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BACKGROUND PAPER

A New Generation of Data for Human Development

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ABSTRACT

Human Development Reports have been annually published by the Human Development Report Office at the United Nations Development Programme (UNDP) since 1990. Discussion about the relevant dimensions of the Human Development Index (HDI), the appropriate way to measure human development and suitable data has not stopped since the design of the HDI. Over the years, substantial improvements have been achieved both in data relevance and quality. Nevertheless, the production of relevant data by national statistical authorities, the activities of the international data-collecting agencies, and the use of data in the production of the HDI and the various human development tables are still subject to serious challenges. Moreover, human development monitoring is expanding both in development dimensions and for special population groups like refugees and migrants, elderly people and others, increasing the scope and quality of data.

In the first part of the paper, the data actually used for human development monitoring are described, and the problems and limitations, including quality issues, are reported, indicating in particular areas that are problematic in the sense that countries have problems in providing these data. The second part deals with issues related to traditional data sources for human development monitoring. Countries may be unable to produce and deliver data due to limitations with respect to resources or competencies or other problems; only a modified version of an indicator may be reported due to problems of the country or due to adjustments of the data by the data collecting agency. Having these limitations and gaps in the availability of data in mind and being aware of the rapidly growing amount of data from all areas of human life, the question of interest is whether data from new sources, so-called alternative data or big data, are suited to supplement or substitute for data used for monitoring human development. The third part of the paper gives an outlook on potential measures for improving data for human development monitoring, with a focus on new and alternative data such as big data, and obstacles to their use. This part also discusses innovative visualization tools, and new ways to present data and statistical results.

Introduction

The Human Development Index (HDI) is a composite index that measures average achievement in three basic dimensions of human development: a long and healthy life, knowledge and a decent standard of living. The HDI uses the geometric mean for averaging. A country scores a higher HDI when the life expectancy at birth is longer, the education period is longer, and the income per capita is higher, but the HDI is penalized by imbalances of the three dimensions. Two names are tied to the development of the index: the Pakistani economist Mahbub ul Haq (UNDP 2010) and the Indian economist Amartya Sen, who was awarded the Nobel Memorial Prize in Economic Sciences in 1998. The *Human Development Report 2016* (UNDP 2017) covers 185 UN Member States; 8 UN Member States are not included because of lack of data. Average HDIs of regions and groups of countries are included for comparison.

The *Human Development Report 2016* contains all composite indices from the family of human development indices: the HDI, the Inequality-adjusted Human Development Index (IHDI), the Gender Development Index (GDI), the Gender Inequality Index (GII) and the Multidimensional Poverty Index (MPI). The first six tables in the report's Statistical Annex are based on these five indices. Nine additional tables present a broader set of human development-related indicators and provide a more comprehensive picture of human development in different countries, dealing with population trends, health, education, national income, work and employment, security, international integration and other indicators. Two dashboards present indicators on gender gaps and sustainable development. Appendix 1 shows a list of the 15 tables as well as the two dashboards together with a short summary of each table.

Human Development Reports have been annually published by the Human Development Report Office at the United Nations Development Programme (UNDP) for 25 years, starting in 1990. From the beginning, the HDI was reported, but with the recognition that the concept of human development is much broader than that measured by the rather condensed concept of the HDI. Issues like food and nutrition, work, job security, inequality, poverty, gender equality, environment, energy use and many others are additional relevant dimensions. The discussion about the appropriate way to measure human development has not stopped since the design of the HDI.

For any measurement, the availability of sufficient quality data is essential. Like the concept of measuring human development, data needed to estimate the HDI have been discussed over the years. Substantial improvements have been achieved both in data relevance and quality. The statistical production of relevant data by national statistical authorities, the activities of international data-collecting agencies, and the use of data in the production of the HDI and the human development

tables are still subject to serious challenges, however. In times of a rapidly growing amount of available data from all areas of human life, options for improving data for monitoring human development and producing Human Development Reports shall be investigated in this paper.

The paper has three parts. The first describes, based on the Human Development Reports for 2015 and 2016, data actually used for human development monitoring. It sketches the problems and limitations, including quality issues, and gives a systematic survey of data needs and availability. The second part discusses traditional data sources for human development monitoring, types of data sources, standards for the work of statistical agencies, barriers to developing the statistical capacities of these agencies, and gaps in human development-relevant data related to special population groups. The third part gives an outlook on potential measures for improving data for human development monitoring, with a focus on new and alternative data such as big data.

What data do we have to measure human development?

The *Human Development Report 2016* covered 188 countries, up from 150 in the first report in 1990, reflecting close to the total number of Member States of the United Nations. Whether a country is included in the Human Development Report or not is a question of data availability. In the 2016 report, only seven countries or territories were not included: the Democratic People's Republic of Korea, the Marshall Islands, Monaco, Nauru, San Marino, Somalia and Tuvalu.

The wide coverage of countries in the Human Development Reports is the result of efforts by the Human Development Report Office to cooperate in data collection with various UN and other international entities such as the World Bank and Gallup, as well as with national statistical institutes and authorities. International agencies have the mandate, resources and expertise to collect national data on specific indicators. They have to do some editing and imputations on collected data in order to improve completeness and comparability, given varying capacities among national institutes and authorities. The Human Development Report Office obtains this standardized data from the international data-gathering agencies, corresponding to the specialization of each. It also uses other sources, including national statistical institutes, to fill gaps and supplement in cases of missing data.

A view into the Human Development Report makes clear that data availability is not perfect. Most of the indicators are missing for some of the countries. Moreover, the quality of the reported indicators is not the same for all countries, depending on the resources and competencies of national authorities in collecting and processing data.

The first of the following sections gives an overview of human development-relevant indicators needed to establish the tables in the Statistical Annex of the Human Development Report. The second

section indicates areas of indicators that are problematic in the sense that some or many countries have problems in providing these data. The third section summarizes the availability and quality of human development-relevant indicators. Finally, some comments are given on the coverage of human development-relevant data available for special population groups like older people and minorities.

THE CATALOGUE OF HUMAN DEVELOPMENT-RELEVANT INDICATORS

Altogether, 199 indicators are contained in the 14 tables and 2 dashboards in the Statistical Annex of the *Human Development Report 2016*. Table 15 does not contain indicators but reports the status of the fundamental human rights treaties for each country. Among the indicators, 165 are taken from the set of data delivered by the mentioned data providers; a further 34 indicators are calculated by the Human Development Report Office on the basis of the provided data. The range of data for establishing the tables and dashboards can be seen in Table A1 in Appendix 2. Definitions of the indicators and corresponding data sources are listed at the end of each table or dashboard in the Human Development Report.

In 2015, the 193 members of the United Nations adopted the 2030 Agenda for Sustainable Development for the period from 2015 to 2030, and signed an ambitious package of goals, the Sustainable Development Goals (SDGs).[1] The package includes 17 goals and 169 targets; the latter correspond to 230 indicators for monitoring progress in reaching the goals. As can be expected, there is considerable overlap between the SDG indicators and the indicators used for the Human Development Report. Hence, an option was to take human development-relevant SDG indicators into consideration for monitoring human development.

However, a closer view revealed some impediments to including the SDG indicators. First, the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs)[2] established the first list of SDG indicators, which were adopted during the 47th session of the UN Statistical Commission (UNSC) in 2016 as a starting point. It was clear from the beginning that the SDG indicators will be subject to refinement. Since then, several studies have been conducted, finding various issues. For example, the ICSU/ISSC (2015) report states that sound definitions are provided for only 29 percent of the targets, and 17 percent of the targets are even non-essential. Some targets rely too much on vague, qualitative language instead of being hard, measurable, time-bound, quantitative targets. Another issue is that indicators for some SDG goals are more detailed than the corresponding human development indicators. For instance, environmental sustainability is covered by three goals and more than 40 SDG

[1] See: https://unstats.un.org/sdgs/.

[2] See: https://unstats.un.org/sdgs/iaeg-sdgs/.

indicators, whereas the monitoring of the environmental sustainability dimension of human development focuses on 15 indicators.

Given this situation, it was decided to limit this report to indicators that are the basis of the actual Human Development Report.

AREAS OF PROBLEMATIC INDICATORS

Data sources for the compilation of the Human Development Report are international agencies of the United Nations like the Department of Economic and Social Affairs (UNDESA), the UN Statistics Division (UNSD) and the United Nations Educational, Scientific and Cultural Organization (UNESCO). Other sources are the International Monetary Fund (IMF) and the World Bank. These agencies collect national data on specific indicators for which they have expertise and resources. Some data, typically those of human development Table 14, with information on individual perceptions, come from private agencies like Gallup. Table A2 (see Appendix 2) indicates the agencies that provide indicators for Tables 1 to 6 in the reports.

Inspection of the report tables reveals that:

- Some indicators are not reported for all countries, and
- The values reported for some other indicators do not correspond to the standard form, but are based on data from alternative sources or are estimated using an imputation technique.

This raises questions around whether national statistical institutes have sufficient capacities to produce and deliver human development data, what mechanisms the data-collecting agencies are using for gathering data from the countries, and whether these mechanisms can ensure compatibility across countries, in particular in the case of data gaps. These questions are the subject of this section. The main weight is on the indicators that are basis of Tables 1 to 6.

COUNTRY COVERAGE BY INDICATORS

Tables 1 to 6 are the core of the Human Development Report 2016. Table 1, HDI and its Components, contains measures of the three basic dimensions of human development, a long and healthy life, represented by the indicator "life expectancy at birth," knowledge, represented by the indicators "mean years of schooling" and "expected years of schooling," and a decent standard of living, represented by "gross national income (GNI) per capita" (in purchasing power parity or PPP $), together with the composite index HDI that measures the average achievement in these three dimensions (see Appendix 3 for definitions). As in all human development tables, the countries are arranged in the order of

decreasing HDI rank. The HDI rank of each country is shown in the first column of Table 1; in the last column, the difference between the GNI per capita rank of the country minus its HDI rank is shown. All indicators are reported for each of the 188 countries. Some data do not come from standard data sources but are taken from another source like Barro and Lee (2016), or are estimated or updated by the Human Development Report Office or the data-gathering agency (see Appendix 4). This is particularly true for the indicator "mean years of schooling," for which, besides the data from UNESCO, additional information has been used in 56 percent of the countries. For the indicator "expected years of schooling," also provided by UNESCO, this is the case in 15 percent of the countries.

Table 2 summarizes the development of the HDI from 1990 to 2015. Starting in 2010, data needed for calculating the HDI are available for all 188 countries.

Table 3, Inequality-adjusted Human Development Index, presents the IHDI, which adjusts the HDI for inequality in the distribution of each dimension across the population. For its calculation, the distributions of the indicators for the three basic dimensions are used. The data on life expectancy are reported for nearly all countries. Education and income data are not reported for 16 percent and 18 percent of countries, respectively. The IHDI is not reported for about 20 percent of countries.

Table 4, Gender Development Index, shows the GDI, which measures gender inequalities in achievements in the three basic dimensions of human development. As for Table 3, the data on life expectancy are reported for nearly all countries. Education and income data are not reported for 6 percent (expected years), 10 percent (mean years) and 6 percent (GNI per capita). The GDI is not reported for about 15 percent of countries.

Table 5, Gender Inequality Index, reports the GII, which reflects gender-based disadvantages in the three basic dimensions. The GII is not reported for 15 percent of the countries. The components of the GII related to population statistics (provided by UNDESA), employment (International Labour Organization, ILO) and education (UNESCO) are not reported for 3 percent, 5 percent and 13 percent of countries, respectively.

Table 6, Multidimensional Poverty Index: developing countries, is based on data from household surveys in 102 developing countries. Data sources are Demographic and Health Surveys, Multiple Indicator Cluster Surveys or national surveys. Data on portions of populations living below the national poverty line and living with less than PPP $1 a day, both provided by the World Bank, are not reported for 12 percent and 17 percent of countries, respectively.

