results
Lee et al. (2020)	India and Singapore	Perceived heat stress	165 hospital workers using PPE during COVID-19 epidemic	May-June 2020	Perceived productivity loss due to heat stress and PPE self-assessed from questionnaire	Workers reported a reduced productivity due to heat and when wearing PPE
Li et al. (2016)	China	Wet-bulb Globe Temperature (WBGT)	16 rebar workers	summer 2014	WBGT-productivity relationship evaluated in regression models (adjusted for age, BMI, work experience)	High-temperature environments decrease labor productivity, with the percentage of direct worktime decreasing by 0.57% and the percentage of idle time increasing by 0.74% when the WBGT increased by 1C.
Mathee et al. (2010)	South Africa	Perceived heat stress	151 workers involved in sun-exposed occupations	March 2009	Perceived productivity loss due to heat. No analysis was carried out, only narrative description of interviews.	Where daily maximum temperatures may reach 40°C, workers reported a wide range of heat-related effects, leading to difficulty in maintaining work levels and output during very hot weather.
Messeri et al. (2019)	Italy	Perceived heat stress	104 native and migrant workers in agriculture and construction	Summer months of 2017	Perceived productivity loss due to heat (the worker noticed to be less productive during a heat wave or need more energy for the same work)	Migrant workers declared that work required greater effort than do native Italian workers (Chi squared $p = 0.001$) but reported less impact from heat on productivity (Chi squared $p = 0.014$) and on thermal discomfort.
Nunfam et al. (2021)	Ghana	Perceived heat stress	320 miners	October 2017–January 2018	Causal analysis evaluating the relationship between heat exposure and productivity outcomes by structural equation models. Evaluation of moderation effect by adaptation strategies and demographic and work variables.	Heat exposure had a significant direct effect on the productivity outcomes of mining workers. This effect was moderated by barriers to adaptation strategies, mediated through adaptation strategies (not significantly), and controlled by some demographic and work-related variables.
Orlov et al. (2020)	Global and regional level	Wet-bulb Globe Temperature (WBGT)	all work sectors agriculture and construction (high-intensity jobs, 400W), manufacturing and services (moderate-intensity, 300W and low-intensity work, 200W)	2020, 2030, 2040, 2050, 2060, 2070, 2080, and 2090 compared to 1981–2005 under RCP8.5 (worst) and RCP2.6 (best) scenarios (and SSP1, SSP4, and SSP5 scenarios for CGE model)	Interdisciplinary approach combines climate projections, epidemiological findings, and economic analyses. Work capacity loss (a physiological variable) estimated using the dose–response function between WBGT and work capacity estimated in literature (Hothaps and ISO).	Heat stress leads to substantial reductions in worker productivity. For RCP8.5, using the Hothaps function with constant work intensity results in an average reduction of 0.7% (1.8%) in global GDP by 2050 (2100) relative to the reference period. Impacts are higher for high-intensity work in low-latitude countries of Africa, South America, and Asia. Given the assumption of absence of air conditioning and constant work intensity, reductions in worker productivity in some regions under RCP8.5 could even exceed 40% by 2100 compared to the reference. Agriculture and construction are the most adversely affected by heat because these sectors require many work-intensive activities in the outdoor environment.

