Cities and Industries are interdependent and determinant among themselves. However, since the first cycle of industrialization in England at the end of the 19th Century, the conflicting coexistence between manufacturing and inhabited areas seems irreconcilable. Modernist planning proposed Industrial Districts designed under a Keynesian perspective. In contemporary times, industrial zones has followed a globalizing logic. Transnational corporations determine on a planetary scale where to locate their production platforms, in favor of profits maximization. This movement is ruled – but also facilitated – by the State in a balance between national interest and a ‘business-friendly ambient’ (Harvey, 1989).

Industries and other sectors of the cities need to be close. The question is: ‘how close?’ Is there a desired distance that guarantees to the City and its inhabitants the highest positive externalities of industrialization, reducing, however, negative impacts and discomforts? Does environmental technology have a real capacity to positively interfere? Which elements should base environmental and neighborhood impact assessments so that: (i) emergent conflicts can be solved; or (ii) due and fair measures can be establish to overcome or compensate for the negative impacts; and (iii) early precise assessments precede new ventures?

This research aims at proposing a decision-aiding method for the management of neighborhood impacts (not regulated by laws or standards), identifying aspects to facilitate coexistence between industries and neighbors.

1. ‘Damage’, ‘environmental impact’ and ‘neighborhood impact’

An important theoretical aspect in this research is the difference between these three headed concepts. Environmental damage is a loss onto a public or private environmental good, resulting from wrongful act or accident, which obliges the responsible agent to remediate and/or to indemnify for the damage. Environmental impact is any change in the quality of the environment, foreseen and eval-
uated in an EIS (Environmental Impact Study) within a licensing process, and which is limited by legally regulated standards or by rules established in the permit itself. Its management requires magnification of the positive impacts, mitigation of the negative ones, and compensation of the immitigable ones. It is here assumed that neighborhood impacts are those ones not under regulation, and which identification depends on neighbors’ perception. They often trigger conflicts and crises, and they demand for continued, participatory and collaborative management, although it does not follow a formal liturgy.

Industry offers the city negative impacts – emissions of physical, chemical or biological nature that may be harmful or inconvenient to the neighborhood – but also positive impacts – employment, income, taxes that may generate better living conditions for nearby populations. The balance between relative importance and magnitude of negative and positive impacts would ideally determine the possibility of coexistence whenever positive effects outweigh negative ones in an integrated socio-environmental multi-criteria cost & benefit assessment.

2. Distance as a variable in the neighborhood impact

One of the variables that influence magnitude, importance and duration of industrial impacts is the distance between factory and inhabited city. In the beginning of industrialization, urban settlements grew around factories. In this arrangement, the industrial site was the main centrality for the urban design – sometimes because the installation of the industry preceded the city. This model represents traditional steel cities. Workers’ access is easier; employment, income, taxes and the industry’s private social investment stay inside the city boundaries. Removing industries to the city’s borders became a common practice since the 1970s. Taxes remain, as well as employment, income and social investments. Nearby cities may attract part of the positive impacts. Increased access time poses a paradoxical effect, multiplying energy costs and pollution along accessing roads.

Despite the expression Industrial District appears in the writings of Marshall (1890) – defining a regional composite of little factories of the same industrial chain recognized by their excellence and effectiveness – the contemporary Planned Industrial District imposed a larger distance between industry and inhabited areas. A new accessibility challenge was brought up: hours lost in traffic, and unprotected exposure of workers (and neighbors to road corridors) to petrol-
fueled individual transportation pollution. This model also demands for infrastructural inversions in remote areas – that means, State induction. However, the informal character of migrations and settlements has induced low-income populations to move in non-ædificandi backyards of heavy industries. In other cases, the official planning has sited industries nearby low-income vicinities.