For Tables 1 to 7, Appendix 4 summarizes the availability of the indicators for countries, showing the number for which the indicator is and is not reported, as well as the number for which the variable

is reported in modified form, based on data estimated or updated by the Human Development Report Office or the data-gathering agency.

For Table 1, for substantial portions of countries, the indicators "mean years of schooling" (65 percent) and "expected years of schooling" (18 percent) do not come from the standard data source, but are taken from another source, like Barro and Lee (2016), or are estimated or updated by the Human Development Report Office or UNESCO.

For Tables 3 to 6, Table A3 (see Appendix 2) shows the average portions of countries for which the indicators of the main data provider are not reported. Whereas the indicators related to population statistics, delivered by UNDESA, are reported for nearly all countries, the education data, provided by UNESCO, and the income data, provided by the World Bank, are reported only for about 90 percent and 80 percent of countries, respectively.

For **Tables 7 to 14** and the dashboards, the average portions of countries for which the indicators of the main data provider are not reported are shown in Table A4 in Appendix 2. Table A4 shows that the portion varies substantially over the data-gathering agencies. Indicators on population statistics, gathered by UNDESA, are reported for 98 percent of countries. Indicators on work and employment statistics, the subject of Table 11, are provided by the ILO. They are not reported for about 23 percent of countries. For even higher portions of the countries, indicators on children (United Nations Children's Fund, UNICEF) and on nutrition (Food and Agriculture Organization, FAO) are not reported. Indicators on education, gathered by UNESCO, on health (World Health Organization, WHO), and on income and consumption (World Bank) are reported on average for about 85 percent of the countries.

Indicators not reported for high portions of countries are shown in Tables A5 and A6 in Appendix 2. Table A5 contains indicators in Tables 3 to 5 that are not reported for 10 percent of the countries or more. For Tables 7 to 14 and the dashboards, extreme portions are much higher, up to 70 percent and more (see Table A6). This list contains a large number of indicators related to children (UNICEF) and employment (ILO).

Table A7 of Appendix 2 reports the number of indicators for each human development table as well as the average portions of countries for which the indicators are not reported. The highest average numbers are shown for Table 12 (human security, 27.5 percent), Table 11 (work and employment, 21.7 percent), and Table 14 (supplementary indicators: perceptions of well-being, 21.2 percent). For the second dashboard (sustainable development), the average portion is around 20 percent.

MODIFIED INDICATORS

In the human development tables, indicators that do not correspond to the standard form include those with a deviation of the reference year, a modified definition, a special data source, an imputation method used to estimate the indicator, etc. Modifications may be conducted by the competent national statistical authority, by the data-collecting agency or by the Human Development Report Office.

The indicator "mean years of schooling" illustrates this issue. For 108 of the 188 countries, the indicator is marked as modified. Among these 108 countries, the values for 53 countries are not reported by UNESCO, but taken from an alternative source, such as Barro and Lee (2016). The values for 14 countries are based on data from the ICF Macro Demographic and Health Surveys for 2006-2015. The values for 13 countries are based on data from the UNICEF Multiple Indicator Cluster Surveys for 2006–2015. And the values for 12 countries are based on cross-country regression, i.e., a missing value is imputed. This example is extreme in the high portion (65 percent) of countries for which the reported values of the indicator do not correspond to the standard form, but is quite typical in the causes for modifications or adjustments.

For the main data-gathering agencies, Table A8 (see Appendix 2) shows the average portions of countries for which modified indicators are reported. This average portion for all data-gathering agencies is below 10 percent, and for most is close to zero. The largest average portion is observed for indicators related to education, gathered by UNESCO, with about 9 percent.

This picture is also reflected by the last column of Table A7, which shows, for each human development table, the average portion of countries for which modified indicators are reported. For four tables, this portion has a substantial value. For Table 1, there are modified indicators for about 20 percent of countries, due to 65 percent and 18 percent of the countries having modified indicators for "mean years of schooling" and "expected years of schooling," respectively. Tables 6 (Multidimensional Poverty Index), 9 (Education achievements) and 11 (Work and employment) have modified indicators—on average—for about 15 percent of countries. These three tables have the highest potential for data improvements, given that they have the highest average portions of countries for which indicators are either not reported or reported only in a modified version. These portions are above 30 percent.

Again, it is interesting to have a look at individual indicators. Table A9 (see Appendix 2) shows indicators with the largest portions reported in modified form. Seven of these indicators are related to education (provided by UNESCO), three are on children (UNICEF), and three are on income and consumption (World Bank).

Modifications of indicators must be considered when comparisons are made based on these indicators; the modifications may have consequences for comparability. This applies in particular to

the fact that two of the four basic indicators of the HDI, "mean years of schooling" and "expected years of schooling," are to a large extent available in modified form only.

AFFECTED DIMENSIONS OF HUMAN DEVELOPMENT

Analysis of the problematic indicators should also consider which dimensions of human development are more and less affected. Health, education, work, national income, etc. correspond to Tables 7 to 14. Table A7 of Appendix 2 shows that the portions of countries with unreported or modified indicators vary considerably over the human development tables and hence over the dimensions. Dimensions with higher portions were mentioned in the preceding sections.

Dimensions least affected by data problems are population development and international integration. Indicators on population development are nearly entirely reported. Among the 12 indicators on international integration, three are not reported for a substantial number of countries. Two are related to financial flows ("private capital flows," at 15 percent, and "net official development assistance," at 27 percent); a third is the indicator on "international student mobility" (29 percent).

The indicators related to health show a similar picture: Only some are problematic. The indicators "death due to malaria" (50 percent) and "HIV prevalence" (44 percent), both provided by WHO, as well as "infants exclusively breastfed" (30 percent) and "child malnutrition, stunting" (27 percent), both provided by UNICEF, are problematic; so, to some extent, is "adult mortality rates" (14 percent). Substantial portions of modified indicators are reported for the two indicators on children, "infants exclusively breastfed" and "child malnutrition, stunting," for 19 percent and 18 percent of the countries, respectively.

For indicators related to national income, only one indicator, "total debt service," is not reported for a major portion (37 percent) of the countries. However, the portion of countries for which indicators are not reported is rather high, between 18 percent and 28 percent, for another five indicators related to taxes, the food price index and governmental consumption expenditures. Most of these indicators are provided by the World Bank, with two on food prices by the FAO. The other six indicators are reported for about 94 percent of the countries. Nearly no modified indicators are reported.

The pattern is similar for indicators related to educational achievements. One indicator, "education quality: primary school teachers trained," is not reported for a substantial 39 percent of countries. Another, "public expenditures on education," is not reported for 25 percent. For the rest of 10 indicators, the portions are rather high, 15 percent on average. All of these indicators are provided by UNESCO. For only one indicator, "population with at least some secondary education," are modified values reported by a considerable portion of countries (17 percent).

Among the 12 indicators related to work and employment, half are not reported for substantial portions of between 31 percent and 45 percent of countries. The problematic indicators have to do with employment in the sectors of agriculture and services, as well as unemployment, "youth not in school or employment," which are not reported for 33 percent, 31 percent and 45 percent, respectively. Others relate to work that is a risk to human development: "vulnerable employment" (31 percent), "child labour" (41 percent) and "working poor" (42 percent). The other six indicators are well reported (only 5 percent to 9 percent not reported). The indicators are provided by the ILO with one exception: "child labour" comes from UNICEF. This is the only indicator for which a modified version is reported for a substantial portion (38 percent) of the countries.

The dimension most affected by problematic indicators is human security. Seven of the 14 indicators are not reported for between 40 percent and 80 percent of countries. Four of these indicators have to do with violence against women or wife-beating, provided by UN Women and UNICEF, respectively; two others are on numbers of "orphaned children" and "internally displaced persons," with a lack of data from 88 percent and 74 percent of countries, respectively. The other seven related indicators are well reported. Four of the problematic indicators, those relating to violence against women or wife-beating, are new in the *Human Development Report 2016*; they were introduced as substitutes for another problematic indicator, "violence against women, partner violence, ever," which could be reported in the *Human Development Report 2015* for only about 40 percent of countries.

A special picture is found for indicators related to the perception of well-being. They are based on results of the Gallup World Poll, which is annually conducted in a large number of countries all over the world. The poll "continually surveys residents in more than 150 countries, representing more than 99% of the world's adult population" (Gallup 2016). In the Human Development Report, the 14 indicators are, on average, not reported for nearly 20 percent of countries.

In summary, two aspects are remarkable:

- For most human development dimensions, about half of the indicators are problematic; the other half are well reported. In nearly all cases, the problem with the indicator is the high portion of countries for which the indicator is not reported.

- Dimensions that are well covered are population development and international integration. The most problematic dimension is human security.

THE MOST PROBLEMATIC HUMAN DEVELOPMENT INDICATORS

Addressing problematic indicators or identifying appropriate substitutes for monitoring corresponding dimensions may be done in two ways. A problematic indicator may be replaced by:

- A less problematic indicator with similar content; or
- An indicator may be obtained from an alternative data source.

Candidates for substitution are listed in Tables A5, A6 and A9 of Appendix 2. These indicators show extreme portions of countries for which the indicator is not reported or reported only in a modified version. In Table A10, for the various data-gathering agencies, the number of such indicators contained in Tables A5, A6 and A9, and the average portions of countries are listed.

The indicators that are most problematic are those related to the educational system, and to work and employment. Four of the indicators related to the educational system are on the list in Table A5, a further four on the list are in Table A9. The average portions of countries for which the indicators are not reported or are reported in a modified way are 57 percent and 24 percent, respectively. Among the indicators on employment, the average portion of countries for which the indicators are not reported is 47 percent. Among indicators reported for a high portion of countries in a modified version, seven are related to the educational system; the average portion is 30 percent. Among these indicators are also the core indicators "expected years of schooling" and "mean years of schooling," which, for 15 percent and 57 percent of the countries, respectively, are reported in a modified or adjusted version only. Altogether, there are about 30 candidates for substitute or alternative indicators.

Data sources used by national statistical authorities are primarily indicator surveys and administrative data. Typically, data related to the educational system are obtained from administrative sources; data on work and employment may be based on administrative sources or surveys. It is in the competence of the data-gathering agencies to coordinate the provision of indicators from the national statistical institutes and help improve their compliance with the standard form. The Human Development Report Office might suggest the substitution of an indicator when the provision of the indicators by the national statistical authorities is problematic. In the context of education indicators, Kovacevic (2011) provides a detailed discussion of possible education indicators, including their availability in countries.

Obviously, for the production of tables related to all relevant dimensions of human development, the available data sources are not sufficient. Limited resources may be the main reason for this insufficiency. While the limitations of statistical capacities are even more difficult to overcome than financial scarcity, progress can be observed. For example, the portions of countries that reported the indicators "expected years of schooling" and "mean years of schooling" in a modified or adjusted

version dropped from 18 percent and 65 percent to 15 percent and 57 percent, respectively, from the 2015 to the 2016 reports, signaling substantial progress.

QUALITY ISSUES AND METADATA

For assessing the reliability and quality of the HDI, documentation is needed that describes the details of generating the index on all levels. In the context of Millennium Development Goal (MDG) reporting, the importance of appropriate documentation of statistical processes became obvious (UNSC 2006). In the SDG-context, the IAEG-SDGs discussed the implementation of a standard for data and metadata, and their exchange within the SDMX framework (Reister and Assa 2016). A template for the compilation of metadata for SDG indicators has been suggested (IAEG-SDGs 2016), which might be used as a model for metadata reporting of human development indicators.

The preceding sections and the numbers mentioned above reflect deficiencies in the availability of the human development indicators, which are not reported or reported only in modified form for some countries. Reasons may be found in the whole statistical process: the collection of national data, the production of the indicator by the national statistical institute or another statistical authority, the delivery of the indicator to the indicator-gathering international agency, the compilation of the data set provided to the Human Development Report Office, and the processing and dissemination by the report. Appropriate documentation would encompass:

- Metadata on the statistical production of human development indicators at the national level,
- A comprehensive description of the mechanisms used by the data-collecting agencies, and
- The methodological report of the Human Development Report Office.

