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Learning from best practices in sustainable urbanization

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ABSTRACT

Attempts for implementing sustainable urbanization have been reported and documented around the world. These efforts have led to a vast number of exemplary sustainable urbanization practices, classified as best practices. Best practices contain valuable information in the form of experiences, and learning from them represents an opportunity to replicate successful practices in other cities. This study collected and analyzed 185 best practices in sustainable urbanization from around the world. The main areas of action, the key methods adopted and the outcomes achieved by these practices were identified. Key elements in successful sustainable urbanization strategies were found by conducting a series of association analyses between the areas of action, methods and outcomes. Findings highlight the importance of community participation, capacity building, education, partnerships and job creation in achieving urban sustainability.

1. Introduction

Urbanization is defined as the physical growth of urban areas due to the concentration of people and economic activity. It represents the most important social transformation in the history of civilization (UN-Habitat, 2004b). Urbanization has proven to be pivotal for economic growth and the wealth of nations. Bringing with it enormous benefits such as employment, education, innovation, welfare, social structures, and institutions. Today more than half the world's population lives in urban areas. It has been projected that by 2050 this figure will reach to 70% at which point 6.3 billion people will be living in cities (UNDESA, 2015). Yet rapid urbanization growth is coming at a price: environmental degradation, climate change, poverty and inequity among others. These appear to be common problems across the world due to the poor quality of urban development. It is considered that unless sustainable development principles are adopted in urbanization practices the projected urbanization growth will further compromise the sustainability of cities.

Consequently sustainable urbanization has emerged as a dynamic process that considers the various environmental, social, economic and governance factors (Mori & Yamashita, 2015; Shen, Ochoa, Shah, & Zhang, 2011; Yigitcanlar, Dur, & Dizdaroglu, 2015). According to the European Commission (2006), sustainable urbanization is defined as

the challenge to solve both the problems experienced within cities and the problems caused by cities, recognizing that cities themselves may provide many potential solutions. The concept is often characterized by issues such as the proper use of resources to guarantee generational equity, protection of the natural environment, minimal use of non-renewable resources, economic vitality and diversity, community self-reliance, individual well-being, and satisfaction of basic human needs (Choguill, 1996:; Hardoy, Miltin, &Satterhwaite, 1992). Therefore sustainable urbanization is not a simple process. It requires the consideration of all aspects of sustainability within the context of the opportunities and challenges posed by the massive scale of global urbanization. Socio-cultural factors are particularly important in defining the context that shapes the sustainable urbanization agenda of cities (Dempsey, Bramley, Sinead, & Brown, 2011).

It is argued that to move towards sustainable urbanization it is important to learn from experiences and to develop new ideas and approaches to address a wide range of concerns (Shen, Ochoa, Zhang, & Yi, 2013). Much can be learned from successful models of sustainable urbanization around the world. Previous studies confirm that learning from 'experiences in best practices' help to mirror good results, accelerate innovation and improve financial sustainability (Shen et al., 2011; UNDESA, 2010). Best practices experiences are understood as the knowledge gained from the formulation and application of strategies

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and can be used when implementing sustainable development principles in urban contexts. This knowledge gained includes the process of selection of areas of intervention, methods, technologies and monitoring indicators (Shen et al., 2013). Therefore best practices are considered outstanding contributions that improve living environments. They are successful initiatives that demonstrate a tangible impact on enhancing quality of life. Best practices are derived from effective partnerships between the public, private and civic sectors of society. They are socially, culturally, economically and environmentally sustainable (UN-Habitat, 2004a). The criteria for best practices in sustainable urbanization is well established and agreed upon by international organizations including the UN-Habitat and the World Bank (Kreimer, 1997; UN-Habitat, 2004a). According to this criteria a best practice in sustainable urbanization should:

- Demonstrate a positive and tangible impact on improving the living environment of people particularly the poor and disadvantaged
- Be based on a partnership between at least two of the major actors (e.g., central government, local authority, the private sector, and non-governmental organizations)
- Result in lasting changes that lead to effective legislation, regulatory frameworks, social policies, institutional frameworks, or transparent and accountable management systems
- Inspire action and change, including change in public policy
- Promote gender equality and social inclusion
- And innovate within the local context

Best practices in sustainable urbanization have been studied in the past for different purposes. Some studies have analyzed best practices to discuss new frameworks of policy learning and policy transfer and the claims of general applicability of successful policies (Bulkeley, 2006; Varney & Van Vliet, 2005). Other studies have focused on analyzing their monitoring systems and indicators (Shen et al., 2011), or using them for developing principles for urban design (Punter, 2007). However, it is appreciated that these studies used only a few number of best practices for their analyses. In this study it is proposed that a collective analysis of a large sample of best practices in sustainable urbanization can help to identify trends, success factors and hidden patterns in the formulation and application of the strategies that determined their success. It is expected that such knowledge will help to select and adapt proven strategies to novel contexts and foster more innovative approaches to sustainable urban development.

2. Research methodology

In line with the aim of this study, a large sample of best practices in sustainable urbanization is studied, and the following objectives are defined: (1) to identify the main areas of action, methods adopted and outcomes achieved (2) to identify associations between areas of action, methods and outcomes.

To secure the sample of best practices in sustainable urbanization, a comprehensive literature review was conducted. The main sources of the best practices used in this study were as follows:

- Exiting databases, such as Best practices database in improving the living environment (UN-Habitat, 2016), Sustainable Cities™: Best Practice Database (DAC, 2016), ICLEI- Local Governments for Sustainability (ICLEI, 2016), Sustainable Cities International (2016), New York City Global Partners (NYC Government, 2016), and C40 Cities climate change group (C40 Cities, 2016)
- Regional reports, such as the ones published by the European Commission (2010)
- National government reports, such as the ones published by the Ministry of Environmental Protection (MEP) in China (MEP, 2008), the Chinese Academy of Sciences (2010) and the Government of Australia (2005).

- City level reports, such as those from Santa Monica (2016), Malmö (2010), City of Vancouver (2016), and City of Seattle (2010).

This study followed a purposeful sampling. More specifically it used a criterion sampling. While there were numerous reports in the sources presented above, only those practices meeting the best practice criteria defined by UN-Habitat (2004a) were collected. Thus 368 best practice cases were identified as a result. Furthermore the collected best practices were filtered to retain only those practices that included a narrative of the definition of sustainable urbanization aims, objectives, strategies, implementation methods, the use of resources, and the results achieved. In other words the practices retained included core pieces of information necessary for identifying the means of their success in the form of actions, methods and outcomes. These core areas had to connect to the antecedents, include self-reflective methods, and focus on the consequences of implementation to provide a valid input-output model (Subiyakto & Ahlan, 2014; Van de Ven & Huber, 1990). Finally, 185 best practices were selected as effective sample cases for analysis. The practices were also representative of different geographical regions; 19% from Latin America, 22% from the Asia Pacific, 18% from Africa, 21% from North America and 20% from Europe. By using a purposeful sampling, this study does not have the intention of theory building but to demonstrate an alternative way of learning from best practices. The intention is that learning from the collective study of 185 best practices allows us to make generalizations that can be useful extensions of the current understanding of sustainable urbanization practices.

The selected sample was analyzed by using the extraction technique from the qualitative content analysis method. The extraction technique consists in the extraction of relevant experiences from case studies using a category system (Kohlbacher, 2006; Mayring, 2000). The extraction technique was used for mining and structuring experiences according to the research objective 1 of this study. Experiences were stored in a database for data analysis. Percentage frequency distribution was used as a quantitative approach for highlighting the relevance of experiences in the context of the sample best practices. Finally, the association rule mining method was applied for identifying associations between areas of action, methods and outcomes as stated in objective 2. Association rule mining is a subfield of data mining and it is useful for identifying relationships hidden in large data sets. Such relationships are normally represented in the form of association rules or sets of frequent items (Li, Shen, & Topor, 2001). The application of the method is explained in section 4. Fig. 1 systematically presents the research methodology applied in this study.