3. Santa Cruz and TKCSA

The case-study is the steel mill ThyssenKrupp CSA, in Santa Cruz – a suburb of 398,000 inhabitants in the City of Rio de Janeiro. Originally rural since 1567, Santa Cruz faced industrialization in the 1960s, due to plans to become Sepetiba Bay the largest hub-port of the South Atlantic. From the late 1970s, real estate prices in centre Rio de Janeiro made of Santa Cruz (with available land and low population density) a new industrial frontier of Rio. In the 1980’s, Industrial District of Santa Cruz (DISC) had received Casa da Moeda (Brazilian equivalent to US Bureau of Engraving and Printing), COSIGUA steelworks and other factories. In 1982, Sepetiba Port (current Itaguaí Port) was officially launched.

Between late 1960s and the 1990s, low-income blocks and parcelings were implanted in DISC surroundings by the Government, initially to receive workers’ villages, and then to house people displaced by natural disasters. Invasions and ‘favelas’ had also spontaneously sprung out. These occupations formed the so called ‘Complexo João XXIII’, in the vicinities of which TKCSA’s would be sited. According to a social diagnosis carried out in 2009, the estimated population was of 22,968 inhabitants (6,609 households). Population did not grow during the construction of TKCSA (less than 1% growth between 2000’ and 2010’ Census).

TKCSA’s steel complex is a joint venture formed in 2002 by the German holding ThyssenKrupp AG and the mining company Vale S/A. Engineering projects started in 2004. It was the first integrated steel mill to be installed in Brazil since the 1980s. Operations began on June 18th, 2010. At the blow-in of the first blast furnace (BF#1) on July 13th, 2010, before the start-up of the steelworks, the first batches of BF hot metal would be routed to an emergency pit, and then to a pig casting machine (PCM, ingot molding). Initial dumping into emergency pits is a standard procedure. This PCM was the innovation to allow the casting of pig-iron, to be used as scrap in the steel converters. The equipment, however, did not work properly. Hot metal was dumped to the emergency pits for a longer time and
with more frequency than expected. Its cooling induces crystallization of graphite, a light and aero-dispersive material. Winter weather conditions with cold fronts from SW carried graphite flakes towards inhabited areas. So-called ‘silver rain’ was formed, affecting neighbors. This negative neighborhood impact was able to rise up the conflict that posed TKCSA as the empirical object of this research.

The seemingly irreconcilable conflict begins to weaken in 2012, when TKCSA reshapes its policies on sustainability and community relationship. The company also signed an Environmental Agreement (‘TAC’), which defined operational improvements, among them, one focused on controlling silver rain.

4. Methodology, analyzes and results

The objective of this exploratory research was to identify in a methodical and structured way the neighborhood impacts perceived by the Santa Cruz community as a result of the installation/operation of TKCSA. Thus, a decision-aiding method was developed for the management of such conflicts. The steps were:

- Theoretical framework from bibliography (deductive reasoning);
- Real and complex case study, evaluating its results;
- Qualitative research on materiality (dialectical method) with focal group;
- Scaling method to quantify the balanced magnitude of the impacts, using available quantitative proxy methods; and
- Decision-aiding matrix/diagram for impact weighting, according to the distance between inhabited and industrial areas.

The methodology provides a multivariate analysis (Multiple Criteria Decision Making - MCDM). Pioneers Kenney and Raiffa (1976) define that the role of a decision-maker is to balance judgments about uncertainties. In the developed method, the first two steps proposed in the authors’ paradigm – pre-analysis and structural analysis – result from a focal group dynamics. The two subsequent steps – uncertainty and utility analyzes – are partially covered by the impacts’ equalization in the decision-aiding matrix/diagram, within the same proxy scale from ‘0’ to ‘5’ according to the distance between factory and inhabited areas.

As limitations to this research, it was not intended to confirm causalities related to the case-study conflicts, or even to give the matrix/diagram back to the focal group for decisions or choices. Therefore, it would remain incomplete the
last stage recommended by Kenney and Raiffa, the optimization analysis for a systematic return of results for a decision.