The basis for a quality assessment of statistical indicators is the information on quality dimensions:

- Accuracy and reliability, i.e., indicators reflect the reality accurately and reliably, and
- Coherence and comparability, i.e., indicators are consistent internally, over time, and comparable between regions and countries.

The metadata should contain information about quality dimensions. For data from sample surveys, the accuracy of the estimated indicators is crucial. The accuracy of a sample estimator is a function of both sampling and non-sampling errors. Sampling errors are due to drawing a probability sample and are a function of the sampling design. Non-sampling errors are mainly associated with data collection and processing procedures; they arise mainly due to misleading definitions and

concepts, inadequate sampling frames, unsatisfactory questionnaires, defective methods of data collection and editing, incomplete coverage of sample units, etc. The usual classification of non-sampling errors distinguishes specification error, coverage or frame error, non-response, measurement error, processing error and error of estimation. The bias of an estimate is a systematic error that causes the estimate to deviate from its 'true' value in a consistent direction, e.g., the value is greater than the true value. A bias occurs typically due to non-sampling errors like incomplete coverage, inadequate sample selection and non-response. Non-sampling can cause huge biases in the survey results; moreover, it is difficult and costly to assess a bias, e.g., by post-survey checks, which mean repeating parts of the sampling. The best and only way to control non-sampling errors is to follow the right procedures of all survey activities from planning, to sample selection, to the analysis of results.

Metadata should contain a detailed account of all measures aimed at controlling non-sampling errors. In the context of human development indicators, dimensions like health, educational achievements, work and employment, human security, perception of well-being and others are in part or widely measured on the basis of surveys. The corresponding surveys are conducted by the respective national authority. Without detailed metadata on survey-based indicators, neither the data-gathering international agency nor the reader of the Human Development Report is able to assess and understand the relevance of such indicators.

Statistics Austria (2009) gives an example for the documentation of metadata. It provides the reader with detailed accounts of quality, relevance, accuracy, timeliness and punctuality, comparability and coherence. The section on accuracy covers sampling and non-sampling errors; among the latter are coverage errors, non-response, measurement error, processing errors and errors of estimation. In each case, the risks for error are reported as well as the measures to avoid or to correct for them. Information on the same quality dimensions are required by the Single Integrated Metadata Structure (SIMS), the SDMX-based standard for quality reporting according to the European Regulation 223/2009 on European statistics (Eurostat 2015).

In the context of the HDI, the crucial information is on the statistical production of human development indicators at the national level. Quality reports or metadata that cover the relevant quality dimensions are needed for each of the indicators. The coordinating function of the international agencies would include that they supervise, guide and harmonize the documentation of the national statistical processes, this way assuring compliance with agreed quality standards. The other elements of comprehensive documentation of the HDI are the report on the mechanisms used by the international agencies and the methodological report of the Human Development Report Office.

The office has published a wide range of methodological reports. The annual Human Development Reports contain analyses of methodological issues and contributions of experts on

relevant questions. The Human Development Report website offers global, regional and national reports in which methodological issues may be part of the discussion. An important source of methodological information is the Technical Notes 1 to 5 (UNDP 2015a), which contain the documentation of the methodology used to compute the family of human development indices, i.e., the HDI, IHDI, GDI, GII and MPI. The notes give references including links to the indicator-gathering agencies.

On the websites of international data-gathering agencies, some information about statistical processes for producing human development indicators can be found, as follows:

- UNDESA's Population Division provides the indicator "life expectancy at birth" and more than 20 other indicators for the Human Development Report, among them are all the indicators of Table 7 (Population trends). The indicators are available for most countries; modified indicators are reported for less than 5 percent. From the website[3] of the Population Division, a wide range of indicators and corresponding metadata can be downloaded. Among the metadata of the indicators, a documentation of data sources is available. For each country, national sources are listed for indicators on total population, fertility, life expectancy, mortality and migration, such as data from population censuses, vital registration data, life tables, etc. This information, however, does not contain methodological details, neither of national statistical processes nor of the data-gathering processes used by UNDESA. An example of a methodological report is UNDESA 2015, which describes methods used in population estimates and projections.

- UNESCO's Institute for Statistics provides the indicators "mean years of schooling" and "expected years of schooling" as well as nearly 20 other indicators, among them most of the indicators of Table 9 (Education achievements). On average, the tables report the indicators for nearly 85 percent of countries, but for about 8 percent, only modified indicators are available. On the UNESCO website,[4] a database, UIS.STAT, allows users to generate tables, graphs and maps, not only for data and indicators in education and literacy, but also in science, technology and innovation, culture, communication and information. Metadata are available for some of the indicators, including a short and general description of the data source and the methodology for estimating the indicator, concepts and classifications, as can be seen in the metadata for the indicator "mean years of schooling" (UNESCO Institute for Statistics 2013). The site "Frequently Asked

[3] See: https://esa.un.org/unpd/wpp/.

[4] See: http://data.uis.unesco.org/.

Questions About Education Statistics"[5] provides information about quality assurance measures applied in the data collection process in order to review national data and produce comparable indicators across countries.

- UNICEF provides 11 indicators, among them many indicators of Tables 8 (Health outcomes) and 12 (Human security). Many of the indicators are available for many or most of the countries, but some, e.g., on orphaned children, nutrition and wife-beating, are not reported for up to 70 percent of the countries. On average, the tables report the indicators for more than 70 percent, and for a further 10 percent, modified indicators are reported. The UNICEF website[6] offers access to and downloads of a wide range of indicators. Metadata contain definitions and data sources; no information, however, is given on the methodological details of national statistical processes or on the data-gathering processes used by UNICEF.

- The World Bank provides the indicator "GNI per capita" and some 30 other indicators, among them most indicators of Table 10 (National income and composition of resources). Many of the indicators are available for the majority of countries, but some, e.g., on taxes, debt and R&D expenditures, are not reported for up to 30 percent of countries. On average, the human development tables report the indicators for about 85 percent of countries; modified indicators are reported for only a few countries. On the World Bank website,[7] the metadata for each country contain the national data source; e.g., for "GNI per capita," the latest population census and the latest household survey. No details are given on methodological details of the national statistical processes or of the data-gathering processes used by the World Bank.

- The ILO provides 14 indicators, among them most indicators of Table 11 (Work and employment). The indicators provided by the ILO are not reported for up to 45 percent of countries. On average, the human development tables report the indicators for more than 75 percent of countries; modified indicators are reported for only a few countries. On the ILO website,[8] detailed description of the indicators as well as standards and guidelines for the production of the indicators are given. Information about the data sources used in each country or corresponding metadata are not shown.

[5] See: http://uis.unesco.org/en/methodology#jumpto-region-28.

[6] See: https://data.unicef.org/.

[7] See: http://databank.worldbank.org/data/home.aspx.

[8] See: www.ilo.org/global/lang--en/index.htm.

In general, the websites of data-gathering agencies reveal that:

- Information on mechanisms used for gathering data from countries, methods to ensure compatibility of indicators across countries and methods to fill in data gaps are not systematically published.
- For most indicators, the national data sources are listed, but no reference is given to methodological details like concepts, survey design, applied editing and imputation techniques, etc.; for some indicators, even the national data sources are not mentioned.

National statistical institutes and other national statistical agencies have to follow internationally agreed standards in the production of the indicators. However, it is not a widespread practice to publish metadata for statistical products. For most countries, detailed information about statistical processes and, in particular, about the relevant quality dimensions is not easily found.

Overall, an assessment of the quality of the HDI is handicapped by the fact that basic information on the quality of different dimensions is not generally available. The Human Development Report Office could aim to provide users of the HDI with comprehensive documentation indicating the comparability of indicators over time, and between regions and countries, among other aspects.

Metadata reports will help to assess the strength and weaknesses of the individual indicators, and are particularly important for HDI users to understand the relevance and limitations of the HDI for monitoring and assessing human development.

- Metadata related to national data should be available according to an agreed framework and a standard metadata format for the indicators.
    - The metadata of each country should provide information about content, definitions and concepts; a description should be given of how each indicator was created.
    - Quality metadata should enable users of the data to judge its fitness for purpose.
- Recommendations related to the international agencies refer to their coordinating role and to methodological issues in data collection activities.
    - Coordination and support to countries in the compilation and analysis of indicators at the national level could help improve quality, and in particular reduce the portion of countries with indicators that are not reported or are modified.

- A standard, probably SDMX-based metadata format for indicators at the national level should be proposed so that basic information is provided that would be helpful for both international agencies and users of the Human Development Report.
- International agencies should provide documentation of the data-gathering processes.
- International agencies should provide detailed documentation of the methods used to modify or adjust national data; this applies in particular to cases where country-level estimates are used in the absence of country data; the strong preference is to use data collected by individual countries wherever possible.
- The implication of the limitations of the national data should be discussed in future Human Development Reports.

A thorough discussion of the role of the international agencies in data collection from national statistical authorities is contained in the report of the Friends of the Chair on MDG Indicators (UNSC 2006). This report was produced in the context of MDG monitoring for the 37th Session of the UNSC. In its 48th Session, the Commission (UNSC 2017) discussed the adequacy of the quality assurance framework (UNSC 2012) for the national and international levels in implementing the SDGs, with a particular view on the emergence of new data providers and data sources like big data. A number of measures were proposed for the national level. In many countries, the national statistical institute has to assure data quality across the entire national statistical system, and to provide adequate guidance and tools for all data providers. To increase the ability to assess the quality of data from different sources, statistical data quality principles should be promoted beyond the national statistical system to potential new data providers and data users, and the adaptation of the national quality assurance framework should be considered. Moreover, the adequacy of quality assurance measures in the global statistical system was considered with respect to further guidance in the context of global reporting of data and indicators.

In following the above recommendations, a focus on indicators that are problematic and on countries known to have problems in conducting statistical processes could result in substantial improvements. The recommendations might stimulate discussion of how more transparency in the generation of the Human Development Report might support understanding and use of it.

EXPANDING HUMAN DEVELOPMENT MONITORING

Since the first Human Development Report in 1990, the monitoring of human development has evolved.

- The measurement of human development has moved from measures of average achievements to distributional aspects, e.g., inequality of outcomes by gender and for other groups are reported.
- The number of dimensions of human development for which data are reported has increased.

The choice of human development indicators is crucial in considerations of both the conceptual basis and the measurement of relevant dimensions. Since the beginning of human development monitoring, in critical evaluations of the HDI, indicators were subject to discussions considering alternatives and modifications of established concepts and measures. UNDP[9] refers to a large number of publications that discuss how to measure human progress. Examples are proceedings of the Conferences on Measuring Human Progress (UNPD 2013, 2015b), the contributions published on the HDialogue blog (e.g., Jahan 2015) and a blog on statistical cooperation (UNDP 2014). Over the years, besides moving from the measures of average achievements to distributional aspects, monitoring has looked not only at the quantity of human development achievements but also their quality.

The increase in dimensions is illustrated by the comparison of themes in the tables presented in the Human Development Reports in 2015 and 2016. Eight themes are covered in both reports. Table 12 (Environmental sustainability) of the 2015 report has been replaced by Dashboard 2 (Sustainable development) in 2016. As a new topic, the gender gap over the life-course is treated in Dashboard 1 of the 2016 report.

Interest in expanding the monitoring of human development focuses on two directions:

- Monitoring development within subpopulations such as gender, and
- Monitoring further dimensions of human development.

The following refers to potentials for deepening reporting and closing gaps.

[9] See: http://hdr.undp.org/en.