3. Identification of areas of action, methods, and outcomes

Areas of action addressed, methods adopted and outcomes achieved by best practices are core pieces of information necessary for identifying the means of their success. By using the content analysis method a list of 34 areas of action, 96 methods and 65 outcomes were originally identified. The lists were rigorously examined by 10 experts in sustainable urbanization, 4 academics, 3 professionals working for NGOs and 3 professionals working for consulting firms. Finally the lists were reduced to 30 areas of action, 76 methods and 58 outcomes respectively by merging the categories with high similarity to assure proper accounting for autonomy and overlaps. The following sections present the areas of action, methods and outcomes identified.

3.1. Areas of action

Sustainable urbanization is well established as a multi-dimensional process which covers environmental, economic, and social dimensions. More recent studies argue that a sustainable urbanization process should also consider the governance, physical and technological dimensions (Cash et al., 2003; Satterthwaite, 1997; Shen et al., 2011, 2013). According to the best practices sample examined in this study,
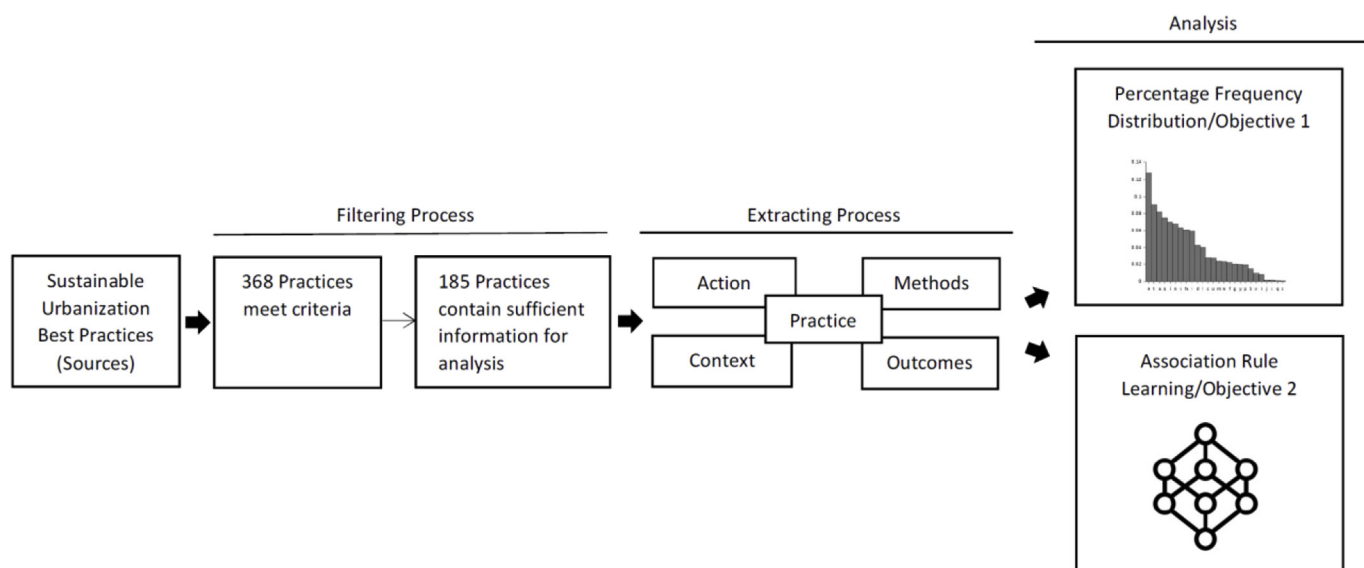
Fig. 1. Research methodology.

Table 1
Areas of action by best practices in sustainable urbanization and their percentage frequency distribution globally and regionally.

Code	Area of Action	Percentage frequency distribution (%)					
		World	Europe	Africa	North America	Latin America	Asia Pacific
AC-1	Architecture and Urban Design	8	15	0	16	7	3
AC-2	Children and Youth	24	27	17	16	35	7
AC-3	Civic Engagement and Cultural Vitality	19	8	10	12	30	20
AC-4	Disaster and Emergency	3	0	0	0	3	10
AC-5	Economic Development	12	8	23	4	15	7
AC-6	Environmental Management	32	31	30	40	23	53
AC-7	Gender Equality and Social Inclusion	15	15	20	12	14	17
AC-8	Housing	18	19	23	16	11	30
AC-9	Infrastructure, Communication, Transportation	11	23	7	8	12	3
AC-10	Land Use Management	5	15	3	4	4	3
AC-11	Poverty Reduction	28	19	50	4	34	17
AC-12	Production and Consumption Patterns	10	12	13	12	5	13
AC-13	Resilient Communities	1	4	0	0	1	0
AC-14	Social Services	29	31	13	12	43	20
AC-15	Technical and International Cooperation	3	4	0	4	3	3
AC-16	Technology, Tools and Methods	5	4	10	4	5	3
AC-17	Urban and Regional Planning	14	19	3	28	9	17
AC-18	Urban Governance	11	8	7	16	12	10
AC-19	Use of Information in Decision Making	6	8	3	0	11	3
AC-20	Water and Sanitation	7	0	13	0	9	7
AC-21	Buildings	4	12	0	8	3	3
AC-22	Energy	7	15	0	12	5	7
AC-23	Renewables	1	0	0	0	3	0
AC-24	Waste Management	6	8	10	4	5	3
AC-25	Education	13	15	7	4	20	7
AC-26	Health	7	0	20	4	8	0
AC-27	Safety and Security	2	4	0	0	3	0
AC-28	Tourism	2	0	0	0	0	10
AC-29	Workforce development	4	4	3	4	5	0
AC-30	Climate Change	14	35	0	40	4	10

*Percentages do not sum to 100% as they account for practices tackling multiple areas of action.

sustainable urbanization efforts have contributed to 30 different areas of action under those six dimensions. In Table 1, each area of action is presented with a global and geographical region percentage frequency distribution that represents the rate of recurrence. It is appreciated that environmental management (AC-6), social services (AC-14), and poverty reduction (AC-11) are the areas of action with the highest frequency demonstrating their importance as a priority in cities worldwide.

3.1.1. Environmental management

It is commonly acknowledged that urbanization and economic growth have resulted in widespread environmental degradation. Therefore, environmental management actions (AC-6) such as water quality and conservation, air quality monitoring and management and noise pollution control programs have emerged to ensure that ecosystems supporting urban activities are protected and maintained for future generations. Environmental management has been long promoted as a key area for achieving urban sustainability and many cities around the world have made this a central element for their local agendas. It is

not surprising then to find environmental management as a highly frequent area of action particularly in Europe, Africa, North America and the Asia Pacific as can be seen in Table 1.

3.1.2. Social services

The provision of social services (AC-14) such as health care, shelter and financial and material support is an essential component for the successful achievement of urban sustainability goals and it has a strong association with poverty reduction (AC-11) and social inclusion (AC-7) (UNDESA, 1992). While many best practices in sustainable urbanization have addressed this area of action, its success is highly dependent on other areas of action. For instance, a single targeted intervention of a best practice focused on providing health care to a community contributes to improving the quality of life of its inhabitants. However, such benefits are compromised if other services such as sanitation, water access and quality shelter are not provided (UNRISD, 2010). Therefore, a balanced and strategic provision of social services is needed. The broadness of social services and its implications explain the high association of best practices with this area of action across all regions.

3.1.3. Poverty reduction

Poverty is a complex multidimensional problem of global dimensions affecting all nations at different levels. This is particularly true in Africa, Latin America and Asia Pacific regions which continue to report the highest indices of extreme poverty internationally (World Bank, 2016). However as appreciated in Table 1, many efforts to alleviate poverty (AC-11) have utilized numerous best practices in these regions. In fact best practices led by poverty reduction actions in Africa and Latin America reached 50% and 34% of all their best practices respectively. Some practices include the KASWESHA housing cooperative project in Nairobi (Kaswesha, 2016), the Mwanzo Mpya initiative in Embu (UN-Habitat, 2016) and the Children Ahead programme in Santiago (UN-Habitat, 2016).

