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Francisco Iván Hernández-Cuevas,
Norma Elena Pérez-Herrera, Javier Becerril-García,
Javier Humberto Perera-Rios & Allan Sosa

Footwear industry, and plastic recycling:

a case of circular economy and green jobs in Yucatán, México

The International Center for Development and Decent Work

Francisco Iván Hernández Cuevas. He holds a Ph.D. in social science from Universidad Autónoma de Yucatán (UADY). He has been part of CONACYT'S post-doctoral program 2020-2021 at the Medicine Faculty-UADY. He is a Ph.D. associate at the International Center for Development and Decent Work (ICDD) of the Kassel University, Germany. His areas of interest are sustainable rural development, green economics, and environmental economics.

Norma Elena Pérez Herrera. She holds a Ph.D. in toxicology from CINVESTAV-IPN, Mexico City. She is a research professor at the Medicine Faculty at Universidad Autónoma de Yucatán (UADY). She has developed research and incidence projects in communities on the risk of occupational health damages by exposure to toxic substances. She is responsible for the Laboratory of Chronic and Degenerative Diseases at the Inter-Agency Clinical and Epidemiological Research Unit of the Faculty of Medicine of the UADY.

Javier Becerril García. He holds a Ph.D. in agriculture economy from Kiel University, Germany. He is a research professor at the Economy School at Universidad Autónoma de Yucatán (UADY). He chairs the Climate Fund of the Yucatán Peninsula 2016-2020 and coordinates UADY's graduate research and liaison 2015-2018. His area of interest is economic impact evaluation.

Javier Humberto Perera-Rios. He holds a master's in health research from Institutional Postgraduate in Health Sciences at Universidad Autónoma de Yucatán. Academic Technician, Faculty of Medicine, UADY. His lines of research: environmental and population toxicology, and public health. He is an active member of the Mexican Society of Toxicology, Academic Group in Public Health, Faculty of Medicine, UADY and Thematic Networks CONACYT, Mexico, Children's Environmental Health and Pesticide Toxicology.

Allan Sosa. He is the CEO of the plastic recycler in Ticul. He has more than ten years of experience in the field of recycling and recovery of plastic waste.

Contact Address
Prof. Dr. Christoph Scherrer
ICDD – University of Kassel, Germany
Mailing address: Mönchebergstr. 19, D-34109 Kassel
Visitors' address: Kleine Rosenstr. 3, D-34117 Kassel
Contact: management@icdd.uni-kassel.de

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Francisco Iván Hernández-Cuevas[1],
Norma Elena Pérez-Herrera[2], Javier Becerril-García[3],
Javier Humberto Perera-Rios[4] & Allan Sosa[5]

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1 Posdoc CONACYT-Universidad Autónoma de Yucatán; ivan.hernandez@correo.uady.mx
2 Medicine Faculty, Universidad Autónoma de Yucatán; norma.perez@correo.uady.mx
3 Economics Faculty, Universidad Autónoma de Yucatán; javier.becerril@correo.uady.mx
4 Medicine Faculty, Universidad Autónoma de Yucatán; javier.perera@correo.uady.mx
5 CEO recycle factory in Ticul, México; preacabadosticul@gmail.com

Contents

Abstract

The social and economic dynamics in Ticul municipality in Yucatán is based on labor-intensive and low-tech pottery and shoe manufacturing, contributing thereby 55% of the municipality's total gross production. Despite its economic importance and employment, there are no environmental policies focused on these economic activities in the community, which has led to environmental, social, health problems in children and concerns of hazardous waste. The article's objective is to document a successful case of a plastics recycler through a mixed-methods approach that allows identifying a critical path for promoting activities in favor of a circular economy and the generation of green jobs in the municipality. The result was higher than 70 per cent in the green employment index. The green employment generated in the plastic recycler in Ticul, Yucatán is considered to be an adequate performance in decent work. Even though the work carried out in the recycler cannot mitigate the waste and toxic substances generated by the manufacture of shoes, this study enables us to conclude that the promotion of such recycling activities facilitates the employment of a more significant number of people to jobs with less precariousness and exposure to toxic substances, therefore, ensuring their better occupational health, as well as reducing negative impacts on the environment.

Keywords: circular economy, environmental health, decent work, toxicity, green jobs

JEL Classification: I15, I18, J01, Q01

1 Introduction

Nature and ecosystems have always been a part of the development of civilizations. However, in the Anthropocene, human beings have become a force for global and geological transformation (Svampa, 2018). The effects of the Anthropocene are visualized in multiple aspects: the commodification of nature and the close relationship between economic growth and environmental degradation.

> *In Mexico, economic growth, the use, and depletion of ecosystem services have been unusual and intense in certain territories. Mexico comprises regions and territories, well identified as industrial, service, and commercial development poles, along with other less industrialized areas. At the state level, the pattern behaves similarly, with high concentration human settlements and the use of ecosystem services that have exceeded the permissible threshold for their recovery. Yucatán is an example, with highly concentrated and dispersed human settlements (Instituto Nacional de Estadística y Geografía, 2021B).*

In Ticul, Yucatán, there are three productive economic activities—footwear, handicrafts, and agriculture (May-Euan, 2018)—involving processes which, on the one hand, sustain the economy of the municipality while on the other hand are a source of potential exposure to chemical substances such as benzene, pesticides, and metals (Pérez-Herrera et al., 2019; Árcega-Cabrera et al., 2017; Perera-Rios et al., (2021). The sociocultural context and the conditions in which these economic activities are carried out, mainly the artisanal production of footwear, is precarious. The houses, where the shoe workshops are located, are being exposed to toxic elements that have the potential to cause harm to the environment (Pérez-Herrera et al., 2019).

There are no environmental policies focusing on the shoe industry in the municipality of Ticul. This situation has permeated at the business level, where shoe manufacturers do not have policies related to the environment and waste generated from economic activity (Parra-Argüello & Martín-Calderón, 2014).

The waste generated by the footwear industry ranges from hazardous waste such as glue, solvents, adhesives, gasoline, thinner, and alcohol as well as common waste such as synthetic material, rubber, leather, cardboard, aluminum/cans, plastic cans (Parra-Argüello & Martín-Calderón, 2014). All these wastes may not have a specific temporary disposal site (time of use) in the factory and end up in the municipal garbage dump (open-air dump[1]) (Cabañas, et al., 2010).