DISAGGREGATION IN CURRENT HUMAN DEVELOPMENT INDICATORS

Since the beginning of human development monitoring, comparisons of development by gender were a focus, putting weight on differences. A look into the *Human Development Report 2016* makes clear that information on gender inequality is a major objective. Three of the tables consider gender issues:

- Table 4, the Gender Development Index, which indicates disparities in the HDI by gender, comparing female and male HDI values;
- Table 5, the Gender Inequality Index, which presents a composite index of gender inequality, highlighting women's empowerment; and
- Dashboard 1, Life-course gender gap, reporting indicators of gender gaps over the life course.

Various other tables report indicators separated for females and males, illustrating gender inequality; examples are the mortality rate in Table 8 (Health outcomes), the literacy rate in Table 9 (Education achievements), the suicide rate in Table 12 (Human security) and enrolment of females in education in Dashboard 1 (Life-course gender gap).

The documentation of development by gender is certainly an important contribution towards a fact-based discussion of related issues. The Overview of the 2016 report states: "Gender equality and women's empowerment are now mainstream dimensions of any development discourse. And there is no denying that with an intention to overcome them constructively, space for discussions and dialogues on issues once taboo is slowly opening." Disaggregating indicators by gender reveals disparities in human development.

The number of countries for which indicators disaggregated by gender are not reported varies for most indicators between 10 and 25, i.e., between 5 percent and 13 percent. Countries for which disaggregated indicators are not reported are often those with medium or low human development. Among the 19 countries for which gender-disaggregated indicators on "mean years of schooling" are not reported are five with medium and five with low human development. Eight others are countries with high human development. Indicators for which gender-disaggregated values are not reported for larger portions of countries include those for human security. Indicators of female and male views of the "justification of wife-beating" are not reported for 43 percent and 66 percent of the countries, respectively. Among the life-course gender gap indicators, the "female to male ratio of old-age pension recipients" and the "share of paid female employment in non-agriculture" is not reported for 59 percent and 43 percent of the countries, respectively.

There are other subpopulations for which disaggregated indicators may reveal inequality in development. They include:

- Groups by age, and
- Urban and rural populations.

The different age groups (children, youth, working-age, pensioners) may have different opportunities in the labour market, may be treated differently in the health system, and may play a different role in migration and integration, etc. The Human Development Report gives values for a few specific indicators. Again, the portions of countries for which age-differentiated or better age-specific indicators are not reported are of interest. Among the population and health indicators, five and two age-specific indicators are found, respectively; these indicators are reported for nearly all countries. The situation changes when the focus is on indicators of educational achievement and employment. For education, five indicators can be identified. The indicator "adult literacy rate" is not reported for nearly 20 percent of the countries, with lower portions for the other indicators. Among the three indicators for employment, the indicators "youth not in school or employment" and "child labour" are not reported for 45 percent and 41 percent of countries, respectively.

In terms of urban and rural populations, huge and growing discrepancies can be observed, particularly in developing countries. The Human Development Report considers various related aspects but does not provide relevant indicators about this rapidly growing challenge.

Extending human development monitoring into new areas requires the availability of appropriate and relevant data. Reporting on indicators for subpopulations means that sufficient amounts of data are collected. This task may be feasible for data from administrative sources, but can be costly in the case of surveys. In terms of urban and rural populations, indicators on the main dimensions of human development like health, education, income and consumption, and labour market participation may be available from administrative sources.

NEW DIMENSIONS OF HUMAN DEVELOPMENT MONITORING

Comparison of the 2015 and 2016 Human Development Reports shows that covered themes are expanding. In the 2016 report, indicators of gender gaps over the life course are shown in Dashboard 1 (Life-course gender gap), and in dimensions such as health, education, the labour market and work, social protection, and others. The substitution of Table 12 (Environmental sustainability) in the 2015 report with Dashboard 2 (Sustainable development) results in a substantial change from indicators of environmental vulnerability and the effects of environmental threats (such as carbon dioxide emissions, natural resource depletion and impacts of natural disasters) to indicators of environmental, economic and social sustainable development (covering indicators such as national savings and debt,

government spending on R&D, the diversity of the economy, changes in income and gender inequality, and dependency ratios). Indicators reported in Dashboard 2 are collected from national agencies mainly by the World Bank; on average, for more than 20 percent of countries, the indicators are not reported, this portion being particularly high for indicators of social sustainability like income, poverty and gender inequality.

A topic gaining interest during the last 10 years in official statistics is the well-being of individuals. In the *Human Development Report 2016,* Table 14 (Supplementary indicators: perceptions of well-being) reports indicators that reflect individuals' perceptions of dimensions like the quality of education, quality of health care, standard of living, personal safety, satisfaction with the country's judicial system and trust in the government. Indicators of individual well-being have been development based on the Brundtland Report (1987) as well as on the Stiglitz-Sen-Fitoussi report (Stiglitz et al. 2009). Initiatives related to monitoring individual well-being have been undertaken by the United Nations, the European Commission and the Organisation for Economic Co-operation and Development (OECD). Measurements and reports on well-being are published by various countries, such as Australia, Austria, Bhutan, France, Germany, Italy and the United Kingdom. The Human Development Report uses data from Gallup's World Poll (Gallup 2016) in Table 14.

Various dimensions of human development are currently not covered or only marginally covered in the Human Development Report. Examples are:

- The development of the civil society, and
- The growing diversity of society.

Examples for the latter are diverging rural and urban societies and growing multi-ethnicity. Both developments are increasingly affecting individuals in their daily life. Sound statistics would be helpful for understanding the relevance and evolution of these rather complex phenomena. The Gallup World Poll contains various questions that might be used in constructing indices. These need a carefully designed theoretical basis and the investigation of a variety of related aspects and interrelations. The selection of appropriate variables has to complement the conceptual and empirical basis, and take into account the availability of data and the capacity of national statistical institutes or other authorities to provide relevant data in sufficient quality. Soft data like the answers on questions about individual perceptions and assessments are not part of the standard statistical working programme of the national statistical institutes. Data from administrative sources and innovative data sources, as discussed in the following sections, offer potentials for meeting data needs.

The difficulty of constructing appropriate indices can be seen from the work of the IAEG-SDGs; see the ICSU/ISSC (2015) report.

THE STATUS OF HUMAN DEVELOPMENT RELEVANT DATA: SUMMARY

In its 15 tables and two dashboards, the *Human Development Report 2016* reports on 165 indicators delivered by the international data-gathering agencies. An additional 34 indicators are calculated by the Human Development Report Office. On average, the portion of countries for which indicators are not reported is about 15 percent, with larger shares for issues including human security, employment, perceptions of well-being and sustainable development. The portion of countries for which the indicators are modified or adjusted is about 4 percent, with a concentration of these in education, and high shares among poverty and employment indicators.

Expanding the monitoring of human development requires two directions:

- Monitoring development within subpopulations, and
- Monitoring further dimensions of human development.

Both ambitions require the enlargement and adaptation of the human development database. Comparisons by gender, a focus since the start of human development monitoring, calls for disaggregated reporting on indicators for females and males, and indicators reflecting specific issues related to sex such as maternity. More could be done as well to cover issues related to the diversity of society.

Traditional data sources for human development monitoring

This section discusses some aspects of human development data used for monitoring, starting with the types in use or that may be used. Types differ in the way they are collected, such as in surveys or censuses, or as a byproduct of administrative processes. Data may also be generated where industrial production, commercial and public services, and the private lives of individuals are supported by information technologies. This discussion is followed by elaboration on standards for the work of statistical authorities as well as on the statistical capacity of national statistical authorities and barriers to its development. The section concludes by looking at data available to extend human development monitoring to special population groups.

TYPES OF DATA SOURCES

Most data for human development monitoring are from administrative sources or surveys. Vital statistics and statistics on educational achievements are examples of data typically obtained from

administrative sources. Data on health, work and employment, and income and consumption may be based on administrative sources or surveys. Indicators reported on multidimensional poverty (Table 6), population trends (Table 7) and perception of well-being (Table 14) use census or survey data.

Administrative bodies are the owners of data that they collect for their specific administrative purposes. Strengths are that the data of such bodies contain information on a full population of well-defined units, and that these data are continuously updated. Owners are mostly public authorities like ministries. Businesses may be owners of data useful for national statistical institutes, such as retail chains that use scanners in their sales, generating a dataset on each individual transaction. National statistical institutes have experimented in using such data for producing the consumer price index.

Surveys based on statistical sampling theory allow inferences on the corresponding target population; the statisticians know to deal adequately with quality issues like non-responses and survey errors. Problems of increasing relevance are the high costs of surveys and the growing resistance of the interviewees to the response burden, however. Censuses offer a strength in that they break down results for small geographic areas and population subgroups. They are simple in terms of statistical methodology but impose enormous costs.

Most of the data used in human development monitoring are collected by national statistical institutes. Data may also be collected by mostly public institutions like ministries, which have the competence for special themes; typically, data related to the educational system and the health system of a country are administered by the corresponding ministries. Monitoring may also be based on indicators provided by private agencies. An example is Table 14, which presents indicators on the perception of individual well-being from data collected in Gallup's World Poll.

STANDARDS FOR DATA COLLECTION AND DISSEMINATION

In human development monitoring, national statistical institutes play a central role. They provide political systems, public administration, businesses, researchers, media and the public in general with independent, high-quality information on the economy and society at the national and regional levels. The Fundamental Principles of Official Statistics (UNSD 2013), the European Statistics Code of Practice (Eurostat 2005a) and other principles state standards for this work.

Principles of major relevance are independence, and impartiality and objectivity. The first of the Fundamental Principles of Official Statistics says: "Official statistics provide an indispensable element in the information system of a democratic society, serving the Government, the economy and the public with data about the economic, demographic, social and environmental situation. To this end, official statistics that meet the test of practical utility are to be compiled and made available on an impartial basis by official statistical agencies to honour citizens' entitlement to public information."

The European Statistics Code of Practice states professional independence as independence of the statistical authority from other policy, regulatory or administrative departments and bodies, as well as from private sector operators. Compliance with this principle impacts the appointment and resignation of the head of the institute, and the (sole) responsibility of the head for deciding on statistical methods, standards and procedures. It affects the content and timing of statistical release and other issues. The Code of Practice requires as a further principle the commitment to quality, implying that strengths and weaknesses are systematically and regularly identified in order to continuously improve process and product quality.

Standards like the Fundamental Principles of Official Statistics and the European Statistics Code of Practice are issued by various institutes as national tools. Compliance is assured by the institutional and organizational environment of national statistical institutes, such as a legal mandate for data collection or sufficient public funding. Within the European Union, providers of European statistics other than national institutes are required to comply with the European Statistics Code of Practice.

Most indicators that are basis of human development monitoring are provided by national statistical institutes. Indicators may also be developed by other institutions, e.g., by researchers on the basis of data from the national institutes. In many countries, statistical organizations give researchers access to unit-level data. For example, via Eurostat, researchers can access various datasets, covering data from most or all European Union member states. These datasets include the European Community Household Panel, the Labour Force Survey, the Statistics on Income and Living Conditions (EU-SILC), and others. IPUMS-International (Integrated Public Use Microdata Series, International) gives access to microdata from censuses from 82 countries from 1960 to the present. An attractive research area based on EU-SILC microdata is poverty, a theme that is less and less confined to developing countries. Indicators related to deprivations among certain age groups or households with certain family statuses may prove relevant for human development monitoring.

Commercial data providers may also follow certain principles in conducting data collection, data processing and dissemination in order to maintain quality standards. Strong compliance with principles of independence, impartiality and objectivity cannot be expected, however.

BARRIERS TO STATISTICAL CAPACITY DEVELOPMENT

In the Human Development Report, the main reasons for unreported or modified indicators may be gaps in the functioning of national statistical institutes. Deficiencies may lie in the data collection infrastructure, such as through poorly educated interviewers, or in registers, which, for example, do not allow proper survey design. Information technology systems may be outdated. Another reason may be the structure of national statistical systems, which often include several statistical authorities

beyond the national institute, such as statistical units in line ministries. Decentralization may lead to a lack of coordination and unclear competencies for reporting to international agencies. All of these issues can lead to the need for modifications and adjustments by the competent international data-collecting agency or the Human Development Report Office in order to maintain international standards.