From Table 1, it is also interesting to find a broad range of areas of action more recently recognized for their contribution to sustainable urbanization. For instance the role of tourism in achieving urban sustainability is now acknowledged. Particularly in cities with problems associated with tourism urbanization that took actions to develop or redevelop to better facilitate sustainable tourism (Chang & Sheppard, 2013; Scott, Peeters, & Gössling, 2010). Similarly, civic engagement and cultural vitality (AC-3), education (AC-25) and children and youth (AC-2) are areas of action contributing to sustainable urbanization particularly when addressing cross-dimensional challenges.

3.2. Methods adopted and outcomes achieved by best practices

3.2.1. Methods adopted by best practices

Methods used for implementing sustainable urbanization are very diverse and their functions could be very specific. For example there are methods which are applied to build awareness and engage the public; to strengthen institutions and promote partnerships; to empower people through capacitation; and to provide education and financial support. Other methods have more specific applications such as the use and transfer of scientific and technological developments. Table A.1 in Appendix A contains the complete list of the methods applied by the best practices analyzed this study.

It is considered important to identify those methods that have been highly adopted by best practices to promote their use for meeting sustainable urbanization goals. Therefore, the frequency of each method was obtained, and a percentage frequency distribution of all methods was produced, as shown in Fig. 2. Their frequency of adoption was divided into different ranges including *very highly adopted* (VHA), *highly adopted* (HA) and *adopted* (A).

Table 2 contains all the methods that fall in the ranges of HA and A globally and by region. There was no method falling in the VHA range.

It is interesting to note that the methods falling in the HA and A ranges in great extent are the same across all regions, denoting a strong consensus on what methods are playing a key role in implementing sustainable urbanization.

Vocational training and capacity building (M-72) was the most adopted method globally. Regionally, it was also the most adopted in Europe, Africa and Latin America. Generally, if practices involve the active participation of the community, the community must be trained to effectively contribute to meeting the goals of the practice. Vocational training and capacity building enables communities to participate actively in solving problems that affect them. Some examples include the Dajopen Waste Management Project (Building and Social Housing Foundation (BSHF), 2017) and the Elmina Heritage Project (Arthur & Mensah, 2013) in which vocational training and capacity building was a fundamental method for achieving their goals.

Community participation (M-73) is the second most adopted method globally, and regionally it is highly adopted in Africa and the Asia Pacific. Community participation is important as it offers groups and individuals the opportunity to participate actively in the design, implementation, and management of practices for achieving urban sustainability goals. Moreover, this method creates a sense of ownership of the practice to the community. Therefore they are motivated to lead it to a successful end and produce an equitable distribution of benefits.

Job creation (M-7) is the third most adopted method globally. Regionally it is highly adopted in Africa. Job creation has demonstrated to be a cost-effective method for the creation of small farms, development of renewable energy and energy efficient systems and promoting community-based construction. By employing the community through these practices, the funds expended are highly retained in the community. All administrative, commercial and managerial skills are transmitted to the people and the development of entrepreneurs is promoted.

Education (M-10) is also in the range of adopted methods globally ranked after job creation. Regionally, education is particularly highly adopted in Latin America. Education as a method is highly relevant to those practices relating to children and youth, and it is used to provide skills and knowledge for meeting challenges faced by their local communities. Such as environmental threats, restoration activities, and natural disasters. Education is also used for building awareness particularly among youth about the efficient use of resources and seeking sustainable consumption patterns.

Public/private/community partnership (M-21) is a method highly adopted particularly in Africa and among the most adopted in Latin America. New forms of partnerships between the public (the government), the private (private businesses) and the community (civil society and NGOs) sectors are recognized as effective and appropriate for managing the complexity of the challenges related to the achievement of urban sustainability goals. These partnerships are a good way to divide responsibilities among different sectors in society. Most importantly they can use their combined strengths and capabilities for developing innovative practices and financial models.

Environmentally sound technologies (M-35) are found in the range of adopted methods in Europe, North America and the Asia Pacific. These technologies are designed to protect the environment by reducing pollution, using resources more sustainably and recycling most of their wastes. Environmentally sound technologies are more than just individual technologies, they include the know-how, equipment, and organizational and management procedures. The majority of the examined practices adopting environmentally sound technologies in this study are related to the area of energy. As such they demonstrate the aim to enhance energy access in cities, improve energy efficiency and promote the use of renewable energy technologies. Other popular adoptions are related to using sustainable construction materials, increasing effectiveness in waste management processes and improving transportation and mobility in cities.
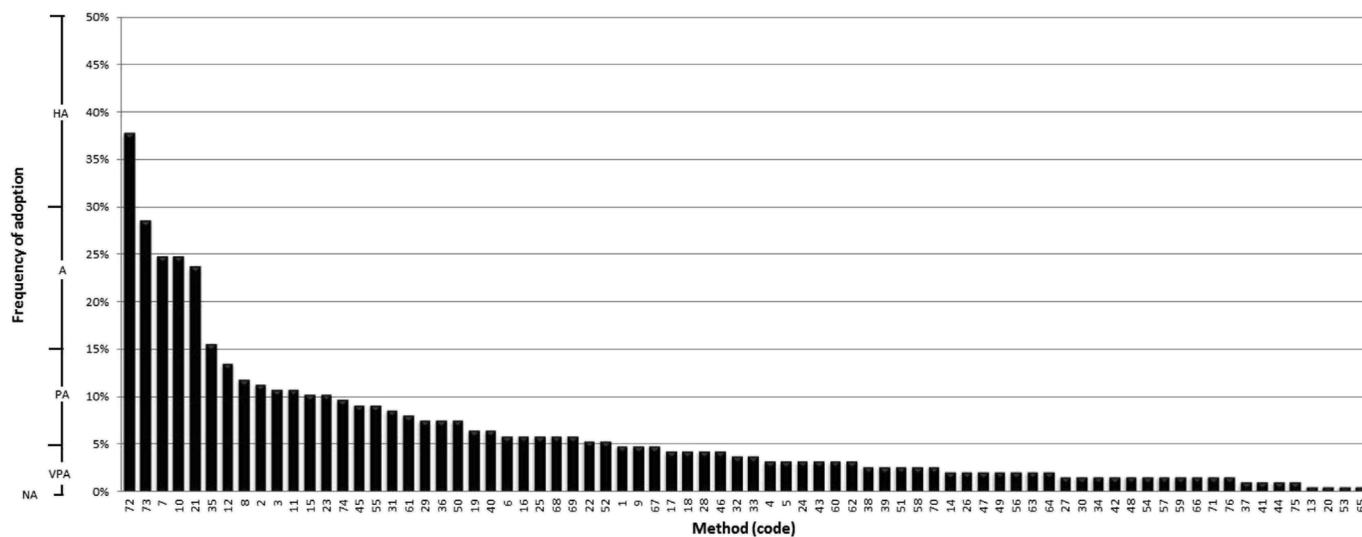
Key - VHA: Very highly adopted; HA: Highly adopted; A: Adopted; PA: Poorly Adopted; VPA: Very poorly adopted; NA: Not adopted

Fig. 2. Percentage frequency distribution of methods.

3.2.2. Outcomes achieved by best practices

Outcomes are the performances that embody and reflect how successful a practice was when compared with its targeted goals and the resources utilized. It is considered important to identify those outcomes that have been highly achieved by best practices to understand their contribution to urban sustainability. Table A.1 in Appendix A contains the complete list of the outcomes achieved by the best practices analyzed in this study. The frequency of each outcome was obtained, and finally, a percentage frequency distribution of all outcomes was produced as shown in Fig. 3. As done previously with methods, the frequency of the outcomes achieved was divided into different ranges including *very highly achieved* (VHA), *highly achieved* (HA) and *adopted* (A).