Reference	Region	Heat measurement	Sample	Period	Analysis	Results
Parks & Xu (2018)	US	Daily mean temperature	Low- and high-risk sectors (farming, fishing and forestry, construction and extraction, Installation Maintenance and Repair, Transportation, and Material Moving Occupations)	1983–2016	Changes in productivity (time lost per day per worker) estimated using the dose–response functions between temperature and working time. Number of minutes individuals work from survey data. Labor loss translated into cost by multiplying lost days per worker by the number of workers in each sector and mean wage per minute.	In high-risk sectors, total cost of lost labor increased from 0.3% in 1983 to 0.58% in 2016 as percentage of total GDP. The total loss of labor productivity in the farming, fishing, and forestry sector was nearly 3 billion USD in 2016. California accounted for 82.60% of the total national loss. In the construction and extraction sector, the total loss amounted to \$34 billion in 2016. Similarly, most of the losses took place in California, Texas and Arizona. Losses in 2016 were 29 billion USD in the installation maintenance and repair occupation and 41 billion USD in the transportation and material moving occupations sector.
Roson & Sartori (2016)	global and regional level	Wet-bulb Globe Temperature (WBGT)	Agriculture (high intensity, 500W), manufacturing (medium intensity, 300W), service (low intensity, 200W)	Global warming scenarios of 1°C, 2°C, 3°C, 4°C, and 5°C increases in average temperature.	The spatiotemporal data of work capacity loss estimated based on WBGT using the dose–response function between WBGT and work capacity.	The estimated percentage variation of labor productivity for 140 regions and for a +1°C increase in temperature is -0.27%. The mean productivity losses range from -2.52% to -17.48%. Agriculture is the sector most significantly affected by higher heat stress.
Sadiq et al. (2019)	Nigeria	Wet-bulb Globe Temperature (WBGT)	396 maize farmers	July to September, 2016	WBGT-productivity relationship is estimated by multiple linear regression adjusting for body mass index (BMI), age, and gender.	Productivity was significantly higher between the hours of 6–9 am ($p < 0.001$) and 12–3 pm ($p < 0.001$), compared to the hours of 9 am–12pm ($p < 0.001$). For temperature increases, productivity decreases (beta coefficient = -0.6, p-value < 0.001).
Sahu et al. (2013)	India	Wet-bulb Globe Temperature (WBGT)	124 rice harvesters	April–June 2011	Productivity loss estimated for WBGT exceeding the standard (26–32°C) corresponding to 30–38°C of air temperature.	High heat exposure in agriculture caused heat strain and reduced work productivity (–5% per 1°C). This reduction will be exacerbated by climate change and may undermine the local economy.
Sett & Sahu (2014)	West Bengal, India	Wet-bulb Globe Temperature (WBGT)	120 female brickfield	October 2008 to May 2009 (first session), from October 2009 to May 2010 (second session), and then from October 2010 to May 2011 (third session)	Productivity loss estimated for WBGT exceeding the standard (26–32°C) corresponding to 30–38°C of air temperature. Comparison of wages by season.	Productivity loss for every degree rise in temperature was about 2%.

Reference	Region	Heat measurement	Sample	Period	Analysis	Results
Singh et al. (2015)	Australia	n.a.	47 workers outdoor in several industries	Summer 2010	Perceived productivity loss due to heat. No analysis was carried out, only narrative description of interviews	All interviewees reported that excessive heat exposure presents a significant challenge for their industry or activity. People working in physically demanding jobs in temperatures >35°C frequently develop symptoms, and working beyond heat tolerance is common. To avoid potentially dangerous health impacts, they must either slow down or change their work habits. Such health-preserving actions result in lost work capacity.
Szewczyk et al. (2021)	Europe	Wet-bulb Globe Temperature (WBGT)	4 classes based on occupational vulnerability to heat stress: cognitive and physical work divided in light (200W), moderate (300W), and heavy (400W) labor	2020, 2050, and 2080 for RCP8.5 vs. 1990 (baseline)	Labor productivity losses (work hours) estimated using the dose–response functions between temperature and work performance by occupational category. Regional employment in the four occupational groups is used to aggregate the occupational losses into a single metric representing regional labor productivity loss by period.	Productivity of labor can be 1.6% lower in the worst-case scenario (RCP8.5), with the largest reductions in southern European regions. Adaptation can reduce the productivity losses by around 40%, with higher rates of reduction for the lower warming levels. The annual economic losses in Europe could reach 563 billion euros or 1.15% of GDP by the 2080s in the worst-case scenario.
Vanos et al. (2019)	Ontario, Canada	Wet-bulb Globe Temperature (WBGT)	Outdoor laborers at an industrial worksite	2012–2018 (May–October)	Worktime loss due to heat is estimated by risk functions for different WBGT levels. Loss of money (Canadian dollars) due to heat per 15-min work interval estimated by laborer type (via hourly wages).	On average, 22h per worker were lost each summer (ca 1% of annual work hours) as a result of taking breaks or stopping due to heat. This amount of time corresponded to an average individual loss of 1100 Canadian dollars to workers.
Venugopal et al. (2016)	South India	Wet-bulb Globe Temperature (WBGT)	84 steel workers	April 2014	Perceived productivity loss due to heat stress defined as: loss in production, not achieving work targets, loss of workdays/work hours due to fatigue/exhaustion, sickness/hospitalization, and/or wages lost due to heat or heat-related illnesses	Workers exposed directly to heat sources reported higher productivity losses than other workers. Heat exposure was related to greater absenteeism (+1% increase), less productivity (–10.6%), larger work extra hours (26.9%), and increase in irritation/interpersonal issues (+7.7%).