The main objective of economic activities is to transform raw materials into products and services. The degree of transformation attained by incorporating labor and technology (or capital) is termed as the generation of added value (VA). Within this process, waste and emissions are associated with loss and non-optimal operation of the raw material, thereby entailing additional cost. Economic impacts are also linked with costs of treatment and final disposal of the waste. The social and environmental impact they generate affects the quality of life of the communities. This is termed as negative environmental externalities (Arroyave-Rojas & Garcés-Giraldo, 2006; Azqueta, 2002).

An alternative to the above is green growth policies, which promote economic growth and development, ensuring the continuity and health of natural resources and ecosystem services (Bowen & Kuralbayeva, 2015). These policies generate green jobs, which offer adequate wages, safe working conditions, job security, respect for labor rights, and career growth, that is, decent jobs whose purpose or activity does not negatively impact the environment.

Another option compatible with green growth policies is the initiative undertaken by circular economy in response to the traditional linear manufacturing and consumption model where products are made from raw materials to be sold to the customer for use and later disposed as waste (Moreno, et.al. 2017). A circular economy focuses on rebuilding all kinds of capital (financial, manufactured, human, social, or natural) to ensure enhanced flows of goods and services to a continuous flow of technical and biological materials (Ellen MacArthur Foundation, 2021).

1 It is a final disposal site of garbage without proper management under the responsibility of the municipality. For more information please visit: www.euro.who.int/__data/assets/pdf_file/0014/240170/E73308.pdf

There is no doubt that the joint implementation of green growth and circular economy policies will increase the possibilities of achieving sustainable local development in the region, considering that it would entail low or no environmental impact while generating economic growth, as well as facilitate better labor and social conditions.

Taking the above into consideration, the objective of this document is to estimate the level of decent work attained through green jobs in a plastic recycling company in Ticul, Yucatán, where such initiatives provide alternatives to using waste generated by other economic activities and thus reducing the pressure on open waste dumps.

The document is structured as follows: Section 2 focuses on the context of urban solid waste generation in the world and Mexico; Section 3 discusses the alternative proposed by circular economy and green jobs, promoting social and economic sectors, as well as changes in the supply chain line to one by cycles, and thus maintaining balanced ecological systems; Section 4 outlines the social and economic dynamics of the municipality of Ticul as a study area. Section 5 focuses on the materials and methods used to collect and process information and subsequent analysis. Section 6 describes in detail the results obtained from the recycling process and the decency levels obtained through green initiatives in its multiple dimensions, and the potential risk of exposure to toxic substances during the manufacturing processes; Section 7 focuses on the discussion and contrast of the results obtained and delves into the context of the case study analyzed. Finally, Section 8 establishes the final reflections and recommendations according to what has been documented.

Shredded material from recycled plastic. Photo: Iván Hernández

2 Current context of the generation of urban solid waste

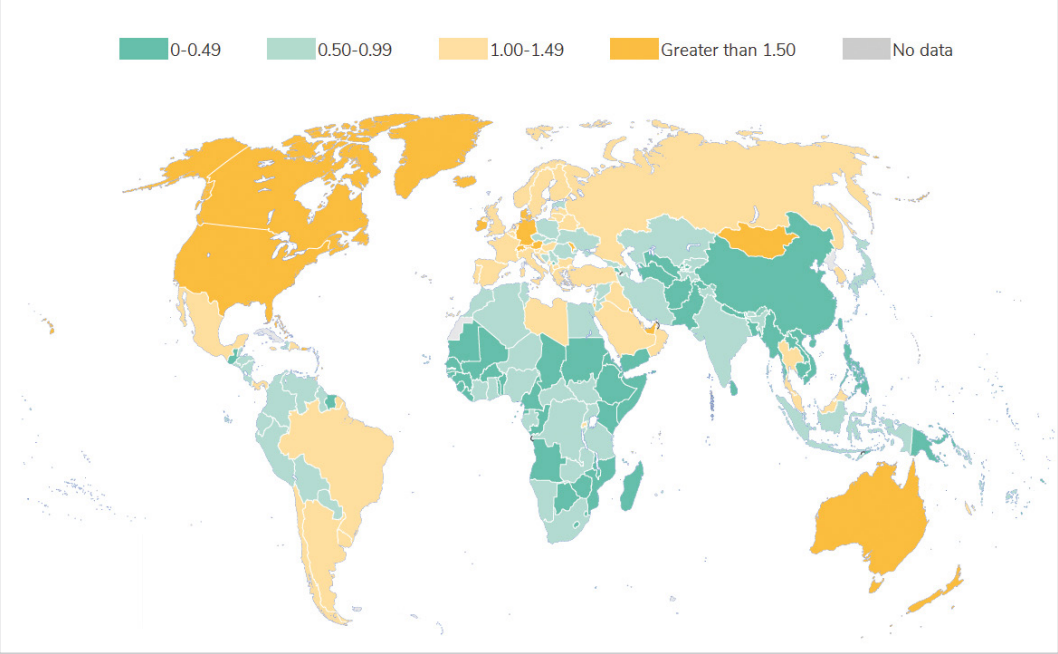
Throughout the life cycle of plastic (extraction to final disposal), different types of substances are generated: emissions (during its production process), additives (at the time of use), or microplastics as waste, which can induce adverse effects on human health as well as other species (Secretaría de Medio Ambiente y Recursos Naturales, 2020).

According to Kaza, Yao, Bhada-Tata & Van Woerden (2018), in 2016, human activities, across the globe, generated 242-million-ton plastic waste (about 12 per cent of all municipal solid waste). The above represents an estimated 1.4-billion-ton carbon dioxide equivalent (CO_2e) greenhouse gas emission (about 5 per cent of global emissions).

The authors illustrate per capita generation of waste at the country level (Fig. 1), where the regions of North America (United States of America, Canada), Oceania (Australia), Europe (Ireland and Germany), and Asia (Mongolia) register the highest volumes of waste generation per capita (exceeding 1.50 kg per day). Countries such as Argentina, Brazil, Chile, Mexico in Latin America, Russia, Saudi Arabia, Turkey in Asia and Belgium, France, Italy, Portugal, Spain, The Netherlands, and the United Kingdom in Europe registered high waste generation volumes with 1.00–1.49 kg per capita a day.