Table 3 contains all the outcomes that fall in the ranges of HA and A globally and by region. There was no outcome falling in the VHA range. As indicated in Table 3, income generation activities (O-7) is the most achieved outcome globally. Regionally, it is also in the range of highly achieved in Africa, Latin America and the Asia Pacific. This outcome is normally targeted by best practices as a secondary outcome. However it is achieved by a high number of practices. Income generation activities is a key outcome indicator in the achievement of urban sustainability goals. It is related to improving livelihoods of residents and promoting self-sufficient economy development. Despite the high frequency of this outcome, not all practices provide sustained employment opportunities, quality jobs or promote entrepreneurship which diminishes their contribution to urban sustainability.

The second most achieved outcome globally is the social inclusion of vulnerable groups (O-1). Regionally, this outcome has been highly achieved in Latin America. The social inclusion of vulnerable groups is an outcome which not only benefits the groups themselves but also the society as a whole. Social inclusion is important in achieving urban sustainability as it helps to minimize social conflicts such as crime, violence, health problems and poverty and explodes the productive potential of minority groups that may otherwise feel alienated. It is also noted from the sample practices that each region tends to target different social groups. For instance, children and youth tend to be the targeted groups in Latin America, migrant workers and refugees in Europe and North America, gender equality in the Asia Pacific and gender equality and people living with HIV/AIDS in Africa.

Poverty reduction (O-30) is found in the range of achieved in the world column as seen in Table 3. It is an outcome highly targeted in Africa and Latin America. Urbanization contributes to sustained

economic growth which is critical to poverty reduction. However, the lack of adequate government policies and planning for urban growth can lead urbanization to high levels of poverty in cities. The practices analyzed in this study show that there are mainly two types of outcomes related to poverty reduction. The first one is related to upgrading urban groups living in extreme poverty to moderate poverty, which involves the practices oriented to meeting their basic needs such as water, sanitation, shelter and food mostly occurring in Africa, Latin America and Asia Pacific regions. The second one is related to taking urban groups out of poverty, which involves the practices related to providing social services, training, jobs, and housing finance.

Increased civic awareness and engagement (O-18) is an outcome generally achieved through education, training and information campaigns. This is an essential outcome particularly when the practice requires changing consumption patterns, behaviors and attitudes towards sustainable practice. This is also an outcome particularly targeted in the practices related to actions towards climate change and environmental management. Such as using renewable resources, alternative and clean ways of transport, and adopting technologies for increasing energy and water use efficiency and recycling.

Improvement of living environment (O-28) is an outcome that highly contributes to urban sustainability as it relates to how the built environment can be designed and improved to support a higher quality of life in cities. Many actions contribute to achieving this outcome such as urban planning, zoning and planning control, building design, infrastructure development, upgrading and designing urban facilities, and investing in resilient infrastructure. This study reveals that the Asia Pacific is the region where this outcome is highly targeted. The current increased allocation of resources to green urban development and urban resilience by several countries in the region could be the explanation (Fook & Gang, 2011; Steele & Mittal, 2012). Countries like China, India, South Korea, Indonesia, and Malaysia are spending a great number of resources for improving quality of life in cities. In the process, they are not only upgrading informal settlements but also developing built environments with state of the art environmental sound technologies (Suzuki, Dastur, Moffatt, Yabuki, & Maruyama, 2010; Wang, Berrah, Peng, Sugar, & Du, 2012). Improvement of living environment is also a frequent outcome in North America and Europe and actions are mostly related to environmental management and climate change goals including urban greening, building retrofits, intelligent and energy efficient streetlights, green buildings and green mobility.

Table 2
Most frequent methods used by best practices.

Frequency of adoption	World	Africa	Europe	North America	Latin America	Asia
Highly Adopted (30%–50%)	•Vocational training and capacity building	•Vocational training and capacity building •Job creation •Public/private/community partnerships •Community participation		•Creating and strengthening networking •Research and development	•Vocational training and capacity building •Education	•Community participation
Adopted (15%–30%)	•Community participation •Job creation •Education •Public/private/community partnerships •Environmentally sound technologies	•Access to credit •Education •Waste management and treatment •Access to housing finance	•Vocational training and capacity building •Education •Transportation and mobility •Job creation •Monitoring, evaluation and auditing •Urban/suburban renewal •Environmentally sound technologies •Community participation	•Environmental government plan •Building civic awareness •Climate change mitigation •Monitoring, evaluation and auditing •Public/private/community partnerships •Community participation •Environmentally sound technologies •Vocational training and capacity building •Mass information campaigns and promotion of rights •Education •Provision of shelter and promotion of the right to adequate housing	•Community participation •Public/private/community partnerships •Job creation •Public policy/legislation •Recreation and entertainment	•Provision of shelter and promotion of the right to adequate housing •Environmentally sound technologies •Waste management and treatment •Urban/suburban renewal •Vocational training and capacity •Job creation •Drainage and sanitation •Public/private/community partnerships •Building civic awareness •Post-disaster rehabilitation/reconstruction

4. Association analysis

As explained above, the association rule mining is applied for identifying the relationships between areas of action, methods and outcomes. Following the definition of association rule mining by Li et al. (2001):

Let *Best Practice (BP)* = {AC, M, O} be a set of *items* namely *Areas of Action (AC), Methods (M)* and *Outcomes (O)*.

Let D = {BP$_1$, BP$_2$, …, BP$_n$}be a set of *Best Practices (BP)* called the *database*. Each *BP* in *D* has a unique ID number.

Every association rule is composed of two different set of items, also known as *itemsets X and Y.*

A rule is defined as an implication of the form X ⇒ Y where X, Y ⊆ BP and X ∩Y = 0.

An example of an association rule can be {AC2} ⇒ {M8}.

Support is an indication of how frequently the *itemset* appears in the database. For instance let *I* be an *itemset*, X ⇒ Y an association rule and *D* a set of *Best Practices* of a given database. The support value of *I* with respect to *D* is defined as the proportion of *Best Practices* in the *database* which contains the *itemset I*. In formula this is supp(I)/N. Support can range from 0 to 100.

4.1. Associations between areas of action

The best practices in sustainable urbanization analyzed in this study have shown us that effective strategies are not focused on single areas of action, but these are efforts that address several areas of action crossing more than one dimension of urban sustainability. It is therefore important to investigate what areas of action are normally found together in these best practices. By using the association rule mining analysis, it was possible to identify what areas of action have strong associations and the results are presented in Fig. 4.

From Fig. 4 it is noted that areas of action such as children and youth (AC-2), social services (AC-14) and environmental management (AC-6), which were identified as highly frequent in Table 1, are also areas of action presenting high levels of association support with other areas of action.

Environmental management (AC-6) was the most frequent area of action found in the best practices studied. When developing environmental management strategies, it is important to acknowledge that there are three types of environmental problems during the urban development process: poverty-related (e.g. lack of adequate water supply, sanitation); industrial production-related (e.g. air, soil, and water pollution) and lifestyle and consumption-related (e.g. greenhouse gas emissions) (Bai & Imura, 2000). Therefore, environmental management actions cannot act alone but have to work together with other areas of action that support the contextual needs around the type of environmental problem addressed. It is interesting to observe from Fig. 4 that environmental management has been highly addressed in combination with several areas of action ranging from poverty reduction (AC-11) to climate change (AC-30). When the environmental problems addressed are lifestyle and consumption-related, environmental management is usually associated with climate change (AC-30), production and consumption patterns (AC-12) and civic engagement (AC-3). Therefore issues such as mobility, provision of green urban areas, green energy sources, energy and water use efficiency and recycling, environmental management are addressed. However when environmental impacts are poverty-related such as sanitation, water supply and slum upgrading, environmental management is usually associated with poverty reduction (AC-11), social services (AC-14) and water and sanitation (AC-20).