Annex B. Review of regions and countries with ILO OSH ratification and OSH legislation.

<i>Region</i>	<i>Country</i>	<i>ILO OSH ratification</i>	<i>National legislation & regulation</i>	<i>Heat risk assessment & occupational heat exposure thresholds & trigger levels</i>	<i>Control & adaptive measures</i>
Americas	Costa Rica	C155 (1982) C187 (2008)	Occupational heat regulation (2015): Protect outdoor workers from heat stress.	- Mandatory heat risk assessment and health surveillance program - Standardized heat measurement using WBGT (occupational heat risk level and triggers) • <91°F (low risk) • 91-102°F (mod. risk) • 103-124°F (high risk) • ≥125°F (extreme risk)	- Identification of occupational vulnerability - Cool rest areas - Hydration - Health checks - Education & Training - PPE
	Chile	C187 (2011)	National OSH Policy 2024-2028 (2023): Prevent occupational risks derived from exposure to extreme temperatures.	- Mandatory heat risk assessment and emergency response plan (job-specific). - Protocol for Heat Stress: Established measurement and standardized methodology for the use of heat stress monitoring equipment in occupational heat exposure assessment. - Heat early warning systems and heat risk management protocol. - Standardized heat measurement and heat stress monitoring using WBGT (work intensity/risk): • 32.2°C (low) • 31.1°C (moderate) • 30.0°C (high)	- Cool rest areas. - Hydration. - Rest / Breaks. - Health checks. - Education & Training. - PPE. - Emergency and contingency plans. - Identification of risk groups. - Work shifts. - Dissemination of information.

<i>Region</i>	<i>Country</i>	<i>ILO OSH ratification</i>	<i>National legislation & regulation</i>	<i>Heat risk assessment & occupational heat exposure thresholds & trigger levels</i>	<i>Control & adaptive measures</i>
	Canada	C187 (2011)	No heat legislation at the Central level. Provincial level legislation: British Columbia, Manitoba, New Foundland, New Brunswick, Nova Scotia: Protect workers in environments that are hot (processes and weather) Collective agreements.	- Mandatory to comply with maximum heat stress values (Labor inspection). - Heat stress considers work intensity and acclimatization. - Heat alerts based on heat index levels and degree of occupational comfort: • <29°C (little discomfort) • 30°C-39°C (some discomfort) • 40°C-45°C (great discomfort) • 46°C (dangerous; heat stroke) - Threshold Limit Values (TLV) in WBGT (for acclimatized workers): • 32°C (light work) • 30°C (moderate work) • 29°C (high-intensity work)	- Alternating work (rest times when TLV reached) - PPE. - Hydration. - Work – rest cycles. - Education and training. - Acclimatization program.
	United States of America		OSH Act (1970) No heat legislation at the Federal level. State level legislation: California, Washington, Oregon Collective agreements.	- Required Heat Illness Prevention Plan (HIPP). - Heat thresholds in place to mandate specific preventive measures by employers. - Recommended heat stress alert limits (RAL). - Heat index: • >80°F preventive measures mandatory • >90°F extra cautionary measures	- Specified alternation work-rest schedule. - Hydration. - Cool rest areas. - Emergency and contingency plans. - Education & Training. - Buddy system. - PPE. - Effective communication and alertness for heat-related illness; preventive rest periods.