There is need to improve solid waste management in developing countries by the implementation of programs that promote reuse or recycle and carry out treatment systems to counteract environmental problems, decrease the consumption of natural resources and minimize the space required for its final disposal (Buenrostro & Bocco, 2003).

Figure 1. The annual municipal solid waste generated per capita (kg/capita/day)

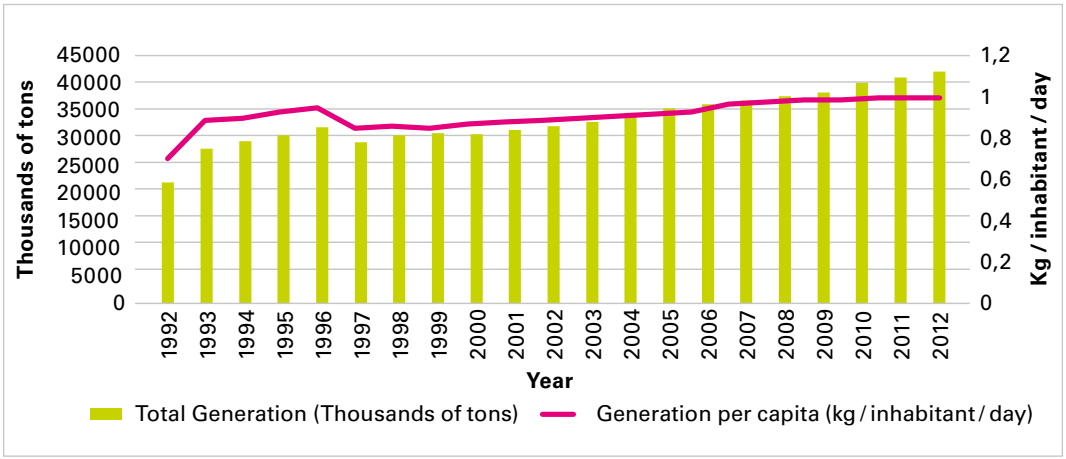


Source: Kaza, Yao, Bhada-Tata & Van Woerden, 2018.

This document focused on waste generation in southeastern Mexico, particularly Ticul, a city of the Yucatecan State. Considering this, the urban solid waste emissions records in Mexico (Fig. 2) have doubled since 1992, exceeding 40,000 ton generated annually and going from 0.6 kg per daily inhabitant to almost 1.2 kg in 2012 (Secretaría de Desarrollo Social, 2013).

The collection, transformation, and recycling of plastics strongly depend on citizen's behavior, companies practices and federal and state legislative regulation as well as infrastructure. According to the Secretaría de Medio Ambiente y Recursos Naturales (2020) report of the 32 states of Mexico, 22 have made modifications in plastic waste management, advancing the minimization of its use up to its eradication in some cases.

Figure 2. Solid waste generation in Mexico.



Source: Own elaboration based on Secretaría de Desarrollo Social (2013).

In this Mexican context, providing sanitation service through the collection and transportation of solid waste rests with the municipality (Buenrostro & Bocco, 2003). Being more specific, Article 10 of the General Law for the Prevention and Management of Waste (LGPGIR—acronym in Spanish) establishing that "The municipalities are in charge of the integral management functions of Muncipality Solid Waste (MSW), which consist of the collection, transfer, treatment, and its final disposal" (Diario Oficial de la Federación, 2014), needs to comply with Article 1 Section I of the General Law of Ecological Balance and Environmental Protection (LGEEPA—acronym in Spanish), that guarantees "the right of everyone to live in a healthy environment for their development, health and well-being". Consequently, within the LGPGIR itself, management plans have been included as mechanisms to facilitate waste management. However, certain logistic complications, poor infrastructure, and practices encourage burning at the final disposal site (Buenrostro & Bocco, 2003).

Its final disposal characterizes urban waste management, particularly management of waste in Yucatán in open-air dumps, which vary in magnitude and frequency of dumping waste, depending on the locality and its number of inhabitants. However, the practices observed at these sites are the accumulation of waste and its subsequent burning to reduce the volume in certain areas defined within the garbage dumps. This phenomenon in these scenarios is recurrent in most of the 106 municipalities of the state. Additionally, the municipality of Ticul, regarding potential sources of hazardous waste, ranks third at the state level, only behind Mérida, Valladolid, and Progreso (Cabañas, et al., 2010). Ticul's solid waste disposal site was considered one of environmental and public health risk (May-Euan, 2018).

3 Circular economy and green jobs

Economic processes and the quality of the environment influence each other in a complex way (Ruth, 1993), since the use of matter and energy provided by the climate allows the sustainability and growth of economic systems, while the production and consumption of goods and services transform matter and energy, which leads to changes in the environment.

In their interaction with nature, human social systems affect ecosystems (its structure, its dynamics, and its evolution) by appropriating natural elements (taking advantage of ecosystem services and the natural base); and the emission of residues and wastes that are generated in the process of production, transformation, distribution, consumption, and disposal (Toledo, Alarcón-Cháires & Barón, 2002).

Therefore, economic, and social development is dependent, in the long term, on adequate maintenance of the ecological systems that sustain it and that constitute the planet's natural capital; that is, the sustainability of economies is subject to the sustainability of the ecosystems that encompass them (Gómez-Baggethun & de Groot, 2007; Ruth, 1993).

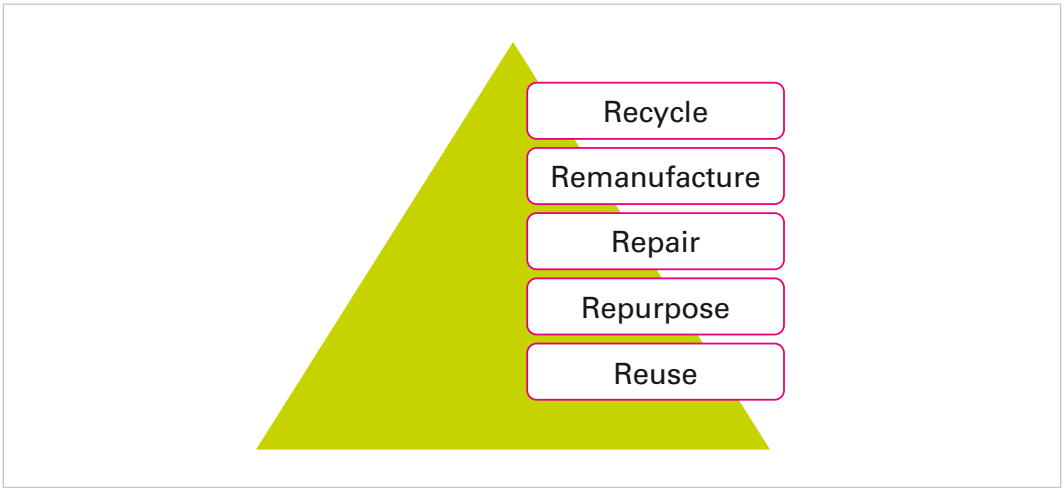
Achieving sustainable development implies incorporating new consumption patterns, forms of production, and government support to replace the linear supply chain with a cycle, or a loop chain.