Children and Youth (AC-2) is an important area of action because people 24 years old and under represent nearly 50% of the world's 7 billion population (UNFPA, 2011). Therefore the involvement of today's youth in the decision-making and implementation of environmental and development programs is critical to the long-term success of sustainable urban development (Bilal et al., 2016; Malone, 2001; Varol,
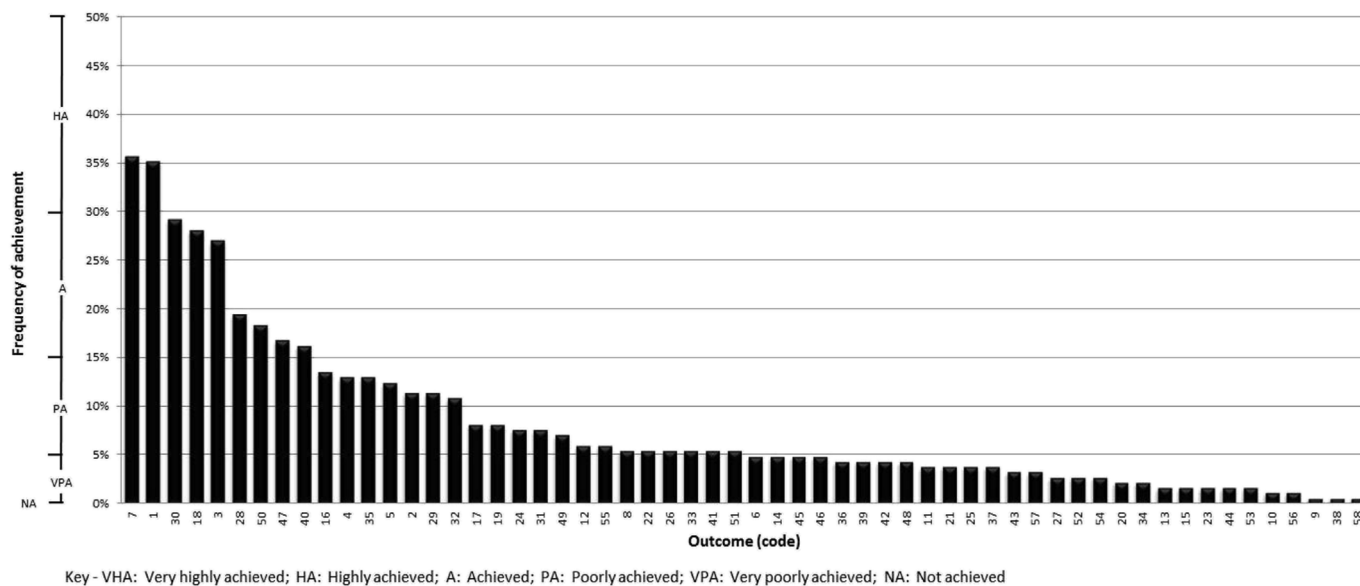
Key - VHA: Very highly achieved; HA: Highly achieved; A: Achieved; PA: Poorly achieved; VPA: Very poorly achieved; NA: Not achieved

Fig. 3. Percentage frequency distribution of outcomes.

Ercoskun, & Gurer, 2011; Wolch, Byrne, & Newell, 2014). From Fig. 4, it is interesting to note how best practices expecting to engage children and youth in the process of sustainable urbanization did so in combination with areas that are intended for providing social inclusion and empowerment such as social services (AC-14), education (AC-25), civic engagement and cultural vitality (AC-3) and poverty reduction (AC-11). For youth living in poverty there is a great need for policies and programs that enable social inclusion. Some of the specific actions taken in the practices studied include integrated care and education centres for disadvantaged children, educational programs for raising cultural and environmental awareness among children, and promoting urban agriculture for a sustainable source of nutrition and income generation.

4.2. Associations between areas of action and methods

For sustainable urbanization practices to succeed, it is crucial that the right methods are selected. Learning from best practices on the selection of methods according to the areas of action addressed is possible by applying the association rule mining method. Fig. 5 presents the results of the analysis.

From Fig. 5, it is noted that nine areas of action have a strong association support with various methods. Poverty reduction (AC-11) for instance has strong association support with vocational training and capacity building (M-72), job creation (M-7), public/private/community partnership (M-21), education (M-10), and access to credit (M-31). Such methods were frequently applied together in practices aiming to reduce poverty. The case of Burkina Faso and the Nubian Vault Programme is a good example (Association La Voûte Nubienne (AVN) 2016). In this practice housing provision through the self-build approach was used as a strategy to alleviate poverty. First a public/private/community partnership was created for identifying local building materials in abundance in the region and preparing the standard design of houses which met the local climate and social needs (M-21). Then members of the community were trained for building their own houses (M-72). Once they learned the building skills, they were educated to become entrepreneurs and run their businesses as builders (M-10). Those who started their business were able to access to credits (M-31). Companies emerging from this practice were a source of employment for many in the community (M-7). Such practices are good examples of how to benefit a community to achieve self-sustainability.

Environmental management (AC-6) has a strong association with methods directly linked to the environment such as environmental

sound technologies (M-35) and water management and treatment (M-15). However it is interesting to note that just as in poverty reduction (AC-11), job creation (M-7), community participation (M-73) and vocational training (M-72) are also key methods associated to environmental management particularly in practices that involve the community and change of behaviors. The Zero Garbage practice in Pune, India is a good example of this best practice (Janwani, 2017).

Children and youth (AC-2) has strong association support with education (M-10), vocational training (M-72), recreation and entertainment (M-74), community participation (M-73) and community support programmes (M-50). All methods in combination are supportive for achieving goals around the inclusion and empowerment of vulnerable social groups. Educational, recreational and sports activities supported and ran by the local communities were successful practices in bringing students back to school. It also increases retention rates, prevents drug addiction and reduces crime rates. Such practices were supported by the revitalization and creation of public space for sports and other recreational activities. A good example of the application of these methods supporting (AC-2) is the practice Sport Inspires Me from Lisbon, Portugal (International Association of Educating Cities (IAEC), 2017). This practice successfully brought together the local government and community to build the physical space and sports programs needed to promote the social inclusion of children and youth population considered at risk.

4.3. Associations between methods and methods

By using the association rule mining method, it was also possible to identify what methods have worked well together in achieving the goals of sustainable urbanization. Fig. 6 shows the associations between methods with strong support.

From Fig. 6, it is noted that the methods previously identified as highly adopted are also methods that work well together including job creation (M-7), education (M-10), vocational training (M-72), community participation (M-73), partnerships (M-21) and access to credit (M-31). These methods could be regarded as 'core methods' as they can be applied to any area of action compared to methods like environmentally sound technologies (M-35), energy use efficiency (M-43) and transportation and mobility (M-46) which their application is limited to fewer areas of action. These core methods are often applied together as part of a strategy such as the Burkina Faso practice described above. The high frequency of application of the core methods

Table 3
Most frequent outcomes achieved by best practices.