<i>Region</i>	<i>Country</i>	<i>ILO OSH ratification</i>	<i>National legislation & regulation</i>	<i>Heat risk assessment & occupational heat exposure thresholds & trigger levels</i>	<i>Control & adaptive measures</i>
<i>Arab States</i>	Qatar		OSH Act (Under review, 2024): Heat Stress Regulation.	- Use of (state) system for receiving real-time weather updates and heat advisories. - Conduct regular heat risk assessments. - Mandatory heat illness prevention plan (HIPPP). - Monitor heat stress levels with WBGT: • >80°F Initial heat trigger (Recommended Alert Level – RAL) • >90°F High heat trigger (Recommended Exposure Level – REL)	- Accurate on-site monitoring of WBGT. - Heat acclimatization programs. - Adequate hydration and shade. - Work-rest planning. - Heat safety training to supervisors and workers - Medical monitoring and emergency response.
			Ministerial decree (2021): Protect workers from heat stress.	- Mandatory annual heat-health checks (risk-based). - Regular nation-wide research into heat exposure of workers (evidence-based heat policy and legislation (adaptation). - Extreme heat work bans and inspection. - Outdoor work is prohibited between June 1 – September 15, 10:00am – 3:30pm (Sanctions apply). - All work is stopped when WBGT > 32.1°C.	- Cool rest areas - Hydration - Rest / Breaks - Health checks - Education & Training - PPE

<i>Region</i>	<i>Country</i>	<i>ILO OSH ratification</i>	<i>National legislation & regulation</i>	<i>Heat risk assessment & occupational heat exposure thresholds & trigger levels</i>	<i>Control & adaptive measures</i>
	Saudi Arabia	C187 (2024)	Ministerial decree (2021): Safeguard workers from excessive heat in the hottest months of the year	- Mandatory annual heat- health checks (risk-based) - Outdoor work is prohibited between June 15 – September 15, 12:00pm – 3:00pm (Sanctions apply) - Heat Index (risk and rest schedule): • 25°C-29°C (low risk) • 30°C-38°C (moderate risk; 25% time break) • 39°C-51°C (high risk; 50% time break)) • ≥52°C (extreme risk; 75% time break) - All work is suspended when heat index > 56°C	- Employers must provide temperature- and humidity-measuring devices - Outdoor work is prohibited during midday - Cool rest areas - Hydration - Rest / Breaks - Health checks - Education & Training - PPE
<i>Asia Pacific</i>	Singapore	C155 (2012) C178 (2019)	Occupational safety and health act (2021) and directives (2023): Safeguard outdoor works from adverse impacts of excessive heat.	- Required use of WBGT meters (dedicated mobile applications) for hourly temperature monitoring and assessment of workplace thermal conditions. - WBGT measurement (work intensity/risk) • 32°C (mod. risk) • 33°C (high risk) - Heat stroke alerts (>40°C).	- Cool rest areas - Hydration - Rest / Breaks - Health checks - Education & Training - Buddy systems
<i>Europe</i>	Cyprus	C155 (1989) C187 (2009)	Health & Safety at Work Act (1996) Workplace regulation (2002, 2004) Government circular for the Protection of	- Heat risk assessments (mandatory) - Provision for heat alerts based on WBGT forecasts - Heat stress monitoring based on WBGT:	Employers are obligated: - to take appropriate organizational and technical measures.