One of the concepts addressed by the above is the so-called circular economy which, according to the Ellen MacArthur Foundation (2021), is based on: "the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems".

From an organizational perspective, the circular economy can contemplate four central aspects: 1. Origin: sustainable contracting, renewable energy, industrial symbiosis; 2. Use: resource efficiency, cleaner production, resource footprint; 3. Management: life cycle thinking, risk management, relationship management; 4. Design: for recycling, extended producer responsibility (Ellen MacArthur Foundation, 2021).

Even though the recycling of secondary materials proposed by UNIDO (2019) is in the last link where reuse, repair, and remanufacturing are prioritized (Fig. 3), the challenge that developing countries must face regarding the problems of solid waste makes its implementation more vital. Recycling plays an essential role in the circular economy by turning post-consumer materials into valuable substances or products, feeding used materials back into the value chain.

Figure 3. Circular economy secondary raw material hierarchy by UNIDO



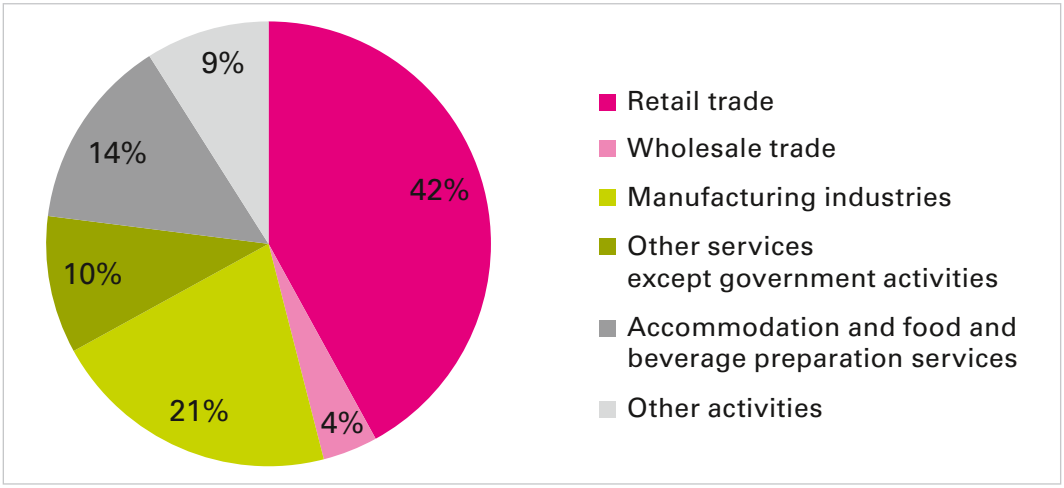
Source: Own elaboration based on UNIDO, 2019.

Now, an element that fits perfectly with the principles of the circular economy is green work. According to the ILO (2016), green jobs are decent jobs that preserve and restore the environment, whether in traditional manufacturing or construction or new emerging sectors such as renewable energy and energy efficiency. Therefore, how green jobs benefit the environment and promote decent working conditions varies.

4 The municipality of Ticul, Yucatán, and its social and economic dynamics

In Ticul, even though the most productive economic activities are manufacturing of footwear, handicrafts, and agriculture (May-Euan, 2018), there are a total of 3,110 business of which 42% of them are centered on retail trade, 21% on manufacturing activities and 14% on tourism such as restaurant and hotels (Fig. 4).

Figure 4. Economic units of Ticul (%)



Source: Own elaboration based on Instituto Nacional de Estadística y Geografía (2020).

The sociocultural context and the conditions in which these economic activities are carried out, mainly the artisanal production of footwear, involve precarious work and potential exposure to toxic substances inside the houses, where there are workshops to make shoes (Pérez-Herrera et al., 2019). Workers of the shoemaking industry do not perceive the risk of damaging human health by using paint, gas, and solvents in the footwear process. In addition, they recognize that other economic activities are the principal cause of contamination of the environment in Ticul more than residues generated during the footwear process (May-Euan, 2018).

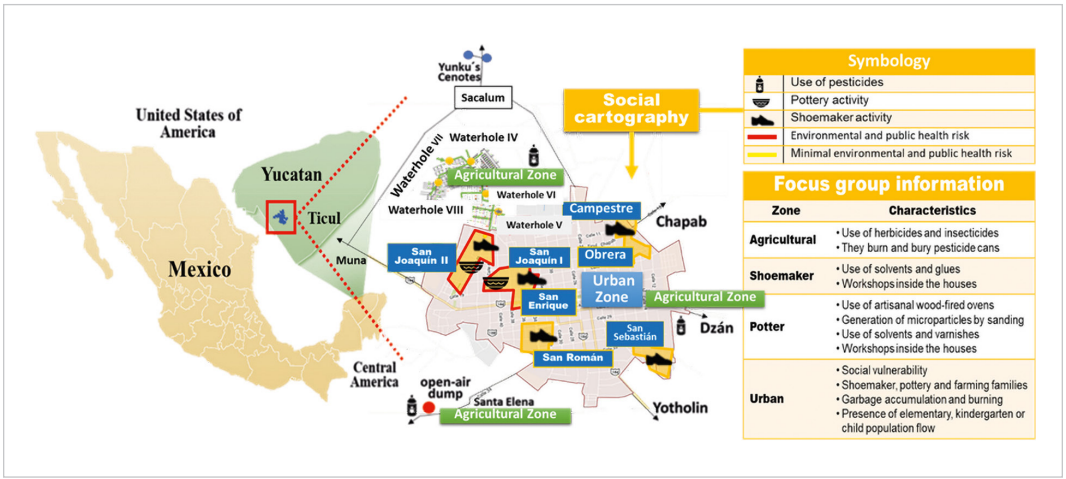
Table 1: Social and economic context, Ticul, Yucatán.