For assessing progress in national capacities to provide human development indicators, comparing the 2015 and 2016 Human Development Reports can allow some insights. Tables that have remained unchanged with respect to reported indicators show minor changes in the portions of countries for which indicators are not reported; examples are tables on health, international integration and perceptions of well-being. Other tables have been modified by adding or dropping indicators, e.g., on income, work and employment, and human security. Indicators from the 2015 report that are no longer shown in the 2016 report typically have high portions of countries for which the indicator is not reported. Examples include "R&D expenditures," "long-term unemployment," "labour productivity" and "partner violence," all with unreported portions between 40 percent and 70 percent. But new indicators also have high portions, for example, indicators like "working poor," "child labour" and "violence against women." No great changes between the two reports can be observed in the portions of countries requiring modified or adjusted indicators.

Summarizing, while progress in the capacities of national statistical authorities is evident in certain areas, in general, it is rather limited.

Quite a number of institutions offer support for the development of statistical capacities.

- At the global level, the United Nations, the IMF and others are supportive institutions. The Human Development Report Office has taken a number of measures for improving human development monitoring. Among others, these include the establishment of the Statistical Advisory Panel, which provides technical guidance on statistical activities, and the organization of a series of conferences on human development measurement. The Partnership in Statistics for Development in the 21st Century (PARIS21)[10] promotes the better use and production of statistics throughout the developing world. The coordinating function of the international data-gathering agencies contributes to statistical capacity-building.

- The Informing a Data Revolution project, financed by a grant from the Bill and Melinda Gates Foundation, aims to improve the production, accessibility and use of data to ensure

[10] See: www.paris21.org/.

that the data revolution serves the 2030 Agenda. The key output is a road map setting out the goals, activities and resources needed for developing countries to use data to achieve the SDGs.

- At a regional level, organizations like Eurostat and the regional organizations of the United Nations—including the Economic Commission for Africa (ECA), the Economic and Social Commission for Western Asia (ESCWA), and the Economic and Social Commission for Asia and the Pacific (ESCAP)—are active. A wide range of national agencies give development support for statistical projects, such as the Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ), the Aid Direct programme of the United Kingdom's Department for International Development (DFID), the Swedish International Development Agency (SIDA), the United States Agency for International Development (USAID) and agencies of most other OECD member countries.

Different forms of development support are in use.

- Quite typical are twinning projects, where experts from the donor country or organization and the beneficiary country aim at achieving concrete operational results through peer-to-peer activities. To give an example: In the course of the pre-accession assistance programme[11] of the European Union, a 1.5 million euros twinning project was planned for Bosnia and Herzegovina that focused on improving the performance of statistics in the area of national accounts, structural business statistics, short-term statistics and tourism statistics.

- Among European Union member states, Eurostat initiates working groups with representatives from a few national statistics institutes who develop methodological innovations that can be implemented by many other countries. An example is a project on the use of mobile positioning data for tourism statistics (Eurostat 2014).

- The IMF uses a more structured approach. It invites national statistical agencies to subscribe to the General Data Dissemination System (GDDS) and the more ambitious Special Data Dissemination Standard (SDDS), which require compliance with certain standards in the provision of economic and financial data. The standards encompass various aspects of the statistical process, including the quality of the disseminated indicators. In the course of the subscription process, IMF experts scrutinize statistical processes.

[11] See: https://ec.europa.eu/neighbourhood-enlargement/tenders/twinning_en.

- In human development monitoring, the international data-gathering agencies carefully review submitted data to ensure completeness and compliance with standards and definitions, and to identify errors. The national authority submitting the data gets a detailed report documenting issues found during the data checks. This feedback has the potential to contribute to capacity development.

The extensive support given to national statistical authorities to improve statistical capacity suggests substantial progress. But a number of barriers can be identified.

- The most restrictive barrier is scarce resources in terms of funding and staffing. Most development support aims at improving the competencies of staff. Some supporting agencies also invest in equipment, such as information technology.

- Less obvious barriers are located in the institutional environment of national statistical authorities.

    - Barriers related to the organizational environment can be found in data collection infrastructure, registers, technology and other areas. Changes are costly and need means or expertise that often is not available. A decentralized structure may result in unclear competences with respect to reporting to international agencies.

    - The ability to use data from administrative sources is an important area of statistical expertise. This requires that suitable administrative data exist, a legal basis enables the statistical authority to have access to the data, and a partnership with the owners of the data ensures exchange of all necessary information and logistical support. Due to the complexity of these requirements, overcoming obstacles may not be straightforward.

    - The societal and cultural situation of a country must allow a statistical authority to comply with international standards like the Fundamental Principles of Official Statistics. Non-compliance with principles such as professional independence, impartiality and objectivity, and equal access to statistical products poses a risk to reliability and quality.

Global and regional level support for the capacity development of national statistical authorities could be more efficient in reducing barriers to statistical capacity development. Examples are:

- Stronger coordination of the many national programmes that support the development of statistical capacities would help to use financial means more efficiently and avoid overlap.

Moreover, too many projects may cause stress for staff in the beneficiary institute, rendering them unable to respond and cooperate appropriately.

- Programmes that support statistical capacities should focus on important gaps, leaving less important themes for later stages. Among other rationales, staff of the beneficiary institute may be more motivated by a priority concern.

ANALYSIS OF THE COVERAGE OF DATA RELATED TO SPECIAL GROUPS

The Human Development Report gives a comprehensive picture of the development of countries and also of regions. Some tables, in particular Tables 3 and 4, report indicators by gender, providing insights on development differences between women and men. Information by age is also provided, although in less detail.

Time use surveys in households provide numerous statistics that illustrate gender-specific differences. The most comprehensive report on time use surveys, a Human Development Report background paper by Charmes (2015), compares 102 surveys carried out in 65 countries. The data from these surveys are the basis of Table 4.1 in *Human Development Report 2015,* a strong documentation of gender imbalances. For Austria, the time use survey Statistics Austria (2009) shows substantial differences in unpaid work, where females have a much higher share in housework, care for children, and nursing, as well as in leisure time, which women have less than men. The Centre for Time Use Research[12] at the University of Oxford offers a database of time use studies that encompasses over 60 datasets from 25 countries. The variables of the datasets cluster into five sets: diary, survey and case information, household-level variables, person-level demographic variables, employment and education, and health. The project Time Allocation among Couples[13] analysed how couples interact and allocate household tasks. Ten European countries (Belgium, Estonia, Finland, France, Germany, Hungary, Norway, Slovenia, Sweden and the United Kingdom) participated in the Harmonised European Time-Use Study (Eurostat 2005b).

Time use surveys in households are well suited to revealing gender-specific differences, and time series of related indicators would be an excellent means for monitoring the development of inequalities. However, time use studies are costly and not a high priority in most countries. The available data as reported by Charmes (2015), covering only about half of the countries, are not sufficient to provide comprehensive analyses at the global level.

[12] See: www.timeuse.org/.

[13] See: http://epp.eurostat.cec.eu.int/portal/.

There is also great interest in other population groups, such as:

- Older people
- Youth
- Refugees and migrants
- Minorities and indigenous peoples
- People living in remote or otherwise special areas

Potential sources for information are the websites of international agencies and national statistical institutes.

To draw a realistic and fact-based picture of the availability of such information, the first step was to scrutinize the websites of the Population Division of UNDESA and other UN agencies, such as UNESCO, WHO, UNICEF and the ILO, and also of the World Bank. The results are as follows:

- For the population of older people, indicators offered by the Population Division are the age composition of the population, the old-age dependency ratio (age 65+/age 20 to 64), and the potential support ratio (age 20 to 69/age 70+). Nothing of relevance could be found on the websites of the other agencies.
- For the population of young people, again the Population Division offers the age composition of the population as well as the child dependency ratio (age 0 to 19/age 20 to 69). The ILO reports the NEET (not in education, employment or training) rate. On the websites of other international agencies, relevant indicators were not found.
- Indicators on migrants can be found again on the website of the Population Division: The net number of migrants in five-years intervals for 1950 to 2100, with projections (2015+) based on a medium fertility variant, and the net migrant rate. These two indicators are also published in the World Bank Open Data and by the ILO. The ILO offers, besides the migrant stocks, data on international migrant flows and migrant employment.
- The United Nations High Commissioner for Refugees (UNHCR) provides two indicators on refugees: The refugee population by country or territory of asylum, and the refugee population by country or territory of origin. These indicators are also available in the World Bank Open Data.

- The United Nations Committee for Development Policy has data for all countries on the share of the population living in low-lying coastal zones and vulnerable to floods, etc., an example of people living in special areas.

- Nothing seems to be available on minorities and indigenous peoples, and there is little on people living in remote areas.

Clearly, these indicators do not allow much insight into the human development of the mentioned population groups. Important dimensions like health, education and income are not covered or only marginally covered.

Scrutinizing the websites of national statistical institutes can clarify whether data related to the groups are available at the national level. For this purpose, three, and in one case four countries were chosen from each of the four human development groups. The choice of the countries assures a good regional mix and a wide range of HDI ranks; moreover, it was based on the subjective expectation that relevant information would be available for the chosen countries. For each country, the website of the national statistical institute was checked for the availability of statistics and indicators related to the special groups.

Very high human development: The websites of Statistics Austria, Canada's StatCan, Saudi Arabia's National Statistical Institute and Sweden's National Statistical Institute were scrutinized.

- Austria (www.statistik.at), HDI rank, 24: Statistics Austria provides a rich amount of information on migration, giving a comprehensive picture of immigrants and asylum seekers including education and language, employment, health and living conditions. Some information on human development indicators is available for youth and older people as well as for minorities.

- Canada (www.statcan.gc.ca/eng/start), HDI rank, 10: The website of StatCan has a rich offer of statistics for many aspects of the situation of migrants, aboriginal people and refugees. Many indicators are available on youth and seniors. No other national statistical institute offers as many statistics on these special groups.

- Saudi Arabia (www.stats.gov.sa/en), HDI rank, 38: No information on human development indicators was found for any of the special groups.

- Sweden (www.scb.se/en_/), HDI rank, 14: The Swedish statistical institute publishes comprehensive information on human development indicators for immigrants and asylum seekers, including statistics on the labour market and living conditions. The website also has statistics for indigenous peoples and those in the NEET category.

High human development: The websites of the national statistical institutes from the Dominican Republic, Jordan and Kazakhstan were checked.

- Dominican Republic (www.one.gob.do), HDI rank, 99: The National Statistical Institute of the Dominican Republic offers no information on human development indicators for the special groups.
- Jordan (web.dos.gov.jo/), HDI rank 86: The Jordan Household International Migration Survey 2014 provides information about many aspects of migration; the report does not distinguish asylum seekers from other immigrants. No information on human development indicators was found for the other groups.
- Kazakhstan (www.stat.gov.kz), HDI rank, 56: The National Statistical Institute of Kazakhstan has some information on human development indicators for migrants, but no information for the other groups.

Medium human development: The websites of the national statistical institutes from Moldova, Namibia and San Salvador were checked.

- Moldova (www.statistica.md/index.php?l=en), HDI rank, 107: The National Statistical Institute of Moldova reports human development statistics for migrants, but has no information on indicators for the other groups.
- Namibia (http://nsa.org.na/), HDI rank, 123: The National Statistical Institute of Namibia offers no information on human development indicators for any special group.
- El Salvador (www.digestyc.gob.sv), HDI rank, 117: On the website of the National Statistical Institute of El Salvador, information on human development indicators could not be found.

Low human development: The websites of the national statistical institutes of Burkina Faso (www.insd.bf/n/), HDI rank, 185; Côte d'Ivoire (www.ins.ci/n/), HDI rank, 171; and Mauritania (www.ons.mr/), HDI rank, 157 do not provide information on human development indicators for any of the special groups.