4.1. Qualitative research with a focal group

The main advantage of using focus groups “is the opportunity to observe a large amount of interactions on a given subject, in a short period of time” (Morgan, 1997). The use of a focal group sought to qualify the perception of materiality (GRI-G4, 2015) or importance (Leopold et al, 1971) of the impacts related to conflicts between communities from Complexo João XXIII and TKCSA, as well as their perception regarding negativity and positivity. The selection of participants and their representation has considered on “minimizing sample bias rather than achieving generalizability” (Morgan, 1990). Santa Cruz focal group was set up with six members representing: (i) two local communities; (ii) one 5km-far community; (iii) one planning/financing agency; (iv) one environmental/health agency; (v) TKCSA. It would be a small-sample heterogeneous group, which means a sampling of maximum variance (Patton, 1990). Santa Cruz focal group met on April 4th, 2017, under the moderation of the researcher. Despite the group did not meet completely the desired representativeness requirements (Morgan, 1997), the given contributions represent a substantial part of the conflict envision before popular eyes. They serve as a comparative basis for future researches.

The meeting followed a three-step dynamics for the construction of a neighborhood impacts qualification grid. The first round consisted on stimulated response, when six historically perceived neighborhood impacts related to conflicts in the vicinities of steel companies, were introduced to the group: (i) dust; (ii) noise; (iii) odor; (iv) impacts on transports; (v) on infrastructure; and (vi) on local economy. Participants were encouraged to position these impacts on the qualification grid (scale ‘0’ to ‘3’ for negativity/positivity and for importance). The result (see pg. 99) was a strong positive perception regarding an improvement in quality of the urban equipment and public services (headed as ‘infrastructure’), as well as the growth of local economy (‘economy’), both perceived as of high positivity and importance. The main negative perception – medium intensity and high importance – refers to impacts on ‘transport’, linked to the construction phase. The group has also framed ‘dust’ as a negative impact of low intensity and medium importance.
In the second round, the moderator requested the residents in areas far from the factory to report whether such qualifications apply to his/her household vicinity. All six neighborhood impacts could be replaced. ‘Transport’ was relocated, once it is was not felt in Center of Santa Cruz, being limited to the near surroundings – more intense between 2 and 3 km away, in Av. João XXIII.

In the third round, the response was spontaneous. Participants were encouraged to pinpoint up to ten neighborhood impacts, keeping or replacing the six original impacts. As a result, ‘noise’ and ‘odor’ were removed from the qualification grid. However, ‘graphite’, ‘education’ and ‘opportunities expectations’ were included. ‘Graphite’ was qualified as of high negativity and importance reflecting the PAST condition (start-up in 2010). TKCSA’s actions in ‘education’ were pointed out as a highly material and positive impact. Generation of opportunities regarding jobs and income (‘opportunities’) was qualified as medium relevant and positive. The group spontaneously suggested a second version of the grid, representing the CURRENT perception on ‘graphite’. Members were unanimous in affirming that this impact is no longer perceived in the region. The group talked about TKCSA’s actions to control graphite emissions, referring to the installation of a ‘filter’. The group shows perception of embedded technology, as well as of the open-door strategies adopted by TKCSA. The final result (more conservative) was the qualification grid - PAST with seven perceived impacts (see pg. 101).

4.2. Proxy methods and the decision-aiding matrix/diagram

Each of the impacts perceived by the focal group had its scalar magnitude measured and qualified, taking as reference: (i) a uniform scale; and (ii) distance intervals between industrial and affected areas. The totally different nature of such impacts and their diverse measuring scales make comparability difficult. It was necessary to equalize the different types of impacts in order to make them as comparable as possible. To do so, proxy quantitative/qualitative methods were adapted from technical literature (or even developed, when applicable) in order to assess the impact magnitude, according to the distance from their emitting sources. Values from ‘0’ to ‘5’ were attributed: score ‘0’ poses as the absence of perception; ‘1’ the smallest perceivable effect; ‘2’, ‘3’ and ‘4’, intermediate values that modulate the decaying curve; and ‘5’ the maximum expression value of this effect. Based on the case study, distance ranges in kilometers were defined: 0.5; 1;
2; 5; 10; 50 and 100 km, and specific proxies were developed for each of the seven impacts pointed out in the focal group dynamics.