VARIABLE	VALUE
Population (2015)	
Total	40,161
Man	19,765
Women	20,435
Mayan-speaking population	
Total	15,116
Man	7532
Women	7584
The economically active population (2010)	
Total	15,435
Men	10,814
Women	4,621
Economy – Total Gross Production (millions of pesos)	
Total	1,067.54
Household (2010)	
Inhabited dwelling	9,000
House with a non-sealed floor	492
Education	
Years (average)	7.86
Marginalization	
Degree of marginalization	Medium
Health	
Population without access to health services	6,707
Men without access to health services	3,888
Women without access to health services	2,819

Source: Own elaboration based on Instituto Nacional para el Federalismo y el Desarrollo Municipal (2020).

Table 1 presents the cultural, social, and economic context of Ticul, Yucatán, as a reliable example of the relationship between economic growth and the depletion of ecosystem services. The above incorporate natural capital into manufactured capital, with clear evidence of generation of negative environmental externalities to the environment. According to the Instituto Nacional para el Federalismo y el Desarrollo Municipal (INAFED) (2020) in 2015, 40 thousand people lived in the municipality (19.8 thousand men compared to 20.4 thousand women). It is essential to underline that the city is inhabited by 15 thousand inhabitants who identify themselves as Mayan speakers[2]. The economically active population (EAP) is 15.4 thousand inhabitants. According to the same source, the average education is 7.86 years of formal education, equivalent to the intermediate unfinished secondary education level. It is pertinent to highlight, and of interest to the project proposal, that 6.7 thousand inhabitants do not have access to health services.

Figure 5. The geographical location of Ticul, social cartography, and information from focus groups of the economic activities in the region.



Source: Own elaboration, Javier Humberto Perera Rios

2 Self-determination as a Mayan-speaking person is an aspect of cultural identity in Yucatán, which is associated with the Mayan worldview: an interpretation of the world that uses a global narrative, where reality is multiple unitary totalities. In other words, it does not objectify realities but instead interprets them based on a deep meaning that they assume for humanity (Gramigna & Estrada, 2020).

5 Materials and Methods

This research is based on mixed methods. For the qualitative approach, the interpretative paradigm techniques were used in its analysis. In the first instance, from an ethnographic approach and an in-depth interview, the operation and value chain associated with the plastic recycling machine and its integration into the product's productive chain of shoe manufacturing in Ticul were identified. For quantitative aspects, we implemented an index to estimate the performance of decent work in the green jobs generated at the plastic recycler proposed by ILO (2013).

Qualitative data analysis

For the qualitative data analysis, we used the following instruments:

- Six in-depth interviews were conducted at the study site: four with the chief executive officer of the plastic recycler; one with the chief of ecology of the municipal government of Ticul and one with the representative of the National Chamber of Commerce, Services and Tourism (CANACOSERVYTUR) Ticul delegation.
- Four unrestructured interviews with small and medium shoemakers of Ticul.
- Three brief informal interviews with some workers from the recycler.

The techniques used for data analysis were speech analysis and keyword identification. All interviews were audio recorded with the informed consent and authorization of the participants. These recordings were imported into the qualitative analysis software Atlas.ti®. All the participants interviewed were from the municipality of Ticul, Yucatán.

Data triangulation was used via photographic information, participant observation in-situ, and multiple interviews with stakeholders to validate the collected data.

Quantitative data analysis

To measure the quality of the work provided by a green job by the waste recycling function it performs, we relied on the dimensions suggested by Leschke, Watt, & Finn (2008) and by the one proposed by ILO (2013); therefore, we selected the following categories:

Table 2. Categories and indicators of job performance

CATEGORIES	QUALITATIVE INDICATOR	QUANTITATIVE INDICATOR
Wage	Average monthly income higher than the minimum established by Mexican federal law.	1 = income higher than the minimum established by Mexican federal law.
Non-standard forms of employment	If the work is performed under contract	1 = if the work is performed under contract
Working time	If the work is performed exceeds 48 hours per week	1 = if the work is performed does not exceeds 48 hours per week.
Working conditions	If the work performed does not have physical work factors (vibrations, noise, high/low temperature, breathing in smoke, fumes, powder, dust, vapors such as solvents and thinners, handling chemical substances, radiation, infectious materials, tiring or painful positions, lifting or moving people, carrying, or moving heavy loads, standing, or walking, repetitive hand, or arm movements)	1 = if the work performed does not have physical work factors
Job security	if there is access to health insurance	0.50 = if there is access to health insurance
	If protective equipment exists	0.50 = if protective equipment exists
Career development	job offers good prospects for career advancement	1 = if job offers good prospects for career advancement
Collective interest representation	if there is a union or workers committee	1 = if there is a union or workers committee

Source: Own elaboration based on Leschke, Watt, & Finn (2008) and ILO (2013).

It is essential to mention that all the data were obtained qualitatively through in-depth interviews with the workers and the recycler's representative. To measure the performance of green work in the recycler, we used an index with the following structure:

Green job performance = 0.50 (Wage)
+ 0.0714 (non-standard forms of employment)
+ 0.0714 (Working time)
+ 0.0714 (Working conditions)
+ 0.0714 (Job security)
+ 0.0714 (Career development)
+ 0.0714 (Collective interest representation)

It is assigning numerical values (1, 0.5, or 0) depending on qualitative data analysis. For this green job performance index, adequate green jobs are considered if it reaches or exceeds the value of 0.70 (following the methodology proposed by ILO, 2013).

Besides the above, we decide to have a co-research approach to overcome methodological individualism with the participation of key local actors (one as co-author of this document), as well as to enrich the investigative process with the benefits identified by Barkin, Esquivel-Ayala & Ramos-Morales (2018): a better interpretation of local processes and adequate systematization of the data through more significant interaction.

Material collected from recycling. Photo: Javier Becerril

6 Results

General company information

The recycler has operated for more than five years, but informally, and only to generate inputs for the family business of trade-in supplies for footwear. The recycler has been in formal operation for approximately two years. It is important to note that the father and his son founded the recycler, but the son has managed it for itself since the last few years. The founder worked for more than 30 years in the recycling sector, and the son also operates a supplier of supplies for shoemakers.