The Human Development Report can include special groups only if a suitable database is available. Inspecting the websites of national statistical institutes shows that human development indicators for the special groups are available only in a few countries. Indicators for migrants can be found only in countries with very high human development that have large numbers of migrants or refugees. For the other special groups, almost no country has human development indicators.

To summarize, available human development data are not sufficient to produce Human Development Reports for special groups like older people, youth, refugees and migrants, minorities, indigenous peoples and people living in remote areas. Indicators on intrahousehold inequalities based on time use studies are available for a few countries, but time use studies are mostly unique.

SUMMARY OF THE GAPS IN TRADITIONAL DATA SOURCES

In most cases, where an indicator is not reported for a country, the country has limitations with respect to resources or competencies or other problems in producing the indicator. If only a modified or adjusted version of an indicator is reported, it might again be due to a problem of the country, or the data-collecting agency makes adjustments to provide high-quality, reliable, internationally comparable indicators. This situation is complicated by the need to cover new and emerging aspects related to refugees and migrants, elderly people and others. It is apparent that:

- In spite of extensive attempts to support statistical capacity in national statistical authorities, gaps in the availability of human development indicators are closing with limited speed.
- Ambitions to expand human development monitoring related to special groups causes further needs for data that are not available at a large scale.

In this situation, the question arises whether data from new sources, so-called alternative data or big data are suitable to supplement or substitute for data used in monitoring human development. This question is theme of the next section of this paper.

A new generation of data for human development monitoring

Most data used in human development monitoring are produced by official statistical agencies, which have increasingly been using data from administrative sources, most produced by public agencies.

Through technology and the wide availability of digital devices, however, the sources and amounts of data have reached such levels and complexity that traditional modes of managing and processing them are not suitable or efficient. The notion of big data has been the subject of increasingly wide discussion. While the concept summarizes diverse data situations and is fuzzy in the various proposed definitions, it is a subject of huge interest by individuals from many areas, including official statistics. The broad range of big data may allow the production of new statistical indicators relevant to human development.

A related notion is real-time data, since a large and increasing percentage of big data is produced and made available immediately after generation.

The open data movement follows the idea that information should be freely available to everyone to be used and republished without restrictions from copyright. The idea gained popularity with the rise of the Internet and the launch of open data government initiatives in the United States in 2009 and the European Union in 2012, among others. Government open data is aimed at making government information available to the public to facilitate transparency, accountability and public participation, Examples of statistical open data websites include UNData,[14] which provides statistical data from UN Member States and UN agencies, and World Bank Open Data,[15] which publishes statistical data relating to developing countries. Such statistical depositories may not necessarily be a source for new and alternative data, but, given the rich content of open data websites, data innovations and new and alternative data may be found there.

This section examines big data and their use in official statistics, including aspects of their relevance for human development monitoring. This is followed by a discussion of obstacles. The use of new data sources has triggered new ways to present data and statistical results, in particular to visualize relations among variables in high-dimensional datasets. A look at innovative visualization tools rounds out the section.

THE USE OF BIG DATA IN OFFICIAL STATISTICS

A survey of using big data in official statistics at national and international levels as well as conclusions about potential ways forward is given in Hackl (2016). A special section of the *Statistical Journal of the IAOS* on big data, edited by Eeg-Henriksen and Hackl (2015), discusses the notion of big data, reports on experiences and challenges in the context of official statistics, and introduces five papers related to international efforts to foster the understanding and use of big data, experiences with the use of big data for collecting price and salary data, and methodological issues.

The growing availability of big data has resulted in new types of data stocks:

- Data generated as a byproduct of technical processes, e.g., smart energy metre data, satellite images and sensor data;
- Data generated as a byproduct of human activities, e.g., mobile phone data;

[14] See: http://data.un.org/Default.aspx.

[15] See: http://data.worldbank.org/.

- Data generated as a byproduct of business transactions, e.g., retail trade scanner data, bookings of transportation services, insurance contracts; and

- Social media and other Internet data.

Such data stocks may be owned by private or public businesses, e.g., by retailers like Amazon, telecommunication providers or service providers of social media like Facebook. In various aspects, the information generated is of new quality, opening new opportunities for businesses and societal activities. The notion of big data is often used in this context. While use for official statistics is still in an experimental stage, these new data sources have the potential to deliver statistical products in shorter time, with more detailed breakdowns, at lesser cost and with a reduced response burden, as discussed by Kitchin (2015) and Hackl (2016).

Big data sources enable new forms of statistical analyses. Within official statistics, projects like the HLG Big Data Project,[16] the ESS BIGD Project[17] and the Global Pulse Initiative[18] (see below) as well as national initiatives like the Australian Bureau of Statistics (ABS) Big Data Flagship Project (Tam and Clarke 2015) have been established, and quite substantial investments have been made in order to investigate and clarify the potential of big data in various statistical domains.

Some of the most successful types of big data in official statistics together with related empirical studies are mentioned here; see Hackl (2016) for more details:

- Mobile phone data are of interest for population, migration and mobility statistics, in particular, tourism statistics. Within the European Statistical System, a feasibility study on the use of mobile positioning data for tourism statistics was conducted (Eurostat 2014). The use of mobile phone data for tourism statistics was also investigated in a number of national projects.

- Data from blogs, social media sites, emails and text messages can be used in various statistical domains like health, income and consumption, labour, population and migration, and tourism, as investigated in projects conducted by the ABS and by Mexico's National Institute of Statistics and Geography (INEGI) (see below).

[16] See: www1.unece.org/stat/platform/display/BDI/UNECE+Big+Data+Inventory+Home.

[17] See: http://web.archive.org/web/20150915101226/http://www.cros-portal.eu/content/big-data.

[18] See: www.unglobalpulse.org/big-data-development-case-studies.

- Smart energy metre data from households have been investigated by the British Office for National Statistics for statistics on mobility and migration.
- Satellite images and remote sensing data have been used in various national projects for agriculture statistics and environment statistics.
- Road traffic data from toll payment systems, traffic loops and webcams have been used by national statistical institutes in Finland and the Netherlands for producing transport and traffic statistics.

A wide variety of applications of big data for official statistics, some particularly related to human development themes, have come from the Global Pulse Initiative[19] of the former UN Secretary-General, Ban Ki-moon. It promotes the discovery, development and adoption of big data innovations for sustainable development and humanitarian action. The repository of Global Pulse projects contains examples in climate and resilience, data privacy and protection, economic well-being, food and agriculture, gender, humanitarian action, public health, real-time evaluation and the SDGs.

A typical project is "Estimating Migration Flows Using Online Search Data,"[20] a study exploring whether Internet search data could be analysed to estimate migration flows and produce a proxy for migration statistics. The project demonstrates, like other Global Pulse projects, how big data can be used for estimating indicators that typically are in the portfolio of official statistics. Many projects are based on mobile phone data, e.g., "Using Mobile Phone Data and Airtime Credit Purchases to Estimate Food Security,"[21] a study that assessed the potential use of mobile phone data as a proxy for food security and poverty indicators. A white paper (UN Global Pulse 2012) has been published that discusses the potential as well as concerns and challenges raised by utilizing new digital data sources in the field of international development.

Big data that might be of particular relevance for human development monitoring are social media data. It might prove successful in measuring health issues like the prevalence of malaria and HIV as well as education and employment issues. Projects conducted by the ABS[22] and INEGI[23] in the production of labour, population and migration statistics have been mentioned above.

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[19] See footnote 15.

[20] See: www.unglobalpulse.org/projects/migration-search-data.

[21] See: www.unglobalpulse.org/projects/mobile-CDRs-food-security.

[22] See: www1.unece.org/stat/platform/display/BDI/Australia+%28ABS%29+-+Social+Linked+%28semantic%29+Data+Processing+for+Various+Statistical+Uses.

[23] See: www1.unece.org/stat/platform/display/BDI/Mexico+%28INEGI%29+-+Tweet+Analysis.

Web-scraping techniques may also prove feasible for collecting information on human development indicators. A project that used scraping data on job vacancies from enterprise websites was performed within the Sandbox Task of the UN Economic Commission for Europe (UNECE) HLG Big Data Project. A Big Data Inventory[24] provides sketches of projects conducted in the Sandbox Task. Even more comprehensive, the Platform for Innovations in Statistics (PISTA),[25] a tool provided by PARIS21, is a collection of information on innovations in official statistics, giving some 200 items in reference to the Sandbox Task and Global Pulse.

Many big data projects have indicated their potential in various areas. To investigate the feasibility of using big data for the production of human development indicators, correspondingly designed projects have to be conducted.

OBSTACLES TO THE USE OF BIG DATA IN OFFICIAL STATISTICS

Big data offer substantial advantages, such as improved timeliness of statistical products, more detailed breakdowns and improved accuracy of statistics, lower costs and a reduced response burden. Their use also involves a number of methodological issues.

- Whereas in sample surveys, the properly taken sample is representative for the target population, such a statement is not possible for big data. When mobile phone data are used for data collection, individuals who have no mobile phone will not be represented in the sample; the target population might be supposed to cover the whole population without any restriction. In data generated by social media, younger generations will be overrepresented. In general, it is even difficult to assess which population big data represent and how good the coverage is.

- Generally, statistical methods for the design and analysis of data are not applicable to big data. Quality criteria such as accuracy, bias, reliability and others need to be adapted for it.

    - Relative to a specific target population, estimates are biased if collected big data do not represent the target population.

[24] See: www1.unece.org/stat/platform/display/BDI.

[25] See: http://pista.paris21.org/.

  - The accuracy of big data-based estimates is not determined by the design of data collection as in a survey; outliers might require the application of imputation methods.

- Comparability over regions and over time certainly benefits from the generally large size of the available datasets of big data. The qualification of datasets from different regions or periods for comparison, however, has to be investigated from case to case.

These issues are related to the nature and concepts of big data. No general rules are available on how to cope with these issues, which have to be discussed in the context of specific applications. Some empirical studies are doing so. Quality issues are a key element of public trust in and the reputation of the national statistical institute. Failing to adequately address data quality issues undermines confidence in the reliability of official statistics. Kitchin (2015) discusses the risks of using big data related to reputation and trust, but also risks related to privacy, data security and other concerns.

Other issues have to do with the operation of big data, which requires national statistical institutes to meet new demands.

- New tools, in particular through information technology, are needed for handling large data amounts. These tools are specific for each of the various types of big data. Two examples are:
  - The extraction of interesting information from social media blogs has to take into account that blogs do not have a specific structure.
  - Search algorithms, e.g., in web scraping or analysing social media blogs, have to be based on semantics.
- To handle big data, national statistical institute staff need new skills in areas like data engineering, data warehousing, high-performance computing and others.

An example can illustrate the complexity of the tools for coping with big data and the involved challenges. A widely used method for collecting big data is web scraping. The corresponding software tools allow automated processes that gather specific data from the web and copy them into a database for later retrieval or analysis. Quite a number of software tools have been developed, e.g., cURL and Data Toolbar, the latter being an add-on to standard browsers. Amazon Web Services and Google provide web scraping tools and services free of cost.

Each big data project has its own characteristics in terms of the nature and type of data, the necessary statistical methodology, the algorithms for computations, the IT-tools, the assessment of the statistical output, etc. National statistical institutes have to develop expertise within their staff or

find experts from outside to conduct studies and acquire experience in related big data methods. Necessary investments and efforts are substantial, and come with the risk that not all studies will result in feasible methods of using big data. Further issues relate to legal dimensions, such as legislation on personal data protection. Potential conflicts between monitoring human development and human rights need to be scrutinized.

The use of big data for human development monitoring certainly will play a role in the future, and has the potential to enhance the availability and quality of indicators. Big data already exist, and there are hardly reasons not to investigate how they can be used for human development monitoring. One step should be a systematic check on whether statistical open data websites contain suitable indicators for HDI construction. As in the UNECE HLG Big Data Project and in the Global Pulse Initiative, an infrastructure should be provided for conducting national or supranational projects and studies in the use of big data, sponsored by the UNSD or the Human Development Report Office, or the competent data-gathering agencies. At a later stage, results and experiences from such studies should be available for the national statistical institutes of all countries, which will help them get involved in the use of big data at much lower costs.