Frequency of adoption	World	Europe	Africa	North America	Latin America	Asia
Highly Achieved (30%–50%)	•Income generation activities •Social inclusion of vulnerable groups	•Increased civic awareness and engagement •Climate change mitigation	•Income generation activities •Poverty reduction	•Increased civic awareness and engagement •Improvement of living environment •Climate change mitigation	•Social inclusion of vulnerable groups •Income generation activities •Equal access to social services •Poverty reduction	•Improvement of living environment •Income generation activities
Achieved (15%–30%)	•Poverty reduction •Increased civic awareness and engagement •Equal access to social services •Improvement of living environment •Environmental health •Social empowerment •Waste dumping reduction	•Improvement of living environment •Social inclusion of vulnerable groups •Income generation activities •Equal access to jobs •Air pollution reduction •Enhanced mobility networks •Poverty reduction	•Equal access to social services •Social inclusion of vulnerable groups •Waste dumping reduction •Equal access to health and welfare services •Environmental health •Food and nutrition security •Increased civic awareness and engagement •Security of tenure •Upgrading of informal settlements	•Social empowerment •Air pollution reduction •Knowledge transfer •Enhanced institutional coordination •Social inclusion of vulnerable groups •Income generation activities	•Increased civic awareness and engagement •Crime reduction and prevention •Social empowerment •Social and cultural vitality •Equal access to jobs •Environmental health	•Waste dumping reduction •Increased civic awareness and engagement •Social inclusion of vulnerable groups •Equal access to housing •Environmental health •Upgrading of informal settlements •Equal access to social services •Poverty reduction

and the strong association support between them suggest that these methods could form the basis of a successful sustainable urbanization strategy.

4.4. Associations between methods and outcomes

It is also of great importance to know the associations between methods and outcomes. In doing so, it is possible to have a better understanding of how those outcomes were achieved. Fig. 7 shows the associations between methods and outcomes with strong support.

Vocational training and capacity building (M-72) was identified as the most adopted method by the practices analyzed in this study. The same method is associated with eight outcomes with high association support particularly with income generation activities (O-7) and social inclusion (O-1). Similarly community participation (M-73) was identified as a highly adopted method, and it is associated with six different outcomes. Social inclusion (O-1), the second most achieved outcome from the practices analyzed, it is strongly associated with (M-72) and (M-73). These two methods are key for achieving (O-1) particularly when combined with other methods like education (M-10) and job creation (M-7).

The wide benefits of applying (M-72) and (M-73) in sustainable urbanization practices have been discussed in the past by numerous scholars including Mabbott (1993), Adekeye Abiona and Bello (2013), Sood and Gupta (2013), and Rabinowicz and Chinapah (2015). This study is able support those findings but also to highlight the importance of these two methods regardless of the targeted area of action.

5. Discussions

The frequency analysis conducted in this study shows that best practices globally have been more oriented to areas that contribute to the conservation and management of resources, followed by actions towards social and economic development. It was also found that there is a great consensus among different regions on what are the most effective methods and the most important outcomes achieved. Such knowledge can be used in the selection of methods according to how effective these were in different regions.

This research also reveals that important differences exist in the areas of action addressed between regions. For instance, regions where developed countries prevail have addressed a wider range of areas and achieved better results particularly in environmental sustainability and climate change. Meanwhile, regions where developing countries exist have excelled in using innovative and creative solutions focused on maximizing the efficiency of resources through achieving greater community participation. This finding highlights the importance of exchange of technology, knowledge, and know-how between developed and developing countries, acknowledging that developed countries can also learn from developing countries.

The association analysis conducted in this study has shed light on what areas of action and methods form a good strategy and what outcomes are associated with particular methods. For instance, findings from this study support the idea that vocational training, capacity building, education, job creation, partnerships and access to credit are core methods for achieving urban sustainability. The high frequency of adoption and the strong association between them suggest that these methods could be used as the foundation for successful sustainable urbanization strategies. It is also suggested that a better understanding of the associations between areas of action could lead to more holistic urbanization strategies and achieve a wider number of outcomes in a single practice. This could address the often criticized narrow focus of urbanization strategies adopted by governments which miss the opportunities to extend the impact of their practices.
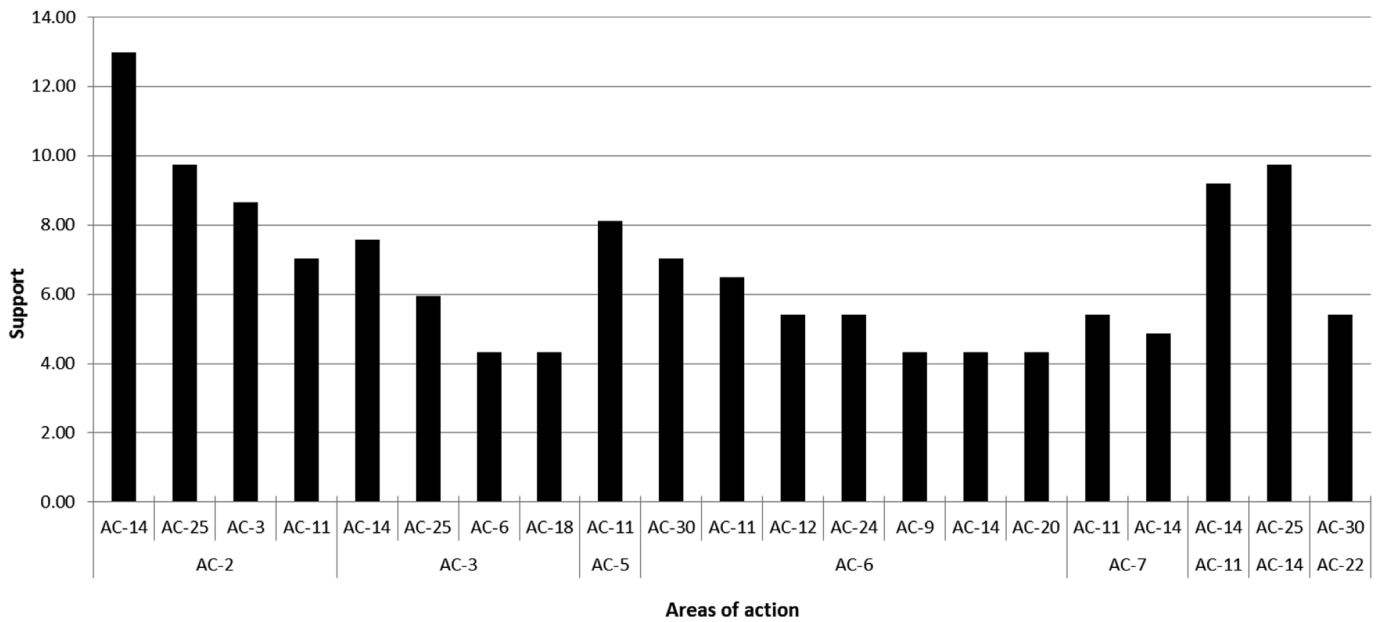
Fig. 4. Associations between areas of action.

6. Conclusions

The literature has revealed various studies that have aimed to learn from best practices in sustainable urbanization. From creating new policy frameworks, developing new principles of urban design, and analyzing monitoring systems and indicators. However previous studies have been limited to the study of only a few best practices at a time. This study argued that the collective analysis of a larger sample of best practices is key to identifying potential success factors and generating

valuable knowledge for future practices. Therefore a systematic analysis of a large set of best practices was proposed as an alternative method for learning from these exemplary practices.