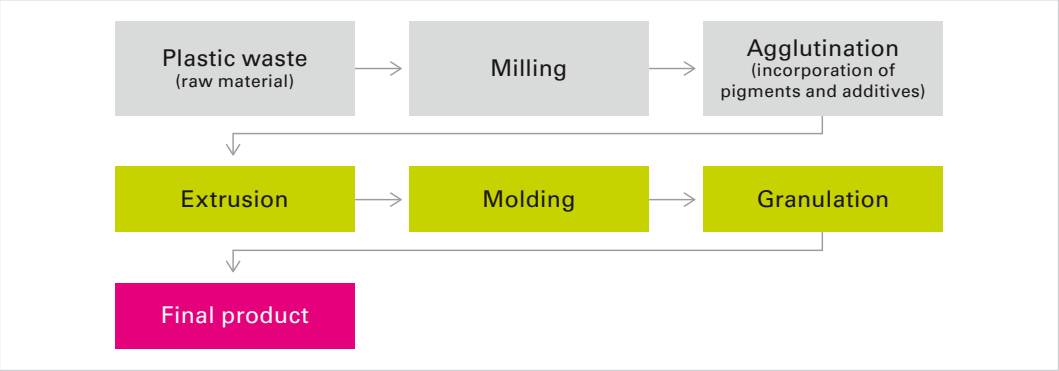
It currently operates with 17 workers spread over a single work shift. The reason for its creation was linked in the first instance, in being able to have lower costs in the inputs for the manufacture of shoes because the administrator's family is dedicated to the manufacture and marketing of footwear. In addition to the above, there was also a strong environmental commitment to help reduce pollution by solid waste.

The recycling processes

The recycling process is carried out fairly and with machinery that allows the grinding and heat pressing of the recycled plastic. Before the closure of activities due to COVID-19 mitigation measures, the recycler collected a total of 8 ton per month of plastic (Polyvinyl Chloride [PVC], Phylon, Ranil, Acrylonitrile Butadiene Styrene [ABS]), during the period of social distancing, the recycler continued operations but with a 50 per cent decrease, collecting a total of 4 ton per month.

The recycling process carried out is called primary or re-extrusion (Figure 6), also known as on-site recycling. It consists of reintroducing waste of post-industrial origin during production in the extrusion process that is carried out during manufacturing.

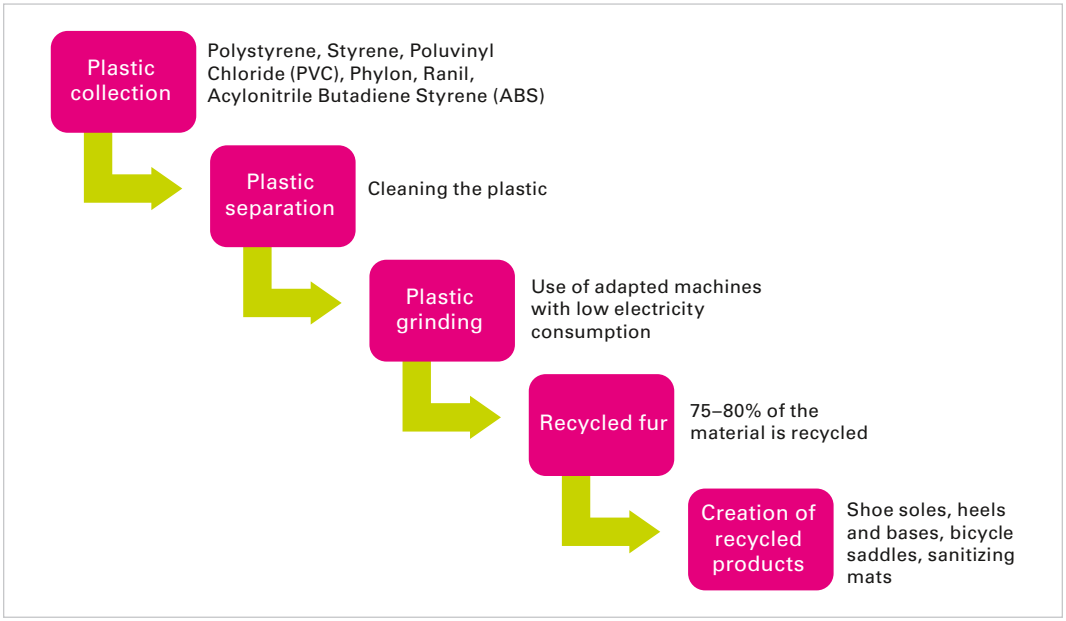
Figure 6. Primary recycling process



Source: Own elaboration based on Al-Salem et al. (2009).

In the recycling process and creating new products, approximately 75–80 per cent of the original material is recuperated; the material that can no longer be recovered is destined for the sanitary landfill. In absolute terms, approximately 200–250 kilos of plastic are an irretrievable waste of a total of one ton. It is essential to mention that the products made in the recycler are used for commercialization in such a way that they are reintegrated into the supply chain of the shoe industry. At this stage of the recycler and due to its physical characteristics, it is impossible to track the number of times that its products enter the recycling process.

Figure 7. Recycler process in Ticul, Yucatán



Source: Own elaboration based on in-depth interviews.

Measuring the decency of green work

Wage

The work scheme is under a piecework system, consisting of 100 pieces of recycled plastic with 1,000 MXN per week per worker. In Mexico and Yucatán, the legal minimum wage is 141.70 MXN per day, for a total of eight hours of work (CONASAMI, 2021). Understanding this scheme, working a full week of 40 hours would represent a total minimum wage of 708.5 MXN per five-day week. Therefore, the payment made for the minimum working day in the recycler is higher than the minimum wage of a week by 29.15 per cent.

Non-standard forms of employment and working time

The hiring scheme is via negotiation, and there is no written contract. However, the employer–worker relationship is maintained. Before COVID-19, the recycler operated 24/7 in three shifts. Now, with demand declining in the shoe manufacturing sector, the recycler operates a single 10-hour shift with a meal break.

Working conditions

The work done is manual and practically handmade. The separation, grinding, and plastic transformation are done through machines that work with electrical energy. The work area is spacious, and the equipment is available to protect the economic activity carried out and mitigate COVID-19. The workspace is covered and ventilated. Notwithstanding the preceding, the use of pressing machines represents an occupational risk.