NEW TOOLS FOR DISSEMINATION AND VISUALIZATION

The Human Development Reports are a rich source of information. Yet the effect on political and societal reality is not least determined by how the results of human development monitoring are disseminated. The presentation of the Human Development Report through global, regional and national events is an excellent means to draw the attention of politicians, media and the general public. Further, with the Internet becoming the main distribution channel for official statistics, UNDP has sites on Facebook and Twitter to efficiently reach certain audiences such as younger people.

Serving the public via social media requires adapting presentation. The Internet has given a big boost to interactive and animated visualization, with a well-known example being Gapminder.[26] This visualization tool produces so-called bubble charts that are an example of dynamic graphics that improve the communication of statistical output. The charts show an animated picture of the relation between several indicators, such as income (x-axis) and life expectancy at birth (y-axis), supplemented with additional related information. Each country is represented by a bubble or circle, the area of the bubble indicating the population size, and the colour of the bubble indicating where the country is located. Diagrams have a time axis going from 1800 until 2015. They can be displayed for each year or

[26] See: www.gapminder.org.

sequenced as a video. Interactivity means that the user has the opportunity to customize the diagram, e.g., by selecting data or choosing the diagram type.

The strength of dynamic graphics in communicating complex relations becomes evident on the Internet. Options to present human development results using innovative visualizations should be investigated for their suitability to serve certain user groups. De Jonge (2012) gives an overview of techniques for diagrams and maps to communicate statistical data.

Human Development Reports might be used as the basis for in-depth analyses by research institutions and academia or in cooperation with them. The panel character of human development data allows answers to even complex questions that combine comparisons with the dynamics of development. Increased and well-planned cooperation between the Human Development Report Office and research institutions could be geared towards not only increasing the efficiency of human development monitoring, but also improving dynamic visualizations of results.

Concluding remarks: Ways to improve human development monitoring

Ambitions to improve human development monitoring focus first of all on the database for the assessment of human development. The fact that human development dimensions are changing, in particular due to new and emerging aspects of development, indicates that the composition of the indicators needs to be considered and checked for adaptation. This paper gives an outlook on potential measures that may enhance statistical capacity at the national and international levels, and improve the effectiveness of human development monitoring, referring to conceptual issues in the context of data availability and potential extensions of monitoring.

The first step of the analysis for this paper was to scrutinize the database of the Human Development Reports 2015 and 2016. This gives a good picture of the availability of indicators. Based on the information at hand, no further assessment of the quality of data is possible. Results include the identification of quite a number of indicators with missing data for larger portions of countries. Indicators with substantial portions of countries for which only modified values are reported are rather the exception.

The second step was the analysis of options for improving the indicators and transparency in the derivation of the HDI and the related human development tables. Potentials for such improvements may be found in:

- Adopting alternative data sources such as big data as well as data from administrative sources;
- Increasing the statistical capacities of national statistical authorities; and
- Documentation of statistical processes on all levels of the production of human development indicators and the Human Development Report.

For the documentation of statistical processes, a standardized metadata format, e.g., within the SDMX framework, should be used. Such comprehensive documentation would be an important step towards transparency and improved quality of the HDI and related tables. Progress in reporting human development, e.g., the trajectory of (hopefully decreasing) portions of countries for which certain indicators are not reported, should also systematically be documented. This would allow analysis of needs and ways for redesigning policies and strategies to fill gaps.

With respect to human development reporting, the search for and test of alternative indicators that could be substituted for problematic indicators is recommended. Big data have promise for developing such alternative indicators, although this is clearly extremely challenging in terms of developing statistical methodologies and work. Big data initiatives for investigating candidate indicators should be supported; the provision of infrastructure for conducting big data projects would be a suitable measure. Some SDG indicators might be seen as candidates for alternative indicators.

Additional indicators are needed when human development monitoring focuses on new aspects of human development. This paper deals with the issue of disaggregation with respect to gender and age groups. Given sufficient amounts of data, i.e., data from enough countries, corresponding human development tables can be produced. Plans to take into account new dimensions in human development monitoring trigger questions around how to identify dimensions that are the determinants of human development. The change in the concept of the Human Development Report with respect to environmental and sustainability issues from 2015 to 2016 also suggests this question.

For the statistician, there might be an empirical answer. If the HDI is a valid measure of human development, the strength of the relation between an indicator and the index might be considered a suitable means to decide whether the dimension represented by the indicator is a determinant of human development. Of course, such a statistical approach is not the only way to design a report on human development. More theory-based approaches have the advantage that they are not affected by data limitations. In the context of Dashboard 2 (Sustainable development) in the *Human Development*

Report 2016, correlations and partial correlations could be used as measures to assess whether the factors represented by these indicators actually are related in a significant way to human development. Bi- and multivariate analyses show strong relations between the indicators of sustainable development and the HDI, but do not give a clear picture. Nevertheless, it might be helpful to report from time to time on the results from analysing the relations between the HDI and indicators of suspected and actually used human development dimensions. Changes in the Human Development Report, e.g., provision of a new human development table, might be explained by quantitative measures, in addition to other arguments.

In sum, the application of measures and ideas discussed in this paper might help to improve the database of Human Development Reports and enhance the statistical process of human development monitoring.

Appendix 1: *Human Development Report 2016*, list of tables

Appendix 1 shows a list of the 15 human development tables and 2 dashboards in the Statistical Annex of the *Human Development Report 2016,* with a short summary of each. The tables provide an overview of key aspects of human development. The first six tables contain the family of composite human development indices and their components. The remaining tables present a broader set of indicators related to human development. The two dashboards introduce partial groupings of countries according to their performance on each indicator.

Tables of core indicators

Table 1, Human Development Index and its components

Table 2, Human Development Index trends, 1990–2015: provides short time series of HDIs, changes in HDI ranks, and average annual HDI growth rates.

Table 3, Inequality-adjusted Human Development Index: provides the loss in HDI due to inequality, the coefficient of human inequality, the difference in rank on the HDI and the IHDI, and three measures of income inequality including the Gini coefficient.

Table 4, Gender Development Index: measures disparities in the HDI by gender; the ratio between HDI values is estimated separately for women and men; values for the three HDI components—longevity, education (with two indicators) and income—are presented by gender.

Table 5, Gender Inequality Index: a composite measure of gender inequality using the dimensions of reproductive health, empowerment and labour.

Table 6, Multidimensional Poverty Index: developing countries: reports the MPI, capturing the population in multidimensional poverty; the population near and in severe multidimensional poverty; the contributions of deprivations in education, health and living standards to overall poverty; and two measures of income poverty.

Tables of human development–related indicators

Table 7, Population trends: major population indicators including total population and subgroups of population, population growth, median age, dependency ratios and fertility rates.

Table 8, Health outcomes: indicators of infant health and mortality, of adult health like deaths due to HIV and malaria, HIV prevalence and quality of health care.

Table 9, Education achievements: presents standard education indicators, literacy, enrolment, dropout, education quality and government expenditure on education.

Table 10, National income and composition of resources: macroeconomic indicators such as GDP, gross fixed capital formation and government final consumption expenditure; taxes on income, profits and capital gain; indicators of debt and inflation.

Table 11, Work and employment: indicators on employment, unemployment, child labour, working poor and employer-related social security.

Table 12, Human security: percentage of registered births; numbers of refugees, displaced persons, people homeless due to natural disasters, orphaned children and prisoners; indicators on homicide, suicide and violence against women; and depth of food deficit.

Table 13, International integration: indicators of globalization: international trade, foreign direct investment and private capital, official development assistance and remittances; indicators of human mobility such as migration rate, stock of immigrants, students from abroad and inbound tourists; indicators of communication such as use of Internet and mobile phone subscriptions.

Table 14, Supplementary indicators: perceptions of well-being: indicators that reflect individuals' perceptions of relevant dimensions of human development: quality of education, quality of health care, standard of living and labour market, personal safety, satisfaction with freedom of choice and life; indicators reflecting perceptions of government: judicial system and trust in the government.

Table 15, Status of fundamental human rights treaties: dates when countries ratified key human rights conventions.

Dashboard 1, Life-course gender gap: indicators of gender gaps over the life course: health, education, labour market and work, leadership, seats in parliament and social protection.

Dashboard 2, Sustainable development: indicators of environmental, economic and social sustainable development; renewable energy consumption; carbon dioxide emissions; natural resource depletion; national savings; external debt stock; government spending on R&D, diversity of the economy; changes in income and gender inequality; and dependency ratio.

Annex 2

Table A1: For tables in the Statistical Annex of the *Human Development Report 2016,* the number of indicators in each table in total; among them, those calculated by the Human Development Report Office, and the main data providers

Table/ dashboard	Content	# of indicators		Main data providers
		Total	Human Development Report Office	
1	Human Development Index and its components	7	2	UNDESA, UNESCO, Word Bank
2	Human Development Index trends, 1990-2015	13	13	
3	Inequality-adjusted HDI	14	12	UNDESA, Word Bank, various surveys
4	Gender Development Index	12	2	UNDESA
5	Gender Inequality Index	9	2	UNDESA, UNESCO, ILO
6	Multidimensional Poverty Index: developing countries	12	1	Household surveys
7	Population trends	13	0	UNDESA
8	Health outcomes	14	0	UNICEF, WHO, World Bank, UNDESA
9	Education achievements	12	0	UNESCO, World Bank
10	National income and composition of resources	12	0	World Bank, FAO
11	Work and employment	12	0	ILO, UNICEF, World Bank
12	Human security	14	0	UNICEF, WHO, FAO, UNODC
13	International integration	12	0	World Bank, UNDESA
14	Supplementary indicators: perceptions of well-being	14	0	Gallup
15	Status of fundamental human rights treaties			
DB1	Life-course gender gap	14	0	UNDESA, UNESCO, ILO, World Bank
DB2	Sustainable development	15	2	World Bank, FAO, UNDESA
		199	34	

Table A2: Data providers for Tables 1 to 6 of the Human Development Report

Table	UNDESA	UNESCO	UNSD	World Bank	IMF	Barro & Lee	ILO	UNICEF	ICF	UN MMEG	IPU
1	y	y	y	y	y	y		y	y		
2	y	y	y	y	y	y					
3	y	y	y	y	y	y			y		
4	y	y		y	y	y	y	y	y		
5	y	y					y			y	y
6				y							

Table A3: For Tables 2 to 6, the main data providers, number of indicators the agency delivered (# ind's) and average portion of countries (average % C) for which the indicators are not reported

Agency	# ind's	Average % C
UNDESA	4	2.7
UNESCO	6	9.0
World Bank	5	19.2
ILO	2	5.9

Table A4: For Tables 7 to 14 and the dashboards, the main data providers, number of indicators the agency delivered (# ind's) and average portion of countries (average % C) for which the indicators are not reported

Agency	# ind's	Average % C
UNDESA	20	2.2
UNESCO	15	16.1
UNICEF	11	27.6
WHO	8	16.0
World Bank	27	14.6
FAO	3	28.7
ILO	14	23.3

Table A5: For Tables 3 to 5, indicators that are not reported for 10 percent of the countries or more, together with the main data provider and the actual percentage of countries (% C) for which the indicator is not reported