<i>Region</i>	<i>Country</i>	<i>ILO OSH ratification</i>	<i>National legislation & regulation</i>	<i>Heat risk assessment & occupational heat exposure thresholds & trigger levels</i>	<i>Control & adaptive measures</i>
			Workers from Heat Stress Directive (2014, 2020). Collective agreements.	- Complete work interruption (for acclimatized workers) when the WBGT rises beyond: • 32.2°C for low-intensity work • 31.1°C for moderate-intensity work • 30.0°C for high-intensity work (for non-acclimatized workers, values are reduced by 2.5°C)	- to document their efforts in monitoring and mitigating heat stress. - avoid exposing vulnerable groups to heat (e.g., those aged over 65, people with chronic respiratory and cardiovascular diseases, chronic renal failure, etc.) - Additional measures include: - Training and education - Cool rest areas - Hydration - Work-rest cycles
	Greece	C187 (2021)	National ordinance for protecting workers from heat stress (2023) Ministerial Decree (for Heat Alert, 2023-2024) Collective agreements.	- Evidence-based heat policy development based on national heat stress assessments. - Heat measurement (WBGT and work intensity level): • 32.5°C (low) • 31.5°C (moderate) • 30.5°C (high) • 30.0°C (very high)	- Cool rest areas - Hydration - Rest / Breaks - Health checks - Education & Training - PPE

<i>Region</i>	<i>Country</i>	<i>ILO OSH ratification</i>	<i>National legislation & regulation</i>	<i>Heat risk assessment & occupational heat exposure thresholds & trigger levels</i>	<i>Control & adaptive measures</i>
				- When temperatures exceed 38°C in the shade, work must be interrupted (without any reduction in daily pay). When temperatures are between 36°C and 37°C, work should be suspended from 2 pm. to 6 pm., and when temperatures reach 38°C, from 1 pm. to 7 pm. - Provision for alerts based on WBGT forecast from national meteorological service. - Real-time WBGT estimate via smartphone application. - Heat risk assessment and emergency response plan.	
	Netherlands	C155 (1991) C187 (Under review)	Working Conditions Act (2023) Working Conditions Decree (2024) Working Conditions Regulation (2024). Collective agreements apply	- No national maximum threshold or occupational heat exposure limits (the WBGT ISO7243 standard was abolished in 2013). - National and local heat plan and early warning system. - Temperature (>30°C) and heat wave (+3 days) trigger. - Mandatory risk assessments and evaluation. - Occupation heat thresholds and triggers are negotiated in OHS catalogue or collective labor agreement. - In agriculture and the construction industry, the following temperature thresholds apply: • Warm occupational temperature (25°C-30°C) • Severe occupational temperature (30°C-35°C)	Required technical, organizational, and personal protection measures to: - Ensure the protection of the health and safety of the employees, with respect to all employment-related aspects. - Conduct a policy aimed at achieving the best possible working conditions. Measures include: - Cool rest areas - Ventilation - Hydration - Flexible work patterns - Temperature-dependent breaks - Work hour adaptation - Health checks

<i>Region</i>	<i>Country</i>	<i>ILO OSH ratification</i>	<i>National legislation & regulation</i>	<i>Heat risk assessment & occupational heat exposure thresholds & trigger levels</i>	<i>Control & adaptive measures</i>
				• Extreme occupational temperature (>35°C)	- Buddy system - Education & Training - PPE - Acclimatization program
	Spain	C155 (1985) C187 (2009)	National law (Occupational Risk Prevention, 1995) Royal decrees (1995, 1997, 2023)	- Spanish law does not stipulate a maximum temperature for outdoor work. - Heat early warning system are in use. - Heat measurement system based on air temperature, relative humidity, and air flow. - Outdoor heat risk trigger levels: • 37°C-40°C (orange alert) • 40°C-44°C (red alert) - Outdoor work regulation of physical-intense work under extreme heat (working day of max 6 hours and 20 mins). - Prevention to ensure workers' health and safety is an employer's obligation under existing legislation. Failure to comply constitutes an offence punishable by fines.	- Required occupational risk assessments, including job characteristics and personal health conditions. - Mandatory safeguards to protect workers from extreme temperatures, including: - Suspending certain tasks - Rest areas - Hydration - Work hour adaptation - Shaded areas - PPE - Information and education - Buddy system
			Collective agreements.		

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