Job security

As there is no signed contract, workers do not have social security. However, it is essential to mention that the employer offers private health insurance to all its workers. This element guarantees fast and channeled attention with treatment for any accident, illness, or health condition in workers. The situation generally takes much longer for public healthcare.

Career development

Job growth within the recycler consists of increasing tasks that involve the use of more specialized machinery. It begins with cleaning, separating the plastic after grinding, followed by pressing and quality control. Due to the size and hierarchical structure of the microenterprise, there are no heads or departments that workers can occupy for now. However, there are managers or persons in charge while the owner is not found; this denotes a reliable sign of trust in the staff.

Collective interest representation

There is no committee or collective of workers. Despite the negative scenario, in the recycler there is an openness to dialogue with the owner, where consensus is always sought between the parties involved, and the worker's needs are prioritized. The foregoing was affirmed by the business owner and the interviewed employees, who argued that it is possible to initiate a dialogue with the owner.

Workers carrying out the process of compaction of plastic by pressure and heat. Photo: Iván Hernández

Measuring the green intensity of recycling job

According to the definition and category of green work, the productive activity carried out by the plastic recycler is a green economic activity by default. Its function focuses on reducing the negative impact that society's consumption of plastic has through the second use of solid plastic waste, thus avoiding the generation of CO_2 into the atmosphere due to the disposal in the form of burning carried out at the final disposal site.

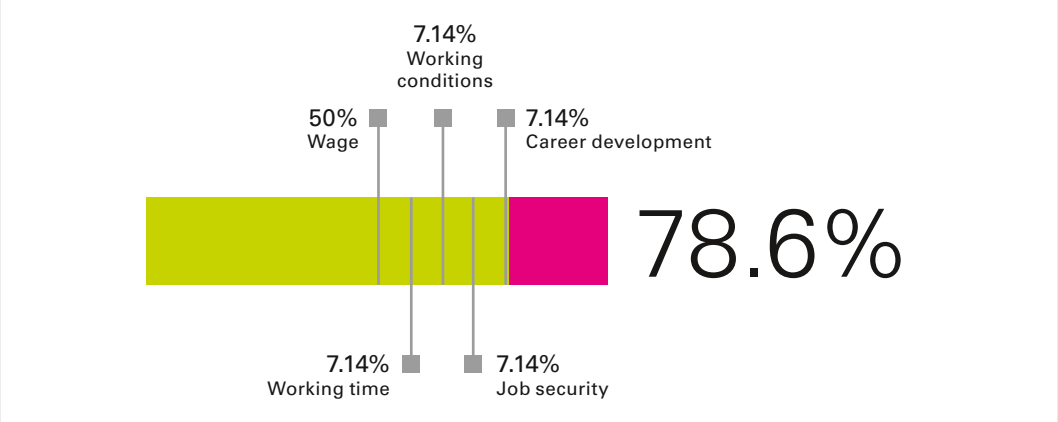
According to ILO (2013), wage represents 50% of the index's performance due to the potential impact on the development of other social elements by income. The different dimensions such as the form of employment, working time, working conditions, job security, career development, and collective labor representation were represented by 7.14% each.

Replacing qualitative analysis accordingly:

Green job performance =
0.50 (1) + 0.0714 (0) + 0.0714 (1) + 0.0714 (1) + 0.0714 (1) + 0.0714 (1) + 0.0714 (0)

Green job performance =
0.5 + 0 + 0.0714 + 0.0714 + 0.0714 + 0.0714 + 0 = **0.7856**

Figure 8. Green job performance index of the Ticul plastic recycler



Source: Own elaboration

The employment generated in the plastic recycler in Ticul, Yucatán was higher than 70 per cent in the green jobs index; this is considered an adequate performance in decent work according to the methodology used (ILO, 2013). This parameter can be used to compare with other industries/jobs in the country in terms of green jobs.

Toxic substances and potential impact on occupational health

The solvents and glues used during the manufacture of the shoes are made based on aliphatic, alicyclic, and aromatic hydrocarbons such as hexane, cyclohexane, benzene, and toluene. The latter two are considered to have a greater risk of adverse health effects, either due to acute or chronic exposure (Table 3). For example, benzene is recognized as a Group-1 carcinogen (IARC, 2012). The working day in the manufacture of shoes is approximately eight hours a day. The conditions of seclusion in the manufacturing sites and the lack of ventilation increase the risk of exposure; conversely, the inadequate disposal of waste, such as accumulation and subsequent burning, contributes to occupational exposure, enhancing toxicological effects.

Final products of the production process. Photo: Iván Hernández

Table 3. Materials and their manufacturing components, used in shoemaking and their impact on health

Products (solvents and glues)	**Sticker líder-pvc, Simón, Voch's**
Processing components	**Toluene [a] and hexane**
Group / classification	**Aliphatic and aromatic hydrocarbons**

Impact on health

[a] To the nervous system, headaches, dizziness or loss of consciousness, drowsiness, incoordination, mental disturbances, loss of vision, and hearing can become permanent with repeated exposure, especially at concentrations associated with inhalation of solvents. In the case of pregnant mothers, children might suffer from mental and growth retardation. Kidney and liver might also get affected, and on reproduction, such babies might lose consciousness and die.

Products (solvents and glues)	**Sticker líder-pu**
Processing components	**Toluene [a], benzene [b], and hexane**
Group / classification	**Aliphatic and aromatic hydrocarbons**

Impact on health

[b] Brief exposure (5 to 10 minutes) to very high levels of benzene in the air (10,000 to 20,000 ppm) can be fatal. Lower levels (700 to 3,000 ppm) can cause lethargy, dizziness, rapid heartbeat, headache, tremors, confusion, and loss of consciousness. Contact with the eyes can cause irritation and damage the cornea, decrease red blood cells, cause anemia and bleeding. The immune system might get damaged, increasing the chances of getting infections and possibly lowering the body's defenses against cancer, leukemia, acute myeloid leukemia. Alterations in irregular menstrual cycles, decrease in the size of the ovaries: delayed bone formation and bone marrow damage are other effects.