Table	Indicator		Source	% C
3	2	Inequality-adjusted HDI, value	Various	19.7
3	5	Coefficient of hum.inequality	Various	19.7
3	9	Inequality-adjusted education index	Various	16.0
3	10	Inequality in income	Various	18.1
3	12	Income inequality: quintile ratio	World Bank	23.9
3	13	Income inequality: Palma ratio	World Bank	23.9
3	14	Income inequality: Gini coefficient	World Bank	23.9
4	1	Gender Development Index, value	Various	14.9
4	3	HDI_female	Various	14.9
4	4	HDI_male	Various	14.9
4	9	Mean years of schooling, female	UNESCO	10.1
4	10	Mean years of schooling, male	UNESCO	10.1
5	1	Gender Inequality Index, value	Various	15.4
5	6	Population with at least some secondary education, % >25, female	UNESCO	13.3
5	7	Population with at least some secondary education, % >25, male	UNESCO	13.3

Table A6: For Tables 7 to 14 and the dashboards, indicators that are not reported for portions of countries higher than 40 percent

Table	Indicator		Source	% C
8	9	Death due to malaria, p 100T	WHO	50.0
8	11	HIV prevalence, % 15-49	WHO	44.1
11	7	Unemployment, youth not in school or empl., % 15-24	ILO	44.7
11	9	Child labour, % of 5-14y	UNICEF	41.0
11	10	Performance of 15-y-old students, science	ILO	41.5
12	3	Internally displaced persons, #	IDMC	73.4
12	5	Orphaned children, #	UNICEF	78.7
12	10	Justification of wife-beating, female	UNICEF	42.6
12	11	Justification of wife-beating, male	UNICEF	66.0
12	12	Violence against women, ever, intimate partner	UN Women	50.5
12	13	Violence against women, ever, non-intimate partner	UN Women	68.6
DB1	10	Adulthood: paid employment in non-agri., female, %	ILO	43.1
DB1	14	Older age: old-age pension recipients, female/male	ILO	58.5
DB2	12	Social sustainability: income quintile ratio, av. an. change, %	World Bank	48.9
DB2	14	Social sustainability: pop. in mul. dim pov., av. an. change, %	Various	66.5

Table A7: For the tables and dashboards, the number of indicators, as well as the average portions of countries (% C) for which the indicators are not reported and countries (% D) for which modified indicators are reported

Table	# ind's	Average % C	Average % D
1	4	0.0	19.8
3	13	17.2	8.4
4	12	9.0	11.8
5	9	8.5	5.5
6	12	14.6	15.1
7	14	2.2	6.2
8	14	13.7	9.6
9	15	17.3	16.5
10	14	16.3	5.6
11	15	21.7	15.4
12	14	27.5	6.8
13	11	8.1	7.2
14	12	21.2	0.0
DB1	14	15.0	2.7
DB2	10	20.4	0.5

Table A8: For the tables and dashboards, the main data providers, the number of indicators the agency delivered (# ind's), and the average portion of countries (average % D) for which modified indicators are reported

Agency	# ind's	Average % D	Human dev. dimension
UNDESA	25	4.2	Population issues
UNESCO	21	8.2	Education
UNICEF	11	10.4	Children's affairs
WHO	8	1.7	Health
WB	33	2.4	Income and consumption
FAO	3	0.2	Nutrition issues
ILO	14	0.6	Employment

Table A9: Indicators with the highest portions of countries for which the indicators are reported in modified form, showing the table, data provider and portion of countries (% D)

Table	Indicator		Source	% D
1	3	Expected years of schooling	UNESCO	14.9
1	4	Mean years of schooling	UNESCO	56.4
3	12	Income inequality: quintile ratio	World Bank	17.0
3	13	Income inequality: Palma ratio	World Bank	17.0
3	14	Income inequality: Gini coefficient	World Bank	16.5
4	9	Mean years of schooling, female	UNESCO	45.2
4	10	Mean years of schooling, male	UNESCO	45.2
5	6	Population with at least some secondary education, % >25, female	UNESCO	17.0
5	7	Population with at least some secondary education, % >25, male	UNESCO	17.0
6	2	MPI, Human Development Report Office definition, index	Household surveys	18.2
6	3	MPI, Human Development Report Office definition, % pop	Household surveys	18.2
6	...	...	Household surveys	18.2
6	10	Contribution of Living Std, %	Household surveys	18.2
8	1	Infants exclusively breastfed	UNICEF	19.1
8	4	Child malnutrition, stunting, % <5	UNICEF	18.1
9	4	Population with at least some secondary education, % >25	UNESCO	16.5
11	9	Work is risk, child labour, % of 5-14y	UNICEF	37.8
12	1	Birth registration, % <5y	UNICEF	20.2
12	10	Justification of wife-beating, female	UN Women	12.2

Table A10: For the various data-gathering agencies, the number of indicators in Tables A5 and A6 (not reporting countries) and A9 (modified version of the indicator reported) and the average portion of countries as well as the number of indicators provided

		Indicators of tables				
		A5 and A6		A9		
Agency	# ind's	# ind's	Av. %	# ind's	Av. %	Human development dimension
UNDESA	24	0		0		Population issues
UNESCO	21	4	11.7	7	30.3	Education
UNICEF	11	4	57.1	4	23.8	Children's affairs
WHO	8	1	47.1	0		Health
World Bank	32	3	23.9	3	16.8	Income and consumption
FAO	3	0		0		Nutrition issues
ILO	14	4	46.9	0		Employment

Appendix 3: The basic indicators of the Human Development Index

The definitions of the basic indicators of the HDI are:

Life expectancy at birth: Number of years a newborn infant could expect to live if prevailing patterns of age-specific mortality rates at the time of birth stay the same throughout the infant's life.

Expected years of schooling: Number of years of schooling that a child of school entrance age can expect to receive if prevailing patterns of age-specific enrolment rates persist throughout the child's life.

Mean years of schooling: Average number of years of education received by people aged 25 and older, converted from education attainment levels using official durations of each level.

Gross national income (GNI) per capita: Aggregate income of an economy generated by its production and its ownership of factors of production, less the incomes paid for the use of factors of production owned by the rest of the world, converted to international dollars using PPP rates, divided by midyear population.

A concise description of the HDI and its calculation is given in UNDP (2017). The Human Development Report Office calculations are based on data from UNDESA (2015), the UNESCO Institute for Statistics (2016), the UNSD (2016), the World Bank (2016), Barro and Lee (2016) and IMF (2016).

Appendix 4: Tables 1 to 6 and the availability of indicators

For each human development table, the indicators are listed. Availability of the indicators is described in columns B to D:

- B Number of countries for which the indicator is reported, based on data delivered from international data-gathering agencies like UNDESA, UNESCO, the World Bank, etc.;
- C Number of countries for which the indicator is not reported; and
- D Number of countries for which the indicator is reported in modified or adjusted form.

An "x" in column A means that the indicator is calculated by the Human Development Report Office on the basis of provided data.

Table 1 Human Development Index and its components

Indicator		A	B	C	D	Agency	% C	% D
1 HDI		x	188					
2 LE_B	Life expectancy at birth		188	0	6	UNDESA		3.2
3 EYS	Expected years of schooling		188	0	28	UNESCO		14.9
4 MYS	Mean years of schooling		188	0	108	UNESCO		56.4
5 GNI_pc	GNI per capita		188	0	9	World Bank		4.8
6 r(GNI_pc)-r(HDI)	GNI per capita rank minus HDI rank	x	188					
7 r(HDI)		x	188					
	Average				37.3			19.8

Table 3 Inequality-adjusted Human Development Index

Indicator		A	B	C	D	Agency	% C	% D
1 HDI		x						
2 IHDI_V	Inequ.adj.HDI, value	x	151	37			19.7	
3 IHDI_L	Inequ.adj.HDI, loss, %	x	151	37			19.7	
4 IHDI_DR	Inequ.adj.HDI, diff in rank	x	151	37			19.7	
5 C_Hineq	Coefficient of hum.inequality	x	151	37			19.7	
6 InEq_LE	Inequ.life expectancy		183	5	0	UNDESA	2.7	0.0
7 InAdj_LE_I	Inequ.adjusted life expectancy index	x	183	5			2.7	
8 IeEq_Ed	Inequ.in education		158	30	0	Various	16.0	0.0
9 InAdj_Ed_I	Inequ.adjusted education index	x	158	30			16.0	
10 IeEq_In	Inequ.in income		154	34	0	Various	18.1	0.0
11 InAdj_In_I	Inequ.adjusted income index	x	154	34			18.1	
12 IncI_QR	Income inequality: quintile ratio	x	143	45	32	World Bank	23.9	17.0
13 IncI_PR	Income inequality: Palma ratio	x	143	45	32	World Bank	23.9	17.0
14 IncI_Gi	Income inequality: Gini coefficient		143	45	31	World Bank	23.9	16.5
	Average			32.4	15.8		17.2	8.4

Table 4 Gender Development Index

Indicator		A	B	C	D	Agency	% C	% D

1	GDI_V	Gender development index, value	x	160	28			14.9	
2	GDI_G	Gender development index, group	x	160	28			14.9	
3	HDI_f	HDI_female		160	28	0	Various	14.9	0.0
4	HDI_m	HDI_male		160	28	0	Various	14.9	0.0
5	LE_B_f	Life expectancy at birth, female		183	5	0	UNDESA	2.7	0.0
6	LE_B_m	Life expectancy at birth, male		183	5	0	UNDESA	2.7	0.0
7	EYS_f	Expected years of schooling, femal		177	11	12	UNESCO	5.9	6.4
8	EYS_m	Expected years of schooling, male		177	11	11	UNESCO	5.9	5.9
9	MYS_f	Mean years of schooling, female		169	19	85	UNESCO	10.1	45.2
10	MYS_m	Mean years of schooling, male		169	19	85	UNESCO	10.1	45.2
11	E_GNI_f	Est.GNI_pc_female	x	177	11	0	Various	5.9	0.0
12	E_GNI_m	Est.GNI_pc_male	x	177	11	7	Various	5.9	3.7
		Average			17	22.2		9.0	11.8

Table 5 Gender Inequality Index

Indicator			A	B	C	D	Agency	% C	% D
1	GII_V	Gender Inequality Index, value	x	159	29		Various	15.4	
2	r(GII)		x	159	29			15.4	
3	MM_r	Maternal mortality ratio		180	8	0		4.3	0.0
4	ABR	Adolescent birth rate		183	5	0	UNDESA	2.7	0.0
5	Sparl	Share of seats in parliament		185	3	9	IPU	1.6	4.8
6	Pop_2Ef	Population with at least some secondary education, % >25, female		163	25	32	UNESCO	13.3	17.0
7	Pop_2Em	Population with at least some secondary education, % >25, male		163	25	32	UNESCO	13.3	17.0
8	LF_p_f	Labour force participation rate, female, % 15+		178	10	0	ILO	5.3	0.0
9	LF_p_m	Labour force participation rate, male, % 15+		178	10	0	ILO	5.3	0.0
		Average			16	10.4		8.5	5.5

Table 6 Multidimensional Poverty Index: developing countries

Indicator			A	B	C	D	Agency	% C	% D
1	YS	Year and survey		102					
2	PI_H_I	MPI, Human Development Report Office def., index		102	0	18			18.2
3	PI_H_p	MPI, Human Development Report Office def., % pop		102	0	18			18.2
4	PI_H_I	MPI, Alkire Robles def, index		102	0	18			18.2
5	PI_H_p	MPI, Alkire Robles def, % pop		102	0	18			18.2
6	MP_T	Mult.poverty, p T		102	0	18			18.2
7	MP_Int	Mult.poverty, Intensity, %		102	0	18			18.2

8	MP_near	Pop near mult.poverty, %	102	0	18			18.2
9	MP_sev	Pop in severe mult.poverty, %	102	0	18			18.2
10	C_MP_Ed	Contribution of educ depriv, %	102	0	18			18.2
11	C_MP_He	Contribution of health depriv, %	102	0	18			18.2
12	C_MP_In	Contribution of educ depriv, %	102	0	18			18.2
13	P_bPl	Pop living below national income poverty line, %	90	12	1	World Bank	12.1	1.0
14	P_b125	Pop living below 1.25 PPP$, %	85	17	1	World Bank	17.2	1.0
		Average		2.4	14.9		14,6	15.1

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