A collective analysis of best practices was conducted in this study. This study was successful in identifying the main areas of action, methods, and outcomes achieved by these best practices. Most importantly it has uncovered the core methods that were successful for each area of action and the outcomes achieved by the application of those methods. Such knowledge is argued to be of value as it can be
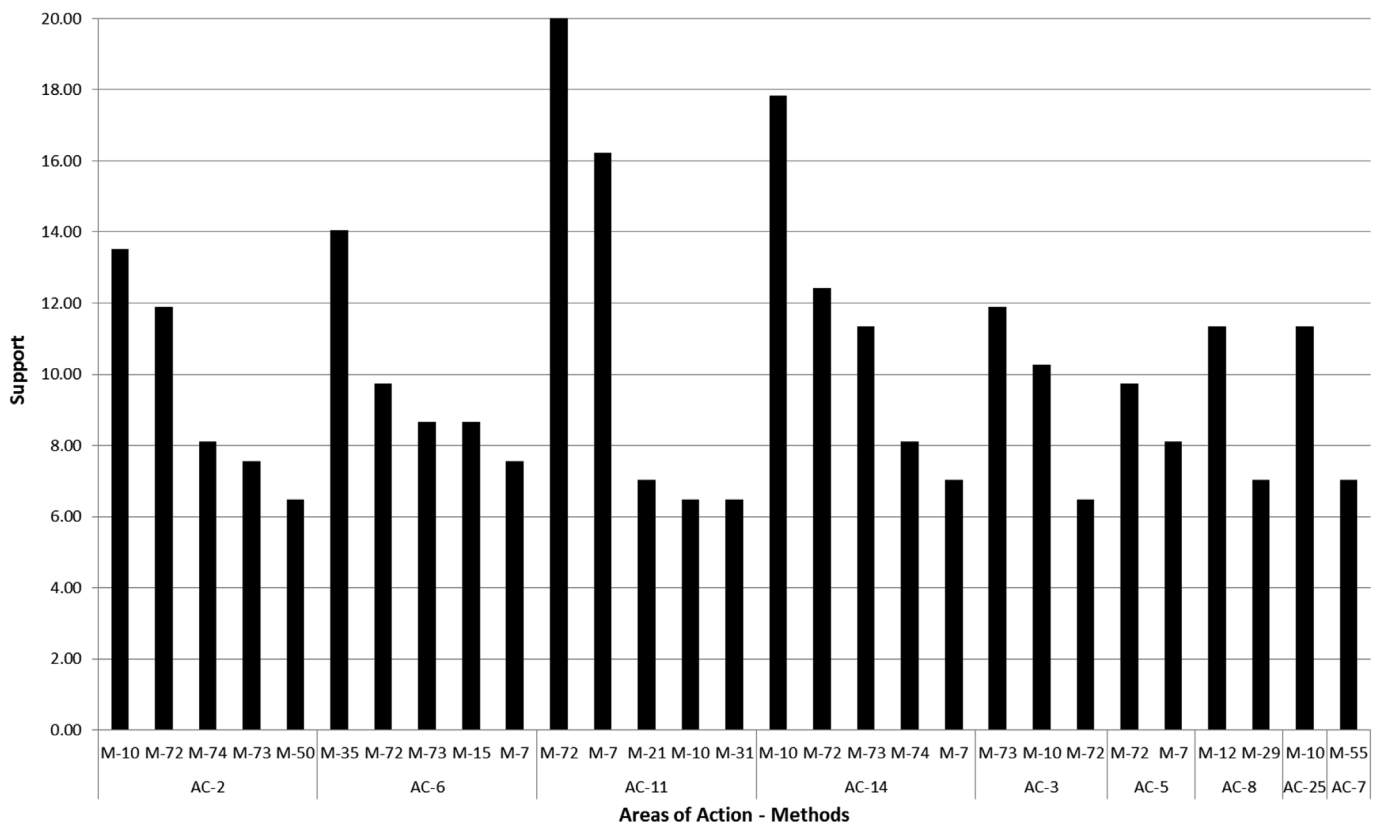

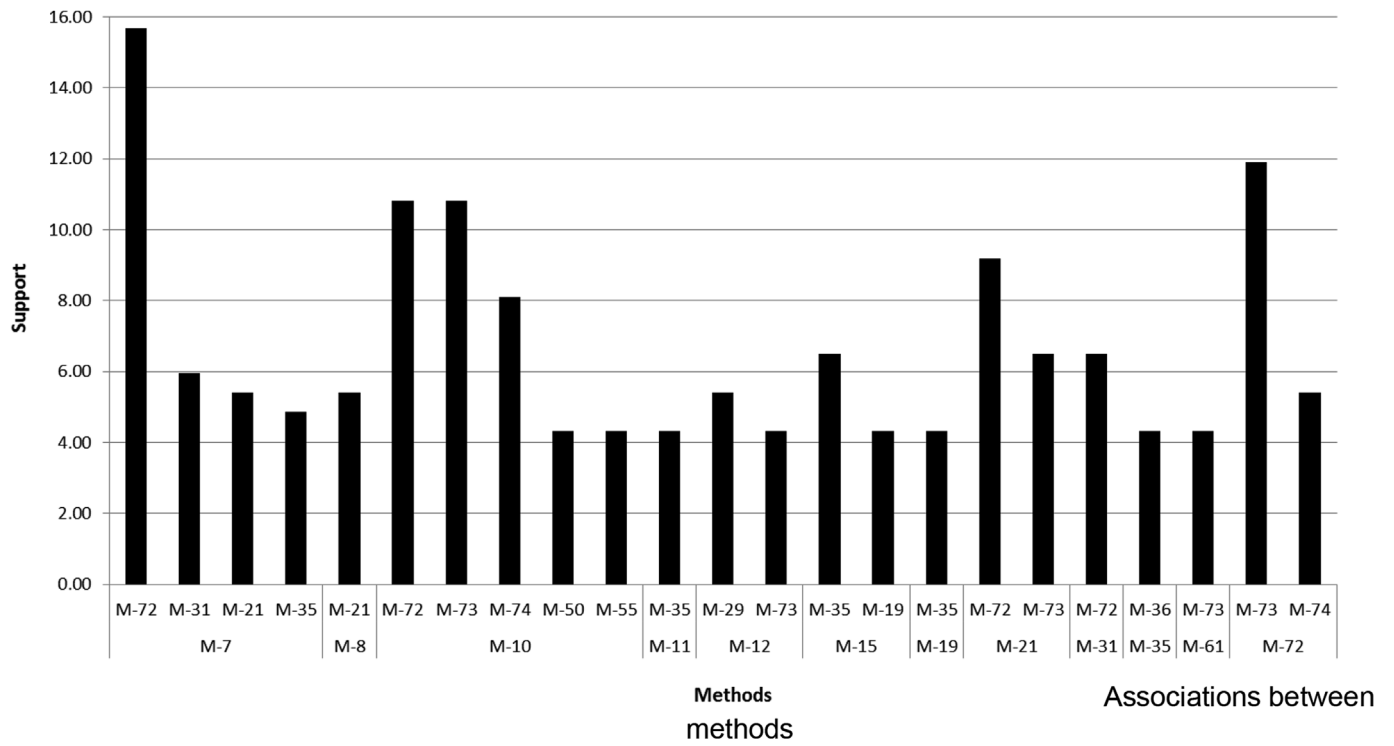**Fig. 5.** Associations between areas of action and methods.
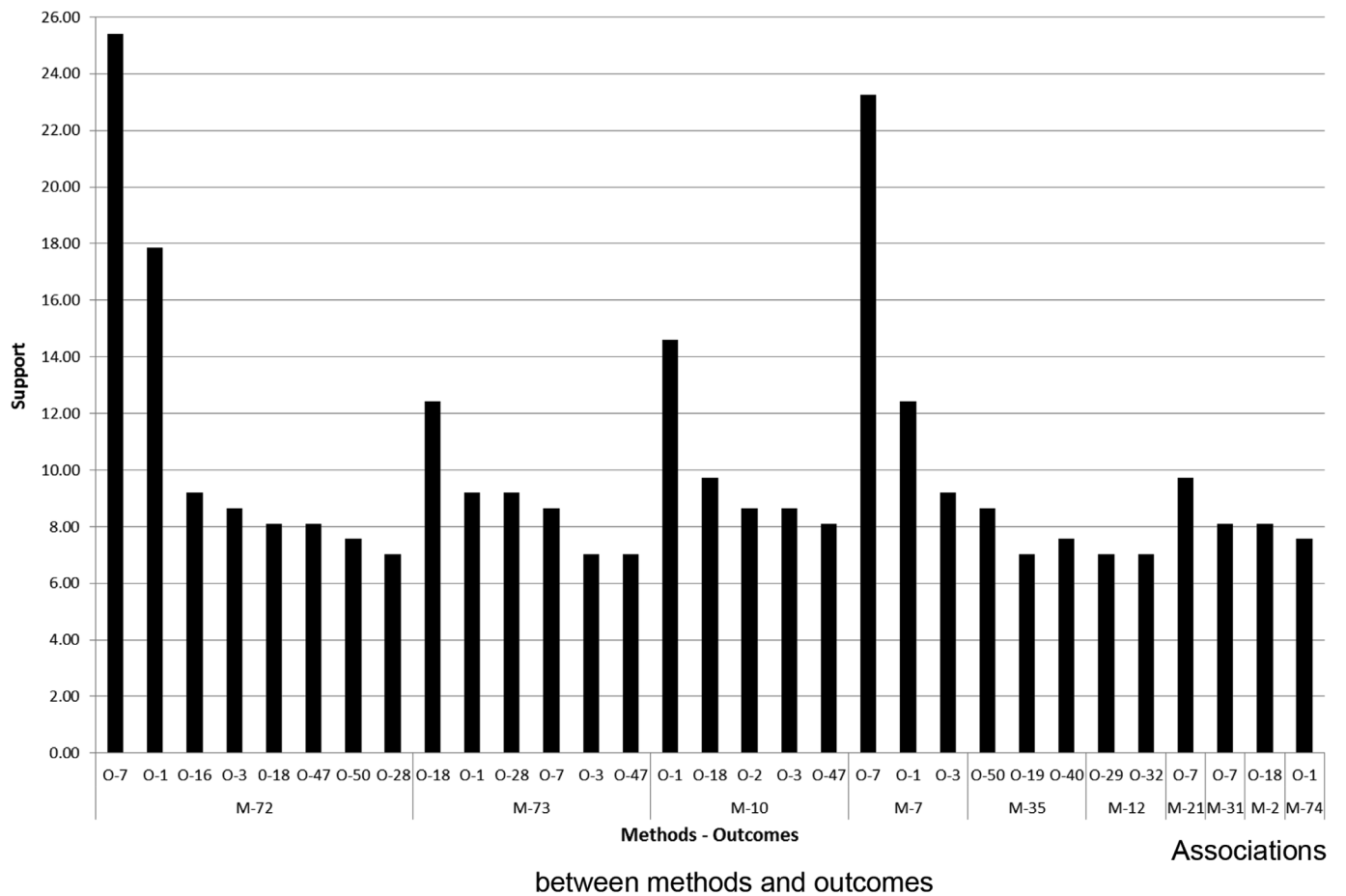
Fig. 6. Associations between methods.