Products (solvents and glues)	**Resistol 5000**
Processing components	**Toluene [a], benzene [b], and hexane**
Group / classification	**Aliphatic and aromatic hydrocarbons**

Products (solvents and glues)	**Thinner, Gasoline**
Processing components	**Toluene [a], xylene [c], and hexane**
Group / classification	**Aliphatic and aromatic hydrocarbons**

Impact on health

[c] Animal testing can help identify health problems such as cancer or congenital disabilities. Brief exposure to high levels of these chemicals might cause irritation of the skin, eyes, nose, and throat; difficulty in breathing; impaired lung function; delayed reaction to visual stimuli; memory disturbances; stomachache; and possibly liver and kidney disease or death.

The prolonged exposures to high concentrations generate headache, lack of muscle coordination, dizziness, confusion, and loss of sense and balance. Some people briefly exposed to very high amounts of xylene died. Most of the information on the effects seen in people exposed to xylene for long periods is derived from studies of workers in manufacturing industries.

The International Agency for Research on Cancer (IARC) and the EPA have determined that there is insufficient information to determine whether xylene is carcinogenic. They consider it not classifiable as to carcinogenicity to humans.

Source: Own elaboration based on the Agency for Toxic Substances and Disease Registry [ATSDR], 2021.

7 Discussions

Plastic recycling industries are new in Mexico; in the whole country, only considering the companies that do the process of collecting waste plastics there are 2,750, and in the state of Yucatán, there is a total of 56 units (Instituto Nacional de Estadística y Geografía, 2021A). This study documents one of the first cases of an industry that is framed in terms of the circular economy by complementing the supply chain of the shoe manufacturing industry in the state of Yucatán.

The results of the green work index indicate a good result compared to the analyses carried out by ILO (2013) in the rest of the country, where only the government sector and the forest management certification sector managed to exceed the 70 per cent threshold slightly. There is a necessity to strengthen this type of activity in critical industries for sustainable development.

Being more specific in the dimensions of the green work index, the salary, despite being higher than the average national salaries, are still low and even more if they are compared with those of other countries in the American continent, both in current dollars and purchasing power parity. (Moreno-Brid, Garry & Monroy-Gómez-Franco, 2014). In this order of ideas, there are two groups of workers in the Mexican labor market: 1. those who have benefits (access to health services, vacations, the availability of a written contract, among others); 2. those who lack labor benefits and make up the largest segment, practically 50 per cent of the Mexican labor base, the vast majority of whom work in micro-businesses or small establishments (Escobar-Toledo, 2014).

This element is perceived in the case analyzed, particularly the lack of trade unions. The unions have lost strength in Mexico in the last 50 years due to a series of changes in the national labor policy focused on the existence of protection contracts (wage containment, weakening of unions, and outsourcing) that have inevitably led to a deterioration in the quality of jobs (Escobar-Toledo, 2019).

One of the most significant contrasts observed in the Mexican market and thus also in the analyzed company is based on the productivity generated, which is one of the highest in Latin America (Moreno-Brid, Garry & Monroy-Gómez-Franco, 2014). Despite the effects of COVID-19, the company has maintained its operations, which are highly demanding in the workforce.

Despite the gaps detected in the analysis of green job performance, the recycling company can serve as an example to replicate itself to more industrial sectors in the region. This can cause the promotion of the economic spillover generated by changing the linear model to a circular one of productive activities. This can be achieved if the quality of the generated jobs is not neglected.

Aerial view of recycling factory. Photo: Iván Hernández

8 Final reflections and recommendations

The use of mixed methods and a co-research approach with key actors in the study area allowed to have a more objective approach to reality, the problems they face, and how to propose alternatives improvements from them.

There is no doubt about the importance of the existence and promotion of green activities, and their potential in the generation of green jobs. The circular economy, specifically the recycling activity under Ticul, Yucatán, is shown as a viable alternative for reducing municipal solid waste that reaches the final disposal site and the generation of products that reuse this waste. It contributes towards reducing CO_2 emissions from the burning of plastic and reducing soil pollution, elements that end up affecting human and ecosystem health.

The decent work performance index within the employment generated in the plastic recycler was good. The primary gaps are the formalization of work through labor contracts, the lack of the existence of workers' committees to maintain the presence and negotiation.

In this context, synergy at the governmental, private sectors, and academic levels is also necessary to design public policies programs to promote green activities, or circular economy schemes to achieve sustainable development and meet nationally determined goals on climate change. Even though the work carried out in the recycler cannot mitigate the waste and toxic substances generated by the manufacture of shoes, the promotion of this type of activities (recycling) allows employing a more significant number of people to jobs with less precariousness, less exposure to toxic substances and therefore, better occupational health as well as reduction of negative impacts to the environment.

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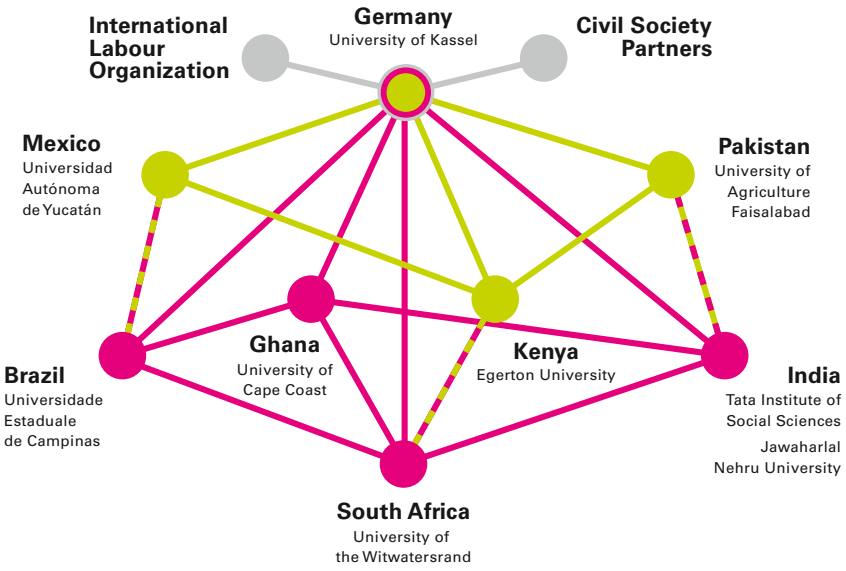

International Center for Development and Decent Work
University of Kassel, Germany
Phone: + 49 (0) 561 804-7399
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