Following this method of scaling equalization, the qualified impacts were hierarchically inserted in a decision-aiding matrix (see pg. 141), observing their weights between ‘-9’ and ‘+9’ assigned by the focal group. With this, the negative impacts perceived as more important come first in the matrix, what helps in the assessment of the tradeoffs. The matrix was thus converted into the decision-aiding diagram (see pg. 141), which helps to visualize the weighted magnitude of the various neighborhood impacts. In fact, it evidences that the decision to extend the distance between the industrial area and the inhabited city may reduce physical negative effects (such as dust, transport), but, on the other hand, may produce a deleterious side-effect regarding socioeconomic positive effects (for example, losses in the local economy, with the retraction of employment and income opportunities, compensations and effects on infrastructure and services).

In this perspective, a specific balance of tradeoffs between negative and positive neighborhood impacts triggered by the presence of TKCSA in the region:

- Might take into account that the nature of the impacts does not impose any emergency condition requiring immediate removal or relocation of neighbors. Mediation/arbitration may be necessary.
- Could foster a condition that – if accorded by the parties – could lead to an adequate, fair and proportional agreement on compensations to be assumed by both TKCSA and the Government, finding solutions that could be (i) satisfactory for the demandants, (ii) stable and legally safe for entrepreneurs, and (iii) shorter and economical for the public authorities.

4.3. Applicability of the method

There are three possible applications for the proposed method. First, in new licensing, stakeholder groups formally empowered for decision making may run joint assessments of former similar qualification grids and decision-aiding matrices/diagrams. The results may support shared and collaborative decisions about the best location of the venture, reducing conflicts arising from unwanted proximity or withdrawal between industrial and inhabited areas.

Second, in the definition of impact control, mitigation or compensation measures as a result from neighborhood crisis after the installation of a project,
the balance of tradeoffs would assume a prominent position. It would be up to the company representatives, neighbors and regulatory authorities to decide what compensations would be fair and acceptable to all parties. Burdens may fall over the entrepreneur, but also over the State – the competent body to impose extreme measures, such as removal of population within a certain radius of distance or influence of impact generating sources. Actual involved groups would produce grids, matrices and diagrams reflecting the hierarchy of perceived impacts.

Third, in Participatory Territorial Planning, the preparation of Urban Expansion/Structuring Plans, Metropolitan/Sector Development Plans, among others, may get assistance in this tool to anticipate neighborhood conflicts and to orient decision-making regarding industrial, logistical, infrastructure and even housing densification. The tool may also be use to plan vulnerable populations’ removals and relocations. This application may require the use of grids, matrices and diagrams already prepared for similar situations, or may provide for specific tools prepared by actually involved focal groups, researchers and decision makers.

5. Final considerations and new researches

The proposed method has an experimental character and requires tests and improvements. New lines of research may be deployed, revisiting the number of members of the focal group, representativeness, new or better proxy methods for determining magnitude, other variables but distance, new equalizing scales and their balancing algorithms. Other researches can target the application of this method in the cited different applications.

Assessing neighborhood impacts is proving to be a contemporary need. The complex relations between communities and companies require the establishment of continuous dialogue that lead to a permission to operate, without which unforeseen legal costs and uncertainties may ruin the business plans. It is hoped that the present decision-aiding method might contribute to this dialogue and open up new fields for applied scientific research on this matter.

Keywords
Conflict management; neighbourhood impacts; urban-industrial planning; TKCSA of Santa Cruz.