Fig. 7. Associations between methods and outcomes.

used to inform policymaking and the development of new sustainable urbanization strategies in novel contexts. Local leaders, policymakers and urban planners using this knowledge could have greater understanding and foresight of the direct and indirect benefits of their proposed strategies. If the application of knowledge gained from best practices proves to be successful over time it could greatly accelerate innovation and improve financial sustainability.

Overall the findings from this study strongly suggest that the collective analysis of best practices is a method conducive to the generation of knowledge that can aid the practice and research of sustainable urbanization. The results of the proposed method are promising and the next stage will involve the analysis of a larger sample of practices in order to uncover more hidden associations. The next phase will allow a larger comparison between regions and also explore changes through time. It is envisaged that this method represents the foundations of a tool that enhances the use of experiences gained from best practices in sustainable urbanization. As such this method can assist in the development of successful urbanization strategies.

Appendix A

Table A.1
Methods applied and outcomes achieved by best practices in sustainable urbanization.

Code	Method	Code	Outcome
M-1	Information and communication technologies	O-1	Social inclusion of vulnerable groups
M-2	Mass information campaigns and promotion of rights	O-2	Crime reduction and prevention
M-3	Creating and strengthening networking	O-3	Equal access to social services
M-4	Institutional reform and strengthening	O-4	Equal access to health and welfare services
M-5	Capital formation and entrepreneurship	O-5	Social and cultural vitality
M-6	Investment development	O-6	Industrial and enterprise development
M-7	Job creation	O-7	Income generation activities
M-8	Public policy	O-8	Food and nutrition security
M-9	By-laws and standards	O-9	Children found
M-10	Education	O-10	Foster care
M-11	Monitoring, evaluation, and auditing	O-11	Legislation changes
M-12	Provision of shelter/right to adequate housing	O-12	Institutional reform
M-13	Grants (economical support)	O-13	Education quality improvement
M-14	Justice system reform	O-14	Reduction of desertion school rates
M-15	Waste management and treatment	O-15	Less referrals of children to psychologist
M-16	Research and development	O-16	Equal access to jobs
M-17	Urban greening	O-17	Cultural development
M-18	Incentives	O-18	Increased civic awareness and engagement
M-19	Drainage and eco-sanitation	O-19	Air pollution reduction
M-20	Provision of social services by micro-enterprises	O-20	Technology transfer
M-21	Public/Private/Community Partnerships	O-21	City-to-city cooperation
M-22	Indicators and statistics	O-22	Knowledge transfer
M-23	Urban/suburban renewal	O-23	Eco-tourism
M-24	Urban planning regulations	O-24	Water supply and demand services
M-25	Health care and welfare services	O-25	Water use efficiency
M-26	Foster care	O-26	Economic development
M-27	Organic farms	O-27	Provision of public space
M-28	Knowledge sharing	O-28	Improvement of living environment
M-29	Access to housing finance	O-29	Upgrading of informal settlements
M-30	Education loans/scholarships	O-30	Poverty reduction
M-31	Access to credit	O-31	Security of tenure
M-32	Water supply and demand management	O-32	Equal access to housing
M-33	Self-built homes construction	O-33	Adequate housing
M-34	Prevention of forced eviction	O-34	Hygiene and sanitation
M-35	Environmentally sound technologies	O-35	Climate change mitigation
M-36	Environmental government plan	O-36	Climate change adaptation
M-37	Enforcement of protected areas	O-37	Renewable/clean energy generation
M-38	Efficient resource management and conservation	O-38	Work safety
M-39	Relocation of inhabitants living in slums	O-39	Energy use efficiency
M-40	Children's participatory planning	O-40	Waste dumping reduction
M-41	Renewal/clean energy generation	O-41	Rural community development
M-42	Eco - reparation of land	O-42	Enhanced mobility networks (transportation)
M-43	Energy use efficiency	O-43	Efficient public transportation
M-44	Eco-tourism	O-44	Reduction of motorized modes of transportation
M-45	Building civic awareness	O-45	Urban renovation/rehabilitation
M-46	Transportation and mobility	O-46	Cultural heritage conservation
M-47	Cultural heritage conservation	O-47	Social empowerment
M-48	Exposure to best practices	O-48	Transparent, participative and decentralized administration

Table A.1 (*continued*)

Code	Method	Code	Outcome
M-49	Land use planning	O-49	Green urban areas
M-50	Community support programmes	O-50	Environmental health
M-51	Transparency and accountability	O-51	Enhanced institutional coordination
M-52	Environmental programmes with a youth focus	O-52	Master city plan
M-53	Abuse prevention of disadvantaged groups	O-53	Increments in agricultural production
M-54	Government decentralization	O-54	Sustainable land use
M-55	Removing barriers to equity	O-55	Green building
M-56	Participatory budgeting and decision-making development	O-56	Increment of tourism affluence
M-57	Legal counseling	O-57	Vulnerability mitigation
M-58	Urban management and administration	O-58	Prevention of immigrants/migrants abuse
M-59	Sustainable agriculture practices		
M-60	Post-disaster rehabilitation/reconstruction		
M-61	Master city plan		
M-62	Regional planning		
M-63	Urban/Rural networking		
M-64	Geographical information systems (GIS)		
M-65	Risk management		
M-66	Climate change adaptation		
M-67	Climate change mitigation		
M-68	Sustainable construction		
M-69	Fundraising		
M-70	Women Empowerment		
M-71	Technology transfer		
M-72	Vocational training and capacity building		
M-73	Community participation		
M-74	Recreation and entertainment		
M-75	Form of expression/animation		
M-76	Sports		

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